Dedication

To my parents, for their unwavering faith in me.
To my in-laws, for their continual support.
To my daughters, who make it meaningful and fun.
Especially to my wife Tiffany, who inspires me in every aspect of my life.
While working on the Orthopedic Service as a medical student I found myself in need of a quick, but comprehensive reference to help me get through my busy clinics and morning rounds. Having had success with pocket references, I searched the bookstores for something similar for orthopedics. Several were available, but none of them had the quick and easy-to-read format I wanted. As a result, I made pocket-sized note cards for my own use.

These cards started with basic anatomy such as diagrams of the Brachial plexus or fascial compartments of the leg. I then added cards for various conditions including notes on pertinent History and Physical Exam findings and treatment options. Many years later, when the growing stack of note cards was too big, unwieldy and tattered to use any longer, I converted the information into a more usable book format. That original hand-assembled book is the foundation of the atlas you are now holding.

One well-drawn anatomic picture often explains far more than several pages of detailed text.

This concise, quick-reference atlas covers the spine and extremities as well as diagnosis and treatment of orthopedic conditions with primary emphasis on illustrations that educate, oftentimes without the need for explanatory text. Text, when necessary, is presented in tabular form to allow for fast review of essential information.

The first nine chapters are divided anatomically. Because I believe quite strongly that the treatment of orthopedic problems is based in anatomy, I have incorporated an extensive review of the anatomy of both the spine and extremities. There are also subsections within each chapter to help in the clinical diagnosis and treatment of the orthopedic patient. For example, the History table offers help in developing a differential diagnosis while the Trauma and Disorder tables assist in the work-up and treatment options of many orthopedic conditions. Chapter Ten is a brief introduction to orthopedic-related basic science.

From the first time I opened Frank Netter's Atlas of Human Anatomy, I was impressed, and even inspired, by the clarity and the incredible amount of information contained within each of his illustrations. I consider his work incomparable. As the basis for this text is also deeply rooted in its extensive use of illustrations, you can imagine how pleased I was when Icon Learning Systems asked me to combine our efforts to create this new publication. I thank them for their diligence, expertise, and patience with this project. I would also like to thank Dr. Jim Heckman for lending his wisdom and years of publishing experience to this effort.

This book is the result of several years of accumulating and condensing Orthopedic-related data. Indeed, as it stands now, this is truly the reference I had searched for as a medical student, but was never able to find. The information inside these covers served to help me synthesize and retain a large body of information when I was a student and young physician. I trust its readers will be as equally well served.

Jon C. Thompson, MD
ABOUT THE AUTHOR

Jon Thompson, MD, received his medical degree from the Uniformed Services University of the Health Sciences in Bethesda, Maryland. He received his undergraduate degree from Dartmouth College. Dr. Thompson has worked as both an emergency room physician and a research assistant in the Extremity Trauma Branch of the Institute of Surgical Research. Currently, he is a resident in orthopedic surgery in the San Antonio Uniformed Services Health Education Consortium at Brooke Army Medical Center and is a corresponding member of the Department of Surgery at the Uniformed Services University of the Health Sciences.

Tables are used to highlight the Netter images and offer key information on bones, joints, muscles and nerves, and surgical approaches. Clinical material is presented in a clear and straightforward manner with emphasis on trauma, minor procedures, history and physical exam, and disorders.

Users will appreciate the unique color-coding system that makes information look-up even easier. Key material is highlighted in black, red, and green to provide quick access to clinically relevant information.

BLACK for standard text

RED highlights key information that if missed could result in morbidity or mortality

GREEN highlights “must know” clinical information.
CHAPTER 1 – SPINE

TOPOGRAPHIC ANATOMY
### Osteology

#### Characteristics

<table>
<thead>
<tr>
<th>C1 Atlas</th>
<th>Ossify</th>
<th>Fuse</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring shaped</td>
<td>Anterior arch (1)</td>
<td>6 yrs</td>
<td>Superior facet articulates with occiput, anterior arch articulates with dens</td>
</tr>
<tr>
<td>Two lateral masses with facets on them</td>
<td>Posterior arch (2) (1 for each half)</td>
<td>Birth</td>
<td>Fractures: most have 2 sites</td>
</tr>
<tr>
<td>No body, no spinous process</td>
<td></td>
<td></td>
<td>Vertebral artery runs in groove on posterior arch</td>
</tr>
<tr>
<td>Post. Arch has a sulcus/groove</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### C2 Axis

<table>
<thead>
<tr>
<th>Dens/odontoid articulates with atlas at median atlantoaxial joint</th>
<th>Lower body (2)</th>
<th>6 yrs</th>
<th>Odontoid has precarious vascular supply watershed area: increased incidence of nonunion with fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dens (2)</td>
<td>Arch (2)</td>
<td>Birth</td>
<td>Rotation in neck mostly occurs between C1 and C2</td>
</tr>
<tr>
<td>Body Tip</td>
<td></td>
<td>12 yrs</td>
<td></td>
</tr>
</tbody>
</table>

#### Cervical (C3-7)

<table>
<thead>
<tr>
<th>Foramina in transverse process</th>
<th>Primary Arch Body Secondary</th>
<th>7-8 wk (fetal)</th>
<th>1-2 yr 7-10 yr 18-25 yr</th>
<th>Vertebral artery runs through transverse foramina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facets: &quot;semicoronal&quot; allow flex/extension, no rotation</td>
<td></td>
<td>11-14 yr</td>
<td></td>
<td>Nerve roots at risk of compression</td>
</tr>
<tr>
<td>Narrow intervertebral foramina</td>
<td></td>
<td></td>
<td></td>
<td>No foramina in transverse process of C7</td>
</tr>
<tr>
<td>Bifid spinous processes</td>
<td></td>
<td></td>
<td></td>
<td>C7 is vertebra prominens, nonbifid spinous process</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Klippel-Feil syndrome: congenital fusion of cervical vertebrae</td>
</tr>
</tbody>
</table>

#### Thoracic

| Facets: form semicircle: allow rotation | 7-14 yr | T1 spinous process is as | |
|----------------------------------------|--------|-------------------------|
• Costal facets (for ribs)
  T1-9: on the transverse process
  T10-12: on the pedicle

Primary Arch
Body

Secondary
• 8wk (fetal)
• 11-14 yr
• 1-2 yr
• 7-10 yr
• 18-25 yr

prominent as that of C7

• Rotation of spine occurs within the thoracic region
• Spinous processes overlap the next lower vertebrae
**LUMBAR**

- Large vertebral bodies
- Short lamina and pedicles
- Primary Arch: 7-8
- L5 is the largest vertebra
- 1-2
pedicles
- Mamillary and accessory processes
- Facets: sagittal: good for flexion/extension, not rotation
- No costal facets

<table>
<thead>
<tr>
<th>Body</th>
<th>Secondary Mamillary process</th>
<th>11-14 yrs</th>
<th>7-10 yrs</th>
<th>18-25 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>First vertebrae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SACRAL
- 5 vertebrae are fused
- 4 pairs of sacral foramina
- Sacral canal opens to hiatus

<table>
<thead>
<tr>
<th>Body</th>
<th>Arches Csp tal elements Secondary</th>
<th>11-14 yrs</th>
<th>2-8 yrs</th>
<th>2-8 yrs</th>
<th>2-8 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 wk (fetal)</td>
<td></td>
<td></td>
<td>8 wk</td>
<td>11-14 yrs</td>
<td></td>
</tr>
</tbody>
</table>

COCCYGEAL
- 4 vertebrae are fused
- Lacks most of the features of typical vertebrae

<table>
<thead>
<tr>
<th>Body</th>
<th>Primary Arch Body</th>
<th>7-8 yrs</th>
<th>1-2 yrs</th>
<th>7-10 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-8 wk (fetal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ossification: Typically 3 primary (body each arch), 5 secondary ossification centers (spinous process, transverse process (2), upper and lower plates of the body (2))

The arches fuse dorsally; spina bifida occurs when it does not fuse

The arches unite with the bodies (6-10 years old) in order: thoracic, cervical, lumbar, sacral (7 years). Neurocentral joint (fusion of arch and body) is in the body.
• Cancellous bone in cortical shell
• Vertebral canal between body and lamina: houses the spinal cord.
• Spinal Curves:
  Cervical: lordosis
  Thoracic: kyphosis (increase in Scheuermann's disease)
  Lumbar: lordosis

• Vertebrae:
  1. Body (centrum): have articular cartilage on superior/inferior aspects; get larger inferiorly
  2. Arch (pedicles lamina) [no arch develops in spina bifida]
  3. Processes: spinous, transverse, costal, mamillary
  4. Foramina: vertebral, intervertebral, transverse

• 3 Columns

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>CORRESPONDING STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2-3</td>
<td>Mandible</td>
</tr>
<tr>
<td>C3</td>
<td>Hyoid cartilage</td>
</tr>
<tr>
<td>C4-5</td>
<td>Thyroid cartilage</td>
</tr>
<tr>
<td>C6</td>
<td>Cricoid cartilage</td>
</tr>
<tr>
<td>C7</td>
<td>Vertebral prominens</td>
</tr>
<tr>
<td>T3</td>
<td>Spine of scapula</td>
</tr>
<tr>
<td>T7</td>
<td>Xiphoid, tip of scapula</td>
</tr>
<tr>
<td>T10</td>
<td>Umbilicus</td>
</tr>
<tr>
<td>L1</td>
<td>End of spinal cord</td>
</tr>
<tr>
<td>L3</td>
<td>Aorta bifurcation</td>
</tr>
<tr>
<td>L4</td>
<td>Iliac crest</td>
</tr>
</tbody>
</table>
## Trauma

### Cervical Fracture

**Description**
- High energy injury:
  - Young - MVA, old - fall
  - Axial compression
  - (most common mech.-anism) results in burst fracture

**Evaluation**
- HX: Trauma. Pain, worse with movement, +/- numbness weakness.
- PE: Tender to palpation, +/- "step off" neurologic or myelopathic

**Classification**
- Based on level location:
  - C1-Jefferson fracture: both arches fractured
  - C1-Lateral mass fracture
  - C2-Hangman's (isthmus)

**Treatment**
- Immobilize all fractures, traction on unstable, lower c-spine fractures
- C1 and 2:
  - Stable: Collar or halo
  - Unstable: Halo for 3 months

---

**Diagram**
- **Type I. Fracture of tip**
- **Type II. Fracture of base or neck**
- **Type III. Fracture extends into body of axis**

---

**Fracture of odontoid process**

- Superior articular facet
- Inferior articular facet

**Jefferson fracture of atlas (C1)**
- Each arch may be broken in one or more places

**Hangman fracture**
- Fracture through inferior arch of atlas (C2), between superior and inferior articular facets

**Subluxation with angulation greater than 11° and/or anterior displacement greater than 3.5 mm generally indicative of instability**

- Anterior displacement greater than 3.5 mm
- Flexion/distraction injury results in dislocation
- Neurologic injury rare (esp. with C12 fracture) seen
- Often have associated injuries
- 9 criteria checklist predicts instability
- Myelopathic signs. Do rectal genital exams.
- Xr: AP, lateral, odontoid: note anterior soft tissue
- CT: Shows canal (fragments may compress canal)
- MR: Evaluate soft tissues
- Levine classification
  - C2: Odontoid: Type 1, 2, 3
  - C3-7 Fracture Spinous process (Clay shoveler’s fracture): C6, 7, T1 (C7 most common)
  - and/or fusion
    - Odontoid type 2: ORIF (worse with traction)
    - C3-7:
      - Stable: Collar or halo
      - Unstable: Fusion
      - Spinous process: Symptomatic

**COMPLICATIONS:** Neurologic injury (e.g., CN VII with C1 fracture, etc.); Residual pain; Osteoarthritis; Nonunion (especially odontoid type 2 fracture)

---

### Three-Column Concept of Spinal Stability

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THORACOLUMBAR FRACTURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Mechanism: MVA, fall
  - 1 column fracture: stable
  - 2 column fracture: unstable
  - Anterior column (Wedge) fracture
    - 50% height loss is
  - HX: Trauma. Pain, +/- numbness weakness
  - PE: Tender to palpation, +/- "step off" neurologic or myelopathic signs. Do rectal genital
  - Mechanism:
    - Compression/wedge: anterior column
    - Burst: fragments displace posteriorly; anterior middle columns (unstable)
  - Stable fractures: bed rest, orthosis (TLSO)
  - Unstable (or with
• 50% height loss is considered 2 columns

Compression/wedge fracture: (most common)
• Chance fracture: rare

Neurologic deficits rare, but seen with Burst fractures

Exams
XR: AP, lateral T-L spine: body height, splaying pedicle
CT: Shows any canal impingement
MR: Evaluate soft tissues

Flexion/distraction (Chance/seatbelt fracture): 2 (or 3) columns: posterior middle (anterior).
Fracture/dislocation: all 3 columns involved.

COMPLICATIONS: Neurologic injury; Osteoarthritis; Associated injuries.

Stable Fracture
**SPINAL CORD TRAUMA**

**DESCRIPTION**

HX: Trauma. Symptoms depend on injury/lesion.

PE: Depends on injury

- Young males most common
  - Complete cord injury: no function AND
  - bulbocavernosus reflex has returned. (spinal shock over)
- Incomplete cord injury: 4 types
  - Anterior cord: #2.
  - Flexion injury; worst prognosis
  - Central cord: most common. Hyperextension injury, seen in elderly (who fall), associated with spondylosis
  - Posterior: very rare (may not exist)
  - Brown-Sequard: rare, best prognosis

**EVALUATION**

Complete: no motor or sensory function below injury level.

- Anterior: LEUE paralysis, pain temperature sensory loss, vibratory proprioception intact.
- Central: Weakness UELE, sacral sensation spared.
- Posterior: Loss of vibratory sensation and proprioception.

B-S: *ipsilateral* motor, vibratory, proprioception loss; *contralateral* pain temperature loss.

XR: C-spine series, +/- TL spine

CT: if evidence of fracture

**CLASSIFICATION**

Complete cord injury: cord severed, no function (spinal shock must be resolved to diagnose it)

Incomplete:

- Anterior: Spinthalamic corticospinal tracts out, posterior columns spared.
- Central: gray matter injury
- Posterior: posterior columns disrupted
- Brown-Séquard (lateral): hemisection of cord

**TREATMENT**

Treat associated injuries: lifethreatening first.

- Mannitol and early IV steroids may improve neurologic function
- Immobilization is the key to treatment

Stable injuries: collar, brace

Unstable injuries: Halo vest or internal fixation

**COMP:** Neurogenic shock; Autonomic dysreflexia (requires urinary catheterization and/or fecal disimpaction); Neurologic sequelae

Spinal Shock: Physiologic cord injury/dysfunction (often from compression or swelling) including paralysis areflexia. Return of bulbocavernosus reflex (arc reflexes) marks the end of spinal shock.
Neurogenic Shock: **Hypotension with bradycardia**. Cord injury results in decreased sympathetic release (unopposed vagal tone).

Central cord syndrome
Central cord syndrome
Centrally located hemisection of spinal cord at cervicothoracic junction with preserved anterior horn cells and anterior columns. Results in loss of motor function below the level of injury (shock) and sparing of pain and temperature sensation below (unlike Brown-Séquard syndrome).

Anterior spinal artery syndrome
Anterior spinal artery syndrome
Arteries supplying the anterior spinal cord from a single vertebra are occluded (infarction). Loss of motor function below the level of injury is seen. Vascular steal may cause ischemia in the posterior columns. When both anterior spinal arteries are occluded, all sensory functions are lost below the level of the injury.

Brown-Séquard syndrome
Brown-Séquard syndrome
Unilateral cord injury occurs with sparing of the opposite side. Results in loss of motor function on the side of injury and pain and temperature sensation on the opposite side.

Posterior column syndrome
Posterior column syndrome
Loss of pain and temperature sensation below the level of injury. Motor function is preserved.
### JOINTS

#### ATLANTOOCIPITAL (Ellipsoid)

<table>
<thead>
<tr>
<th>LIGAMENT</th>
<th>ATTACHMENT</th>
<th>COMMENT</th>
</tr>
</thead>
</table>
| Tectoral membrane | Axis body to occiput around facets | Extension of the PLL  
Joint stabilized by attachment to dens; known to be weak in Down's Syndrome |

#### MEDIAN ATLANTOAXIAL C1-2 (Plane and Pivot)

<table>
<thead>
<tr>
<th>LIGAMENT</th>
<th>ATTACHMENT</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse</td>
<td>Lateral mass-dens-lateral mass</td>
<td>Strongest ligament: holds dens in place</td>
</tr>
<tr>
<td>Apical</td>
<td>Dens to occiput</td>
<td>Part of cruciate ligament</td>
</tr>
<tr>
<td>Alar</td>
<td>Dens to occiput condyles</td>
<td>Prevent excessive head rotation</td>
</tr>
<tr>
<td>Superior</td>
<td>Dens to basilar occiput</td>
<td>With transverse apical forms cruciate ligament</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>Dens to axis body</td>
<td></td>
</tr>
<tr>
<td>Inferior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIGAMENT</td>
<td>ATTACHMENT</td>
<td>COMMENT</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>ZYGAPPHYSEAL</strong> (Facet Plane)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Has articular discs: this joint allows the most mobility in the spine</td>
</tr>
<tr>
<td>Capsule</td>
<td>Around facets</td>
<td>Changes orientation at different vertebral levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation dictates plane of motion; C5-6 most mobile (#1 degeneration site) L4-5 most flexion</td>
</tr>
<tr>
<td>Intervertebral</td>
<td>Superior aspect of bodies</td>
<td>Strongest attachments of bodies</td>
</tr>
<tr>
<td>Disc ALL PLL</td>
<td>Anterior: body to body</td>
<td>Thicker than PLL</td>
</tr>
<tr>
<td></td>
<td>Posterior: body to body</td>
<td>Thinner, disc herniation usually posterolateral.</td>
</tr>
<tr>
<td>COSTOVERTEBRAL (Luschka)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capsule</td>
<td>Surrounds rib head joint</td>
<td>Holds head to vertebrae</td>
</tr>
<tr>
<td>Intraarticular</td>
<td>Head of rib to disc</td>
<td>Reinforces joint anteriorly</td>
</tr>
<tr>
<td>Radiate</td>
<td>Anterior head to both bodies</td>
<td></td>
</tr>
</tbody>
</table>
# LIGAMENTS

<table>
<thead>
<tr>
<th>LIGAMENT</th>
<th>LOCATION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Longitudinal [ALL]</td>
<td>Anterior surface of vertebral bodies</td>
<td>Strong; thicker in center of body</td>
</tr>
<tr>
<td>Posterior Longitudinal [PLL]</td>
<td>Posterior surface of bodies (connects discs)</td>
<td>Weaker thinner [herniation occurs laterally or posterolaterally]</td>
</tr>
<tr>
<td>Intervertebral</td>
<td>Between transverse processes</td>
<td>Weak, adds little support</td>
</tr>
<tr>
<td>Apophyseal joint capsule</td>
<td>Around facet joint</td>
<td>Weak, adds little support</td>
</tr>
<tr>
<td>Ligamentum Flavum</td>
<td>Connects anterior surfaces of laminae</td>
<td>Strong; constantly in tension</td>
</tr>
<tr>
<td>Ligamentum Nuchae</td>
<td>C7 to occipital protuberance</td>
<td>Extension of supraspinous ligament</td>
</tr>
<tr>
<td>Supraspinous</td>
<td>Alongs dorsal spinous processes to C7</td>
<td>Unknown contribution to stability</td>
</tr>
<tr>
<td>Interspinous</td>
<td>Between spinous processes</td>
<td>Unknown contribution to stability</td>
</tr>
<tr>
<td>Tectoral membrane</td>
<td>Posterior aspect of bodies dens to clivus</td>
<td>Extension of PLL</td>
</tr>
<tr>
<td>Transverse ligament</td>
<td>Lateral mass to dens to lateral mass</td>
<td>Part of cruciate ligament, major stabilizer</td>
</tr>
<tr>
<td>Alar</td>
<td>Dens to occiput tubercles</td>
<td>Resists excessive rotation</td>
</tr>
<tr>
<td>Iliolumbar</td>
<td>L5 transverse process to ilium</td>
<td>Avulsion fracture can occur in trauma</td>
</tr>
</tbody>
</table>

## INTERVERTEBRAL DISCS [made of fibrocartilage]

<table>
<thead>
<tr>
<th>DISC</th>
<th>DESCRIPTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annulus fibrosis</td>
<td>Outside, type I collagen, connects to vertebral hyaline cartilage, buffers</td>
<td></td>
</tr>
<tr>
<td>Nucleus pulposus</td>
<td>compression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inside, type II collagen, high water content until old age, derived from</td>
<td></td>
</tr>
<tr>
<td></td>
<td>notochord, can protrude/herniate through annulus, is avascular</td>
<td></td>
</tr>
</tbody>
</table>
HISTORY

Lower back pain

- Trauma: MVA (seatbelt?)
  - Cervical strain (whiplash), cervical fractures, ligamentous injury

- Activity: Sports (stretching injury)
  - "Burners/stingers" (especially in football)

- Neurologic Symptoms: Pain, numbness, tingling, Spasticity, clumsiness, Bowel or bladder symptoms
  - Radiculopathy, neuropathy, Myelopathy, Cauda equina syndrome

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ANSWER</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AGE</td>
<td>Young</td>
<td>Disc injuries, spondylolisthesis</td>
</tr>
<tr>
<td></td>
<td>Middle age</td>
<td>Sprain/strain, hemiated disc, degenerative disc disease</td>
</tr>
<tr>
<td></td>
<td>Elderly</td>
<td>Spinal stenosis, hemiated disc, degenerative disc disease, arthritis</td>
</tr>
<tr>
<td>2. PAIN</td>
<td></td>
<td>Disc injuries, spondylolisthesis</td>
</tr>
<tr>
<td>a. Character</td>
<td>Radiating (shooting)</td>
<td>Radiculopathy (Herniated disc, spondylolisthesis)</td>
</tr>
<tr>
<td></td>
<td>Diffuse, dull, non-radiating</td>
<td>Cervical or lumbar strain (soft tissue injury)</td>
</tr>
<tr>
<td>b. Location</td>
<td>Unilateral vs. bilateral Neck</td>
<td>Unilateral: hemiated disc; Bilateral: systemic or metabolic disease;space occupying lesion</td>
</tr>
<tr>
<td></td>
<td>Arms (+/- radiating)</td>
<td>Cervical spondylosis, neck sprain or muscle strain</td>
</tr>
<tr>
<td></td>
<td>Lower back Legs (+/- radiation)</td>
<td>Cervical spondylosis (+/- myelopathy), hemiated disc</td>
</tr>
<tr>
<td></td>
<td>Herniated Disc Disease, back sprain or muscle strain, spondylolisthesis, tumor</td>
<td>Degenerative Disc Disease, back sprain or muscle strain, spondylolisthesis, tumor</td>
</tr>
<tr>
<td>c. Occurrence</td>
<td>Night pain</td>
<td>Tumor</td>
</tr>
<tr>
<td></td>
<td>With activity</td>
<td>Usually mechanical etiology</td>
</tr>
<tr>
<td>d. Alleviating</td>
<td>Arms elevated</td>
<td>Herniated cervical disc</td>
</tr>
<tr>
<td></td>
<td>Sit down</td>
<td>Spinal stenosis (stenosis relieved)</td>
</tr>
<tr>
<td>e. Exacerbating</td>
<td>Back extension</td>
<td>Spinal stenosis (e.g. going down stairs)</td>
</tr>
<tr>
<td>3. TRAUMA</td>
<td>MVA (seatbelt?)</td>
<td>Cervical strain (whiplash), cervical fractures, ligamentous injury</td>
</tr>
<tr>
<td>4. ACTIVITY</td>
<td>Sports</td>
<td>&quot;Burners/stingers&quot; (especially in football)</td>
</tr>
<tr>
<td>5. NEUROLOGIC SYMPTOMS</td>
<td>Pain, numbness, tingling, Spasticity, clumsiness, Bowel or bladder symptoms</td>
<td>Radiculopathy, neuropathy, Myelopathy, Cauda equina syndrome</td>
</tr>
<tr>
<td>6. SYSTEMIC</td>
<td>Fever weight</td>
<td></td>
</tr>
</tbody>
</table>

Neurolion collision with stationary object or oncoming vehicle may. If seat belts not used, drive forehead against windshield. This sharply hyperextends neck, resulting in dislocation with or without fracture of cervical vertebrae.
| SYSTEMIC COMPLAINTS | Fever, weight loss | Infection, tumor |
## PHYSICAL EXAM

**Inspection**

<table>
<thead>
<tr>
<th>Exam</th>
<th>Technique</th>
<th>Clinical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait</td>
<td>Leaning forward</td>
<td>Spinal stenosis</td>
</tr>
<tr>
<td></td>
<td>Wide-based</td>
<td>Myelopathy</td>
</tr>
<tr>
<td>Alignment</td>
<td>Malalignment</td>
<td>Dislocation, scoliosis, lordosis, kyphosis</td>
</tr>
<tr>
<td>Posture</td>
<td>Head tilted</td>
<td>Dislocation, spasm, spondylosis, torticollis</td>
</tr>
<tr>
<td></td>
<td>Pelvis tilted</td>
<td>Loss of lordosis: spasm</td>
</tr>
<tr>
<td>Skin</td>
<td>Disrobe patient</td>
<td>Cafe-au-lait spots, growths: possibly neurofibromatosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Port wine spots, soft masses: possibly spina bifida</td>
</tr>
</tbody>
</table>

**Palpation**

<table>
<thead>
<tr>
<th>Exam</th>
<th>Technique</th>
<th>Clinical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissues</td>
<td>Cervical facet joints</td>
<td>Tenderness: osteoarthritis, dislocation</td>
</tr>
<tr>
<td></td>
<td>Coccyx-via rectal exam</td>
<td>Tenderness: fracture or contusion</td>
</tr>
<tr>
<td></td>
<td>Paraspinal muscles</td>
<td>Diffuse tenderness indicates sprain/muscle strain. Trigger point: spasm</td>
</tr>
<tr>
<td></td>
<td>Supraclavicular fossa</td>
<td>Swelling suggests clavicle fracture</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>Fatty masses: possibly spina bifida</td>
</tr>
</tbody>
</table>

**Range of Motion**

<table>
<thead>
<tr>
<th>Flexion/Extension</th>
<th>Cervical Lumbar</th>
<th>Cervical</th>
<th>Lumbar</th>
<th>Normal: Flexion: chin within 3-4cm of chest; Extension 70 degrees Normal: 45-60 degrees in flexion, 20-30 degrees in extension Normal: 30-40 degrees in each direction Normal: 10-20 degrees in each direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chin to chest/occiput back</td>
<td>Ear to shoulder</td>
<td>Bend to each side Stabilize</td>
<td></td>
</tr>
</tbody>
</table>
A complete neurologic examination should be performed.

**Sensory**

**CERVICAL**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Deficit indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraclavicular (C2-3)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Axillary nerve (C5)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Musculocutaneous nerve (C6)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Radial Nerve (C6)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Median Nerve (C7)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Ulnar Nerve (C8)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Medial Cutaneous nerve forearm(T1)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Anterior neck clavicle area</td>
<td></td>
</tr>
<tr>
<td>Lateral shoulder</td>
<td></td>
</tr>
<tr>
<td>Lateral forearm</td>
<td></td>
</tr>
<tr>
<td>Dorsal thumb web space</td>
<td></td>
</tr>
<tr>
<td>Radial border mid finger</td>
<td></td>
</tr>
<tr>
<td>Ulnar border small finger</td>
<td></td>
</tr>
<tr>
<td>Medial forearm</td>
<td></td>
</tr>
</tbody>
</table>

**LUMBAR**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Deficit indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral/Saphenous nerve (L4)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Superficial/Deep Peroneal Nerve (L5)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Tibial/sural nerve (S1)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Sacral nerves (S 2, 3, 4)</td>
<td>corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Medial leg ankle</td>
<td></td>
</tr>
<tr>
<td>Dorsal foot 1st-2nd toe web space</td>
<td></td>
</tr>
<tr>
<td>Lateral foot</td>
<td></td>
</tr>
<tr>
<td>Perianal sensation</td>
<td></td>
</tr>
</tbody>
</table>

**Motor**

**CERVICAL**

<table>
<thead>
<tr>
<th>Muscle/Musculocutaneous nerve (C5-6)</th>
<th>Weakness =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal accessory (CN11)</td>
<td>Sternocleidomastoid or nerve/root lesion</td>
</tr>
<tr>
<td>Axillary nerve (C5)</td>
<td>Deltoid or nerve/root lesion</td>
</tr>
<tr>
<td>Musculocutaneous nerve (C5-6)</td>
<td>Brachialis or nerve/root lesion</td>
</tr>
<tr>
<td>Radial nerve (PIN) (C7)</td>
<td>EDC, EIP, EDM or nerve/root lesion</td>
</tr>
<tr>
<td>Median nerve (C8)</td>
<td>Peroneus longus/brevis or corresponding nerve/root lesion</td>
</tr>
</tbody>
</table>

**LUMBAR**

<table>
<thead>
<tr>
<th>Muscle/Musculocutaneous nerve (C5-6)</th>
<th>Weakness =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Peroneal nerve (L4)</td>
<td>Tibialis anterior or nerve/root lesion</td>
</tr>
<tr>
<td>Deep Peroneal nerve (L5)</td>
<td>Extensor hallucis longus or nerve/root lesion</td>
</tr>
<tr>
<td>Superficial Peroneal nerve (L5)</td>
<td>Peroneus longus/brevis or corresponding nerve/root lesion</td>
</tr>
</tbody>
</table>

**Straight Leg Test**

Extend knee, hip relaxed

Passively flex hip. Stop when pain occurs. Lower leg until pain resolves then dorsiflex foot.
### Superficial Peroneal (S1) 
**Tibial nerve (S1)**

Great toe flexion

*Weakness = Flexor hallucis longus or nerve/root lesion*

### Reflexes

<table>
<thead>
<tr>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>L4</th>
<th>S1</th>
<th>S1, 2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps</td>
<td>Brachioradialis</td>
<td>Triceps</td>
<td>Patellar</td>
<td>Achilles reflex</td>
<td>Bulbocavernosus</td>
</tr>
<tr>
<td>Hypoactive/absence indicates C5 radiculopathy</td>
<td>Hypoactive/absence indicates C6 radiculopathy</td>
<td>Hypoactive/absence indicates C7 radiculopathy</td>
<td>Hypoactive/absence indicates L4 radiculopathy</td>
<td>Hypoactive/absence indicates S1 radiculopathy</td>
<td>Finger in rectum, squeeze/pull penis (Foley), anal sphincter contracts</td>
</tr>
</tbody>
</table>

**UMN**

Babinski/clonus

*Upgoing toe is consistent with upper motor neuron lesion*

### Pulses

**Upper extremity**

Brachial, radial, ulnar

Femoral, popliteal, dorsalis pedis, posterior tibial

*Diminished/absent = vascular injury or compromise*

**Lower extremity**

*Diminished/absent = vascular injury or compromise*

### Forward Bending Test

**EXAM**

**TECHNIQUE**

**CLINICAL APPLICATION**

**SPECIAL TESTS**

#### CERVICAL

**Spurling**

Axial load, then laterally flex rotate neck

*Radiating pain indicates nerve root compression*

**Distraction**

Upward distracting force

*Relief of symptoms indicates foraminal compression of nerve root*

#### LUMBAR

**Straight leg**

Flex hip to pain, dorsiflex foot

*Symptoms reproduced (pain below knee) indicative of radicular etiology*

**Straight leg 90/90**

Supine: flex hip knee 90°, extend knee

*20° of flexion = tight hamstrings: source of pain*

**Rowstron**

Raise leg, flex knee, Radicular pain with popliteal pressure indicates sciatic
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Position</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting root (flip sign)</td>
<td>Sit: distract patient, passively extend knee</td>
<td>Patient with sciatic pain will arch or flip backward on knee extension</td>
</tr>
<tr>
<td>Kernig</td>
<td>Supine: flex neck</td>
<td>Pain in or radiating to legs indicates meningeal irritation or infection</td>
</tr>
<tr>
<td>Brudzinski</td>
<td>Supine: flex neck, flex hip</td>
<td>Pain reduction with knee flexion indicates meningeal irritation.</td>
</tr>
<tr>
<td>Forward Bending</td>
<td>Standing, bend at waist</td>
<td>Asymmetry of back (scapula/ribs) is indicative of scoliosis</td>
</tr>
<tr>
<td>Trendelenburg</td>
<td>Stand on one leg</td>
<td>Drooping pelvis on elevated leg side: gluteus medius weakness</td>
</tr>
<tr>
<td>Hoover</td>
<td>Supine: hands under heels, patient then raises one leg</td>
<td>Pressure should be felt under opposite heel (not being raised). No pressure indicates lack of effort, not true weakness</td>
</tr>
<tr>
<td>Waddell signs</td>
<td>Presence indicates non-organic pathology: 1) exaggerated response or overreaction, 2) pain to light touch, 3) non-anatomic pain localization, 4) negative flip sign with positive straight leg test.</td>
<td></td>
</tr>
</tbody>
</table>
### Muscles: Anterior Neck

**Platysma**
- **Origin:** Fascia; Deltoid/pectoralis major
- **Insertion:** Mandible; skin
- **Action:** Depress jaw
- **Nerve:** CN 7

**Suprahyoid Muscles**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digastric</td>
<td>Anterior: Mandible</td>
<td>Hyoid body</td>
<td>Elevate hyoid, depress mandible</td>
<td>Anterior: Mylohyoid (CN 5) Posterior: Facial (CN 7)</td>
</tr>
<tr>
<td></td>
<td>Posterior: Mastoid notch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mylohyoid</td>
<td>Mandible</td>
<td>Raphe on hyoid</td>
<td>Same as above</td>
<td>Mylohyoid (CN 5)</td>
</tr>
<tr>
<td>Stylohyoid</td>
<td>Styloid process</td>
<td>Body of hyoid</td>
<td>Elevate hyoid</td>
<td>Facial nerve (CN 7)</td>
</tr>
<tr>
<td>Geniohyoid</td>
<td>Genial tubercle of mandible</td>
<td>Body of hyoid</td>
<td>Elevate hyoid</td>
<td>C1 Via CN 12</td>
</tr>
</tbody>
</table>

**Infrahyoid Muscles [strap muscles includes the SCM]**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternohyoid</td>
<td>Manubrium clavicle</td>
<td>Body of hyoid</td>
<td>Depress hyoid</td>
<td>Ansa cervicalis (C1-3)</td>
</tr>
<tr>
<td>Omohyoid</td>
<td>Suprascapular notch</td>
<td>Body of hyoid</td>
<td>Depress hyoid</td>
<td>Ansa cervicalis (C1-3)</td>
</tr>
</tbody>
</table>

**Deep**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyrohyoid</td>
<td>Thyroid cartilage</td>
<td>Greater horn of hyoid</td>
<td>Depress/retract hyoid/larynx</td>
<td>C1 via CN 12</td>
</tr>
<tr>
<td>Stemothryoid</td>
<td>Manubrium</td>
<td>Thyroid cartilage</td>
<td>Depress/retract hyoid/larynx</td>
<td>Ansa cervicalis (C1-3)</td>
</tr>
<tr>
<td>Sternocleidomastoid</td>
<td>Manubrium clavicle</td>
<td>Mastoid process</td>
<td>Turn head opposite side</td>
<td>CN 11</td>
</tr>
</tbody>
</table>
MUSCLES: POSTERIOR NECK

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>NERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectus capitis posterior: major</td>
<td>Spine of axis</td>
<td>Inferior nuchal line</td>
<td>Extend, rotate, laterally flex</td>
<td>Suboccipital nerve</td>
</tr>
<tr>
<td>Rectus capitis posterior: minor</td>
<td>Posterior tubercle of atlas</td>
<td>Occipital bone</td>
<td>Extend, laterally flex</td>
<td>Suboccipital nerve</td>
</tr>
<tr>
<td>Obliquus capitis superior</td>
<td>Atlas transverse process</td>
<td>Occipital bone</td>
<td>Extend, rotate, laterally flex</td>
<td>Suboccipital nerve</td>
</tr>
<tr>
<td>Obliquus capitis inferior</td>
<td>Spine of axis</td>
<td>Atlas transverse process</td>
<td>Extend, laterally rotate</td>
<td>Suboccipital nerve</td>
</tr>
</tbody>
</table>
### SUPERFICIAL MUSCLES: POSTERIOR NECK AND BACK

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>NERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>Spinous process C7-T12</td>
<td>Clavicle; Scapula (AC, SP)</td>
<td>Rotate scapula</td>
<td>CN 11</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Spinous process T6-S5</td>
<td>Humerus</td>
<td>Extend, adduct, IR arm</td>
<td>Thoracodorsal</td>
</tr>
<tr>
<td>Levator scapulae</td>
<td>Transverse process C1-4</td>
<td>Scapula (medial)</td>
<td>Elevate scapula</td>
<td>C3, 4, Dorsal scapular</td>
</tr>
<tr>
<td>Rhomboid minor</td>
<td>Spinous process C7-T1</td>
<td>Scapula (spine)</td>
<td>Adduct scapula</td>
<td>Dorsal scapular</td>
</tr>
<tr>
<td>Rhomboid major</td>
<td>Spinous process T2-T5</td>
<td>Scapula (medial border)</td>
<td>Adduct scapula</td>
<td>Dorsal scapular</td>
</tr>
<tr>
<td>Serratus posterior superior</td>
<td>Spinous process C7-T3</td>
<td>Ribs 2-5 (upper border)</td>
<td>Elevate ribs</td>
<td>Intercostal nerve (T1-4)</td>
</tr>
<tr>
<td>Serratus posterior inferior</td>
<td>Spinous process T11-L3</td>
<td>Ribs 9-12 (lower border)</td>
<td>Depress ribs</td>
<td>Intercostal nerve (T9-12)</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
DEEP MUSCLES: POSTERIOR NECK AND BACK

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>NERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splenius capitis</td>
<td>Ligamentum nuchae</td>
<td>Mastoid nuchal line</td>
<td>Both: laterally flex rotate neck to same side</td>
<td>Dorsal rami of inferior cervical nerves</td>
</tr>
<tr>
<td>Splenius cervicus</td>
<td>Spinous process T1-6</td>
<td>Transverse process C1-4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INTERMEDIATE LAYER: SACROSPINALIS GROUP (Erector spinae) All have 3 parts: thoracis, cervicis and capitis

<p>| Iliocostalis Longissimus Spinalis | Common origin: Sacrum, iliac crest, and lumbar spinous process. | Ribs | TC spinous process, mastoid process T-spine: spinous process | Laterally flex, extend, rotate head (to same side) and vertebral column | Dorsal rami of spinal nerves |</p>
<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>NERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semispinalis (CT)</td>
<td>Transverse process</td>
<td>Spinous process</td>
<td>Extend, rotate opposite side</td>
<td>Dorsal primary rami</td>
</tr>
<tr>
<td>Semispinalis capitis</td>
<td>Transverse process T1-6</td>
<td>Nuchal ridge</td>
<td></td>
<td>Dorsal primary rami</td>
</tr>
<tr>
<td>Multifidi [C2-S4]</td>
<td>Transverse process</td>
<td>Spinous process</td>
<td>Flex laterally, rotate opposite</td>
<td>Dorsal primary rami</td>
</tr>
<tr>
<td>Rotatores</td>
<td>Transverse process</td>
<td>Spinous process +1</td>
<td>Rotate superior vertebrae opposite</td>
<td>Dorsal primary rami</td>
</tr>
<tr>
<td>Interspinales</td>
<td>Spinous process</td>
<td>Spinous process +1</td>
<td>Extend column</td>
<td>Dorsal primary rami</td>
</tr>
<tr>
<td>Intertransversarii</td>
<td>Transverse process</td>
<td>Transverse process +1</td>
<td>Laterally flex column</td>
<td>Dorsal primary rami</td>
</tr>
</tbody>
</table>
NERVES OF THE UPPER EXTREMITY: CERVICAL PLEXUS

1. Lesser Occipital Nerve (C2-3): arises from posterior border of SCM
   - Sensory: Superior region behind auricle
   - Motor: NONE

2. Great Auricular Nerve (C2-3): exits inferior to Lesser Occipital nerve, then ascends on SCM
   - Sensory: Over parotid gland and below ear
   - Motor: NONE

3. Transverse Cervical Nerve (C2-3): exits inferior to Greater Auricular nerve, then to anterior neck
   - Sensory: Anterior triangle of the neck
   - Motor: NONE

4. Supraclavicular (C2-3): splits into 3 branches: anterior, middle, posterior
   - Sensory: Over clavicle, outer trapezius, deltoid
   - Motor: NONE

1. Ansa Cervicalis (C1-3): superior (C1-2) inferior (C2-3) roots form loop
   - Sensory: NONE
3. **Motor:**
   - Omohyoid
   - Sternohyoid
   - Sternothyroid

4. **Phrenic Nerve** (C3-5): On anterior scalene, into thorax between subclavian artery and vein

5. | Sensory: | Pericardium and mediastinal pleura |
   | Motor:  | Diaphragm |

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
NERVES: BRACHIAL PLEXUS

SUPRACLAVICULAR [approach through posterior triangle]

ROOTS

Dorsal Scapular (C5): pierces middle scalene, deep to Levator Scapulae Rhomboids.
- Sensory: NONE
- Motor: Levator scapulae, Rhomboid Minor and Major

Long Thoracic (C5-7): on anterior surface of Serratus Anterior with Lateral Thoracic artery.
- Sensory: NONE
- Motor: Serratus Anterior (wing scapula with nerve dysfunction)

SUPRACLAVICULAR [approach through posterior triangle]

UPPER TRUNK

Suprascapular (C5-6): through scapular notch, under superior transverse scapular ligament.
- Sensory: NONE
- Motor: Supraspinatus, Infraspinatus

Nerve to Subclavius (C5-6): descends anterior to plexus, posterior to clavicle
- Sensory: NONE
- Motor: Subclavius

INFRACLAVICULAR [approach through axilla]

LATERAL CORD

Lateral Pectoral (C5-7): named for lateral cord, is medial to Medial Pectoral nerve runs with pectoral artery.
- Sensory: NONE
- Motor: Pectoralis Major, Pectoralis Minor (via loop to MPN)

Musculocutaneous (C5-7): pierces coracobrachialis, runs between biceps brachialis.
- Sensory: Lateral forearm (via Lateral cutaneous nerve)
- Motor: Pectoralis Minor, Pectoralis Major (overlying muscle)

INFRACLAVICULAR [approach through axilla]

MEDIAL CORD

Medial Pectoral (C8-T1): named for medial cord, is lateral to Medial Pectoral nerve runs with pectoral artery.
- Sensory: NONE
- Motor: Pectoralis Minor, Pectoralis Major (overlying muscle)

Medial Cutaneous Nerve of Arm (Brachial, C8-T1): joins Intercostobrachial
- Sensory: Medial (inner) arm
- Motor: NONE

Medial Cutaneous Nerve of Forearm (Antibrachial, C8-T1): runs with basilic vein.
- Sensory: Medial forearm, anterior arm
- Motor: NONE

Ulnar (C7-T1): runs behind medial epicondyle in groove. Multiple sites of possible compression
- Sensory: Medial palm 1 1/2 digits via: palmar palmar digital branches
- Motor: Flexor carpi ulnaris, Flexor digitorum profundus (digits 4,5), Hand (divides at hypothenar eminence)
- Superficial Branch [lateral to pisiform]
- Deep (Motor) Branch [around hook of hamate]
- Forearm [runs between the two muscles]
- Adductor pollicis

10. THENAR MUSCLES
- Flexor pollicis brevis (FPB)[with median]
- Hypotenar Muscles
- Abductor digit minimi (ADM)
- Flexor digitii minimi brevis (FDMB)
- Opponens digitii minimi (ODM)
- INTRINSIC MUSCLES
- Dorsal interosseus (DOI) [abduct DAB]
- Volar interossei (VIO) [adduct PAD]
- Lumbricals (medial two (3,4)]
### BRACHIAL PLEXUS (C5-T1 ventral rami) [variations: C4-T2] (also see Shoulder)

#### INFRACLAVICULAR [approach through axilla]

<table>
<thead>
<tr>
<th>LUMBRICALS</th>
<th>MEDIAL AND LATERAL CORDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Median</strong> (C5-6-T1): runs anteromedial, no branches in arm</td>
</tr>
<tr>
<td>2.</td>
<td>Sensory: Dorsal distal phalanges of lateral 3 1/2 digits via: proper palmar digital branches</td>
</tr>
<tr>
<td>3.</td>
<td>Volar 3 1/2 digits and lateral palm via: palmar palmar digital branches</td>
</tr>
<tr>
<td>4.</td>
<td><strong>ANTERIOR COMPARTMENT OF FOREARM</strong></td>
</tr>
<tr>
<td>5.</td>
<td><strong>Superficial Flexors</strong></td>
</tr>
<tr>
<td>6.</td>
<td>Pronator Teres (PT)</td>
</tr>
<tr>
<td>7.</td>
<td>Flexor Carpi Radialis (FCR)</td>
</tr>
<tr>
<td>8.</td>
<td>Palmaris longus (PL)</td>
</tr>
<tr>
<td>9.</td>
<td>Flexor digitorum superficialis (FDS) [sometimes considered a “middle” flexor]</td>
</tr>
<tr>
<td>10.</td>
<td><strong>Deep Flexors: AN (Anterior Interosseous Nerve)</strong></td>
</tr>
<tr>
<td>11.</td>
<td>Motor: Flexor digitorum profundus (digits 2, 3)</td>
</tr>
<tr>
<td>12.</td>
<td>Flexor pollicis longus (FPL)</td>
</tr>
<tr>
<td>13.</td>
<td>Promotor Quadratus (PQ)</td>
</tr>
<tr>
<td>14.</td>
<td><strong>HAND, Motor Recurrent</strong> (Thenar motor) Thenar</td>
</tr>
<tr>
<td>15.</td>
<td>Abductor pollicis brevis (APB)</td>
</tr>
<tr>
<td>16.</td>
<td>Opponens pollicis</td>
</tr>
<tr>
<td>17.</td>
<td>Flexor pollicis brevis (FPB) [with ulnar]</td>
</tr>
<tr>
<td>18.</td>
<td><strong>Intrinsic</strong></td>
</tr>
<tr>
<td>19.</td>
<td>Lumbricals [lateral two (1, 2)]</td>
</tr>
</tbody>
</table>

#### POSTERIOR CORD

<table>
<thead>
<tr>
<th>UPPER SUBSCAPULAR (C5-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory: NONE</td>
</tr>
<tr>
<td>Motor: Subscapularis [upper portion]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOWER SUBSCAPULAR (C5-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory: NONE</td>
</tr>
<tr>
<td>Motor: Subscapularis [lower portion]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THORACODORSAL (C7-8): runs with Thoracodorsal artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory: NONE</td>
</tr>
<tr>
<td>Motor: Latissimus dorsi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AXILLARY (C5-6): runs with Posterior Circumflex Humeral artery through the Quadrangular space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory: Lateral upper arm: via Superior lateral cutaneous nerve of arm</td>
</tr>
<tr>
<td>Motor: Deltoid (Deep branch)</td>
</tr>
<tr>
<td>Teres minor (Superficial branch)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RADIAL (C5-T1): runs with Deep Artery of Arm in Triangular Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory: Lateral arm: via inferior lateral cutaneous nerve of arm</td>
</tr>
<tr>
<td>Posterior arm: via Posterior cutaneous nerve</td>
</tr>
<tr>
<td>Dorsal 3 1/2 digits and hand: via superficial branch (dorsal digit branches)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSTERIOR COMPARTMENT OF ARM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps (medial, long, lateral heads)</td>
</tr>
<tr>
<td>Anconeus</td>
</tr>
<tr>
<td><strong>MOBILE WAD, (Radial nerve-Deep branch) Superficial Extensors</strong></td>
</tr>
<tr>
<td>Brachioradialis (BR)</td>
</tr>
<tr>
<td>Extensor carpi radialis longus (ECRL)</td>
</tr>
<tr>
<td>Extensor carpi radialis brevis (ECRB)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSTERIOR COMPARTMENT OF FOREARM: PIN Multiple possible compression sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>(see Forearm)</td>
</tr>
<tr>
<td>Superficial Extensors</td>
</tr>
<tr>
<td>Extensor carpi ulnaris (ECU)</td>
</tr>
<tr>
<td>Extensor digiti minimi (EDM)</td>
</tr>
<tr>
<td>Extensor digitorum (ED)</td>
</tr>
<tr>
<td>Deep Extensors</td>
</tr>
<tr>
<td>Supinator</td>
</tr>
<tr>
<td>Abductor pollicis longus</td>
</tr>
<tr>
<td>Extensor pollicis longus</td>
</tr>
<tr>
<td>Extensor pollicis brevis</td>
</tr>
<tr>
<td>Extensor indicis proprius</td>
</tr>
</tbody>
</table>
NERVES: LUMBAR PLEXUS

**ANTERIOR DIVISION**

**Subcostal (T12):**
- Sensory: Subxiphoid region
- Motor: NONE

**Iliohypogastric (L1):**
- Sensory: Above pubis, posterolateral buttocks
- Motor: Transversus abdominus, internal oblique

**Ilioinguinal (L1):**
- Sensory: Inguinal region
- Motor: NONE

**Genitofemoral (L1-2):** pierces Psoas, lies on anteromedial surface.
- Sensory: Scrotum/mons
- Motor: Cremaster

**Obturator (L2-4):** exits via obturator canal, splits into anterior posterior divisions. Can be injured by retractors placed behind the transverse acetabular ligament.
- Sensory: Inferomedial thigh via cutaneous branch of Obturator nerve
- Motor: External oblique, adductor longus (anterior division)
<table>
<thead>
<tr>
<th>Motor</th>
<th>Adductor brevis (ant post division)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adductor magnus (posterior division)</td>
</tr>
<tr>
<td></td>
<td>Gracilis (anterior division)</td>
</tr>
<tr>
<td></td>
<td>Obturator externus (posterior division)</td>
</tr>
</tbody>
</table>

**Accessory Obturator** (L2-4): inconsistent

<table>
<thead>
<tr>
<th>Sensory</th>
<th>NONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>Psoas</td>
</tr>
</tbody>
</table>

**POSTERIOR DIVISION**

1. Lateral Femoral Cutaneous [LFCN](L2-3): crosses ASIS, can be compressed at ASIS
   - Sensory: Lateral thigh
   - Motor: NONE

2. **Femoral** (L2-4): lies between psoas major and iliacus
   - Sensory: Anteromedial thigh via anterior intermediate cutaneous nerves, Medial leg foot via medial cutaneous nerves (*Saphenous Nerve*)
   - Motor: Psoas, Iliacus, Pecineus, Quadriceps, Rectus femoris, Vastus lateralis, Vastus intermediialis, Vastus medialis, Sartorius, Articularis genu
# SACRAL PLEXUS

## ANTERIOR DIVISION

**Tibial (L4-S3):** descends between heads of Gastrocnemius to medial malleolus

| Sensory: | Posterolateral proximal calf: via Medial sural  
| | Posterolateral distal calf: via Sural  
| | Medial plantar heel: via Medial calcaneal  
| | Medial plantar foot: via Medial plantar  
| | Lateral plantar foot: via Lateral plantar  |

### POSTERIOR THIGH

- Biceps femoris [long head]
- Semitendinosus
- Semimembranosus

### SUPERFICIAL POST. COMPARTMENT OF LEG

- Soleus: via nerve to Soleus  
- Gastrocnemius
- Plantaris

### DEEP POSTERIOR COMPARTMENT OF LEG

- Popliteus: via nerve to Popliteus  
- Tibialis posterior [TP] (Tom)  
- Flexor digitorum longus [FDL] (Dick)  
- Flexor hallucis longus [FHL] (Harry)

### FIRST PLANTAR LAYER OF FOOT

- Abductor hallucis: Medial plantar
- Flexor digitorum brevis [FDB]: Medial plantar
- Abductor digiti minimi: Lateral plantar

### SECOND PLANTAR LAYER OF FOOT

- Quadratus plantae: Lateral plantar
- Lumbricales: Medial lateral plantar

### THIRD PLANTAR LAYER OF FOOT

- Flexor hallucis brevis [FHB]: Medial plantar
- Adductor hallucis: Lateral plantar
- Flexor digitorum minimus brevis [FDMB]: Lateral plantar

### FOURTH PLANTAR LAYER OF FOOT

- Dorsal interosseous: Lateral plantar
- Plantar interosseous: Lateral plantar

**Nerve to Quadratus femoris (L4-S1):**

| Sensory: | NONE |
| Motor: | Quadratus femoris  
| | Inferior gemelli |

**Nerve to Obturator internus (L5-S2):** exits greater sciatic foramen

| Sensory: | NONE |
| Motor: | Obturator internus  
| | Superior gemelli |

**Pudendal (S2-4):** exit greater then re-enters lesser sciatic foramen

| Sensory: | Perineum: via Perineal (scrotal/labial branches)  
| | via Inferior rectal nerve  
| | via Dorsal nerve to penis/clitoris |
| Motor: | Bulbospongiosus: Perineal nerve  
| | Ischiocavernosus: Perineal nerve  
| | Urethral sphincter: Perineal nerve  
| | Urogenital diaphragm: Perineal nerve  
| | Sphincter ani externus: inferior rectal nerve |

**Nerve to Coccygeus (S3-4)**

| Sensory: | NONE |
| Motor: | Coccygeus |
POSTERIOR DIVISION

Common Peroneal (L4-S2): in groove between biceps lateral head of Gastrocnemius. Wraps around fibular head, deep to peroneus longus; then divides

**Sensory:**
- Proximal lateral leg: via Lateral sural nerve
- Distal lateral leg dorsal foot: via Superficial peroneal
- Lateral foot: via Sural (lateral calcaneal dorsal cutaneous branches)
- 1st/2nd interdigital space: Deep peroneal

**Motor:**
- **POSTERIOR THIGH**
  - Biceps femoris [short head]
- **ANTERIOR COMPARTMENT of LEG:**
  - Deep Peroneal
  - Tibialis anterior [TA]
  - Extensor hallucis longus [EHL]
  - Extensor digitorum longus [EDL]
  - Peroneus tertius
- **LATERAL COMPARTMENT of LEG:**
  - Superficial Peroneal
  - Peroneus longus
  - Peroneus brevis
- **FOOT:** Deep Peroneal
  - Extensor hallucis brevis [EHB]
  - Extensor digitorum brevis [EDB]

**Superior Gluteal (L4-S1):**

**Sensory:** NONE

**Motor:**
- Gluteus medius
- Gluteus minimus
- Tensor fascia lata

**Inferior Gluteal (L5-S2):**

**Sensory:** NONE

**Motor:** Gluteus maximus

**Nerve to piriformis (S2):**

**Sensory:** NONE

**Motor:** Piriformis

**Posterior Femoral Cutaneous Nerve (PFCN) (S1-3):**

**Sensory:** Posterior thigh

**Motor:** NONE
### ARTERIES

<table>
<thead>
<tr>
<th>ARTERY</th>
<th>COURSE</th>
<th>BRANCHES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebral</td>
<td>Major arterial supply of cervical spine and cord.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off both subclavian through transverse foramen of C1-6</td>
<td>Anterior and posterior segmental medullary</td>
<td>Feed Anterior Posterior spinal arteries respectively</td>
</tr>
<tr>
<td></td>
<td>Anterior spinal</td>
<td>Forms superiorly from both vertebrals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posterior spinal</td>
<td>Each branch superiorly from vertebrals</td>
<td></td>
</tr>
<tr>
<td>Ascending cervical</td>
<td>From Thyrocevical</td>
<td>Contributes to Anterior Posterior spinal arteries via segmental medullary arteries</td>
<td></td>
</tr>
<tr>
<td>Deep cervical</td>
<td>From Costocervical</td>
<td>Contributes to Anterior Posterior spinal arteries via segmental medullary arteries</td>
<td></td>
</tr>
<tr>
<td>Segmental/Intercostal</td>
<td>Branch from aorta</td>
<td>Dorsal branch Dorsal branch Spinal branch Spinal branch Major anterior segmental medullary (Adamkiewicz Artery)</td>
<td>Supplies dura, posterior elements Supplies cord and bodies Supplies vertebral bodies Supplies inferior thoracic superior, L-spine, feeds anterior spinal artery in L-spine</td>
</tr>
<tr>
<td>Spinal branch</td>
<td>Along vertebral bodies</td>
<td>Anterior segmental medullary Posterior segmental medullary Radicular arteries (Anterior Posterior)</td>
<td>On ventral root; feeds anterior spinal artery Feeds posterior spinal arteries Along nerve roots, do not feed spinals</td>
</tr>
<tr>
<td></td>
<td>Anterior segmental medullary On Posterior</td>
<td></td>
<td>On ventral root; feeds anterior</td>
</tr>
</tbody>
</table>
Lumbar arteries
Branch from aorta
segmental medullary
Radicular arteries (Anterior Posterior)
spinal artery
Feeds Posterior spinal arteries

Anterior segmental medullary
Along nerve roots
Anterior spinal artery
Anterior radicular arteries
Single artery, runs midline
Do not feed spinal arteries

Posterior segmental medullary
Along nerve roots
Posterior spinal artery
Posterior radicular arteries
Paired arteries (left/right)
Do not feed spinal arteries

Anterior spinal
Midline anterior surface of cord
Sulcal branches
Pial arterial plexus
Supplies anterior 2/3 of cord; has multiple contributions from segmental arteries

Posterior spinal
Off midline (L R)
Supplies post 1/3 of cord; has multiple contributions from segmental arteries

Each nerve root has either a segmental medullary or a radicular artery associated with it.
## DISORDERS

### Spine Involvement in Osteoarthritis

![Image of spine involvement in osteoarthritis](image)

Extensive thinning of cervical discs and hyperextension deformity with narrowing of intervertebral foramina. Lateral radiograph reveals similar changes.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cauda Equina Syndrome</strong></td>
<td>HxPE: Back, buttock, leg pain. Bladder (#1) and bowel dysfunction. Leg numbness paralysis</td>
<td>XR: no emergent need MR (or myelography): to show compression</td>
<td>Immediate surgical decompression (when diagnosis is confirmed)</td>
</tr>
<tr>
<td><strong>Cervical Spondylosis</strong></td>
<td>Hx: Older, men. Neck UE pain, stiffness or grinding. PE: Decreased ROM, midline neck TTP. Radicular or myelopathic signs if HNP or cord compressed</td>
<td>XR: AP, lateral: 1. Osteophytes 2. Spinal stenosis 3. Disc space narrowed 4. Facet osteoarthrosis 5. Instability</td>
<td>Discogenic: soft collar, NSAID, Physical therapy, +/- traction Persistent radiculopathy or myelopathy: decompression and fusion (not for discogenic pain)</td>
</tr>
<tr>
<td><strong>Cervical Strain/Muscle Strain (Whiplash)</strong></td>
<td>Hx: Stiffness, pain (dull/nonradiating) in neck traps PE: Paraspinal muscles tender to palpation (+/- spasm). Spurling test</td>
<td>XR: if history of trauma or neurologic or persistent symptoms</td>
<td>Soft collar immobilization (Philadelphia collar) 1. NSAID, muscle relaxant 2. +/- Ice, heat, massage</td>
</tr>
</tbody>
</table>

**DEGENERATIVE DISC DISEASE (DDD)**
### Degenerative Disc Disease

- **Aging process:** disc desiccates and tears. Facet degeneration and sclerosis. Associated with tobacco use.

- **Hx:** Chronic LBP (± buttock), stiffness (worse with activity). PE: Back tender to palpation ±. Waddell’s signs.

- **XR:** AP, lateral: aging, osteophytes, disc space narrowed, “vacuum sign”

### Herniated Cervical Disc (Herniated nucleus pulposus)

- **Nucleus pulposus protrudes presses on root.** Usually posterolateral at C5-6 or C6-7.

- **Hx:** Young or middle age. Numbness radiating pain. PE: Weakness, decreased sensation reflexes, 1 Spurling test

- **XR:** AP, lateral: spondylosis MR: bulging nucleus pulposus

### Treatment

1. NSAIDs (no narcotics)
2. Antidepressants if indicated
3. Physical therapy, exercise, weight control

---

### Herniated Cervical Disc (Herniated nucleus pulposus)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
</table>
| DDD annulus tear: nucleus herniates, +/- root or cauda compression. | Hx: DDD sx (+/- radicular sx). Increased with sneeze, decreased with hip flexion PE: Root weakness, decreased sensation reflexes, 1 straight leg bowstring tests. | XR: AP, lateral: age changes EMG/NCS: + after 3 weeks MR: shows herniation | 1. Bed rest, NSAIDs
2. Physical therapy, fitness program
3. Discectomy
4. Cauda Equina Syndrome: a surgical emergency |
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LUMBAR BACK SPRAIN/MUSCLE STRAIN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| • Strain or lifting injury  
  Soft tissue injury (muscle spasm, ligament or tendon injury, disc tear-without bulge) | Hx: LBP (+/- radiation to buttock, not leg), paraspinal spasm tenderness  
  PE: Normal neurologic exam | XR: if neurologic symptoms present or refractory to treatment | 1. Rest (1-2 day bed rest), NSAIDs (no narcotics)  
  2. Physical therapy  
  3. Increase fitness |

| **SCHEUERMANN’S DISEASE** | | | |
| Increased thoracic kyphosis (Cobb angle 45°) with 3 vertebral bodies | Hx: Adolescent with poor posture, +/-back pain PE: “rounded back” on examination, usually nontender to palpation | XR: AP, lateral T-spine:  
  1. Increased kyphosis  
  2. Anterior wedging (3)  
  3. Schmorl nodes | Immature: exercise, brace or orthosis  
  Mature: Anterior release and posterior fusion |

| **SCOLIOSIS** | | | |
| Lateral spine curve (+/- rotation)  
  Multiple etiologies: #1 idiopathic  
  Girls.boys (needing bx)  
  Find on school screening  
  Progression: based on skeletal maturity, curve angle | Hx: +/-pain, fatigue, visible physical deformity. PE: Neurologic exam usually normal. Forward bend test. Determine plumb line (hang string from C7) | XR: Full length AP, lateral: Lateral curve on AP. Measure Cobb angle: angle between lines drawn perpendicular to most superior inferior affected vertebrae | Curves:  
  1. 30° observation  
  2. 30-40° bracing  
  3. 40° surgery: spinal fusion |

| **SPINAL STENOSIS** | | | |
| Congenital vs. acquired (most common)  
  Canal narrowing with symptoms  
  Etiology: DDD or facet osteoarthritis ligament laxity | Hx: Neurogenic claudication (fatigue), +/-pain; Back extension reproduces sx. PE: Weakness, decreased pin prick reflexes | XR: AP, laterat: age changes CT/MR: better to evaluate canal, shows stenosis | Physical Therapy: abdominal strength back flexion exercises  
  2. NSAIDs (+/- steroids)  
  3. Laminectomy |

| **SPONDYLOLISTHESIS** | | | |
| Forward slipped vertebrae  
  6 Types (common sites):  
  1. Congenital: facet defect (S1)  
  2. Isthmic (most common): pars defect | Hx: Type: I (peds), II (young), III (elderly). Mechanical back pain, +/-radicular symptoms | XR: AP, lateral: measure forward slippage for grade (I-V, 0-100°)  
  Type: Scottie dog: long | 1. Activity modification, rest, NSAIDs  
  2. Flexion exercises  
  3. Surgical |
2. Defect (L5-S1; associated with hyperextension); Degenerative: facet arthropathy (L4-5)
3. Traumatic
4. Pathologic
5. Post-surgical

PE: +/- palpable step-off spasm. +/- radicular signs (e.g. weakness, decreased sensation reflexes)

**SPONDYLOLYSIS**
- Defect or stress fracture (without slippage) in pars interarticularis
- Leads to spondylolisthesis
- L5 most common site

**Hx:** Young, athlete (football, gymnast). Low back pain, worse with activity (#1 cause in pediatrics)

**XR:** Oblique L-spine “Scottie dog has a collar”

**TUMORS**

Metastatic are most common. Most common primary: Multiple Myeloma (malignant)
# PEDIATRIC DISORDERS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MYELODYSPLASIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neural tube (closure) defect; No function below level of lesion; level determines function (L1 paraplegic/S1 near normal)</td>
<td>Hx: Some have family history PE/XR: Depends on type of defect: 1. Spina bifida occulta 2. Meningocele 3. Myelomeningocele 4. Rachischisis</td>
<td>Must individualize for each patient: Most need ambulation assistance, orthoses, surgical releases, etc. Common problems requiring treatment: Deformities and/or contractures of spine, hips, knees, ankles, and feet</td>
</tr>
<tr>
<td>Associated with increased AFP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associated with many deformities</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SCOLIOSIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral spine curve +/- rotation</td>
<td>Hx: +/- pain fatigue, visible deformity, found in school screening PE: + forward bend test (asymmetric). Neurologic exam usually normal. Determine plumb line from C7 XR: AP full length: measure Cobb angle. (See Disorder Table)</td>
<td>Based on curves and Risser stage; 1. 30°: observation (most) 2. 30-40°: bracing (Boston, for apex below T8 vs. Milwaukee brace) 3. 40°: spinal fusion</td>
</tr>
<tr>
<td>Multiple etiologies: #1 idiopathic</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TORTICOLLIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contracture of SCM Associated with other disorders Associated with intrauterine position</td>
<td>Hx: Parents note deformity PE: Head tilted to one side, chin to opposite side, 1/2facial asymmetry XR: Spine hins: rule out</td>
<td>1. Physical therapy/stretching of the sternocleidomastoid Surgical release if persistent Complication: poor eye</td>
</tr>
</tbody>
</table>
Etiology: several theories
### Anterior Approach to Cervical Spine

**Surgeons**

**Internervous Plane**

<table>
<thead>
<tr>
<th>USES</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anterior Approach</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Herniated disc removal</td>
<td>Superficial: 1. SCM (CN 11)</td>
<td>1. Recurrent laryngeal nerve</td>
<td>Access C3 to T1 Right recurrent laryngeal nerve more susceptible to injury-most choose approach on left side.</td>
</tr>
<tr>
<td>2. Vertebral fusion</td>
<td>1. Strap muscles (C1-3) Deep: 2. Between left and right Longus colli muscles</td>
<td>2. Sympathetic nerve</td>
<td>Thyroid arteries limit extension of the approach</td>
</tr>
<tr>
<td>3. Osteophyte removal</td>
<td></td>
<td>3. Carotid artery</td>
<td></td>
</tr>
<tr>
<td>4. Tumor or biopsy</td>
<td></td>
<td>4. Internal jugular</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Vagus nerve inferior</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Thyroid artery</td>
<td></td>
</tr>
</tbody>
</table>
Posterior Approach to Cervical Spine

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVOS PLANNE</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERVICAL</td>
<td></td>
<td></td>
<td>POSTERIOR APPROACH</td>
</tr>
<tr>
<td>1. Posterior</td>
<td></td>
<td>1. Spinal cord</td>
<td>Most common c-spine approach</td>
</tr>
<tr>
<td>fusion</td>
<td></td>
<td>2. Nerve roots</td>
<td>Mark the level of pathology with a radiopaque marker pre-op to assist finding the appropriate level intraoperatively</td>
</tr>
<tr>
<td>2. Herniated</td>
<td>Left and Right</td>
<td>3. Posterior rami</td>
<td></td>
</tr>
<tr>
<td>disc</td>
<td>paracervical muscles (posterior cervical rami)</td>
<td>4. Vertebral artery</td>
<td></td>
</tr>
<tr>
<td>3. Facet</td>
<td></td>
<td>5. Segmental vessels</td>
<td></td>
</tr>
<tr>
<td>dislocation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUMBAR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Herniated</td>
<td>Left and Right</td>
<td></td>
<td>Incision is along the spinous processes.</td>
</tr>
<tr>
<td>disc</td>
<td>paraspinal muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(dorsal rami)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Explore</td>
<td>Segmental vessels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nerve roots</td>
<td>to paraspinals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
CHAPTER 2 – SHOULDER

TOPOGRAPHIC ANATOMY
OSTEOLOGY

### CHARACTERISTICS

<table>
<thead>
<tr>
<th>CLAVICLE</th>
<th>OSSIFY</th>
<th>FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical; S shaped</td>
<td>Primary (2)</td>
<td>7 weeks fetal</td>
<td>Clavicle is first to ossify, last to fuse</td>
</tr>
<tr>
<td>Middle: narrowest, no ligament attachments</td>
<td>(medial/lateral)</td>
<td>25 years (sternal)</td>
<td>It starts as intramembranos ossification, ends as membranous.</td>
</tr>
<tr>
<td></td>
<td>Secondary (sternal/acromial)</td>
<td>19-20 yrs (acromial)</td>
<td></td>
</tr>
<tr>
<td>SCAPULA</td>
<td></td>
<td></td>
<td>Blood supply:</td>
</tr>
<tr>
<td>Flat, triangular shape</td>
<td>1. Body</td>
<td>8 weeks (fetal)</td>
<td>Subscapular</td>
</tr>
<tr>
<td>Only attachments to axial skeleton are muscular.</td>
<td>2. Coracoid</td>
<td>1 year</td>
<td>(and circumflex scapular arteries)</td>
</tr>
<tr>
<td></td>
<td>3. Coracoid/glenoid</td>
<td>15 yrs</td>
<td>1. Suprascapular artery</td>
</tr>
<tr>
<td></td>
<td>4. Acromion</td>
<td>15 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Inferior angle</td>
<td>16 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>All fuse between 15-20 years</td>
</tr>
</tbody>
</table>
**TRAUMA**

**DESCRIPTION**

**EVALUATION**

**CLASSIFICATION**

**TREATMENT**

### CLAVICLE FRACTURE

- Most common fracture
- Fall on shoulder or direct blow.
- Football, hockey
- Rare neurovascular damage (subclavians)

- PE: Gross deformity at fracture site with ttp. Must do neurological and vascular exams.
- XR: AP and 45° cephalad Group II: stress views

<table>
<thead>
<tr>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle 1/3: 80%</td>
<td>Distal 1/3: 15%</td>
<td>Proximal 1/3: 5%</td>
</tr>
<tr>
<td>Type I minimally displaced; between ligaments.</td>
<td>Displaced, fracture medial to CC ligament.</td>
<td>Fracture through AC joint. Ligaments intact.</td>
</tr>
</tbody>
</table>

Closed treatment (no reduction) with figure of eight brace or sling for mid/proximal 1/3, distal 1/3 (Types I and III) (3-4 weeks; ROM)

Open treatment for Type II to prevent nonunion. (also open fracture, vascular injury)

### SCAPULAR FRACTURE

- Relatively uncommon
- Males-young
- High-energy trauma
- 85% w/associated injuries (including

- HX: Trauma. Pain in back and/or shoulder.
- PE: Swelling and tenderness to palpation
- XR: AP/Anterior

**Anatomic classification: A-G Idleberg (glenoid fracture)**

<table>
<thead>
<tr>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior avulsion fracture</td>
<td>Tranverse/oblique fracture thru glenoid; exits inferiorly</td>
<td>Oblique</td>
</tr>
</tbody>
</table>

Closed treatment with a sling for 2 weeks for most fractures. Then early ROM.

ORIF for intraarticular fx
**ACROMIOCLAVICULAR (AC) SEPARATION**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation is subluxation or dislocation of AC joint</td>
<td>HX: Trauma. Range of pain: minimal to severe. PE: AC joint TTP, gross deformity with grade III up. XR: AP, stress view: grade II vs. grade III.</td>
<td>6 Grades: (based on ligament tear clavicle position)</td>
<td>Grade I: Sprain, AC ligament intact. Grade II: AC tear, CC sprain. Grade III: AC/CC (both) torn AC joint is dislocated. Grade IV: III with clavicle posterior into/thru trapezius muscle. Grade V: III with clavicle elevated 100% superiorly. Grade VI: III with clavicle inferior.</td>
</tr>
<tr>
<td>Fall onto acromion Contact sports: hockey football, wrestling Males</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPLICATIONS:** Permanent deformity; Stiffness, early OA; Distal clavicle osteolysis (pain); Associated injuries: Fracture, pneumothorax.
| **GLENOHUMERAL DISLOCATION** | **HX: Trauma or hx of shoulder slipping out. Intense pain. PE: Deformity, flattened shoulder silhouette. Exquisitely tender. Do full neurovascular PE** | **Anatomic Classification:** Where humeral head is:  
- Anterior (90%)  
- Posterior (5%)  
- Inferior (luxatio erecta) very rare  
- Superior: very, very rare | **Reduce dislocation:** Pre and Post neurological exam. Conscious sedation (IV benzo + narcotic)  
**Methods:**  
1. Traction/countertraction  
2. Hippocratic  
3. Stimson  
4. Milch  
**Immobilize (2-6 weeks), rehabilitation Surgery for recurrent/TUBS, posterior dislocation 3 wks** |

| **Anterior:** Abd/ER injury 2 mechanisms | **TUBS** [Traumatic Unilateral, Bankart lesion, Surgery]  
1. **AMBRI** [Atraumatic Multi-directional, Bilateral, responds to Rehab, Inferior capsule repair] 20 yo: 80% recur  
2. Hill Sachs Bankart lesions predisposed to recurrence  
- Posterior: after seizure often missed | | |
## JOINTS

<table>
<thead>
<tr>
<th>JOINT</th>
<th>TYPE</th>
<th>LIGAMENTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glenohumoral</td>
<td>Spheroidal Ball and Socket</td>
<td>Highly mobile, decreased stability (needs Rotator cuff); #1 dislocated joint (anterior 90%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capsule</td>
<td>Loose, redundant, with gaps; minimal support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coracohumoral</td>
<td>Provides anterior support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glenohumoral</td>
<td>Discrete capsular thickenings; 3 ligaments: superior, middle, inferior=strongest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glenoid labrum</td>
<td>Increases surface area depth of glenoid; Injuries: SLAP lesion/Bankart lesion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transverse humeral</td>
<td>Holds biceps (LH) tendon in groove</td>
</tr>
<tr>
<td>Acromioclavicular [AC joint]</td>
<td>Plane/Gliding</td>
<td>Capsule</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anterior and Posterior SC ligaments</td>
<td>Posterior stronger; Anterior dislocation more common</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interclavicular</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Costoclavicular</td>
<td>Strongest SC ligament</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Capsule has a disc in joint; Horizontal stability; torn in Grade II AC injury</td>
<td></td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Acromioclavicular</td>
<td>Can cause impingement</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Coracoacromial</td>
<td>Vertical stability; torn in Grade III AC injury</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Conoid</td>
<td>Posterior/medial position; stronger</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Trapezoid</td>
<td>Anterior/lateral position</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Conoid</td>
<td>Posterior/medial position; stronger</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Superior transverse scapular ligament and suprascapular notch</td>
<td></td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Coracoid process</td>
<td>Broken line indicates position of subcencious bursa of subscapularis</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Intertrabecular tension sheath</td>
<td>communicates with synovial cavity</td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Subscapularis tension (cut)</td>
<td></td>
</tr>
<tr>
<td>Scapulothoracic</td>
<td>not an articulation</td>
<td>Biceps brachii tendon (long head)</td>
<td></td>
</tr>
</tbody>
</table>

---

**Image:** [Anterior view of the shoulder joint](https://example.com/shoulder_joint_image)
**STRUCTURE** | **FUNCTION**
---|---
**MUSCLES** |  
**ROTATOR CUFF** | Holds humeral head in glenoid  
Supraspinatus | Most commonly torn tendon  
Infra spinatus |  
Teres Minor |  
Subscapularis | Anterior support  
**LIGAMENTS** |  
Capsule | Rotator cuff tendons fused to it  
Glenohumeral | Superior: resists inferior translation  
| Middle: resists anterior translation  
| Inferior: resists ant/inf translation  
Coracohumeral | Resists post/inferior translation  
Labrum | Deepens glenoid  

---

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### INJECTION OF THE ACROMIOCLAVICULAR (AC) JOINT

1. Ask patient about allergies
2. Palpate clavicle distally to AC joint (sulcus)
3. Prepare skin over AC joint (iodine/antiseptic soap)
4. Anesthetize skin with local (quarter size spot)
   - Use 21 gauge or smaller, insert needle into joint vertically. Aspirate to ensure not in a vessel, then inject 2ml of 1:1 local/corticosteroid preparation into AC joint. (You will feel the needle "pop/give" into the joint)
5. Dress injection site

### INJECTION OF SUBACROMIAL SPACE

1. Ask patient about allergies
2. Palpate the acromion: define it's borders
3. Prepare skin over shoulder (iodine/antiseptic soap)
4. Anesthetize skin with local (quarter size spot)
   - Hold finger (sterile glove) on acromion, insert needle under posterior acromion w/cephalad tilt. Aspirate to ensure not in a vessel, then inject 5-10cc of preparation-will flow easily if in joint). Use:
   - **a.** diagnostic injection: local only
   - **b.** therapeutic injection: local/corticosteroid 5:1
5. Dress injection site

### GLENOHUMERAL ARTHROCENTESIS

1. Palpate the coracoid process/humeral head
2. Prepare skin over shoulder (iodine/antiseptic soap)
3. Anesthetize skin (quarter size spot)
4. Abduct arm/downward traction (by an assistant)
5. Insert needle between humeral head and coracoid process
6. Synovial fluid should aspirate easily
7. Dress insertion site
### HISTORY

![Clinical appearance](image)

**Injury to acromioclavicular joint.** Usually caused by fall on tip of shoulder, depressing acromion (shoulder separation).

![Clinical appearance](image)

**Rupture of biceps brachii muscle.**

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ANSWER</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AGE</td>
<td>OLD YOUNG</td>
<td>Rotator cuff tear/impingement, arthritis (OA), adhesive capsulitis (frozen shoulder), humerus fracture (after trauma) Instability, AC injury, osteolysis, impingement in athletes</td>
</tr>
<tr>
<td>2. PAIN</td>
<td></td>
<td>Fracture, rotator cuff tear, acromioclavicular injury, dislocation Impingement, arthritis AC joint arthrosis Classic for Rotator Cuff tear, tumor Rotator Cuff tear Cervical radiculopathy</td>
</tr>
<tr>
<td></td>
<td>a. Onset</td>
<td>Acute Chronic On top/AC joint Night pain Overhead worse Overhead better</td>
</tr>
<tr>
<td></td>
<td>b. Location</td>
<td>Night pain Overhead worse Overhead better</td>
</tr>
<tr>
<td></td>
<td>c. Occurrence</td>
<td>Night pain Overhead worse Overhead better</td>
</tr>
<tr>
<td></td>
<td>d. Exacerbating /relieving</td>
<td>Night pain Overhead worse Overhead better</td>
</tr>
<tr>
<td>3. STIFFNESS</td>
<td>Yes</td>
<td>Osteoarthritis, adhesive capsulitis</td>
</tr>
<tr>
<td>4. INSTABILITY</td>
<td>“Slips in and out”</td>
<td>Dislocation: 90% anterior - occurs with abduction external rotation (e.g. throwing motion)</td>
</tr>
<tr>
<td>5. TRAUMA</td>
<td>Direct blow Fall on outstretched hand</td>
<td>Acromioclavicular injury Glenohumeral dislocation</td>
</tr>
<tr>
<td></td>
<td>Overhead usage</td>
<td>Osteolysis (distal clavicle)</td>
</tr>
<tr>
<td></td>
<td>WORK/ACTIVITY</td>
<td>PMHx</td>
</tr>
<tr>
<td>---</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>6.</td>
<td>Weight lifting Athlete: throwing type Long term manual labor</td>
<td>Referred pain to shoulder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Neurologic Symptoms</td>
<td>Numbness/tingling/ &quot;heavy&quot;</td>
</tr>
<tr>
<td>8.</td>
<td>PMHx</td>
<td>Cardiopulmonary/GI</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
# Physical Exam

<table>
<thead>
<tr>
<th>EXAM</th>
<th>TECHNIQUE/FINDINGS</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symmetry</td>
<td>Compare both sides</td>
<td></td>
</tr>
<tr>
<td>Wasting</td>
<td>Loss of contour/muscle mass</td>
<td>Rotator Cuff tear</td>
</tr>
<tr>
<td>Gross deformity</td>
<td>Superior displacement</td>
<td>Acromioclavicular injury (separation)</td>
</tr>
<tr>
<td>Gross deformity</td>
<td>Anterior displacement</td>
<td>Anterior dislocation (glenohumeral joint)</td>
</tr>
<tr>
<td>Gross deformity</td>
<td>“Popeye” arm</td>
<td>Biceps tendon rupture (usually proximal end of long head)</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC joint</td>
<td>Feel for end of clavicle</td>
<td>Pain indicates Acromioclavicular pathology</td>
</tr>
<tr>
<td>Subacromial bursa</td>
<td>Feel acromion-down to acromiohumeral sulcus</td>
<td>Pain: bursitis and/or supraspinatus tendon rupture</td>
</tr>
<tr>
<td>Coracoclavicular ligament</td>
<td>Feel between acromion coracoid</td>
<td>Pain indicates impingement</td>
</tr>
<tr>
<td>Greater tuberosity</td>
<td>Prominence on lateral humeral head</td>
<td>Pain indicates Rotator Cuff tendinitis</td>
</tr>
<tr>
<td>Biceps tendon</td>
<td>Feel proximal insertion on humerus</td>
<td>Pain indicates biceps tendinitis</td>
</tr>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward flexion</td>
<td>Arms from sides forward</td>
<td>0-160° normal</td>
</tr>
<tr>
<td>Abduction</td>
<td>Arms from sides outward</td>
<td>0-160/180° normal</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>Reach thumb up back-note level</td>
<td>Mid thoracic normal-compare sides</td>
</tr>
<tr>
<td>External rotation</td>
<td>1. Elbow at side, rotate forearms lateral</td>
<td>30-60° normal External rotation decreased in adhesive capsulitis</td>
</tr>
<tr>
<td></td>
<td>2. Abduct arm to 90°, externally rotate up</td>
<td></td>
</tr>
<tr>
<td>Rotator Cuff tear: AROM decreased, PROM ok, Adhesive Capulitis: both are decreased</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NEUROVASCULAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory</td>
<td>Light touch, pin prick, 2 pt</td>
<td></td>
</tr>
<tr>
<td>Supraclavicular nerve (C4)</td>
<td>Superior shoulder/ clavicular area</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Axillary nerve (C5)</td>
<td>Lateral shoulder</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>T2 segmental nerve</td>
<td>Axilla</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal accessory (CN11)</td>
<td>Resisted shoulder shrug</td>
<td>Weakness = Trapezius or corresponding nerve lesion.</td>
</tr>
<tr>
<td>Suprascapular (C5-6)</td>
<td>Resisted abduction</td>
<td>Weakness = Supraspinatus or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td></td>
<td>Resisted external rotation</td>
<td>Weakness = Infraspinatus or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Axillary nerve (C5)</td>
<td>Resisted abduction</td>
<td>Weakness = Deltoid or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td></td>
<td>Resisted external rotation</td>
<td>Weakness = Teres minor or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Dorsal scapular</td>
<td>Shoulder shrug</td>
<td>Weakness = Lev Scap/Rhomboid or</td>
</tr>
<tr>
<td>EXAM</td>
<td>TECHNIQUE/FINDINGS</td>
<td>CLINICAL APPLICATION</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td><strong>SPECIAL TESTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>Bilateral: 30° add, 90° FF, IR, resist</td>
<td>Weakness indicates Rotator cuff (supraspinatus) tear,</td>
</tr>
<tr>
<td>(empty can)</td>
<td>down force</td>
<td>impingement</td>
</tr>
<tr>
<td>Drop Arm</td>
<td>Passively abduct 90°, lower slowly</td>
<td>Weakness or arm drop indicates rotator cuff tear</td>
</tr>
<tr>
<td>Liftoff</td>
<td>Hand behind back, push posteriorly</td>
<td>Weakness or inability indicates subscapularis rupture</td>
</tr>
<tr>
<td>Speed</td>
<td>Resist forward flexion of arm</td>
<td>Pain indicates biceps tendinitis</td>
</tr>
<tr>
<td>Yergason</td>
<td>Hold hand, resist supination</td>
<td>Pain indicates biceps tendinitis, biceps tendon subluxation</td>
</tr>
<tr>
<td>Impingement</td>
<td>Forward flex greater than 90°</td>
<td>Pain indicates Impingement Syndrome</td>
</tr>
<tr>
<td>sign (Neer)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hawkins sign</td>
<td>Forward flex 90°, elbow @ 90°, then IR</td>
<td>Pain indicates Impingement Syndrome</td>
</tr>
<tr>
<td>Cross Body</td>
<td>90° Forward flex then adduct arm across</td>
<td>Pain indicates Acromioclavicular pathology, Decreased</td>
</tr>
<tr>
<td>Adduction</td>
<td>body</td>
<td>ROM indicates tight posterior capsule</td>
</tr>
<tr>
<td>AC Shear</td>
<td>Cup hands over clavicle/scapula: then</td>
<td>Pain/movement indicates AC pathology</td>
</tr>
<tr>
<td></td>
<td>squeeze</td>
<td></td>
</tr>
</tbody>
</table>

Test for partial tear of cuff is inability to maintain 90° abduction against mild resistance.

Extensive rupture of left cuff. To bring about abduction, deltoid muscle contracts strongly but only pulls humerus upward toward acromion while scapula rotates and shoulder girdle is elevated. 45° abduction thus possible.
<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Compression</td>
<td>90° FF, max IR, then adduct/flex</td>
<td>Pain or pop indicates a SLAP lesion</td>
</tr>
<tr>
<td>(O'Brien's)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load and shift</td>
<td>Push into glenoid, translate ant/post</td>
<td>Motion indicates instability in that direction (anterior vs. posterior)</td>
</tr>
<tr>
<td>Apprehension sign</td>
<td>Throwing position-continue to externally rotate</td>
<td>Apprehension indicates anterior instability</td>
</tr>
<tr>
<td>Relocation (Jobe)</td>
<td>90° Abd, full ER, posterior force on humeral head</td>
<td>Relief of pain/apprehension, or increased external rotation indicates anterior instability</td>
</tr>
<tr>
<td>Posterior Apprehension sign</td>
<td>FF 90°, internally rotate, posterior force</td>
<td>Apprehension indicates posterior instability</td>
</tr>
<tr>
<td>Inferior instability</td>
<td>Abd 90°, downward force on mid-humerus</td>
<td>Slippage of humeral head or apprehension: inferior instability or Multidirectional instability</td>
</tr>
<tr>
<td>Sulcus sign</td>
<td>Arm to side, downward traction</td>
<td>Increased acromiohumeral sulcus: inferior instability or Multidirectional instability</td>
</tr>
<tr>
<td>Adson</td>
<td>Palpate radial pulse, rotate neck to ipsilateral side</td>
<td>Reproduction of symptoms indicates thoracic outlet syndrome</td>
</tr>
<tr>
<td>Roo (EAST)</td>
<td>Bilateral arm: abduct/ER, open and close fist 3 minutes</td>
<td>Reproduction of symptoms indicates thoracic outlet syndrome</td>
</tr>
<tr>
<td>Spurling</td>
<td>Lateral flex/axial compression of neck</td>
<td>Reproduction of symptoms indicates cervical disc pathology</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### MUSCLES: INSERTIONS AND ORIGINS

<table>
<thead>
<tr>
<th>CORACOID PROCESS</th>
<th>GREATER TUBERCLE</th>
<th>ANTERIOR PROXIMAL</th>
<th>MEDIAL EPICONDYLE</th>
<th>LATERAL EPICONDYLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORIGINS</td>
<td>INSERTIONS</td>
<td>INSERTIONS</td>
<td>ORIGINS</td>
<td>ORIGINS</td>
</tr>
<tr>
<td>Biceps (SH)</td>
<td>Supraspinatus</td>
<td>Pectoralis major</td>
<td>Pronator Teres</td>
<td>Anconeus</td>
</tr>
<tr>
<td>Coracobrachialis</td>
<td>Infraspinatus</td>
<td>Latissimus dorsi</td>
<td>Common Flexor</td>
<td>Common. Extensor</td>
</tr>
<tr>
<td>INSERTIONS</td>
<td>Teres minor</td>
<td>Teres major</td>
<td>Tendon [FCR, PL]</td>
<td>Tendon [ECRB,ED,</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td></td>
<td></td>
<td></td>
<td>EDM, ECU]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### MUSCLES: BACK/SCAPULA REGION

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>C7-T12 spinous</td>
<td>Clavicle, Acromion spine of</td>
<td>Cranial nerve</td>
<td>Elevate rotate scapula</td>
<td>Connect UE to spine</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>T7-T12, iliac crest</td>
<td>Humerus (intertubercular groove)</td>
<td>Thoracodorsal</td>
<td>Adduct, extend arm, IR humerus</td>
<td>Connect UE to spine</td>
</tr>
<tr>
<td>Levator scapulae</td>
<td>C1-C4 transverse</td>
<td>Superior medial scapula</td>
<td>Dorsal scapular/ C3-4</td>
<td>Elevates scapula</td>
<td>Connect UE to spine</td>
</tr>
<tr>
<td>Rhomboid minor</td>
<td>C7-T1 spinous</td>
<td>Medial scapula (at the spine)</td>
<td>Dorsal scapular</td>
<td>Adduct scapula</td>
<td>Connect UE to spine</td>
</tr>
<tr>
<td>Rhomboid major</td>
<td>T2-T5 spinous</td>
<td>Medial scapula</td>
<td>Dorsal scapular</td>
<td>Adduct scapula</td>
<td>Connect UE to spine</td>
</tr>
</tbody>
</table>
MUSCLES: ROTATOR CUFF

<table>
<thead>
<tr>
<th>SPACE</th>
<th>BORDERS</th>
<th>STRUCTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangular Space</td>
<td>Teres Minor</td>
<td>Circumflex Scapular Artery</td>
</tr>
<tr>
<td></td>
<td>Teres Major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triceps (Long Head)</td>
<td></td>
</tr>
<tr>
<td>Quadrangular Space</td>
<td>Teres Minor</td>
<td>Axillary Nerve</td>
</tr>
<tr>
<td></td>
<td>Teres Major</td>
<td>Posterior Circumflex Artery</td>
</tr>
<tr>
<td></td>
<td>Triceps (Long Head)</td>
<td>Humeral Artery</td>
</tr>
<tr>
<td></td>
<td>Triceps (Lateral Head)</td>
<td></td>
</tr>
<tr>
<td>Triangular Interval</td>
<td>Teres Major</td>
<td>Radial Nerve</td>
</tr>
<tr>
<td></td>
<td>Triceps (Long Head)</td>
<td>Deep Artery of Arm</td>
</tr>
<tr>
<td></td>
<td>Triceps (Lateral Head)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltoid</td>
<td>Clavicle, Acromion</td>
<td>Humerus (Deltoid tuberosity)</td>
<td>Axillary</td>
<td>Abduct arm</td>
<td>Atrophy: Axillary nerve damage</td>
</tr>
<tr>
<td>Teres major</td>
<td>Inferior angle of the scapula</td>
<td>Humerus (intertubercular groove)</td>
<td>Lower subscapular</td>
<td>IR, adduct arm</td>
<td>Protects radial nerve in posterior approach</td>
</tr>
<tr>
<td>Rotator Cuff(4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.Supraspinatus</td>
<td>Supraspinatus fossa</td>
<td>Greater tuberosity (superior)</td>
<td>Suprascapular</td>
<td>Abduct arm (initiate)</td>
<td>Trapped in impingement #1 torn tendon (RC tear)</td>
</tr>
<tr>
<td>2.Infraspinatus</td>
<td>Infraspinatus fossa</td>
<td>Greater tuberosity (middle)</td>
<td>Suprascapular</td>
<td>ER arm, stability</td>
<td>Weak ER: damage to nerve, lesion in notch Dissection</td>
</tr>
<tr>
<td>3. Teres Minor</td>
<td>Lateral scapular</td>
<td>Greater tuberosity (inferior)</td>
<td>Axillary</td>
<td>ER arm, stability</td>
<td>Dissection can damage circum-flex vessels</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------</td>
<td>-----------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>4. Subscapularis</td>
<td>Subscapular fossa (scapula)</td>
<td>Lesser tuberosity</td>
<td>Upper Lower Subscapular</td>
<td>IR, adduct arm, stability</td>
<td>Can rupture in anterior dislocation</td>
</tr>
</tbody>
</table>
# MUSCLES: DELTOID/PECTORAL REGION

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deltoid</td>
<td>Clavicle, Acromion, spine of scapula</td>
<td>Humerus (Deltoid tuberosity)</td>
<td>Axillary</td>
<td>Abduct arm</td>
<td>Atrophy: Axillary nerve damage</td>
</tr>
<tr>
<td>Pectoralis</td>
<td>1. Clavicle 2. Sternum</td>
<td>Humerus (intertubercular groove)</td>
<td>Lateral/medial pectoral</td>
<td>Adduct arm, IR humerus</td>
<td>Can rupture during weight lifting</td>
</tr>
<tr>
<td>Pectoralis</td>
<td>ribs 3-5</td>
<td>Coracoid process (scapula)</td>
<td>Medial pectoral</td>
<td>Stabilizes scapula</td>
<td>Divides Axillary artery into 3 parts</td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>ribs 1-8 (lateral)</td>
<td>Scapula (antero-medial border)</td>
<td>Long thoracic</td>
<td>Holds scapula to chest wall</td>
<td>Paralysis indicates wing scapula</td>
</tr>
<tr>
<td>Subclavius</td>
<td>Rib 1 (and costal cartilage)</td>
<td>Clavicle (inferior border/mid 3rd)</td>
<td>Nerve to subclavus</td>
<td>Depresses clavicle</td>
<td>Cushions subclavian vessels</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
NERVES

BRACHIAL PLEXUS

- C5-T1 ventral rami Variations: C4 (prefix) T2 (post-fix)
- Rami (Roots), Trunks, Divisions, Cords, Branches (Rob Taylor Drinks Cold Beer)
  Supraclavicular (rami trunks) portion in posterior triangle of neck Rami exit
  between Anterior Medial Scalene, then travel with Subclavian artery in axillary sheath
  Divisions occur under (posterior) to clavicle and subclavius muscle
- Anterior Divisions: Flexors
- Posterior Divisions: Extensors
- Infracavicular (cords branches) portion in the axilla
1. **Spinal Accessory** (CN11,C1-C6): in posterior cervical triangle on levator scapula
   - Sensory: NONE
   - Motor: Trapezius, Sternoceildomastoid

2. **Suprascapular** (C2-3): splits into 3: anterior middle, posterior branches
   - Sensory: over clavicle, outer trap, deltoid
   - Motor: NONE

<table>
<thead>
<tr>
<th>CERVICAL PLEXUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPRACLAVICULAR [approach through posterior triangle]</td>
</tr>
<tr>
<td>INFRACLAVICULAR [approach through axilla]</td>
</tr>
<tr>
<td>ROOTS</td>
</tr>
<tr>
<td>LATERAL CORD</td>
</tr>
</tbody>
</table>

3. **Dorsal Scapular** (C3, 4, 5): pierces middle scalene, deep to Levator
   - Sensory: NONE
   - Motor: Pectoralis Major

<table>
<thead>
<tr>
<th>MEDIAL CORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhomboid Minor and Major</td>
</tr>
</tbody>
</table>

4. **Long Thoracic** (C5-7): on anterior surface of Serratus Anterior. Runs with lateral thoracic artery
   - Sensory: NONE
   - Motor: Serratus Anterior

<table>
<thead>
<tr>
<th>POSTERIOR CORD</th>
</tr>
</thead>
</table>

5. **Suprascapular** (C5-6): thru scapular notch, under ligament
   - Sensory: NONE
   - Motor: Subscapularis [upper portion]

6. **Upper Subscapular** (C5-6)

<table>
<thead>
<tr>
<th>UPPER TRUNK</th>
</tr>
</thead>
</table>

7. **Lateral Pectoral** (C5-7): named for cord, runs with pectoral artery
   - Sensory: NONE
   - Motor: Pectoralis Minor

<table>
<thead>
<tr>
<th>LATERAL CORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhomboid Minor and Major</td>
</tr>
</tbody>
</table>

8. **Medial Pectoral** (C8-T1): named for cord
   - Sensory: NONE
   - Motor: Pectoralis Minor (overlying muscle)

<table>
<thead>
<tr>
<th>MEDIAL CORD</th>
</tr>
</thead>
</table>

9. **Upper Subscapular** (C5-6)

<table>
<thead>
<tr>
<th>POSTERIOR CORD</th>
</tr>
</thead>
</table>

10. **Lower Subscapular** (C5-6)
<table>
<thead>
<tr>
<th>Nerve</th>
<th>Motor</th>
<th>Sensory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve to Subclavius (C5-6): descends anterior to plexus, posterior to clavicle</td>
<td>Supraspinatus</td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td>Infraspinatus</td>
<td>Subscapularis [lower portion]</td>
</tr>
<tr>
<td>6. Nerve to Subclavius (C5-6): descends anterior to plexus, posterior to clavicle</td>
<td>Teres major</td>
<td></td>
</tr>
<tr>
<td>11. Thoracodorsal (C7-8): runs with thoracodorsal artery</td>
<td>Latissimus dorsi</td>
<td>NONE</td>
</tr>
<tr>
<td>Sensory:</td>
<td>Subclavius</td>
<td>NONE</td>
</tr>
<tr>
<td>Sensory:</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>Motor:</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>Motor:</td>
<td>Lateral upper arm; via Superior Lateral Cutaneous Nerve of arm</td>
<td></td>
</tr>
<tr>
<td>Motor:</td>
<td>Deltoid; via deep branch</td>
<td></td>
</tr>
<tr>
<td>Motor:</td>
<td>Teres minor; via superficial branch</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
<table>
<thead>
<tr>
<th>TRUNK</th>
<th>BRANCH</th>
<th>COURSE/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thyroacic</strong></td>
<td>thyrocervical</td>
<td>Over superior transverse scapular ligament.</td>
</tr>
<tr>
<td><strong>Trunk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subclavian</strong></td>
<td>supra scapular</td>
<td>Over superior transverse scapular ligament.</td>
</tr>
<tr>
<td></td>
<td>infraspinatus</td>
<td>Bends around spine of scapula</td>
</tr>
<tr>
<td></td>
<td>branch</td>
<td></td>
</tr>
<tr>
<td><strong>Artery</strong></td>
<td></td>
<td>Subclavian artery comes off: Left - aorta, Right - brachiocephalic. Then goes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between anterior and middle scalene muscles with brachial plexus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subclavian</strong></td>
<td>Dorsal Scapular</td>
<td>Splits around levator scapulae; descends medial to scapula</td>
</tr>
<tr>
<td><strong>Artery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parts determined</td>
<td>pectoralis minor.</td>
<td>Part I of the axillary artery has 1 branch, Part II has 2 branches, Part III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>has 3 branches</td>
</tr>
<tr>
<td><strong>Axillary</strong></td>
<td>Superior thoracic</td>
<td>To serratus anterior and pectoralis muscles</td>
</tr>
<tr>
<td>(Part I)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thoracocromial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clavicular branch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acromial branch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deltoid branch</td>
<td>Courses with basilic vein</td>
</tr>
<tr>
<td></td>
<td>Pectoral branch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lateral thoracic</td>
<td>To serratus anterior with Long Thoracic nerve.</td>
</tr>
<tr>
<td>(Part III)</td>
<td>Subscapular</td>
<td></td>
</tr>
<tr>
<td>Muscle Type</td>
<td>Location Description</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Circumflex scapular</td>
<td>Seen posteriorly in Triangular space</td>
<td></td>
</tr>
<tr>
<td>Thoracodorsal</td>
<td>Follows Thoracodorsal nerve</td>
<td></td>
</tr>
<tr>
<td>Anterior circumflex</td>
<td>Supplies humeral head (anterior humerus)</td>
<td></td>
</tr>
<tr>
<td>Posterior circumflex</td>
<td>** Seen posteriorly in Quadrangular space. Injury in proximal humeral fracture.**</td>
<td></td>
</tr>
<tr>
<td>DISORDERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DESCRIPTION</strong></td>
<td><strong>H P</strong></td>
<td><strong>WORK-UP/FINDINGS</strong></td>
</tr>
<tr>
<td><strong>ADHESIVE CAPSULITIS (FROZEN SHOULDER)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Inflammatory process; leads to joint fibrosis</td>
<td>Hx: Middle age women, DM</td>
<td>XR: Usually normal</td>
</tr>
<tr>
<td></td>
<td>Slow onset: pain/stiffness</td>
<td>Arthrogram: decreased joint volume</td>
</tr>
<tr>
<td></td>
<td>•Associated with old Colles fracture</td>
<td></td>
</tr>
<tr>
<td><strong>ARTHRITIS: ACROMIOCLAVICULAR (AC) JOINT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Usually osteoarthritis</td>
<td>Hx: Pain at AC, esp. with motion</td>
<td>XR: Osteophytes, joint narrowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE: Tender to palpation</td>
<td></td>
</tr>
<tr>
<td><strong>ARTHRITIS: GLENOHUMERAL JOINT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Multiple etiologies: OA, RA, post-traumatic</td>
<td>Hx: Older, pain increases with activity</td>
<td>XR: True AP, axillary lateral: joint space narrowed</td>
</tr>
<tr>
<td></td>
<td>•Often overuse condition</td>
<td>PE: +/- wasting, crepitus, decreased AROM</td>
</tr>
<tr>
<td><strong>BICEPS TENDINITIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Associated with impingement or subluxation/transverse humeral ligament tear</td>
<td>Hx: Pain in shoulder</td>
<td>XR: Normal views: usually normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PE: Tenderness along groove</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+Speed, + Yergason</td>
</tr>
<tr>
<td><strong>BICEPS TENDON RUPTURE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Long Head of biceps rupture</td>
<td>Hx: Old, or young weight lifter, sudden pain</td>
<td>XR: Normal; rule out fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arthrogram: rule out RC tear</td>
</tr>
<tr>
<td>•Due to impingement, micro-trauma or trauma</td>
<td>PE: Proximal arm bulge (Popeye arm)</td>
<td></td>
</tr>
<tr>
<td>•Associated with RC tear</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BRACHIAL PLEXUS INJURY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>•Traction of brachial plexus</td>
<td>Hx: Football players, paraesthesias in</td>
<td>XR: Shoulder series: normal</td>
</tr>
</tbody>
</table>
### Bursitis: Subacromial

- **Often from impingement**
- **Hx/PE:** Pain at shoulder
- **IMPINGEMENT**
  - **RC (supraspinatus), Biceps tendon trapped under acromion or coracoacromial ligament**
    - **Hx Older, or athlete. Pain/Inability to do overhead activity.**
    - **XR:** Normal views + **outlet view:** type III acromion or subacromial spur
  - **Associated with Type III acromion**
    - **PE:** +Neer, +Hawkins

### Instability/Dislocation: Glenohumeral Joint Two Types

1. **TUBS [Trauma Unilateral Bankart lesion, Surgery]**
   - **Hx/Pain:** Arm slips out, TUBS history
   - **XR:** Trauma (+/- Stryker) Bankart/Hill Sachs lesion
   - **90% anterior (posterior after seizure)**
   - **PE:** +PE for unilateral instability (e.g. + Apprehension, relocation)
   - **Axillary nerve injury (esp. with anterior)**

2. **Pts 20yrs: 80% recur**
   - **2. AMBRI Atraumatic**
     - **Multi-directional, Bilateral, Rehab responsive, Inferior capsule repair**
     - **Hx Pain:** Arms slip out + AMBRI history
     - **XR:** Trauma series
     - **PE:** +sulcus, general joint laxity in MDI

### Rotator Cuff Tear

- **Acute rupture (superior view). Often associated with splitting tear parallel to tendon fibers. Further retraction results in crescentic defect as shown at right.**
- **Communication between shoulder joint and subdeltoid bursa is pathognomonic of cuff tear.**

### Instability/Dislocation: Sternoclavicular Joint

- **Tear of capsule**
  - **Hx Large force:** sports/MVA, pain (anterior: ant prominence, posterior: +/- pulm, XR:** May not show injury
  - **Anterior:** sling/closed reduction
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Examination/Tests</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GI</td>
<td>•Most anterior; Posterior rare, has increased Complications (great vessels)</td>
<td>CT: Helpful in diagnosis</td>
<td>Posterior: early closed reduction immobilize, PT</td>
</tr>
<tr>
<td>LABRUM INJURY (SLAP LESION)</td>
<td>Bicep tendon attachment injury</td>
<td>Hx: Pain, 1/2 instability symptoms PE: 1 O'Brien test</td>
<td>XR: Shoulder series MR/Arthroscopy to diagnose SLAP lesion</td>
</tr>
<tr>
<td></td>
<td>By type:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I. Bicep fraying/anchor intact</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II. Tear in anchor (labrum)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>III. Bucket handle tear</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. III 1 tear in bicep</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>•Nerve injury results in serratus anterior dysfunction</td>
<td>Hx: Usually trauma PE: Winged scapula</td>
<td>NONE</td>
</tr>
<tr>
<td>LONG THORACIC NERVE INJURY</td>
<td>•Often in weightlifters</td>
<td>Hx: Pain in shoulder</td>
<td>XR: Distal clavicle lucency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PECTORALIS MAJOR RUPTURE</td>
<td>•Maximal eccentric contraction</td>
<td>Hx/PE: Sudden, pain, palpable defect</td>
<td>NONE</td>
</tr>
<tr>
<td>ROTATAR CUFF TEAR</td>
<td>•Due to poor vascularity, overuse, micro or macro trauma, degeneration, or abnormal acromion</td>
<td>Hx: Older; pain is deep at night, worse with overhead activity</td>
<td>XR: Trauma series: high-riding humerus</td>
</tr>
<tr>
<td></td>
<td>•Supraspinatus most common</td>
<td>PE: Atrophy, decreased AROM, normal PROM, + drop arm/empty can, + lift off (subscapular tear)</td>
<td>Arthrogram (or MR/Arthrogram): Gold standard: shows communication with subdeltoid bursa</td>
</tr>
<tr>
<td>THORACIC OUTLET SYNDROME</td>
<td>•Compression of neurovascular structure (vein, artery, or plexus) between first rib and scalene muscle • Also seen with cervical ribs</td>
<td>Hx: Women 20-50 yo. Worse with overhead activity Vein: edema, discolor; Artery: cool, claudication Plexus: paresthesias</td>
<td>XR: Shoulder usually normal C-spine: Rule out mass CXR: Rule out mass</td>
</tr>
<tr>
<td></td>
<td>PE: +Adson, +Roos tests</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### SURGICAL APPROACHES

#### Deltopectoral Approach to Shoulder Joint

**Uses** | Internervous Plane | Dangers | Comment
---|---|---|---

#### Arthroscopy Portals

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
</table>
1. Anterior | “Soft spot” between biceps tendon, anterior glenoid, superior edge of subscapular tendon | 1. Musculocutaneous nerve | 1. Usually placed AFTER the posterior portal |
| | | | |
| | | 2. RC tendons | 2. Aim to coracoid when placing |
| 3. Lateral | Through deltoid | 1. Axillary nerve | 1. To access subacromial space |

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OSSIFY</th>
<th>FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUMERUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Long bone characteristics</td>
<td>Primary: Shaft 8-9th wk (fetal)</td>
<td>By birth</td>
<td>• Surgical neck: common fracture site</td>
</tr>
<tr>
<td>• Lateral condyle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Epicondyle: non-articular</td>
<td>Secondary Proximal (3):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Blood supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Medial condyle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Epicondyle: non-articular</td>
<td></td>
<td>3-5 yrs</td>
<td>Distal: Branches from anastomosis</td>
</tr>
<tr>
<td>2. Trochlea: articular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cubital tunnel: covered with Osbourne's fascia</td>
<td></td>
<td>Distal (4):</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Capitellum 1 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Medial epicondyle 4-6 yr</td>
<td>13-14 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Trochlea 9-10 yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Lateral epicondyle 12 yr</td>
<td>15-20 yrs</td>
<td></td>
</tr>
</tbody>
</table>
### PROXIMAL HUMERUS FRACTURE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• Common fracture</strong></td>
<td>HX: Fall/trauma. Pain worse with movement</td>
<td>Neer: based on number of fragments (parts) 1-4</td>
<td>1 part: sling, early motion.</td>
</tr>
<tr>
<td><strong>• Osteoporosis, elderly, female</strong></td>
<td>PE: Swelling, ecchymosis, good neurovascular exam</td>
<td>Multiple combinations of fractures possible</td>
<td>2 part: closed reduction splint. Irreducible, intraarticular anatomic neck fx: ORIF. Greater tuberosity fx: ORIF and Rotator Cuff repair</td>
</tr>
<tr>
<td><strong>• Mechanism:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1. Elderly: fall on outstretched hand</strong></td>
<td>XR: Trauma series Also fracture dislocation, and intraarticular fx</td>
<td></td>
<td>3-4 part: ORIF or hemiarthroplasty (elderly)</td>
</tr>
<tr>
<td></td>
<td>CT: shows intraarticular glenoid involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Young: high energy trauma (e.g. MVA, fall)</strong></td>
<td>MR: sensitive for AVN 4 parts: head, shaft, greater and lesser tuberosities</td>
<td>Fracture/Dislocation:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>• 80% non or minimally displaced (1 part fx)</strong></td>
<td>Each part: 1cm displaced or 45° angulated</td>
<td>2 part: closed treatment except when displaced</td>
<td></td>
</tr>
<tr>
<td><strong>• Most heal well</strong></td>
<td></td>
<td></td>
<td>3-4 part: ORIF or hemiarthroplasty</td>
</tr>
</tbody>
</table>
### Humerus Shaft Fractures

<table>
<thead>
<tr>
<th>Description</th>
<th>Evaluation</th>
<th>Classification</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common fracture</td>
<td>HX: Trauma, fall. Severe pain, swelling</td>
<td>Descriptive</td>
<td>Closed: Most fractures: coaptation splint or fracture brace for 6-8 weeks</td>
</tr>
<tr>
<td>Mechanism: direct blow or fall on outstretched arm</td>
<td>PE: Swelling, deformity +/- radial nerve findings</td>
<td>Location: level of humerus</td>
<td>Open Neurovascular injury, multitrauma, pathologic fracture. Severe comminution requires plates/screws or intermedullary (IM) nail</td>
</tr>
<tr>
<td>Displacement based on fracture site relation to deltoid pectoralis major insertion</td>
<td>XR: AP lateral arm, shoulder and elbow series</td>
<td>Pattern: oblique, spiral, transverse</td>
<td></td>
</tr>
<tr>
<td>Almost 100% union</td>
<td>Displacement or comminution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site of pathologic fx</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPLICATIONS:** Stiffness/adhesive capsulitis; Avascular necrosis (AVN); 4 part anatomic neck, axillary nerve and brachial plexus injury; axillary artery injury, nonunion.

### Distal Humerus Fracture

<table>
<thead>
<tr>
<th>Description</th>
<th>Evaluation</th>
<th>Classification</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncommon</td>
<td>HX: Pain, deformity, discoloration, swelling</td>
<td>Displaced vs. non-displaced</td>
<td>Early motion important to avoid loss of motion</td>
</tr>
<tr>
<td>High morbidity</td>
<td>PE: Swelling, ecchymosis, crepitus, tenderness, good neurovascular exam</td>
<td>Multiple types:</td>
<td>Intercondylar: ORIF or total joint arthroplasty (closed treatment if comminuted or elderly)</td>
</tr>
<tr>
<td>Often intraarticular</td>
<td>XR: AP lateral: posterior fat pad/sail sign</td>
<td>Intercondylar</td>
<td>Transcondylar: reduce, percutaneous pinning</td>
</tr>
<tr>
<td>Mechanism: fall onto hand, ulna forced into humerus</td>
<td>CT: Optional: useful in pre-operative planning</td>
<td>Transcondylar</td>
<td>Others:</td>
</tr>
</tbody>
</table>

**Description:**
- High morbidity: Swelling, ecchymosis, crepitus, tenderness, good neurovascular exam.
- Mechanism: Fall onto hand, ulna forced into humerus.

**Evaluation:**
- Displaced vs. non-displaced.

**Classification:**
- Intercondylar: ORIF or total joint arthroplasty.
- Transcondylar: Reduce, percutaneous pinning.

**Treatment:**
- Early motion important to avoid loss of motion.
- Intercondylar: ORIF or total joint arthroplasty (closed treatment if comminuted or elderly).
- Transcondylar: Reduce, percutaneous pinning.

**Others:**
• Intercondylar most common in adults
  Supracondylar Nondisplaced: closed treatment; 10-14 days and early motion.

• Condylar, capitellum, Trochlea, Epicondylar all rare
  Condylar Displaced or comminuted (or elderly) require ORIF
  Capitellum
  Trochlea
  Epicondylar (medial or lateral)

COMPLICATIONS: Stiffness/arthritis; Compartment syndrome; Median/Ulnar nerve injury; Brachial artery injury; Nonunion

### SUPRACONDYLAR FRACTURE

**DESCRIPTION**
- Common childhood fracture

**EVALUATION**
- HX: Fall. Pain, swelling, will not use arm.

**CLASSIFICATION**
- Occurs at metaphysis, above growth plate
- Extension type

**TREATMENT**
- Neurovascularly intact: closed reduction and percutaneous pinning under general anesthesia (fluoroscopy)
- Extension: Unplaced Partially displaced Fully displaced
- Flexion (rare)

**CLINICAL PEARLS**
- PE: Swelling, point tenderness, +/- neurovascular signs: check distal pulses do neurologic exam
- Pulseless/Perfused: same
most common (90%): shaft is anterior, distal fragment is posterior

XR: AP lateral (note capitellum position to anterior humeral line)  
Pulseless/Unperfused: open reduction exploration

• Associated with significant morbidity; prompt treatment essential.
Arteriogram: if pulseless

COMPLICATIONS: Neurovascular injury: brachial artery; AIN injury; Compartment syndrome can lead to Volkmann's ischemic contracture; Deformity: cubitus varus

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELBOW DISLOCATION</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Common in children and young adults

HX: Fall/trauma. Pain, inability to flex elbow  
Location of ulna (radius)  
Posterior (common)  
Posterolateral (90%)  
Anterior  
Lateral  
Medial  
Closed reduction: + / - local anesthesia and/or conscious sedation

• Younger, sports related fall on hand

PE: Deformity, tenderness, + / - neurovascular signs. Check distal pulses neurologic exam

Splint 7 days for comfort, then early ROM

• Associated with radial head fracture, brachial artery median

XR: AP lateral: rule out fracture

Open: if unstable or with entrapped

Elbow Dislocation  
Radial Head Subluxation

Posterior dislocation of elbow with disruption of ligaments of posterior capsule. Note prominence of olecranon posteriorly.

Dislocation of radius at elbow

Reduction: With thumb in antecubital space as a fulcrum, the forearm is supinated and flexed.
COMPLICATIONS Neurovascular injury: brachial artery; median or ulnar nerve; Loss of extension; Instability/redislocation; Heterotopic ossification

RADIAL HEAD SUBLUXATION (NURSEMAID'S ELBOW)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both collateral ligaments ruptured</td>
<td>Divergent (ulna and radius opposite)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPLICATIONS:</td>
<td>Recurrence</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## Elbow Joints

<table>
<thead>
<tr>
<th>Joint</th>
<th>Type</th>
<th>Articulation</th>
<th>Ligaments</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbow</td>
<td>Includes 3 joints</td>
<td>Capsule (common to all 3)</td>
<td>Ulnar (medial) collateral:</td>
<td>Carrying angle: 10-15°valgus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. Anterior band</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Posterior band</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Transverse band</td>
<td></td>
</tr>
<tr>
<td>Ulnohumeral</td>
<td>Ginglymus [Hinge]</td>
<td>Trochlea and trochlear notch</td>
<td>Radial (lateral) collateral:</td>
<td>Torn in posterior dislocation</td>
</tr>
<tr>
<td>&quot;Trochlear joint&quot;</td>
<td></td>
<td></td>
<td>1. Ulnar part</td>
<td>Strongest: resists valgus stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Radial part</td>
<td></td>
</tr>
<tr>
<td>Radiohumeral</td>
<td>Trochoid [Pivot]</td>
<td>Capitellum radial head</td>
<td>Annular</td>
<td>Weak</td>
</tr>
<tr>
<td>Proximal radioulnar</td>
<td>Radial head radial notch</td>
<td></td>
<td>Oblique cord</td>
<td>Gives posterolateral stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadrade</td>
<td>Supports rotary movements</td>
</tr>
</tbody>
</table>

Carrying angle: 10-15°valgus
MINOR PROCEDURES

ELBOW ARTHROCENTESIS

1. Extend elbow, palpate lateral condyle, radial head and olecranon laterally; feel triangular sulcus between all three
2. Prepare skin over sulcus (iodine/antiseptic soap)
3. Anesthetize skin locally (quarter size spot)
4. May keep arm in extension or flex it. Insert needle in the “triangle” between bony landmarks
5. Fluid should aspirate easily
6. Dress injection site

OLECRANON BURSA ASPIRATION

1. Prepare skin over olecranon (iodine/antiseptic soap)
2. Anesthetize skin locally (quarter size spot)
3. Insert 18 gauge needle into bursa and aspirate fluid.
4. If suspicious of infection, send fluid for Gram stain and culture
5. Dress injection site

TENNIS ELBOW INJECTION

1. Ask patient about allergies
2. Flex elbow 90°, palpate ERCB distal to lateral epicondyle.
3. Prepare skin over lateral elbow (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Insert 22 gauge or smaller needle into ERCB tendon at its insertion just distal to the lateral epicondyle. Aspirate to ensure needle is not in a vessel, then inject 2-3ml of 1:1 local/corticosteroid preparation.

6. Dress insertion site

7. Annotate improvement in symptoms
### HISTORY

**Elbow fractures and dislocations** can result from fall on outstretched dorsiflexed hand.

**Ulnar Nerve Compression**

Compression of nerve on hard surface (chair arm, desk, operating table, etc.)

Numbness and tingling in ulnar nerve distribution in hand. Interosseous wasting between thumb and index finger.

### QUESTION | ANSWER | CLINICAL APPLICATION
--- | --- | ---
1. **AGE**
Young | Dislocation, fracture
Middle age, elderly | Tennis elbow (epicondylitis), arthritis

2. **PAIN**
   
a. **Onset**
   Acute | Dislocation, fracture, tendon avulsion/rupture, ligament injury
   Chronic | Cervical spine pathology

   b. **Location**
   Anterior | Biceps tendon rupture, arthritis
   Posterior | Olecranon bursitis
   Lateral | Lateral epicondylitis, fracture (especially radial head—hard to see on x-ray)
   Medial | Medial epicondylitis, nerve entrapment, fracture, MCL strain

   c. **Occurrence**
   Night pain/at rest | Infection, tumor
   With activity | Ligamentous and/or tendinous etiology

3. **STIFFNESS**
   Without locking | Arthritis, effusions (trauma)

4. **SWELLING**
   Over olecranon | Olecranon bursitis. Other: dislocation, fracture, gout
<table>
<thead>
<tr>
<th><strong>5. TRAUMA</strong></th>
<th>Fall on elbow, hand</th>
<th>Dislocation, fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6. ACTIVITY</strong></td>
<td>Sports, repetitive motion</td>
<td>Epicondylitis, ulnar nerve palsy</td>
</tr>
<tr>
<td><strong>7. NEUROLOGIC SYMPTOMS</strong></td>
<td>Pain, numbness, tingling</td>
<td>Nerve entrapments (multiple possible sites), cervical spine pathology, thoracic outlet syndrome</td>
</tr>
<tr>
<td><strong>8. HISTORY OF ARTHRITIDES</strong></td>
<td>Multiple joints involved</td>
<td>Lupus, rheumatoid arthritis, psoriasis</td>
</tr>
<tr>
<td>EXAM/OBSERVATION</td>
<td>INSPECTION</td>
<td>CLINICAL APPLICATION</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td>----------------------</td>
</tr>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross deformity, swelling</td>
<td>Compare both sides</td>
<td>Dislocation, fracture, bursitis</td>
</tr>
<tr>
<td>Carrying angle (normal 5-15°)</td>
<td>Negative (5 degrees)</td>
<td>Cubitus varus: physeal damage (e.g. malunion supracondylar fracture)</td>
</tr>
<tr>
<td></td>
<td>Positive (15 degrees)</td>
<td>Cubitus valgus: physeal damage (e.g. lateral epicondyle fracture)</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>Epicondyle supracondylar line</td>
<td>Pain: medial epicondylitis (Golfer’s elbow), fracture, MCL rupture</td>
</tr>
<tr>
<td>Ulnar nerve in ulnar groove</td>
<td>Parathesias indicate ulnar nerve entrapment</td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>Epicondyle supracondylar line</td>
<td>Pain: lateral epicondylitis (Tennis elbow), fracture</td>
</tr>
<tr>
<td>Radial head</td>
<td>Pain: arthritis, fracture, synovitis</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>Biceps tendon in antecubital fossa</td>
<td>Pain can indicate biceps tendon rupture</td>
</tr>
<tr>
<td>Posterior</td>
<td>Flex elbow; olecranon olecranon fossa</td>
<td>Olecranon bursitis, triceps tendon rupture</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXAM/OBSERVATION</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow at side, flex extend</td>
<td>Normal: 0.5° to 140-150°</td>
<td></td>
</tr>
<tr>
<td>Flex and extend</td>
<td>Elbow at side, flex at elbow, note if PROM AROM</td>
<td>Normal: 0°–140°/150°; note if PROM AROM</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Pronate and supinate</td>
<td>Tuck elbows, pencils in fists, rotate wrist</td>
<td>Normal: supinate 90 degrees, pronate 80–90 degrees</td>
</tr>
</tbody>
</table>

**NEUROVASCULAR**

<table>
<thead>
<tr>
<th>Sensory</th>
<th>LT, PP, 2 pt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary nerve (C5)</td>
<td>Superolateral arm</td>
</tr>
<tr>
<td>Radial nerve (C5)</td>
<td>Interolateral and posterior arm</td>
</tr>
<tr>
<td>Medial Cutaneous nerve of the Arm (T1)</td>
<td>Medial arm</td>
</tr>
</tbody>
</table>

**Motor**

<table>
<thead>
<tr>
<th>Musculocutaneous n. (C5-6)</th>
<th>Resisted elbow flexion</th>
<th>Weakness = Brachialis/biceps or corresponding nerve/root lesion.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musculocutaneous n. (C6)</td>
<td>Resisted supination</td>
<td>Weakness = Biceps or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Median nerve (C6)</td>
<td>Resisted pronation</td>
<td>Weakness = Pronator Teres or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Median nerve (C7)</td>
<td>Resisted wrist flexion</td>
<td>Weakness = FCR or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Radial nerve (C7)</td>
<td>Resisted elbow extension</td>
<td>Weakness = Triceps or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Radial nerve/PIN (C6-7)</td>
<td>Resisted wrist extension</td>
<td>Weakness = ECRL-B/ECU or corresponding nerve/root lesion.</td>
</tr>
<tr>
<td>Ulnar nerve (C8)</td>
<td>Resisted wrist flexion</td>
<td>Weakness = FCU or corresponding nerve/root lesion.</td>
</tr>
</tbody>
</table>

**Reflexes**

<table>
<thead>
<tr>
<th>C5</th>
<th>Biceps</th>
<th>Hypoactive/absence indicates corresponding radiculopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>Brachioradialis</td>
<td>Hypoactive/absence indicates corresponding radiculopathy</td>
</tr>
<tr>
<td>C7</td>
<td>Triceps</td>
<td>Hypoactive/absence indicates corresponding radiculopathy</td>
</tr>
</tbody>
</table>

**Pulses**

| Brachial, Radial, Ulnar |

**SPECIAL TESTS**

<table>
<thead>
<tr>
<th>Tennis Elbow</th>
<th>Make fist, pronate, extend wrist and fingers against resistance</th>
<th>Pain at lateral epicondyle suggests lateral epicondylitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golfer's Elbow</td>
<td>Supinate arm, extend wrist Elbow</td>
<td>Pain at medial epicondyle suggests medial epicondylitis</td>
</tr>
<tr>
<td>Ligament Instability</td>
<td>25° flexion, apply varus/valgus stress</td>
<td>Pain or laxity indicates LCL/MCL damage</td>
</tr>
<tr>
<td>Tinel's Sign (at the elbow)</td>
<td>Tap on ulnar groove (nerve)</td>
<td>Tingling in ulnar distribution indicates entrapment</td>
</tr>
<tr>
<td>Elbow Flexion</td>
<td>Maximal elbow flexion for</td>
<td>Tingling in ulnar distribution</td>
</tr>
<tr>
<td>Test</td>
<td>Duration</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Elbow Flexion</td>
<td>3-5min</td>
<td>Indicates entrapment</td>
</tr>
<tr>
<td>Pinch Grip</td>
<td></td>
<td>Pinch tips of thumb and index finger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inability (or pinching of pads, not tips)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>indicates AIN pathology</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### MUSCLES: INSERTIONS AND ORIGINS

<table>
<thead>
<tr>
<th>CORACOID PROCESS</th>
<th>GREATER TUBEROUSITY</th>
<th>ANTERIOR PROXIMAL HUMERUS</th>
<th>MEDIAL EPICONDYLE</th>
<th>LATERAL EPICONDYLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ORIGINS</strong></td>
<td><strong>INSERTIONS</strong></td>
<td><strong>INSERTIONS</strong></td>
<td><strong>ORIGINS</strong></td>
<td><strong>ORIGINS</strong></td>
</tr>
<tr>
<td>Biceps (SH)</td>
<td>Supraspinatus</td>
<td>Pectoralis major</td>
<td>Pronator</td>
<td>Anconeus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Teres</td>
<td></td>
</tr>
<tr>
<td>Coracobrachialis</td>
<td>Infra spinatus</td>
<td>Latissimus dorsi</td>
<td>Common</td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flexor Tendon</td>
<td>Extensor Tendon</td>
</tr>
<tr>
<td><strong>INSERTIONS</strong></td>
<td>Teres minor</td>
<td>Teres major</td>
<td>[FCR, PL, FCU, FDS]</td>
<td>[ECRB, ED, EDM, ECU]</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## ANTERIOR MUSCLES

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coracobrachialis</td>
<td>Coracoid process</td>
<td>Middle humerus</td>
<td>Musculocutaneous</td>
<td>Flex and adduct arm</td>
<td></td>
</tr>
<tr>
<td>Brachialis</td>
<td>Distal anterior humerus</td>
<td>Ulnar tuberosity</td>
<td>Musculocutaneous</td>
<td>Flex forearm</td>
<td>Often split in anterior surgical approach</td>
</tr>
<tr>
<td>Biceps brachii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Head</td>
<td>Supraglenoid tubercle</td>
<td>Radial tuberosity</td>
<td>Musculocutaneous</td>
<td>Flex supinate forearm</td>
<td>Can rupture proximally-results in Popeye arm</td>
</tr>
<tr>
<td>Short Head</td>
<td>Coracoid process</td>
<td>Radial tuberosity</td>
<td>Musculocutaneous</td>
<td>Flex supinate forearm</td>
<td>Covers brachial artery</td>
</tr>
</tbody>
</table>
### POSTERIOR MUSCLES

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps Brachii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Head</td>
<td>Infraglenoid tubercle</td>
<td>Olecranon (proximal)</td>
<td>Radial n.</td>
<td>Extends forearm</td>
<td>Border of quadrangular triangular space interval</td>
</tr>
<tr>
<td>Lateral Head</td>
<td>Posterior humerus (proximal)</td>
<td>Olecranon (proximal)</td>
<td>Radial n.</td>
<td>Extends forearm</td>
<td>Border in lateral approach</td>
</tr>
<tr>
<td>Medial Head</td>
<td>Posterior humerus (distal)</td>
<td>Olecranon (proximal)</td>
<td>Radial n.</td>
<td>Extends forearm</td>
<td>One muscular plane in posterior approach</td>
</tr>
</tbody>
</table>
NERVES

### Cutaneous Innervation

**LATERAL CORD**

1. **Musculocutaneous** (C5-7): pierces coracobrachialis between bicep and brachialis. At risk for injury during anterior approach to shoulder.

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>NONE (in arm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>ANTERIOR COMPARTMENT OF ARM</td>
</tr>
<tr>
<td></td>
<td>Coracobrachialis</td>
</tr>
<tr>
<td></td>
<td>Biceps brachii</td>
</tr>
<tr>
<td></td>
<td>Brachialis</td>
</tr>
</tbody>
</table>

**MEDIAL CORD**

2. **Medial Cutaneous Nerve of Arm** (C8-T1): joins intercostal-brachial nerve

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>Medial (inner) arm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>NONE</td>
</tr>
</tbody>
</table>

3. **Ulnar** (C7-T1): travels from anterior to posterior compartment via arcade of Struthers[1], then to cubital tunnel[2].

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>NONE (in arm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>NONE (in arm)</td>
</tr>
</tbody>
</table>

**POSTERIOR CORD**

4. **Radial** (C5-T1): runs with deep artery of arm in triangular interval, then spiral groove 15cm from elbow (injured in shaft fx; at risk in surgery), then it divides at the elbow: 1. PIN (motor), 2. superficial radial nerve (sensory)

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>Lateral arm via Inferior Lateral Cutaneous Nerve of arm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>POSTERIOR COMPARTMENT OF ARM</td>
</tr>
<tr>
<td></td>
<td>Triceps [medial, long, lateral heads]</td>
</tr>
</tbody>
</table>
Anconeus

* possible compression site
ANASTOMOSES AROUND THE ELBOW

<table>
<thead>
<tr>
<th>SUPERIOR</th>
<th>INFERIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior Ulnar Collateral</td>
<td>Posterior Ulnar Recurrent</td>
</tr>
<tr>
<td>Inferior Ulnar Collateral</td>
<td>Anterior Ulnar Recurrent</td>
</tr>
<tr>
<td>Middle Collateral (branch of Deep Artery)</td>
<td>Interosseous Recurrent</td>
</tr>
<tr>
<td>Radial Collateral (branch of Deep Artery)</td>
<td>Radial Recurrent</td>
</tr>
</tbody>
</table>

TRUNK          | BRANCH                               | COURSE/COMMENT                                                                 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachial Artery</td>
<td>Continuation of axillary artery</td>
<td>Medial to biceps, runs with median nerve</td>
</tr>
<tr>
<td></td>
<td>1. Deep artery of arm</td>
<td>Runs with radial nerve in radial groove (posterior humerus)</td>
</tr>
<tr>
<td></td>
<td>2. Nutrient humeral artery</td>
<td>Enters nutrient canal</td>
</tr>
<tr>
<td></td>
<td>3. Superior ulnar collateral</td>
<td>Branches in middle of arm, runs with ulnar nerve</td>
</tr>
<tr>
<td></td>
<td>*Anastomosis with posterior ulnar collateral at elbow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Inferior ulnar collateral</td>
<td>*Anastomosis with anterior ulnar collateral at elbow</td>
</tr>
<tr>
<td></td>
<td>Brachial artery can be clamped below this branch: collateral circulation is usually sufficient.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Muscular</td>
<td></td>
</tr>
</tbody>
</table>
5. Muscular branches
Variable, usually branch laterally

6. Radial artery
These are the two terminal branches of Brachial artery, it divides in the cubital fossa.

7. Ulnar artery

<table>
<thead>
<tr>
<th>Deep Artery of arm</th>
<th>Radial collateral</th>
<th>Anastomosis with Radial recurrent artery at elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial Artery</td>
<td>Middle collateral</td>
<td>Anastomosis with Recurrent interosseous artery at elbow</td>
</tr>
<tr>
<td></td>
<td>Radial Recurrent</td>
<td>Anastomosis with radial collateral artery at elbow</td>
</tr>
<tr>
<td>Ulnar Artery</td>
<td>Anterior ulnar recurrent</td>
<td>Anastomosis with inferior ulnar collateral artery at elbow</td>
</tr>
<tr>
<td></td>
<td>Posterior ulnar recurrent</td>
<td>Anastomosis with superior ulnar collateral artery at elbow</td>
</tr>
<tr>
<td></td>
<td>Common interosseous artery Recurrent interosseous artery</td>
<td>Anastomosis with middle collateral artery at elbow</td>
</tr>
</tbody>
</table>

Collateral branches are all superior branches, recurrent branches are all inferior branches of the anastomosis at the elbow
## DISORDERS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARTHRITIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Uncommon condition</td>
<td>Hx: Chronic pain stiffness</td>
<td>XR: OA vs. inflammatory</td>
<td>1. Conservative (rest, NSAID)</td>
</tr>
<tr>
<td>• Osteoarthritis seen in athletes</td>
<td>PE: Decreased ROM tenderness</td>
<td>Blood: RF, ESR, ANA</td>
<td>2. Debridement</td>
</tr>
<tr>
<td>• Site for arthritides</td>
<td></td>
<td>Joint fluid: crystals, cells, culture</td>
<td>3. Joint replacement</td>
</tr>
<tr>
<td><strong>BICEPS TENDON RUPTURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Trauma: forced elbow flexion against resistance</td>
<td>Hx: Acute onset of pain</td>
<td>XR: usually normal</td>
<td>Surgical reattachment</td>
</tr>
<tr>
<td>• Rare (proximal distal)</td>
<td>PE: Decreased or absent elbow flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CUBITAL TUNNEL SYNDROME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Trauma or stretching of ulnar nerve in cubital tunnel</td>
<td>Hx: Numbness/tingling (+/- pain) in ulnar distribution</td>
<td>XR: Usually negative</td>
<td>1. Rest, ice, NSAID</td>
</tr>
<tr>
<td>• Occurs near FCU origin</td>
<td>PE: +/- decreased grip strength, Tinel's and/or elbow flexion test</td>
<td>Nerve conduction: gives objective data, but often not necessary</td>
<td>2. Splints (day and/or night)</td>
</tr>
<tr>
<td>• Can also be trapped at arcade of Struthers</td>
<td></td>
<td></td>
<td>3. Casting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Nerve decompression and transposition</td>
</tr>
<tr>
<td><strong>LATERAL EPICONDYLITIS (Tennis Elbow)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Degeneration of common extensor tendons (esp. ECRB)</td>
<td>Hx: Age 30-60, chronic pain at lateral elbow, worse with wrist finger extension</td>
<td>XR: Rule out fracture OA. Calcification of tendons can occur (esp. ECRB)</td>
<td>1. Activity modification, ice, NSAIDs</td>
</tr>
<tr>
<td>• Due to overuse (e.g. tennis) or injury (microtrauma)</td>
<td>PE: +Tennis elbow test</td>
<td></td>
<td>2. Use of brace or strap</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Stretching/strengthening</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Corticosteroid injection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. Surgical release of tendon</td>
</tr>
<tr>
<td><strong>LCL SPRAIN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rare condition</td>
<td>Hx: +/- catching and locking</td>
<td>XR: Usually negative</td>
<td>Conservative unless recurrent subluxation, then surgical reconstruction</td>
</tr>
<tr>
<td></td>
<td>PE: + instability with varus stress, + posterolateral (pivot shift) drawer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCL SPRAIN</td>
<td>Hx: Young, throwing athletes, chronic pain or acute onset of pain at MCL, + / - &quot;pop&quot;</td>
<td>XR: occasional spur; rule out fracture (+ / - stress view)</td>
<td>Grade I: conservative (rest, ice, NSAID)</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>• Due to single traumatic or repetitive valgus stress</td>
<td>PE: + / - instability with valgus stress</td>
<td>MRI: before surgery</td>
<td>Grade III (complete tear): surgical repair (use PL)</td>
</tr>
<tr>
<td>• Usual mechanism: throwing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Anterior Band is affected</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEDIAL EPICONDLITIS (Golfer's Elbow)</th>
<th>Hx: Medial elbow pain</th>
<th>XR: Rule out fracture OA. Calcification of tendons can occur</th>
<th>Same as Tennis elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Degeneration of pronator/ flexor group (PT FCR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Due to injury or overuse</td>
<td>PE: Focal medial epicondyle tenderness, + Golfer's elbow test</td>
<td>Surgery is less effective than for lateral epicondylitis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OLECRANON BURSITIS</th>
<th>Hx: Swelling, acute or chronic</th>
<th>Aspirate bursa: send purulent fluid for culture and Gram stain</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inflammation of bursa (Infection/trauma/other)</td>
<td>PE: Palpable mass at olecranon</td>
<td>1. Compressive dressing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Reaspirate if recurs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Corticosteroid injection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OSTEOCHONDRTIS DISSECANS OF ELBOW: OCD</th>
<th>Hx: Young, active (thrower or gymnast), lateral elbow pain</th>
<th>XR: lucency and/or loose body</th>
<th>Type I (fragment stable): Ice, discontinue activity, NSAID</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Repetitive valgus stresses (e.g. throwing or gymnastics)</td>
<td>PE: + / - catching and/or locking, crepitus with pronation and supination</td>
<td>CT/MRI: determine articular and subchondral involvement</td>
<td>Type II-III (loose fragment): Drill or curette fragment</td>
</tr>
<tr>
<td>• Vascular compromise and microtrauma of capitellum</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TRICEPS TENDON RUPTURE</th>
<th>Hx: Pain in posterior elbow</th>
<th>XR: usually normal</th>
<th>Surgical reattachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Trauma: forced elbow extension against resistance</td>
<td>PE: Loss of active elbow extension</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SURGICAL APPROACHES

#### HUMERUS: ANTERIOR APPROACH

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVOUS PLANES</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ORIF of fractures</td>
<td>Proximal</td>
<td>Proximal</td>
<td>• Anterior humeral circumflex artery may need ligation.</td>
</tr>
<tr>
<td></td>
<td>1. Deltoid [Axillary]</td>
<td>1. Axillary nerve</td>
<td></td>
</tr>
<tr>
<td>2. Bone biopsy or tumor removal.</td>
<td>Distal</td>
<td>Distal</td>
<td>• The brachialis has a split innervation which can be used for an internervous plane.</td>
</tr>
<tr>
<td></td>
<td>1. Brachialis splitting</td>
<td>1. Radial nerve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lateral [Radial]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medial [MC]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### ELBOW: LATERAL APPROACH (KOCHER)

<table>
<thead>
<tr>
<th>USES</th>
<th></th>
<th></th>
<th></th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most radial head procedures</td>
<td>Most radial head procedures</td>
<td></td>
<td></td>
<td>• Protect PIN: stay above annular ligament; keep forearm pronated</td>
</tr>
<tr>
<td>1. Anconeus [Radial]</td>
<td>1. PIN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ECU [PIN]</td>
<td>2. Radial nerve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USES</td>
<td>INTERNERVIOUS PLANES</td>
<td>DANGERS</td>
<td>COMMENT</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td>ELBOW: POSTERIOR APPROACH (BRYAN/MORREY)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Arthroplasty</td>
<td>No planes</td>
<td>Ulnar nerve</td>
<td>Triceps is detached from the olecranon. MCL release may be necessary.</td>
<td></td>
</tr>
<tr>
<td>2. Distal humerus and olecranon fractures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Loose body removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 4 - FOREARM

- TOPOGRAPHIC ANATOMY
- OSTEOLOGY OF THE FOREARM
- OSTEOLOGY OF THE WRIST
- TRAUMA
- JOINTS: WRIST
- OTHER WRIST STRUCTURES
- MINOR PROCEDURES
- HISTORY
- PHYSICAL EXAM
- MUSCLES: ORIGINS & INSERTIONS
- ANTERIOR COMPARTMENT MUSCLES: SUPERFICIAL FLEXORS
- POSTERIOR COMPARTMENT MUSCLES: SUPERFICIAL EXTENSORS
- ANTERIOR COMPARTMENT MUSCLES: DEEP FLEXORS
- POSTERIOR COMPARTMENT MUSCLES: DEEP EXTENSORS
- MUSCLES: CROSS SECTIONS
- NERVES
- ARTERIES
- DISORDERS: ARTHRITIS & INSTABILITY
- DISORDERS: NERVE COMPRESSION
- OTHER DISORDERS
- SURGICAL APPROACHES
OSTEOLOGY OF THE FOREARM

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OSSIFY</th>
<th>FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RADIUS</strong></td>
<td></td>
<td></td>
<td>Elbow ossification: used to determine bone age in peds</td>
</tr>
<tr>
<td>• Cylindrical long bone</td>
<td></td>
<td>8-9 weeks</td>
<td>14-21 years</td>
</tr>
<tr>
<td>• Head within elbow joint</td>
<td>Primary: Shaft</td>
<td>fetal</td>
<td>years</td>
</tr>
<tr>
<td>• Tuberosity outside joint</td>
<td>Secondary</td>
<td>1. Proximal epiphysis</td>
<td>1-9</td>
</tr>
<tr>
<td>• Palpate head laterally</td>
<td>2. Distal epiphysis</td>
<td>14-21 years</td>
<td></td>
</tr>
<tr>
<td>• Styloid is distal</td>
<td></td>
<td>years</td>
<td></td>
</tr>
</tbody>
</table>

| **ULNA** | | | |
| • Cylindrical long bone | | 8-9 weeks | |
| Olecranon | Primary: Shaft | | Olecranon |

Elbow ossification order: Capitelum, Radial head, Medial epicondyle, Trochlea, Olecranon, Lateral Epicondyle (Captain Roy Makes Trouble On Leave)
- palpable posteriorly at elbow
- Styloid process distally

<table>
<thead>
<tr>
<th>Secondary</th>
<th>(fetal)</th>
<th>16-20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Olecranon</td>
<td>10 years 5-6 yrs</td>
<td>16-20 years</td>
</tr>
<tr>
<td>2. Distal epiphysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Olecranon and coronoid give the elbow bony stabilization.
### OSTEOLOGY OF THE WRIST

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OSSIFY FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROXIMAL ROW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scaphoid: boat shaped,</td>
<td>5th 5</td>
<td>• Lies beneath the anatomic snuffbox</td>
</tr>
<tr>
<td>80% of surface is</td>
<td>years 14-16</td>
<td>Distal (to waist) blood supply (radial artery); proximal pole is</td>
</tr>
<tr>
<td>articular (not the</td>
<td>yrs</td>
<td>susceptible to necrosis if injured</td>
</tr>
<tr>
<td>waist)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunate: moon shaped</td>
<td>4th 4</td>
<td>• Dislocations often missed</td>
</tr>
<tr>
<td></td>
<td>years 14-16</td>
<td>Blood supply is palmar: palmar fractures need ORIF to protect against</td>
</tr>
<tr>
<td></td>
<td>yrs</td>
<td>osteonecrosis; dorsal fractures treated nonsurgically</td>
</tr>
<tr>
<td>Triquetrum: pyramid</td>
<td>3rd 3</td>
<td></td>
</tr>
<tr>
<td>shaped</td>
<td>years 14-16</td>
<td></td>
</tr>
<tr>
<td>Pisiform: large</td>
<td>8th 9-12</td>
<td>• In the FCU tendon; TCL attaches</td>
</tr>
<tr>
<td>sesamoid bone</td>
<td>years 14-16</td>
<td></td>
</tr>
<tr>
<td><strong>DISTAL ROW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trapezium: most radial</td>
<td>6th 5-6</td>
<td>• Articulates with 1st metacarpal; TCL attaches, FCR</td>
</tr>
<tr>
<td></td>
<td>years 14-16</td>
<td></td>
</tr>
<tr>
<td>Trapezoid: wedge shape</td>
<td>7th 5-6</td>
<td>• Articulates with 2nd metacarpal</td>
</tr>
<tr>
<td></td>
<td>years 14-16</td>
<td></td>
</tr>
<tr>
<td>Capitate: largest</td>
<td>1st 1</td>
<td>• First to ossify</td>
</tr>
<tr>
<td>carpal bone</td>
<td>year 14-16</td>
<td></td>
</tr>
<tr>
<td>Hamate: has a hook</td>
<td>2nd 1-2</td>
<td>• TCL, FCU attach to the hook</td>
</tr>
<tr>
<td>Text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamate: has a hook</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCL, FCU attach to the hook</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ossification: each from a single center: counterclockwise (anatomic position) starting with capitate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpal tunnel borders: Roof: Transverse carpal ligament; Lateral wall: scaphoid trapezium; Medial wall: pisiform hamate Contents: Median nerve, flexor tendons</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guyon's canal: Roof: volar carpal ligament; Floor: TCL; Lateral wall: hamate (hook); Medial wall: pisiform Contents: Ulnar nerve and artery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anatomic snuffbox: Between tendons of EPL and EPB; Contents: Radial artery (scaphoid directly deep to snuffbox)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
TRAUMA

### OLECRANON FRACTURE

- **Mechanism:**
  - Fall directly on elbow; fall on hand
  - Articular surface always involved
  - Triceps tendon pulls fragment

- **HX:** Fall/trauma. Swelling, pain, +/- numbness.
- **PE:** Effusion, tenderness; +/- decreased elbow extension. Good neurovascular exam (esp. ulnar nerve)
- **XR:** AP/lateral

- **Colton:**
  - Undisplaced: 2mm
  - Displaced:
    - avulsion
    - transverse/oblique
    - comminuted
    - fracture/dislocation

- **TREATMENT:**
  - Undisplaced: Cast at 45-90° for 3 weeks, then gentle ROM
  - Displaced: ORIF with tension band wires or bicortical screw. (comminuted fracture: excise bone then reattach triceps)

**COMPLICATIONS:**

- Ulnar nerve injury (most resolve); Decreased ROM; Arthritis

### RADIAL HEAD FRACTURE

- **Common**
  - Fall on outstretched arm radius pushed into capitellum
  - Intraarticular fracture
  - Can be associated with elbow dislocation

- **HX:** Fall. Pain, swelling, decreased function.
- **PE:** Tenderness of radial head, decreased ROM especially pronation/supination. Test MCL stability
- **XR:** AP/lateral: +fat pad

- **Mason: 4 Types**
  - Type I: Undisplaced
  - Type II: Displaced
  - Type III: Comminuted (head)
  - Type IV: Fracture with elbow dislocation

- **TREATMENT:**
  - Type I: Splint for 3 days, then early ROM
  - Type II: If motion intact-splint, then early ROM. If 1/3 of head involved or 3mm displaced-ORIF or excision
### Type III: Radial Head Excision

**COMPLICATIONS**: Decreased ROM; Instability

### BOTH BONE FRACTURE

- **Mechanism**: high energy injuries
  - Fractures in shaft of single bone shorten, resulting forces cause fracture in other bone
  - Nightstick fracture: ulnar shaft fracture only

**HX**: Trauma. Pain, swelling.
**PE**: Tenderness, deformity. Check compartments and do neurovascular PE
**XR**: AP/lateral: including wrist and elbow

**Descriptive**:
- Undisplaced
- Displaced
- Comminuted

**ORIF** (usually plates and screws) through two separate incisions.
- **Nightstick**: Undisplaced-closed treatment; Displaced-ORIF
- **Peds**: closed, LAC 6-8wks

**COMPLICATIONS**: Loss of Pronation and supination; Nonunion

---

### Monteggia Fracture

Fractures of proximal ulna often characterized by anterior angulation of ulna and anterior dislocation of radial head (Monteggia fracture).

**HX**: Fall. Pain, swelling.
**PE**: Tenderness, deformity. Check compartments and do neurovascular PE
**XR**: AP/lateral: including wrist and elbow

- **Bado (based on radial head location)**:
  - I: Anterior (common)
  - II: Posterior

**Ulna**: ORIF (plates/screws)
**Radial head**: closed reduction (open if irreducible or)

---

### Galeazzi Fracture

**Anteroposterior view** of fracture of distal radius with dislocation of distal radioulnar joint (Galeazzi fracture)

**Dislocation of distal radioulnar joint** better demonstrated in lateral view

---

### Table: MONTEGGIA FRACTURE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal ulna fracture, shortening • forces result in radial head dislocation.</td>
<td>HX: Fall. Pain, swelling. PE: Tenderness, deformity. Check compartments and do neurovascular PE</td>
<td>Bado (based on radial head location): I: Anterior (common) II: Posterior</td>
<td>Ulna: ORIF (plates/screws) Radial head: closed reduction (open if irreducible or)</td>
</tr>
</tbody>
</table>
**Galeazzi/Piedmont Fracture**

**Mechanism:** Fall on outstretched hand. Distal radial shaft fracture, shortening forces result in distal radioulnar dislocation.

**HX:** Fall, pain, swelling. PE: Tenderness, deformity. Check compartments and do neurovascular exam. 

**XR:** AP/lateral: including wrist and elbow.

**By mechanism:**
- **Pronation:** Galeazzi
- **Supination:** Reverse Galeazzi (ulna shaft fracture with DRUJ dislocation)

**Radius:** ORIF (plate/screws) 
**DRUJ:** closed reduction, +/- percutaneous pins. (open treatment if unstable)

Cast immobilization for 4-6wks.
Peds: closed reduction, cast.

**Comlications:** Nerve injury; Decreased ROM; Nonunion; Distal radioulnar joint (DRUJ) arthrosis
**DESCRIPTION**
- Most common carpal fracture
- Fall on outstretched arm
- High complication rate

**EVALUATION**
- HX: Fall. Pain worse with gripping, swelling.
- PE: "Snuffbox" tenderness, swelling on radial wrist

**CLASSIFICATION**
- By location:
  - Proximal pole
  - Middle ("waist")
  - Distal pole

**TREATMENT**
- If clinical symptoms with negative xray: thumb spica for 10-14 days then re-evaluate.
- Nondisplaced: cast 6-12 wks
- Displaced: ORIF or external fixation

---

**COMPLICATIONS:** Loss of motion; Deformity; Median nerve injury; Malunion; Scapholunate dislocation

---

**Scaphoid Fracture**

[Image of scaphoid fracture]

**Carpal Dislocation**

[Image of carpal dislocation]

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCAPHOID FRACTURE</td>
<td>Most common carpal fracture</td>
<td>HX: Fall. Pain worse with gripping, swelling.</td>
<td>If clinical symptoms with negative xray: thumb spica for 10-14 days then re-evaluate.</td>
</tr>
<tr>
<td>Fall on outstretched arm</td>
<td>PE: &quot;Snuffbox&quot; tenderness, swelling on radial wrist</td>
<td>Proximal pole, Middle (&quot;waist&quot;), Distal pole</td>
<td>Nondisplaced: cast 6-12 wks</td>
</tr>
<tr>
<td>High complication rate</td>
<td>By location: Proximal pole, Middle (&quot;waist&quot;), Distal pole</td>
<td>If clinical symptoms with negative xray: thumb spica for 10-14 days then re-evaluate.</td>
<td>Displaced: ORIF or external fixation</td>
</tr>
</tbody>
</table>
- Proximal pole with tenuous blood supply
- Also PA with ulnar deviation/oblique
- Displaced, ORIF (K-wire or Herbert screw)

COMPLICATIONS: Nonunion/malunion; Osteonecrosis: especially of proximal pole; Degenerative Joint Disease (DJD)

<table>
<thead>
<tr>
<th>CARPAL DISLOCATION: PERILUNATE INSTABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncommon: hyperextension supination injury</td>
</tr>
<tr>
<td>Injury determined by progression of ligament disruption (see joint chart)</td>
</tr>
<tr>
<td>Space of Poirer is weak (Capitate-lunate joint)</td>
</tr>
<tr>
<td>HX: Fall. Pain. PE: Wrist pain, + Watson sign. XR: AP/lateral: 3mm SL gap is Terry Thomas sign, +/- 2 Scaphoid ring sign Cinearthrogram: definitive diagnosis</td>
</tr>
<tr>
<td>Mayfield (4 stages):</td>
</tr>
<tr>
<td>I: Scapholunate diastasis</td>
</tr>
<tr>
<td>II: Perilunate dislocation</td>
</tr>
<tr>
<td>III: Lunotriquetral diastasis</td>
</tr>
<tr>
<td>IV: Volar lunate dislocation.</td>
</tr>
<tr>
<td>Closed reduction and cast simple cases. Open reduction, pin fixation, and primary ligament repair usually required.</td>
</tr>
</tbody>
</table>

COMPLICATIONS: Wrist instability and/or pain; SLAC wrist

**DESCRIPTION**

**EVALUATION**

**CLASSIFICATION**

**TREATMENT**

<table>
<thead>
<tr>
<th>INCOMPLETE FRACTURE: TORUS GREENSTICK FRACTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common in children (usually ages 6-12)</td>
</tr>
<tr>
<td>Mechanism:</td>
</tr>
<tr>
<td>Hx: Trauma. Pain, inability to use arm</td>
</tr>
<tr>
<td>Torus (Buckle): concave cortex compresses</td>
</tr>
<tr>
<td>Torus: reduction rarely needed</td>
</tr>
<tr>
<td>Mechanism</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

- **use arm.**
- **PE: +/- deformity.**
- **Point tenderness swelling.**
- **XR: AP and lateral: only one cortex involved.**
- **Greenstick: concave cortex intact, convex/tension side fracture/plastic deformity**

**COMPLICATIONS:** Deformity; Malunion; Neurovascular injury (rare)

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
JOINTS: WRIST

LIGAMENTS | ATTACHMENTS | COMMENTS
--- | --- | ---
**RADIOCARPAL** (Ellipsoid type)
Capsule | Surrounds joint | Loose, provides little support
Volar radiocarpal (VRC) | Multiple intracapsular ligaments | Strong; space of Poirier (lunocapitate) is weak. Injury leads to instability.
Radioscaphocapitate (RSC) | Radial styloid to capitute | Stabilizes radial wrist, distal row, midcarpal joint. Disrupted in perilunate instability stage II.
Radioscapholunate (RSL) | Radial styloid to lunate | Stabilizes radial wrist, scapholunate joint; Disrupted in DISI, perilunate instability stage I.
Radiolunotriquetral (RTL) | Radial styloid to triquetrum | Largest, volar sling for lunate, lunotriquetral joint stabilizer. Disrupted in perilunate instability stage III.
Dorsal radiocarpal (DRC) | Radius, scaphoid, lunate, triquetrum | Weak; stabilizes proximal row, radiolunate joint. Disrupted in perilunate instability stage IV.
Radial collateral | Radius, scaphoid, trapezium, TCL | Stabilizes proximal row. Radial artery runs adjacent to it.

**RADIOULNAR** (Pivot type)
Triangular Fibrocartilage Complex (TFCC): Multiple components stabilize joint, absorbs axial load; any tear or injury results in pain

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>ORIGIN</th>
<th>INSERTION</th>
</tr>
</thead>
</table>
Dorsal Volar Radioulnar | Ulnar radius | Caput ulna |
Triangular fibrocartilage (disc) | Radius/ulna | Triquetrum |
Meniscus homologue | Ulna/disc | Triquetrum |
Ulnar collateral/ECU | Ulna | Fifth metacarpal |

**OTHER LIGAMENTS**
Ulnocarpal: Often considered part of TFCC; Stabilizes proximal row of carpus
Ulnolunate | Ulna | Lunate |
Ulnotriquetral  Ulna  Triquetrum

### JOINT TYPE

- **INTERCARPAL**

### LIGAMENTS

- **Dorsal:** Stronger

### ATTACHMENTS

- **Stabilize**
<table>
<thead>
<tr>
<th>Proximal Row</th>
<th>Gliding</th>
<th>2 Dorsal intercarpal</th>
<th>2 Palmar intercarpal</th>
<th>2 Interosseous</th>
<th>Scapholunate, lunotriquetral</th>
<th>Scapholunate, lunotriquetral</th>
<th>Scapholunate, lunotriquetral.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stabilize SL or LT joints</td>
<td>DISI: SL ligament injury</td>
<td>VSI: LT ligament injury</td>
</tr>
<tr>
<td>Pisiform Articulation</td>
<td>Capsule</td>
<td>Ulnar collateral</td>
<td>Volar radiocarpal</td>
<td>Pisohamate</td>
<td>Pisometacarpal</td>
<td>Pisiform triquetrum</td>
<td>Ulna to pisiform</td>
</tr>
<tr>
<td>Distal Row</td>
<td>Gliding</td>
<td>3 Dorsal intercarpal</td>
<td>3 Palmar intercarpal</td>
<td>2 interosseous</td>
<td>All four bones in distal row</td>
<td>All four bones in distal row</td>
<td>Trapezoid to capitate to hamate</td>
</tr>
<tr>
<td>MIDCARPAL</td>
<td>Ellipsoid</td>
<td>Palmar (Volar) intercarpal</td>
<td>Carpal collaterals</td>
<td>Capitotriquetral (CTL)</td>
<td>Proximal distal carpal rows</td>
<td>Capitate to triquetrum</td>
<td>1/3 of wrist extension, 2/3 of wrist flexion occurs here</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### OTHER WRIST STRUCTURES

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>FUNCTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensor Retinaculum Dorsal Compartments</td>
<td>Covers dorsum of the wrist</td>
<td>Forms six fibroosseous dorsal compartments</td>
</tr>
<tr>
<td></td>
<td>I: APL, EPB</td>
<td>DeQuervain’s tenosynovitis can develop here</td>
</tr>
<tr>
<td></td>
<td>II: ECRL, ECRB</td>
<td>Tendinitis (carpal bossing)</td>
</tr>
<tr>
<td></td>
<td>III: EPL</td>
<td>Around Listet’s tubercle: tendon can rupture</td>
</tr>
<tr>
<td></td>
<td>IV: EDC, EIP</td>
<td>Tenosynovitis, ganglions</td>
</tr>
<tr>
<td></td>
<td>V: EDM</td>
<td>Jackson-Vaughn syndrome (rupture from RA)</td>
</tr>
<tr>
<td></td>
<td>VI: ECU</td>
<td>Tendon can “snap” over ulnar styloïd</td>
</tr>
</tbody>
</table>

| Transverse Carpal Ligament (TCL, Flexor Retinaculum)        | Covers volar wrist Attaches to:                                         | Roof of carpal tunnel, floor of Guyon’s canal (ulnar nerve can entrap here) |
|                                                             | Medial: pisiform hook of hamate                                          |                                                                         |
|                                                             | Lateral: scaphoid trapezium                                             |                                                                         |
MINOR PROCEDURES

**WRIST ASPIRATION/INJECTION**

1. Ask patient about allergies
2. Palpate radiocarpal joint dorsally for EPL, ECRB, Lister's tubercle and the space ulnar to them
3. Prepare skin over dorsal wrist (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
   - Aspiration: Insert 20 gauge needle into space ulnar to Lister's tubercle/ECRB and radial to EDC, aspirate.
   - Injection: Insert 22 gauge needle into same space, aspirate to ensure not in vessel, then inject 1-2ml of local or local/steroid preparation into RC joint.
5. Dress injection site
6. If suspicious for infection, send fluid for Gram stain culture

**CARPAL TUNNEL INJECTION/MEDIAN NERVE BLOCK**

1. Ask patient about allergies
2. Ask patient to pinch thumb and small finger tips, Palmaris longus (PL) tendon will protrude (10-20% do not have one) median nerve is directly beneath PL, just ulnar to FCR
3. Prepare skin over volar wrist (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
   - Insert 22 gauge or smaller needle into wrist under PL at flexion crease. Aspirate to ensure needle is not in a vessel. Inject 1-2ml of local or local/steroid preparation.
5. Dress injection site
### HISTORY

**Colles Fracture**
Most commonly results from fall on outstretched dorsiflexed hand.

**Fracture of Scaphoid**
Usually caused by fall on outstretched hand with impact on thenar eminence.

### QUESTION | ANSWER | CLINICAL APPLICATION
---|---|---
1. **AGE**<br>Young<br>Middle age-elderly | Trauma: fractures and dislocations, ganglions<br>Arthritis, nerve entrapments, overuse |
2. **PAIN**
   a. Onset<br>b. Location<br>Acute<br>Chronic<br>Dorsal<br>Volar<br>Radial<br>Ulnar | Trauma<br>Arthritis<br>Kienbock's disease, ganglion<br>Carpal tunnel syndrome (CTS), ganglion (especially radiovolar)<br>Scaphoid fracture, DeQuervain's tenosynovitis, arthritis<br>Triangular Fibrocartilage Complex (TFCC) tear, tendinitis |
3. **STIFFNESS**
   with dorsal pain<br>with volar pain (at night) | Kienbock's disease<br>Carpal tunnel syndrome |
4. **SWELLING**
   Joint: after trauma<br>Joint: no trauma<br>Along tendons | Fracture or sprain<br>Arthritis, infection, gout<br>Flexor or extensor tendinitis (calcific), DeQuervain's disease |
5. **INSTABILITY**
Popping, snapping | Scapholunate dissociation |
<table>
<thead>
<tr>
<th>6. MASS</th>
<th>Along wrist joint</th>
<th>Ganglion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. TRAUMA</td>
<td>Fall on hand</td>
<td>Fractures: distal radius, scaphoid; Dislocation: lunate, ulna TFCC tear</td>
</tr>
<tr>
<td>8. ACTIVITY</td>
<td>Repetitive motion (typing)</td>
<td>Carpal Tunnel Syndrome (CTS), DeQuervain's tenosynovitis</td>
</tr>
<tr>
<td>9. NEUROLOGIC SYMPTOMS</td>
<td>Numbness, tingling Weakness</td>
<td>Nerve entrapment, thoracic outlet syndrome, radiculopathy Nerve entrapment (median e.g. CTS), ulnar, or radial</td>
</tr>
<tr>
<td>10. HISTORY OF ARTHRITIDES</td>
<td>Multiple joints involved</td>
<td>Arthritis</td>
</tr>
</tbody>
</table>
## PHYSICAL EXAM

<table>
<thead>
<tr>
<th>EXAMINATION</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross deformity</td>
<td>Bones and soft tissues</td>
<td>Fractures, dislocations: forearm and wrist</td>
</tr>
<tr>
<td>Swelling</td>
<td>Especially dorsal or radial</td>
<td>Ganglion</td>
</tr>
<tr>
<td></td>
<td>Diffuse</td>
<td>Trauma, infection</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin changes</td>
<td>Warm, red</td>
<td>Infection, gout</td>
</tr>
<tr>
<td></td>
<td>Cool, dry</td>
<td>Neurovascular compromise</td>
</tr>
<tr>
<td>Radial and Ulnar</td>
<td>Palpate each separately</td>
<td>Tenderness may indicate fracture</td>
</tr>
<tr>
<td>styloids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpal bones</td>
<td>Both proximal and distal row</td>
<td>Snuffbox tenderness: scaphoid fracture; lunate tenderness: Kienbock's disease.</td>
</tr>
<tr>
<td></td>
<td>Proximal row</td>
<td>Scapholunate dissociation</td>
</tr>
<tr>
<td></td>
<td>Pisiform</td>
<td>Tenderness: pisotrequetral arthritis or FCU tendinitis</td>
</tr>
<tr>
<td>Soft tissues</td>
<td>6 dorsal extensor compartments</td>
<td>Tenderness over 1st compartment: DeQuervain's disease</td>
</tr>
<tr>
<td></td>
<td>TFCC: distal to ulnar styloid</td>
<td>Tenderness indicates TFCC injury</td>
</tr>
<tr>
<td></td>
<td>Compartments</td>
<td>Firm/tense compartments: compartment syndrome</td>
</tr>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flex and extend</td>
<td>Flex (toward palm), extend opposite</td>
<td>Normal: flexion 80°, extension 75°</td>
</tr>
<tr>
<td>Radial/ulnar</td>
<td>In same plane as the palm</td>
<td>Normal: radial 15-20°, ulnar 30-40°</td>
</tr>
<tr>
<td>deviation</td>
<td>Flex elbow 90°; hold pencil, rotate wrist</td>
<td>Normal: supinate 90°, pronate 80-90° (only 10-15° is in the wrist, most motion is in elbow)</td>
</tr>
<tr>
<td>Pronate and supinate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NEUROVASCULAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory</td>
<td>(LT, PP, 2 pt)</td>
<td></td>
</tr>
<tr>
<td>Musculocutaneous</td>
<td>Lateral forearm</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>nerve (C6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial Cutaneous</td>
<td>Medial forearm</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>nerve of forearm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(T1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Radial Nerve (C6-7)
- **Resisted wrist extension**
  - Weakness: ECRL/B or corresponding nerve/root lesion

### PIN (C6-7)
- **Resisted ulnar deviation**
  - Weakness: ECU or corresponding nerve/root lesion

### Ulnar Nerve (C8)
- **Resisted wrist flexion**
  - Weakness: FCR or corresponding nerve/root lesion

### Median Nerve (C7)
- **Resisted wrist flexion**
  - Weakness: FCR or corresponding nerve/root lesion

### Median Nerve (C6)
- **Resisted pronation**
  - Weakness: Pronator Teres or nerve/root lesion

### Musculocutaneous (C6)
- **Resisted supination**
  - Weakness: Biceps or corresponding nerve/root lesion

### Reflex
- **C6**
  - Brachioradialis
  - Hypoactive/absence indicates corresponding radiculopathy

### Pulses
- **Radial, Ulnar**
  - Diminished/absent = vascular injury or compromise (perform Allen test)

### Phalen Test
- Maximal flexion of both wrists for several minutes
  - Reproduction of symptoms (numbness or tingling): Carpal Tunnel Syndrome (CTS)

### Tinel Test
- Tap volar wrist (carpal tunnel/TCL)
  - Pain, numbness suggests Median nerve compression (CTS)

### Finkelstein Test
- Make fist with thumb inside, then ulnar deviation
  - Pain over 1st compartment (APL, EPB) suggests DeQuervain's tenosynovitis
<table>
<thead>
<tr>
<th>Watson</th>
<th>Push scaphoid anteroposterior with wrist in radial or ulnar deviation</th>
<th>Positive if scaphoid subluxes or reduces: carpal ligament injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen</td>
<td>Occlude radial ulnar arteries, pump fist then release one artery only</td>
<td>Delay or absent of “pinking up” of palm suggest arterial compromise of artery released</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
MUSCLES: ORIGINS INSERTIONS

<table>
<thead>
<tr>
<th>PROXIMAL ULNA</th>
<th>PROXIMAL RADIUS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTERIOR</strong></td>
<td><strong>ANTERIOR</strong></td>
</tr>
<tr>
<td><strong>INSERTIONS</strong></td>
<td><strong>INSERTIONS</strong></td>
</tr>
<tr>
<td>Brachialis</td>
<td>Biceps</td>
</tr>
<tr>
<td>Supinator</td>
<td></td>
</tr>
<tr>
<td><strong>ORIGINS</strong></td>
<td><strong>ORIGINS</strong></td>
</tr>
<tr>
<td>Flexor Digitorum</td>
<td>Flexor Digitorum</td>
</tr>
<tr>
<td>Superficialis [1 head]</td>
<td>Superficialis [1 head]</td>
</tr>
<tr>
<td>Pronator teres</td>
<td></td>
</tr>
<tr>
<td>Flexor Pollicis longus</td>
<td></td>
</tr>
<tr>
<td>Supinator</td>
<td></td>
</tr>
</tbody>
</table>
### Proximal Ulna Proximal Radius

#### Posterior

<table>
<thead>
<tr>
<th>Origins</th>
<th>Insertions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor carpi ulnaris</td>
<td>NONE</td>
</tr>
<tr>
<td>Triceps brachii muscle</td>
<td>(medial head)</td>
</tr>
<tr>
<td>Triceps brachii tendon</td>
<td></td>
</tr>
<tr>
<td>Anconeus muscle</td>
<td></td>
</tr>
<tr>
<td>Brachialis muscle</td>
<td></td>
</tr>
<tr>
<td>Supinator muscle</td>
<td></td>
</tr>
<tr>
<td>Abductor pollicis longus muscle</td>
<td></td>
</tr>
<tr>
<td>Extensor pollicis longus muscle</td>
<td></td>
</tr>
<tr>
<td>Extensor carpi radialis longus muscle</td>
<td></td>
</tr>
<tr>
<td>Extensor carpi radialis brevis muscle</td>
<td></td>
</tr>
<tr>
<td>Extensor digitorum muscle (central tendon)</td>
<td></td>
</tr>
<tr>
<td>Extensor digiti minimi muscle</td>
<td></td>
</tr>
<tr>
<td>Extensor digitorum muscle (lateral band)</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### ANTERIOR COMPARTMENT MUSCLES: SUPERFICIAL FLEXORS

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pronator Teres [PT]</td>
<td>Medial epicondyle coronoid process</td>
<td>Lateral radius-middle 1/3</td>
<td>Median</td>
<td>Pronate and flex forearm</td>
<td>May trap AIN (AIN syndrome)</td>
</tr>
<tr>
<td>Flexor carpi radialis [FCR]</td>
<td>Medial epicondyle</td>
<td>Base of 2nd 3rd metacarpal</td>
<td>Median</td>
<td>Flex wrist, radial deviation</td>
<td>Radial artery is immediately lateral</td>
</tr>
<tr>
<td>Palmaris Longus [PL]</td>
<td>Medial epicondyle</td>
<td>Flexor retinaculum palmar aponeurosis</td>
<td>Median</td>
<td>Flex wrist</td>
<td>Used for tendon transfers. 10% congenitally absent</td>
</tr>
<tr>
<td>Flexor carpi ulnaris [FCU]</td>
<td>Medial epicondyle posterior ulna</td>
<td>Pisoform, hook of hamate, 5th MC</td>
<td>Ulnar</td>
<td>Flex wrist, ulnar deviation</td>
<td>Most powerful wrist flexor</td>
</tr>
<tr>
<td>MUSCLE</td>
<td>ORIGIN</td>
<td>INSERTION</td>
<td>NERVE</td>
<td>ACTION</td>
<td>COMMENT</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------------------------------</td>
<td>------------------------------------------</td>
<td>-------------</td>
<td>----------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Flexor digitorum superficialis [FDS]</td>
<td>1. Medial epicondyle, coronoid process</td>
<td>Middle phalanges of digits (not thumb)</td>
<td>Median</td>
<td>Flex PIP (also flex digit and hand)</td>
<td>Sublimus test will isolate test function</td>
</tr>
<tr>
<td></td>
<td>2. Anteroproximal radius</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor digitorum profundus [FDP]</td>
<td>Anterior ulna Intossseus membrane</td>
<td>Distal phalanx (IF/MF)</td>
<td>Median/AIN</td>
<td>Flex DIP (also flex digit and hand)</td>
<td>Avulsion: Jersey finger.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FDP and FPL are most susceptible to Volkmann's contracture.</td>
</tr>
<tr>
<td>Flexor pollicis longus [FPL]</td>
<td>Anterior radius coronoid process</td>
<td>Distal phalanx of thumb</td>
<td>Median/AIN</td>
<td>Flex thumb (P)</td>
<td></td>
</tr>
<tr>
<td>Pronator quadratus [PQ]</td>
<td>Medial distal ulna</td>
<td>Anterior distal radius</td>
<td>Median/AIN</td>
<td>Pronate forearm</td>
<td>Primary pronator (initiates pronation)</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## Anterior Compartment Muscles: Deep Flexors

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve</th>
<th>Action</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaconeus</td>
<td>Posterior-lateral epicondyle</td>
<td>Posterior-poximal ulna</td>
<td>Radial</td>
<td>Forearm extension</td>
<td>Must retract on Kocher approach</td>
</tr>
<tr>
<td>Mobile Wad (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachioradialis [BR]</td>
<td>Lateral supracondylar humerus</td>
<td>Lateral distal radius</td>
<td>Radial</td>
<td>Forearm flexion</td>
<td>Is a deforming force in radius fractures.</td>
</tr>
<tr>
<td>Extensor carpi radialis longus [ECRL]</td>
<td>Lateral supracondylar humerus</td>
<td>Base of 2nd MC</td>
<td>Radial</td>
<td>Wrist extension</td>
<td>Used for tendon transfer</td>
</tr>
<tr>
<td>Extensor carpi radialis brevis [ECRB]</td>
<td>Lateral epicondyle</td>
<td>Base of 3rd MC</td>
<td>Radial</td>
<td>Wrist extension</td>
<td>Inflamed in Tennis elbow, can compress PIN</td>
</tr>
<tr>
<td>Extensor digitorum [ED]</td>
<td>Lateral epicondyle</td>
<td>Sagittal bands, central slip, distal phalanx</td>
<td>Radial-PIN</td>
<td>Digit extension</td>
<td>Distal avulsion is mallet finger injury</td>
</tr>
<tr>
<td>Extensor digitii minimi [EDM]</td>
<td>Lateral epicondyle</td>
<td>Sagittal bands, central slip, distal phalanx of SF</td>
<td>Radial-PIN</td>
<td>SF extension</td>
<td>In 5th dorsal compartment.</td>
</tr>
<tr>
<td>Extensor carpi ulnaris [ECU]</td>
<td>Lateral epicondyle</td>
<td>Base of 5th MC</td>
<td>Radial-PIN</td>
<td>Hand extension and</td>
<td>Must retract on Kocher approach</td>
</tr>
</tbody>
</table>
### POSTERIOR COMPARTMENT MUSCLES: DEEP EXTENSORS

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supinator</td>
<td>Posterior medial ulna</td>
<td>Proximal lateral radius</td>
<td>Radial-PIN</td>
<td>Forearm supination</td>
<td>Can compress PIN</td>
</tr>
<tr>
<td>Abductor pollicis longus [APL]</td>
<td>Posterior radius/ulna</td>
<td>Base of 1st MC</td>
<td>Radial-PIN</td>
<td>Abduct and extend thumb (CMC)</td>
<td>1st compartment: DeQuervain Disease</td>
</tr>
<tr>
<td>Extensor pollicis brevis [EPB]</td>
<td>Posterior radius</td>
<td>Base of proximal phalanx of thumb</td>
<td>Radial-PIN</td>
<td>Extend thumb (MCP)</td>
<td>Same as above, radial border of snuffbox</td>
</tr>
<tr>
<td>Extensor pollicis longus [EPL]</td>
<td>Posterior ulna</td>
<td>Base of thumb distal phalanx</td>
<td>Radial-PIN</td>
<td>Extend thumb (P)</td>
<td>Tendon turns 45° on Lister's tubercle</td>
</tr>
<tr>
<td>Extensor indicis proprius [EIP]</td>
<td>Posterior ulna</td>
<td>Sagittal bands, central slip, distal phalanx of index finger</td>
<td>Radial-PIN</td>
<td>Index finger extension</td>
<td>Border of snuffbox</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
NERVES

**INFRACLAVICULAR**

**LATERAL CORD**

**Musculocutaneous (C5-7):** only sensory in the forearm

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>Lateral forearm [via Lateral cutaneous nerve of forearm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>NONE (in forearm)</td>
</tr>
</tbody>
</table>

**MEDIAL CORD**

**Medial Cutaneous Nerve of Forearm (Antibrachial) (C8-T1):** runs with basilic vein

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>Medial forearm anterior arm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td>NONE</td>
</tr>
</tbody>
</table>

**Ulnar (C7)-T1:** runs behind medial epicondyle in groove and between 2 heads of ECU\(^*\), then under FCU\(^*\), then to Guyon's canal\(^*\).
### 3. Sensory: NONE (in forearm)
### Motor: Flexor carpi ulnaris

**MEDIAL AND LATERAL CORDS**

**Median** (C5,6-T1): runs between 2 heads of PT*, through ligament of Struthers[*] and lacertus fibrosus[*], under FDS[*] into carpal tunnel[*] (Martin Gruber formation: ulnar motor branches run with median nerve then branch to ulnar nerve distally). In wrist, median divides to Motor branch and palmar cutaneous (runs between FCR/PL); at risk in CTS release

### 4. Sensory: NONE (in forearm)

**Deep Flexors**

- Anterior Interosseous N. (AIN) AIN compressed by PT in forearm, injured in supracondylar fractures
- Flexor digitorum profundus [digits 2, 3]
- Flexor pollicis longus [FPL]
- Pronator Quadratus [PQ]

* Potential nerve compression site
INFRACLAVICULAR

POSTERIOR CORD

Radial (C5-T1): Divides into 2 branches:
1. superficial radial (sensory) and 2. deep (motor)-which then pierces supinator and becomes PIN

<table>
<thead>
<tr>
<th>Sensory:</th>
<th>Posterior forearm: via Posterior Cutaneous Nerve of forearm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor:</td>
<td><strong>MOBILE WAD(3): Radial Nerve</strong> (deep branch): runs around radius into posterior compartment, through radial tunnel; becomes PIN</td>
</tr>
<tr>
<td></td>
<td><strong>POSTERIOR COMPARTMENT: PIN:</strong></td>
</tr>
<tr>
<td></td>
<td>Posterior Interosseous Nerve Multiple sites of compression: 1. fibrous tissue of radial head, 2. leash of Henry, 3. Arcade of Frohse, 4. distal supinator, 5. ECRB</td>
</tr>
<tr>
<td></td>
<td>Deep Extensors: Supinator, Abductor pollicis longus, Extensor pollicis longus, Extensor pollicis brevis, Extensor indicis proprius</td>
</tr>
</tbody>
</table>

* Potential nerve compression site
### Arteries

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
<th>Branches</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radial</strong></td>
<td>over Pronator Teres, under Brachioradialis.</td>
<td>Radial recurrent muscular branches (leash of Henry)</td>
<td></td>
</tr>
<tr>
<td><strong>Ulnar</strong></td>
<td>on FDP, under FDS</td>
<td>Anterior ulnar recurrent, Posterior ulnar recurrent, Common interosseous, Anterior interosseous, Posterior interosseous, Recurrent interosseous, Muscular branches</td>
<td>See Arm chapter for arterial anastomosis around the elbow</td>
</tr>
</tbody>
</table>

#### Radial Artery
- **Volar:** lateral to FCR, dorsal: between EPL, APL/EPB
- **3 branches:**
  - Palmar carpal branch
  - Dorsal carpal branch
  - Superficial palmar branch
  - Deep palmar arch
  - Terminal branch of radial artery

#### Ulnar Artery
- **on the TCL, lateral to pisiform.**
- **4 branches:**
  - Palmar carpal branch
  - Dorsal carpal branch
  - Deep palmar branch
  - Deep to FDSDep to extensor tendons

**Notes:**
- In most persons, blood supply enters only distal part of scaphoid, fracture through waist may lead to necrosis of proximal part.
<table>
<thead>
<tr>
<th>Allen test</th>
<th>Superficial palmar arch</th>
<th>Terminal branch of ulnar artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Occlude both radial and ulnar arteries at wrist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Patient should squeeze fist several times Release pressure on one artery</td>
<td></td>
<td>Hand perfusion (&quot;pinking up&quot;) after release indicates patent arches collateral circulation.</td>
</tr>
<tr>
<td>3. Repeat releasing other artery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### DISORDERS: ARTHRITIS INSTABILITY

#### Rheumatoid Arthritis

**DESCRIPTION**
- Systemic inflammatory disorder affecting synovium, destroys joint
- Wrist common site
- Associated with tenosynovitis CTS

**HP**
- Pain, stiffness (worse in AM)
- PE: Swelling throughout joint, decreased ROM, ulnar drift at MCPs.

**WORK-UP/FINDING**
- XR: Hand series: joint destruction erosion
- Labs: RF, ANA, WBC, ESR, uric acid

**TREATMENT**
1. Medical management, splint joints
2. Synovectomy (single joint)
3. Tendon transfer or repair
4. Arthrodesis or arthroplasty

---

#### OSTEOARTHRITIS/DEGENERATIVE JOINT DISEASE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Wear tear&quot;: articular cartilage loss</td>
<td></td>
<td>Hx: Older, women, pain (worse with activity) PE: Swelling, decreased ROM</td>
<td>1. NSAID, splint, steroid injection 2. Arthrodesis (pain relief)</td>
</tr>
<tr>
<td>1° or 2° (e.g. trauma.)</td>
<td></td>
<td>XR: OA findings: spurs, joint space loss, sclerosis</td>
<td></td>
</tr>
<tr>
<td>Seen in SLAC wrist</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### DEQUERVAIN'S DISEASE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenosing tenosynovitis of 1st dorsal compartment (APL/EPB)</td>
<td></td>
<td>Hx: Often history of tennis or golf. Pain, swelling. PE: 1 Finkelstein test</td>
<td>1. Splint, NSAID, injection 2. Surgical release</td>
</tr>
<tr>
<td></td>
<td></td>
<td>XR: Possible calcified tendons Lab: Uric acid (rule out gout)</td>
<td></td>
</tr>
</tbody>
</table>

---

#### INSTABILITY

**SLAC: SCAPHOLUNATE ADVANCED COLLAPSE**

- Radiograph shows cartilage thinning at proximal interphalangeal joints, erosion of carpal and wrist joint, osteoporosis, and finger deformities
- Same patient after 14 years (right). Carpus, wrist joint, and ulnar head completely eroded
| Degenerative arthritis secondary to instability (SL ligament disruption or scaphoid fracture/injury) | Hx/PE: Chronic pain, remote history of trauma. | XR: Radioscaphoid OA: (CL joint also involved, RL joint spared) | 1. Scaphoid excision, capitolunate fusion  
Proximal row carpectomy or fusion |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SCAPHOLUNATE DISSOCIATION: (static/dynamic)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| SL/RCL ligament disrupted: lunate displaced dorsally  
[DISI: Dorsal Intercalated Segment Instability]  
Late: STT fusion, carpectomy, or wrist fusion. |
### DISORDERS: NERVE COMPRESSION

#### de Quervain Disease

![de Quervain Disease](image)

**Course of abductor pollicis longus and extensor pollicis brevis tendons through 1st compartment of extensor retinaculum, transverse incision, and relation of sensory branches of radial nerve and synovial sheaths.**

---

#### AIN (Anterior Interosseous Nerve) SYNDROME

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIN trapped under:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. PT</td>
<td>Hx: No sensory findings</td>
<td>XR: Rule out other pathology</td>
<td>1. Conservative treatment</td>
</tr>
<tr>
<td>2. FDS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. FCR</td>
<td>PE: decreased thumb flexion, no “OK” sign (+ Kiloh-Nevinsign)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### CARPAL TUNNEL SYNDROME (CTS)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median nerve trapped in carpal tunnel</td>
<td>Hx: Repetitive motion, night pain, paraesthesias, clumsy</td>
<td>XR: Rule out other pathology</td>
<td>1. Activity modification</td>
</tr>
<tr>
<td>Most common nerve entrapment</td>
<td>PE: Weak thenar muscles, + Tinel/Phalen tests</td>
<td>EMG/NCS: Localize the lesion</td>
<td>2. Cock-up splint, NSAID, steroid injection</td>
</tr>
<tr>
<td>Associated with metabolic disease (DM, EtOH, pregnancy, thyroid disease)</td>
<td></td>
<td></td>
<td>3. Carpal tunnel release [avoid palmar branch]</td>
</tr>
</tbody>
</table>

#### PIN SYNDROME (Saturday Night Palsy)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN trapped by:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Supinator (proximal border most common)</td>
<td>Hx: +/- pain</td>
<td>XR: Rule out other pathology</td>
<td>1. Observe. It may resolve</td>
</tr>
<tr>
<td>2. Arcade of Frohse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Leash of Henry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Fibrous bands 5. ECRB</td>
<td>PE: No sensory findings, Wrist drop</td>
<td>EMG/NCS:</td>
<td>2. Surgical</td>
</tr>
<tr>
<td>Lesion</td>
<td>Median nerve trapped by: 1. PT, 2. Ligament of Struther, 3. Lacertus fibrosus, 4. FDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>Forearm pain, increases with activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray</td>
<td>Rule out other pathology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical examination (PE)</td>
<td>Thenar weakness, Tinel Phalen tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electromyography/Nerve Conduction Studies (EMG/NCS)</td>
<td>Localize the lesion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>1. NSAID, rest, splint</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Surgical release after 3-4 months</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pronator Syndrome

- **Median nerve** trapped by: 1. PT, 2. Ligament of Struther, 3. Lacertus fibrosus, 4. FDS.
- **History (Hx):** Forearm pain, increases with activity.
- **X-ray (XR):** Rule out other pathology.
- **Physical examination (PE):** Thenar weakness, Tinel Phalen tests.
- **Electromyography/Nerve Conduction Studies (EMG/NCS):** Localize the lesion.
- **Management:** 1. NSAID, rest, splint. 2. Surgical release after 3-4 months.

### Radial Tunnel Syndrome

- **Radial nerve** trapped in radial tunnel (1 of 4 places).
- **History (Hx):** Pain in lateral forearm.
- **X-ray (XR):** Rule out other pathology.
- **Physical examination (PE):** No motor/sensory findings.
- **Management:** 1. Rule out lateral epicondylitis. 2. Activity modification, splinting. 3. Surgical exploration/release.

### Ulnar Tunnel Syndrome

- **Ulnar nerve** trapped in Guyon's canal.
- **History (Hx):** Pain, numbness, intrinsic weakness.
- **X-ray (XR):** Not indicated.
- **Physical examination (PE):** +Tinel of ulnar nerve at wrist.
- **Electromyography/Nerve Conduction Studies (EMG/NCS):** will localize lesion.
- **Management:** 1. Activity modification, rest, immobilize. 2. Surgical decompression.

---

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## GANGLION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ganglion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyst with mucinous/joint fluid</td>
<td>Hx/PE: Round, large or small transilluminating mass, +/- pain</td>
<td>XR: Wrist series, no radiographic evidence of ganglion</td>
<td>1. Asymptomatic: reassurance</td>
</tr>
<tr>
<td>Communicates with joint</td>
<td></td>
<td></td>
<td>2. Symptomatic: aspirate or surgically excise (with stalk or it will recur)</td>
</tr>
<tr>
<td>Most common mass in wrist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorsal (SL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volar (ST)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## KIENBÖCK'S DISEASE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HP</th>
<th>WORK-UP/FINDING</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kienböck's Disease</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteonecrosis of lunate</td>
<td>Hx: Pain, swelling, stiffness</td>
<td>XR: Opacity of lunate</td>
<td>I. NSAID, splinting</td>
</tr>
<tr>
<td>Wrist trauma or short ulna</td>
<td>PE: Grip strength may be reduced.</td>
<td>Bone scan/MRI: will confirm diagnosis</td>
<td>II/III. Joint leveling procedure/carpal fusion</td>
</tr>
<tr>
<td>4 stages: based on collapse</td>
<td></td>
<td></td>
<td>IV. Proximal row carpectomy or fusion</td>
</tr>
</tbody>
</table>
## Surgical Approaches

### Forearm: Anterior Approach (Henry)

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteotomy</td>
<td>Proximal 1. Brachioradialis [Radial] 2. Pronator Teres [Median]</td>
<td>2. Superficial radial nerve</td>
<td>2. If not ligated, hemorrhage could result in Compartment syndrome and/or Volkmann's contracture</td>
</tr>
<tr>
<td>Biopsy bone tumors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Wrist: Dorsal Approach

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusion</td>
<td>1. 3rd dorsal compartment [EPL]</td>
<td>Radial nerve (Superficial)</td>
<td>1. Incise to the extensor retinaculum. This leaves cutaneous nerves intact in the subcutaneous fat.</td>
</tr>
<tr>
<td>Stabilization</td>
<td>2. 4th dorsal compartment [EDC, EIP]</td>
<td></td>
<td>2. Neuroma can develop from cutting cutaneous nerves.</td>
</tr>
<tr>
<td>ORIF fractures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Wrist: Volar Approach

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal tunnel</td>
<td>No planes</td>
<td>1. Median nerve*</td>
<td>1. Retract PL/FPL radially</td>
</tr>
<tr>
<td>Palmar cutaneous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*Note: \[Median\], \[Radial\], \[EPL\], \[EDC, EIP\] indicate nerve or muscle location.*
<table>
<thead>
<tr>
<th>decompression</th>
<th>branch</th>
<th>Recurrent motor</th>
<th>Retract FDS/FDP ulnarily</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. ORIF volar fracture</td>
<td>2. Palmar arch</td>
<td>2. Dissect TCL carefully to avoid nerve damage.</td>
<td></td>
</tr>
<tr>
<td>3. Dislocated lunate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Tendon laceration</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 5 – HAND

TOPOGRAPHIC ANATOMY
<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OSSIFY</th>
<th>FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>METACARPALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Triangular in cross section: gives 2 volar muscular attachment sites</td>
<td>Primary: Body 9 wks (fetal)</td>
<td>18 yrs</td>
<td>• Named I-V (thumb to small finger)</td>
</tr>
<tr>
<td>• Thumb MC has saddle shaped base: increases its mobility</td>
<td>Epiphysis 2 yrs</td>
<td></td>
<td>• Only one epiphysis per bone in the head. In thumb MC it is in the base.</td>
</tr>
<tr>
<td><strong>PHALANGES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Palmar surface is almost flat</td>
<td>Primary: Body 8 wks (fetal)</td>
<td>14-18 years</td>
<td>• 3 phalanges in each digit except thumb</td>
</tr>
<tr>
<td>• Tubercles and ridges are sites for attachment.</td>
<td>Epiphysis 2-3 yr</td>
<td></td>
<td>• Only one epiphysis per bone in base.</td>
</tr>
</tbody>
</table>

Nomenclature for digits: thumb, index finger, middle finger, ring finger, small finger
**METACARPAL FRACTURES**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Common in adults</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 5th MC most common (Boxer's fracture at neck)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 1st MC base. Bennett Rolando fracture: displaced, intraarticular.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 4th 5th MC tolerate angulation; 2nd 3rd do not</td>
<td>HX: Trauma. Swelling, pain, deformity. PE: Swelling, tenderness, +/- rotational deformity, shortening. Decreased ROM.</td>
<td>By location:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Head</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Neck (most common)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Shaft (transverse, spiral, Oblique)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Base (Bennett, Rolando, &quot;Baby Bennett&quot; - base of 5th MC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>XR: PA, lateral, oblique</td>
<td>Nondisplaced: ulnar gutter splint 4 weeks, then ROM. Severely Angulated or shortened: percutaneous pins or ORIF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Displaced or intraarticular: reduce then pin. Unstable: ORIF</td>
</tr>
</tbody>
</table>

**COMPLICATIONS:** Rotational deformity grip abnormalities (malunion)

**PHALANGEAL FRACTURES**

<p>| HX: Trauma. |
| Descriptive/location: |
| Extraarticular |
| Undisplaced: buddy tape and or splint |</p>
<table>
<thead>
<tr>
<th>Location</th>
<th>Symptoms</th>
<th>Imaging</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children/Adults</td>
<td>Swelling, pain, deformity.</td>
<td>PE: Swelling, tenderness, +/- rotational deformity, shortening. Decreased</td>
<td>Displaced: reduce, splint. Unstable: pin or ORIF</td>
</tr>
<tr>
<td><strong>Distal phalanx</strong> (MF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Early ROM important for good results</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Articular surfaces do not Tolerate incongruity. Close follow up is critical for intraarticular fractures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal phalanx</td>
<td>Most common (MF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## JOINTS

### Posterior (dorsal) view

<table>
<thead>
<tr>
<th>JOINT</th>
<th>TYPE</th>
<th>LIGAMENTS</th>
<th>ATTACHMENTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CARPOMETACARPAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thumb</td>
<td>Saddle</td>
<td>Capsule</td>
<td>Trapezium to metacarpals</td>
<td>Highly mobile; common site for arthritis</td>
</tr>
<tr>
<td>Finger</td>
<td>Gliding</td>
<td>Capsule</td>
<td>Carpal to metacarpal bones</td>
<td>Dorsal strongest</td>
</tr>
<tr>
<td>Interosseous CMC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>METACARPOPHALANGEAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ellipsoid</td>
<td>Capsule</td>
<td>Metacarpal to proximal phalanx</td>
<td></td>
<td>Loose in extension, tight in flexion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 collateral (radial and ulnar)</td>
<td>Metacarpal to proximal phalanx</td>
<td>Cast in flexion or ligaments will shorten</td>
</tr>
<tr>
<td>Palmar [volar plate]</td>
<td></td>
<td>Metacarpal to proximal phalanx</td>
<td></td>
<td>Thumb ulnar collateral:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deep transverse metacarpal</td>
<td></td>
<td>• stabilizes pinch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• injury is Gamekeeper's</td>
</tr>
<tr>
<td><strong>INTERPHALANGEAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hinge</td>
<td>Capsule</td>
<td></td>
<td>Adjacent phalanges</td>
<td>Obliquely oriented</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 collateral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmar [volar]</td>
<td></td>
<td>Adjacent phalanges</td>
<td></td>
<td>Prevents hyperextension</td>
</tr>
</tbody>
</table>
### Other Structures: Flexor Tendon Sheath and Pulleys

<table>
<thead>
<tr>
<th>Structure</th>
<th>Characteristics</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor tendon sheath</td>
<td>Fibroosseous tunnel, lined with tenosynovium</td>
<td>Pulleys (5 annular, 3 cruciate) are thickenings of sheath. <em>A2, A4 most important mechanically</em>. A1, 3, 5 cover joints; <em>A1 common cause of triggering</em>.</td>
</tr>
<tr>
<td></td>
<td>Protect, lubricate, nourish tendons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In sheath: vinculae are vascular supply to tendons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site of potential infection: <em>Kanavel signs often present</em> (see Disorders)</td>
<td></td>
</tr>
<tr>
<td>Intrinsic Apparatus</td>
<td>Sagittal bands</td>
<td>EDC attaches extends MCP</td>
</tr>
<tr>
<td>Central Slip</td>
<td>EDC attaches extends PIP: injury can result in Boutonniere deformity</td>
<td></td>
</tr>
<tr>
<td>Lateral bands</td>
<td>Lumbricals attach extend PIP</td>
<td></td>
</tr>
<tr>
<td>Volar plate (transverse fibers)</td>
<td>FDS attaches flexes PIP</td>
<td></td>
</tr>
<tr>
<td>Oblique retinacular ligaments</td>
<td>Interossei attach flex MCP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EDC attaches extends DIP</td>
<td></td>
</tr>
</tbody>
</table>
### OTHER STRUCTURES: HAND SPACES

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>CHARACTERISTICS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hand Spaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thenar</td>
<td>Between flexor tendon and Adductor pollicis</td>
<td>Potential space: <strong>site of possible infection</strong></td>
</tr>
<tr>
<td>Mid-palmar</td>
<td>Between flexor sheath and metacarpal</td>
<td>Potential space: <strong>site of possible infection</strong></td>
</tr>
<tr>
<td>Radial bursa</td>
<td>Proximal extension of FPL sheath</td>
<td>Infection can track proximally</td>
</tr>
<tr>
<td>Ulnar bursa</td>
<td>Communicates with SF, FDS, FDP flexor tendon sheath</td>
<td>Flexor sheath infection can track proximally into bursa</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### OTHER STRUCTURES: FINGER

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>CHARACTERISTICS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FINGERTIP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nail</td>
<td>Cornified epithelium</td>
<td>If completely avulsed, replace to keep eponychium and matrix separated until nail can grow back.</td>
</tr>
<tr>
<td>Nail bed/Matrix</td>
<td>Germinal: to lunula, under eponychium</td>
<td>Where nail grows (1mm a week), <strong>must be intact (repaired) for nail growth</strong></td>
</tr>
<tr>
<td>Pulp</td>
<td>Multiple septae, nerves, arteries</td>
<td>Felon is an infection of the pulp</td>
</tr>
</tbody>
</table>

![Diagram of finger structures](image-url)
FLEXOR TENDON INJURY ZONES

Flexor Zones of Hand

<table>
<thead>
<tr>
<th>ZONE</th>
<th>BOUNDARIES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>FDS insertion to distal tip</td>
<td>Injuries amenable to repair (e.g. Jersey finger)</td>
</tr>
<tr>
<td>II</td>
<td>Midpalm fibroosseous tunnel to FDS insertion</td>
<td>Called &quot;No man's land&quot; because high rate of complications. Careful PE is required for diagnosis, the injury may not be at skin laceration site. FDS FDP may both require repair. A2, A4 must be preserved.</td>
</tr>
<tr>
<td>III</td>
<td>Transverse Carpal ligament to fibro-osseous tunnel</td>
<td>Repair in zones 3-5 should be immediate</td>
</tr>
<tr>
<td>IV</td>
<td>Transverse carpal ligament (carpal tunnel)</td>
<td>Injuries often associated with Median nerve or arterial arch injuries. Explore and repair all.</td>
</tr>
<tr>
<td>V</td>
<td>Proximal to the TCL</td>
<td>Uncommon site of injury. Repair usually requires carpal tunnel release and repair. Median nerve at risk.</td>
</tr>
<tr>
<td>Thumb I</td>
<td>Thumb IP to distal tip</td>
<td>Injuries require end-to-end repair</td>
</tr>
<tr>
<td>Thumb II</td>
<td>Thumb CMC to IP</td>
<td>Similar to finger</td>
</tr>
<tr>
<td>Thumb III</td>
<td>Thenar eminence</td>
<td>Repair may require lengthening or graft procedure</td>
</tr>
</tbody>
</table>
MINOR PROCEDURES

INJECTION OF THUMB CMC JOINT

1. Ask patient about allergies
2. Palpate thumb CMC joint on volar radial aspect
3. Prepare skin over CMC joint (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
   Palpate base of thumb MC, pull axial distraction on thumb with slight flexion to open joint. Use 22 gauge or smaller needle, and insert into joint. **Aspirate to ensure needle is not in a vessel.**
5. **Needle is not in a vessel.** Inject 2-3ml of 1:1 local (without epinephrine)/corticosteroid preparation into CMC joint. (The fluid should flow easily if needle is in joint)
6. Dress injection site

FLEXOR TENDON SHEATH BLOCK

1. Ask patient about allergies
2. Palpate the flexor tendon at the distal palmar crease.
3. Prepare skin over palm (iodine/antiseptic soap)
4. Insert 22 gauge needle into flexor tendon at the level of the distal palmar crease. Withdraw needle so it is just outside tendon, but inside sheath. Inject 2-5ml of local anesthetic without epinephrine.
5. Dress injection site

DIGITAL BLOCK

1. Prepare skin over dorsal proximal finger web space (iodine/antiseptic soap)
   Insert 22 gauge needle between metacarpal heads on both sides of finger. **Aspirate to ensure needle is not in a vessel.** Inject 2-5ml of local anesthetic without epinephrine. The dorsum of the proximal digit may also require anesthesia for adequate anesthesia.
2. Care should be taken not to inject too much fluid into the closed space of the proximal digit
3. Dress injection site
## HISTORY

**“Jersey Finger”**

Avulsion of flexor digitorum profundus tendon

Caused by violent traction on flexed distal phalanx, as in catching on jersey of running football player.

**Boxer Fracture**

Fractures of metacarpal neck commonly result from end-on blow of fist. Often called street-fighter or boxer fractures.

**“Fight Bite”**

Penetration of metacarpophalangeal joint by tooth in fistfight.

Usually caused by direct blow on extended distal phalanx, as in baseball, volleyball.

## QUESTION | ANSWER | CLINICAL APPLICATION
--- | --- | ---
1. **HAND DOMINANCE** | Right or left | Dominant hand injured more often
2. **AGE** | Young | Trauma, infection
| Middle age, elderly | Arthritis, nerve entrapments
3. **PAIN**
   a. Onset | Acute | Trauma, infection
| Chronic | Arthritis
   b. Location
   | CMC (thumb) | Arthritis (OA) especially in women
   | Volar (fingers) | Purulent tenosynovitis (1 Kanavel signs)
4. **STIFFNESS** | In AM, with “catching” | Trigger finger, rheumatoid arthritis
5. **SWELLING**
   After trauma | Infection (e.g. purulent tenosynovitis, felon, paronychia)
| No trauma | Arthritis, gout, tendinitis
6. **MASS** | Ganglion, Dupuytren's contracture, giant cell tumor
7. **TRAUMA**
   Fall, sports injury in dirty environment | Fracture, tendon avulsion
| | Infection
8. **ACTIVITY**
   Sports, mechanic | Trauma (e.g. fracture, dislocation, tendon rupture)
9. **NEUROLOGIC SYMPTOMS**
   Pain, numbness, tingling | Nerve entrapment (e.g. carpal tunnel), thoracic outlet syndrome, radiculopathy
| Weakness | Nerve entrapment (usually in wrist or more
<table>
<thead>
<tr>
<th>Weakness</th>
<th>Proximal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple joints involved</td>
<td>Rheumatoid arthritis, Reiter syndrome, etc.</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
**EXAMINATION** | **TECHNIQUE** | **CLINICAL APPLICATION**
--- | --- | ---
**INSPECTION**
Gross deformity | Ulnar drift or swan neck | Rheumatoid arthritis
Rotational or angular deformity | Fracture | 
Finger position | Flexion | Dupuytren contracture, purulent tenosynovitis
Skin, hair, nail changes | Cool, hairless, spoon nails, etc. | Neurovascular disorders: Raynaud’s, diabetes, nerve injury
Swelling | DIPs | Nodes from osteoarthritis: Heberden’s (at DIPs: #1), Bouchard’s (at PIPs)
 | PIPs |  
 | MCP’s | Rheumatoid arthritis | 
 | Fusiform shape finger | Purulent tenosynovitis |  
Muscle wasting | Thenar eminence | Median nerve injury, CTS, C8/T1 pathology, CMC arthritis
 | Hypothenar eminence or intrinsics | Ulnar nerve injury |
**EXAMINATION** | **TECHNIQUE** | **CLINICAL APPLICATION**
--- | --- | ---
**PALPATION**
Skin | Warm, red | Infection
Cool, dry | Neurovascular compromise
Metacarpals | Each along its length | Tenderness may indicate fracture
Phalanges finger joints | Each separately | Tenderness: fracture, arthritis; Swelling: arthritis
Soft tissues | Thenar hypothenar eminences | Wasting indicates median ulnar nerve injury respectively
Palm (palmar fascia) | Nodules: Dupuytren's contracture; Snapping with finger extension: Trigger finger
Flexor tendons: along volar finger | Tenderness suggests purulent tenosynovitis
Sides of finger | Giant cell tumors
All aspects of finger tip | Tenderness: paronychia or felon

**RANGE OF MOTION**
Finger: MCP joint | Flex 90°, extend 0°, Add/abd 0-20° | Decreased flexion if casted in extension (collateral ligaments shorten)
PIP joint | Flex 110°, extend 0° | Hyperextension leads to swan-neck deformity
DIP joint | Flex 80°, extend 10° | All fingers should point to scaphoid at full flexion
Thumb: CMC joint | Radial abduction: Flex 50°, extend 50° | Motion is in plane of palm
 | Palmar abduction: Abduct 70°, adduct 0° | Motion is perpendicular to plane of the palm
MCP joint | In plane of palm: Flex 50°, extend 0° | 
IP joint | In plane of palm: Flex 90°, extend 10° | 
Opposition | Touch thumb to small fingertip | Motion is mostly at CMC joint

*Rotation displacement of ring finger. All fingers should point toward scaphoid when clenched.*

*Patient unable to extend affected finger. It can be extended passively, and extension occurs with distinct and painful snapping action. Circle indicates point of tenderness where nodular enlargement of tendons and sheath is usually palpable.*
<table>
<thead>
<tr>
<th>Neurovascular</th>
<th>Sensory</th>
<th>Radial Nerve (C6)</th>
<th>Light touch pinprick, 2 point</th>
<th>Deficit indicates corresponding nerve/root lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory</td>
<td>Median Nerve (C6-7)</td>
<td>Radial border middle finger</td>
<td>Dorsal thumb web space</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Sensory</td>
<td>Ulnar Nerve (C8)</td>
<td>Ulnar border small finger</td>
<td>Dorsal thumb web space</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Motor</td>
<td>Radial nerve/PIN (C7)</td>
<td>Finger extension</td>
<td>Weakness 5 EDC(4), EIP(4), EDM(5) or nerve lesion</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Median nerve/AIN (C8)</td>
<td>Thumb abduction extension</td>
<td>Weakness 5 APL(1) / EPL(3) or nerve/root lesion</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Ulnar nerve (Deep branch) (T1)</td>
<td>MCP flexion (index/middle fingers)</td>
<td>Weakness 5 IF, MF lumbaricals or nerve/root lesion</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Motor Recurrent Branch</td>
<td>“OK” sign</td>
<td>Weakness 5 APB, OP, 1/2 FPB or nerve lesion; (CTS)</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Ulnar nerve (Deep branch) (T1)</td>
<td>Finger cross (abduct/adduct)</td>
<td>Weakness 5 Dorsal/Volar interosseous or nerve lesion</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Ulnar nerve (Deep branch) (T1)</td>
<td>Small finger abduction</td>
<td>Weakness 5 DFM, ODM, ADM or nerve/root lesion</td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Ulnar nerve (Deep branch) (T1)</td>
<td>MCP flexion (ring/small fingers)</td>
<td>Weakness 5 RF, SF lumbaricals or nerve/root lesion</td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Hoffmann</td>
<td>Tap a finger distal phalax</td>
<td>Only pathologic (1 if different phalanx flexes); UMN syndrome</td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Hoffmann</td>
<td>Stabilize PP in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Hoffmann</td>
<td>Stress test for nerve lesion</td>
<td>Tests ulnar and radial artery patency</td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Hoffmann</td>
<td>Allen's test</td>
<td>Pulsed/capillary refill</td>
<td></td>
</tr>
<tr>
<td>Reflex:</td>
<td>Hoffmann</td>
<td>Doppler: arches, digital pulses</td>
<td>SPECIAL TESTS</td>
<td></td>
</tr>
</tbody>
</table>

**SPECIAL TESTS**
<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Profundus</strong></td>
<td>Stabilize PIP in extension, flex DIP only</td>
<td>Inability to flex DIP alone indicates <strong>FDP pathology</strong></td>
</tr>
<tr>
<td><strong>Sublimis</strong></td>
<td>Extend all fingers, flex a single finger at PIP</td>
<td>Inability to flex PIP of isolated finger indicates <strong>FDS pathology</strong></td>
</tr>
<tr>
<td><strong>Froment's sign</strong></td>
<td>Hold paper with thumb index finger, pull paper</td>
<td>Thumb PIP flexion is positive, suggest Adductor Pollicis or Ulnar nerve palsy</td>
</tr>
<tr>
<td><strong>CMC grind</strong></td>
<td>Axial compress rotate CMC joint</td>
<td>Pain indicates arthritis at CMC and/or MCP joints of thumb</td>
</tr>
<tr>
<td><strong>Finger instability</strong></td>
<td>Stabilize proximal joint, apply valus valgus stress</td>
<td>Laxity indicates collateral ligament damage</td>
</tr>
<tr>
<td><strong>Thumb instability</strong></td>
<td>Stabilize MCP, apply valgus stress</td>
<td>Laxity indicates <strong>ulnar collateral ligament strain (Gamekeeper's thumb)</strong></td>
</tr>
<tr>
<td><strong>Murphy sign</strong></td>
<td>Make fist, observe height of MCP's</td>
<td>If 3rd MC (normally elevated) is flat with 2nd 4th MC, suggests lunate dislocation</td>
</tr>
<tr>
<td><strong>Bunnel-Littler</strong></td>
<td>Extend MCP, passively flex PIP</td>
<td>Tight or inability to flex PIP, improved with MCP flexion indicates tight intrinsic muscles</td>
</tr>
</tbody>
</table>
### MUSCLES

#### THENAR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abductor pollicis brevis</td>
<td>Scaphoid, trapezium</td>
<td>Lateral proximal phalanx of thumb</td>
<td>Median</td>
<td>Thumb abduction</td>
<td>Palpable in lateral thenar eminence</td>
</tr>
<tr>
<td>Flexor pollicis brevis</td>
<td>Trapezium</td>
<td>Base of proximal phalanx of thumb</td>
<td>Median</td>
<td>Thumb MCP flexion</td>
<td>Palpable in medial thenar eminence</td>
</tr>
<tr>
<td>Opponens pollicis</td>
<td>Trapezium</td>
<td>Lateral thumb</td>
<td>Median</td>
<td>Oppose thumb, rotate medially</td>
<td>Opposition is most important action</td>
</tr>
</tbody>
</table>

#### ADDUCTOR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adductor pollicis</td>
<td>1. Capitate, 2nd 3rd MC</td>
<td>Base of proximal phalanx of thumb</td>
<td>Ulnar</td>
<td>Thumb adduction</td>
<td>Radial artery between its two heads</td>
</tr>
<tr>
<td></td>
<td>2. 3rd Metacarpal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### HYPOTHENAR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmaris brevis</td>
<td>Transverse carpal ligament</td>
<td>Skin on medial palm</td>
<td>Ulnar</td>
<td>Wrinkles skin</td>
<td>Protects ulnar nerve</td>
</tr>
<tr>
<td>Abductor digit minimi</td>
<td>Pisiform</td>
<td>Base of proximal phalanx of SF</td>
<td>Ulnar</td>
<td>SF abduction</td>
<td>Palpable laterally</td>
</tr>
<tr>
<td>Flexor digit minimi brevis</td>
<td>Hamate, TCL</td>
<td>Base of proximal phalanx of SF</td>
<td>Ulnar</td>
<td>SF MCP flexion</td>
<td>Palpable medially</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opponens digiti minimi [ODM]</td>
<td>Hamate, TCL</td>
<td>Medial side 5th MC</td>
<td>Ulnar</td>
<td>Oppose 5th, rotate laterally</td>
<td>Deep to other muscles in the group</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## INTRINSIC MUSCLES

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbricals 1</td>
<td>FDP tendons (lateral 2)</td>
<td>Lateral bands</td>
<td>Median</td>
<td>Extend PIP, flex MCP</td>
<td>Only muscles in body to insert on their own antagonist.</td>
</tr>
<tr>
<td>Lumbricals 2</td>
<td>FDP tendons (medial 3)</td>
<td>Lateral bands</td>
<td>Ulnar</td>
<td>Extend PIP, flex MCP</td>
<td></td>
</tr>
<tr>
<td>Interosseous:</td>
<td>Adjacent metacarpals</td>
<td>Proximal phalanx extensor expansion</td>
<td>Ulnar</td>
<td>Digit abduction</td>
<td>DAB: Dorsal ABduct</td>
</tr>
<tr>
<td>Dorsal [DIO]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interosseous:</td>
<td>Adjacent metacarpals</td>
<td>Proximal phalanx extensor expansion</td>
<td>Ulnar</td>
<td>Digit adduction</td>
<td>PAD: Palmar Adduct (volar 5 palmar)</td>
</tr>
<tr>
<td>Volar [VIO]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
NERVES

INFRACLAVICULAR

MEDIAL CORD

1. **Ulnar** (C7-T1): through Guyon's canal, past hook of hamate

   **Sensory:** Medial palm 1/2 digits via: palmar, palmar digital branches
   Medial dorsal hand 1/2 digits via: dorsal, dorsal digital, proper digital branches
   Nerve divides at hypothenar eminence

   **Motor:** Superficial Branch @ lateral to pisiform
   - *Palmaris brevis*
   - *Adductor pollicis*

   **THENAR MUSCLES**
   - Flexor pollicis brevis [FPB] [with median]

   **HYPOTHENAR MUSCLES**
   - Abductor digit minimi [ADM]
   - Flexor digit minimi brevis [FDMB]
   - Opponens digit minimi [ODM]

   **INTRINSIC MUSCLES**
   - Dorsal interossei [DIO] [abduct DAB]
   - Volar interossei [VIO] [adduct PAD]
   - Lumbricals [medial two (3,4)]
2. **Median (C5)-T1**: runs through carpal tunnel, then cutaneous branches off at (risk in Carpal Tunnel release)

**Sensory:**
- **Palmar Cutaneous Branch**
  - Dorsal distal phalanges of 3 1/2 digits: via proper palmar digital branches
  - Volar wrist capsule
  - Volar 3 1/2 digits and lateral palm: via palmar digital branches (multiple variations of thumb sensory innervation)

**Motor:**
- **Motor Recurrent (Thenar motor) Branch**: Usually branches off median before carpal tunnel
  - **THENAR**
    - Abductor pollicis brevis [APB]
    - Opponens pollicis
    - Flexor pollicis brevis [FPB]
  - (Joint innervation with ulnar nerve)

- **INTRINSIC**
  - Lumbricals [lateral two (1,2)]

**INFRACLAVICULAR**

**MEDIAL AND LATERAL CORDS**

3. **Radial (C5-T1):**

**Sensory:**
- Dorsal 3 1/2 digits and hand: via superficial branch (dorsal digit branches)
  - Dorsal wrist capsule
| Motor: | NONE (in hand) |
### DEEP PALMAR ARCH

<table>
<thead>
<tr>
<th>COURSE</th>
<th>BRANCHES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through heads of the adductor pollicis</td>
<td>Terminal branch of radial artery deep branch of the ulnar artery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Princeps pollicis</td>
<td>Under FPL, along 1st metacarpal</td>
</tr>
<tr>
<td></td>
<td>Radialis indicis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proper digital artery of thumb</td>
<td>May come from deep arch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Palmar metacarpal (3)</td>
<td>Joins common digital artery</td>
</tr>
</tbody>
</table>

### SUPERFICIALS PALMAR ARCH

<table>
<thead>
<tr>
<th>COURSE</th>
<th>BRANCHES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just deep to aponeurosis.</td>
<td>Terminal branch of ulnar artery superficial branch of the radial artery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Common palmar digital (3)</td>
<td>Bifurcates</td>
</tr>
<tr>
<td></td>
<td>Proper palmar digital</td>
<td>Along sides of fingers</td>
</tr>
<tr>
<td></td>
<td>Proper palmar digital</td>
<td>Of small finger only</td>
</tr>
</tbody>
</table>
## DISORDERS: ARTHRITIS

### OSTEOARTHRITIS/DEGENERATIVE JOINT DISEASE (DJD)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HISTORY/PHYSICAL EXAM</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear and tear arthritis</td>
<td>Hx: Older, women, pain worse with activity</td>
<td>XR: OA findings: osteophytes, joint space loss, sclerosis, subchondral cysts</td>
<td>1. NSAID, splint, steroid injection</td>
</tr>
<tr>
<td>Loss of articular cartilage</td>
<td>PE: + IP (DIP and/or PIP) nodes, + CMC grind test</td>
<td></td>
<td>2. DIP: arthrodesis, CMC/PIP: arthroplasty</td>
</tr>
<tr>
<td>DIP #1 [Heberden's nodes] CMC, IP #2 [Bouchard's nodes]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RHEUMATOID

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HISTORY/PHYSICAL EXAM</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic inflammatory disease affecting synovium destroys joints. MCP #1</td>
<td>Hx: Painful, stiff (worse in AM)</td>
<td>XR: Hand series: joint destruction</td>
<td>I. Medical management splinting</td>
</tr>
<tr>
<td>Has 4 stages</td>
<td>PE: Multiple joint swelling, deformities: ulnar drift (MCP) swan neck, boutonniere</td>
<td>Labs: RF, ANA, WBC, ESR, uric acid</td>
<td>II. Synovectomy (single joint)</td>
</tr>
<tr>
<td>Associated with tenosynovitis, Carpal Tunnel Syndrome</td>
<td></td>
<td></td>
<td>III/IV. Tendon transfer or repair, arthrodesis, arthroplasty</td>
</tr>
</tbody>
</table>

### FLEXOR TENOSYNOVITIS: TRIGGER FINGER/THUMB

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HISTORY/PHYSICAL EXAM</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodule on tendon</td>
<td>Hx: Age: 40-50, tender</td>
<td></td>
<td>1. Steroid injection (+/-)</td>
</tr>
<tr>
<td>Condition</td>
<td>Age: 40</td>
<td>XR: None needed</td>
<td>Treatment</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>-----------------</td>
<td>------------</td>
</tr>
<tr>
<td>Catch's Pulley (A1 most common)</td>
<td>tender nodule</td>
<td></td>
<td>1. Steroid injection (+/- splint)</td>
</tr>
</tbody>
</table>

- Also seen in Diabetes Mellitus

PE: Pain. Locking with flexion extension

2. A1 release [must spare A2]
### DISORDERS: LIGAMENT INJURIES

#### CENTRAL SLIP INJURY: BOUTONNIÈRE DEFORMITY
- **Description**: Extensor tendon (central slip) at PIP ruptures, lateral bands slip volar and flex PIP.
  - Hx: Hand trauma
  - XR: Hand series: normal

#### FLEXOR TENDON INJURY: JERSEY FINGER
- **Description**: Flexor tendon avulses from forceful extension
  - Hx: Extension injury, 1/2 pain.
  - XR: Rule out fracture (1/2 avulsion fracture)

#### MALLET FINGER
- **Description**: Extensor tendon rupture at distal phalanx
  - Hx: Minor trauma
  - XR: 1/2 avulsion fracture

#### SWAN NECK DEFORMITY
- **Description**: FDS rupture/volar plate injury
  - Hx: Trauma, RA, spastic
  - XR: Hand series

---

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-Up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Slip Injury: Boutonniere Deformity</td>
<td>• Extensor tendon (central slip) at PIP ruptures, lateral bands slip volar and flex PIP.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hx: Hand trauma</td>
<td>XR: Hand series: normal</td>
<td>1. Splint PIP in extension, DIP free</td>
</tr>
<tr>
<td></td>
<td>PE: PIP flexed, no active extension, DIP extended</td>
<td></td>
<td>2. Reconstruct central slip and bands</td>
</tr>
<tr>
<td></td>
<td>• Associated with RA</td>
<td></td>
<td>3. Severe: fusion or arthroplasty</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Central Slip Injury: Boutonniere Deformity</th>
<th>• Extensor tendon (central slip) at PIP ruptures, lateral bands slip volar and flex PIP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fx: Hand trauma</td>
<td>XR: Hand series: normal</td>
</tr>
<tr>
<td>PE: PIP flexed, no active extension, DIP extended</td>
<td></td>
</tr>
<tr>
<td>• Associated with RA</td>
<td>3. Severe: fusion or arthroplasty</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flexor Tendon Injury: Jersey Finger</th>
<th>• Flexor tendon avulses from forceful extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fx: Extension injury, 1/2 pain.</td>
<td>XR: Rule out fracture (1/2 avulsion fracture)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mallet Finger</th>
<th>• Extensor tendon rupture at distal phalanx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fx: Minor trauma</td>
<td>XR: 1/2 avulsion fracture</td>
</tr>
<tr>
<td>PE: Cannot extend DIP, minimal pain swelling</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Swan Neck Deformity</th>
<th>• Lateral bands subluxes dorsally, PIP hyperextends DIP flexed</th>
<th>PE: PIP yperextended, DIP flexed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fx: Trauma, RA, spastic</td>
<td>XR: Hand series</td>
<td>1. Early: splint</td>
</tr>
<tr>
<td>PE: PIP yperextended, DIP flexed</td>
<td>2. Late: surgical repair (individualize)</td>
<td></td>
</tr>
</tbody>
</table>
ULNAR COLLATERAL OF THUMB: GAMEKEEPER’S THUMB

<table>
<thead>
<tr>
<th>• Ulnar collateral ligament torn</th>
<th>Hx: Trauma. Pain swelling.</th>
<th>XR: 1/2 avulsion fracture.</th>
<th>1. Incomplete: splint 2-4 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mechanism: forceful radial deviation</td>
<td>PE: Ulnar thumb unstable with radial extension/abduction</td>
<td>Stress view shows injury</td>
<td>2. Complete: surgical repair (treat Stener lesion)</td>
</tr>
<tr>
<td>• Often in ski pole injury</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## DISORDERS: INFECTIONS

### BITES: HUMAN/ANIMAL

**• Usually dominant hand**
- **Hx:** Laceration or puncture, dorsal MCP most common location
- **XR:** Rule out fracture

**• Classic mechanism: fist fight**
- **Labs:** Aerobic anaerobic cultures, WBC

**• Human: poly bacterial including Eikenella corrodens**
- **PE:** Red, swollen, 1/2 drainage, streaking. Decreased extension if tendon torn
- **[Contact health officials if animal possibly rabid]**

**• Animal: Pasteurella multocida**

### DEEP SPACE INFECTION

**• From palm puncture or spread from finger (+/- Horseshoe)**
- **Hx/PE:** Erythema, fluctuance, and tenderness
- **XR:** Usually normal
- **Dorsal volar ID and IV antibiotics**

### FELON

**• Deep infection or abscess in pulp**
- **Hx/PE:** Erythematous, swollen, and painful.
- **XR:** Usually normal
- **1. ID, release septae**
- **2. IV antibiotics**

**• Staph Aureus #1 organism**

### PARONYCHIA/Eponychia

**• Nail bed infection (most common finger infection)**
- **Hx/PE:** Red, painful, swollen, often purulent drainage
- **XR:** Usually normal
- **1. Soaks and oral antibiotics**
- **2. ID with nail removal if necessary**

**• Staph Aureus #1**
<table>
<thead>
<tr>
<th>Organism</th>
<th>PURULENT TENOSYNOVITIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected tendon</td>
<td>• Infection of flexor tendon sheath</td>
</tr>
<tr>
<td>Hx</td>
<td>Hx: Puncture wound</td>
</tr>
<tr>
<td>XR</td>
<td>XR: Possible foreign body or subcutaneous air</td>
</tr>
<tr>
<td>ID/antibiotics</td>
<td>1. Mild (early): IV antibiotics, re-evaluate within 24 hours</td>
</tr>
<tr>
<td></td>
<td>2. Most: I D (1/2 drain) and IV antibiotics</td>
</tr>
<tr>
<td></td>
<td>2. May extend into palm and develop &quot;horseshoe&quot; infection</td>
</tr>
<tr>
<td></td>
<td>No treatment results in adhesions necrosis</td>
</tr>
</tbody>
</table>

| SPOROTRICHOSIS    |                                                                                       |
| Infected tissue   | • Lymphatic infection (from roses)                                                    |
| Hx/PE             | Hx/PE: Discoloration or rash                                                          |
| XR                | XR: None                                                                              |
| Solution/medication | Potassium iodine solution                                                           |

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### DISORDERS: MASSES TUMORS

#### Deep Space Infections

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HISTORY/PHYSICAL EXAM</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DUPUYTREN’S DISEASE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Proliferation of fascia (long bands)</td>
<td>Hx: Male, 401 years old</td>
<td>XR: None needed</td>
<td>1. No proven conservative treatment</td>
</tr>
<tr>
<td>• Northern European descent</td>
<td>PE: nodule, non-tender,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>flexed digit (RF#1, SF#2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Associated with DM, epilepsy</td>
<td></td>
<td></td>
<td>2. Fasciotomy</td>
</tr>
<tr>
<td><strong>ENCHONDROMA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• #1 Primary bone tumor</td>
<td>Hx: Pain after pathologic fracture</td>
<td>XR: Lytic lesion</td>
<td>Curettage and bone graft</td>
</tr>
<tr>
<td>• Usually proximal phalanx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EPIDERMAL INCLUSION CYST</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Epidermal cells embedded deep into tissue</td>
<td>Hx: Trauma or puncture</td>
<td>XR: Normal</td>
<td>Excision (get all epidermal cells or it will recur)</td>
</tr>
<tr>
<td></td>
<td>PE: Painless mass, usually on digits, no transillumination</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GANGLION RETINACULAR CYST</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cyst (arises from joint or tendon) with mucinous joint fluid</td>
<td>Hx: Young patient</td>
<td>XR: No osteophyte in corresponding area</td>
<td>Aspiration of cyst if symptomatic. (may recur)</td>
</tr>
<tr>
<td></td>
<td>PE: Visible, firm mass (volar MCP flexor tendon #1 site)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Most common mass in hand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GIANT CELL TUMOR (FIBROXANTHOMA)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Originates from tendon sheath</td>
<td>Hx/PE: Firm, painless mass, usually volar finger (IF,MF)</td>
<td>XR: Normal</td>
<td>Excise, they do recur</td>
</tr>
<tr>
<td>• 2nd most common hand mass</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Infection of thenar space from tenosynovitis of index finger due to puncture wound. Note: thenar space also extends dorsal to adductor pollicis muscle. Line of incision indicated.

Infection of midpalmar space secondary to tenosynovitis of middle finger. Focus is infected puncture wound at distal crease. Line of incision indicated.
| MALIGNANT TUMORS |  |  | 
| --- | --- | --- | --- | 
| #1 Primary: squamous cell | Hx/PE: Mass, usually on dorsum of hand | XR: Normal | Excise | 
| #1 Metastatic: lung |  |  |  | 

| MUCOUS CYST |  |  | 
| --- | --- | --- | --- | 
| A ganglion of dorsal DIP | Hx: Women, older patients | XR: OA and/or spur at DIP | Excision and osteophyte or joint debridement | 
| Associated with OA at DIP | PE: Dorsal DIP mass, 1/2 pain |  |  | 

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### SURGICAL APPROACHES

#### Finger: Volar Approach

<table>
<thead>
<tr>
<th>USES</th>
<th>Internervous Plane Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flexor tendons (repair/explore)</td>
<td>No planes</td>
<td>1. Make a “zig-zag” incision with angles of 90°</td>
</tr>
<tr>
<td>2. Digital nerve</td>
<td></td>
<td>2. Digital nerve</td>
</tr>
<tr>
<td>3. Soft tissue releases</td>
<td></td>
<td>2. Neurovascular bundle is lateral to the tendon sheath</td>
</tr>
<tr>
<td>4. Infection drainage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Finger: Mid-Lateral Approach

<table>
<thead>
<tr>
<th>Phalangeal fractures</th>
<th>No planes</th>
<th>1. Digital nerve</th>
<th>Soft tissues are thin, capsule can be incised if care is not taken.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2. Digital artery</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
OSTEOLOGY

CHARACTERISTICS | OSSIFY | FUSE | COMMENT
--- | --- | --- | ---
INNOMINATE: COXAL BONE
• One bone: started as 3, connected by tri-radiate cartilage at acetabulum ilium; body ala ischium; body ramus Pubis: body 2 rami Primary (one in each body) | 2-6 mo | to acetabulum 15 yrs | • iliac wing and superior pubic ramus are “weak spots”

• ASIS: avulsion fracture can result from sartorius

Secondary iliac crest Acetabulum Ischial tuberosity AIIS Pubis 15 yrs | All fuse 20 yrs | • AIIS: avulsion fracture can result from rectus femoris

• Two innominate per pelvis (L R)

• iliac crest ossification used to determine skeletal maturity (Risser stage)
| Acetabulum: anteverted and oblique orientation (approx. 45°) | Iliac crest contusion referred to as “hip pointer” |

**SACRUM**

See spine chapter

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>ATTACHMENTS/RELATED STRUCTURES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIS</td>
<td>Sartorius Inguinal ligament</td>
<td>LFCN crosses the ASIS can be compressed there (Meralgia paresthetica)</td>
</tr>
<tr>
<td></td>
<td>Transverse internal oblique abdominal muscles</td>
<td>Sartorius can avulse from it (avulsion fracture)</td>
</tr>
<tr>
<td>AIIS</td>
<td>Rectus femoris Tensor fascia lata iliofemoral ligament (hip capsule)</td>
<td>Rectus femoris can avulse from it (avulsion fracture)</td>
</tr>
<tr>
<td>PSIS</td>
<td>Posterior sacroiliac ligaments</td>
<td>Excellent bone graft site</td>
</tr>
<tr>
<td>Arcuate line</td>
<td>Pectineus muscle</td>
<td>Strong, weight bearing region</td>
</tr>
<tr>
<td>Gluteal lines</td>
<td>3 lines: anterior, inferior, posterior</td>
<td>Separate origins of gluteal muscles</td>
</tr>
<tr>
<td>Greater trochanter</td>
<td>SEE ORIGINS/INSERTIONS</td>
<td>Tender with trochanteric bursitis</td>
</tr>
<tr>
<td>Lesser trochanter</td>
<td>Iliacus Psoas muscles</td>
<td></td>
</tr>
<tr>
<td>Ischial tuberosity</td>
<td>SEE ORIGINS/INSERTIONS Sacrotuberous ligaments</td>
<td>Excessive friction can cause bursitis (Weaver's bottom)</td>
</tr>
<tr>
<td>Ischial spine</td>
<td>Coccygeus Levator ani attach Sacrospinous ligaments</td>
<td></td>
</tr>
<tr>
<td>Anterior (iliopubic) column of acetabulum</td>
<td>Consists of: 1. Pubic ramus 2. Anterior acetabulum 3. Anterior iliac wing</td>
<td>Involved in several different fracture patterns</td>
</tr>
<tr>
<td>Posterior (ilioischial) column of acetabulum</td>
<td>Consists of: 1. Ischial tuberosity 2. Posterior acetabulum 3. Sciatic notch</td>
<td>Involved in several different fracture patterns</td>
</tr>
<tr>
<td>Lesser sciatic foramen</td>
<td>Short external rotators exit: Obturator externus Obturator internus</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Nerves (structures) that exit inferior to the piriformis (medial to lateral)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TRAUMA

**Classification of Pelvic Fractures (Young and Burgess)**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PELVIC FRACTURE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Mechanism**
  1. High energy force (e.g., MVA), Lateral force more common than AP
  2. Usually associated with other injuries (often life threatening).
  3. Open pelvic fracture with associated GI and/or GU injury: 50% mortality
  4. Posterior SI ligament is key to pelvic stability
  5. Mechanism

- **HX:** Trauma. Swelling, pain, deformity.
- **PE:** ABC's. Affected LE shortened, +/- blood in rectum/vagina/urethra.
- **Do good neurovascular exam:** +/- pulses in groin LE with neurologic deficits including loss of rectal tone bulbocavernosus reflex.
- **XR:** AP, Inlet, Outlet Judet views of the pelvis.

- **Young and Burgess:**
  - AP compression (APC):
    1. 2.5cm pubic diastasis fracture of 1-2 rami
    2. 2.5cm diastasis; SI disruption, but stable
    3. Complete disruption pubis symphysis SI joint: unstable fracture
  - Lateral Compression (LC):
    1. Sacral compression with rami fractures

- **Treat life threatening injuries first (ABC's).**
  - Treat pelvic hemorrhage with external fixation (+/- embolization)
  - Diverting colostomy for GI injury (avoid sepsis)
  - Stable fractures:
    - (single ramus, avulsion fx, APC or LC II): conservative treatment; bedrest, decreased...
Mechanism 2: Minor trauma (e.g. fall on osteopenic bone): stable single ramus fracture

Mechanism 3: Stable avulsion fracture - ASIS (Sartorius) - AIIS (Rectus femoris) - Ischium (hamstring)

CT: Scan entire pelvis
AGRAM: for hemorrhage

II. Hami fracture, posterior SI ligament disrupted, but stable
III. LC II, with contralateral APC III ("windswept")


Unstable fractures: external fixation with ORIF as needed
Early mobilization aids recovery

COMPLICATIONS: Associated injuries (especially with APC III): 1. GI, 2. GU, 3. Vascular/hemorrhage, 4. Neurologic; Prolonged hospital stay with associated risks (infection, DVT, etc.); Residual deformity and/or pain (lower back or SI); Leg length discrepancy
ACETABULAR FRACTURE

**DESCRIPTION**
- Uncommon, younger
- High energy or violent injury; femoral head is forced into acetabulum
- Dislocation of hip is often associated
- Also GI, GU, vascular associated injuries.

**EVALUATION**
- HX: Trauma (e.g. dashboard injury). Pain, deformity.
- PE: LE shortened, rotated. Usually neurovascually intact distally.
- XR: AP. Internal external obliques (Judet views): many possible fracture sites
- CT: shows fracture pattern and loose fragments

**CLASSIFICATION**
- Judet/Letournel:
  - I. Posterior wall
  - II. Posterior column
  - III. Anterior wall
  - IV. Anterior column
  - V. Transverse
  - VI. Posterior column wall
  - VII. Transverse post. wall
  - VIII. T-type
  - IX. Anterior column posterior emi-transverse
  - X. Both columns

**TREATMENT**
- Traction on affected side
- Nondisplaced, congruent joint, Displaced, dislocation, unstable fx
- ORIF
- XRT (600 rads) prophylaxis for heterotopic bone.

**COMPLICATIONS:** Need for Total Hip Arthroplasty; Nerve injury (sciatic); Heterotopic bone formation; Osteonecrosis osteoarthritis
**Joint**

**Ligaments**

**Attachments**

**Comments**

<table>
<thead>
<tr>
<th>SACROILIAC (GLIDING)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posterior SI (short long)</strong></td>
</tr>
<tr>
<td><strong>Anterior SI</strong></td>
</tr>
<tr>
<td><strong>Interosseous</strong></td>
</tr>
<tr>
<td>LIGAMENTS</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td><strong>SYMPHYSIS PUBIS</strong></td>
</tr>
<tr>
<td>Superior pubic ligament</td>
</tr>
<tr>
<td>Arcuate pubic ligament</td>
</tr>
<tr>
<td><strong>OTHER LIGAMENTS</strong></td>
</tr>
<tr>
<td>Sacrospinous</td>
</tr>
<tr>
<td>Sacrotuberous</td>
</tr>
<tr>
<td>Iliolumbar</td>
</tr>
<tr>
<td>Lumbosacral</td>
</tr>
<tr>
<td>QUESTION</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>1. AGE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2. PAIN</td>
</tr>
<tr>
<td>a. Onset</td>
</tr>
<tr>
<td>b. Character</td>
</tr>
<tr>
<td>c. Occurrence</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3. PMHx</td>
</tr>
<tr>
<td>4. TRAUMA</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5. ACTIVITY/WORK</td>
</tr>
<tr>
<td>6. NEUROLOGIC SYMPTOMS</td>
</tr>
<tr>
<td>7. HISTORY of ARTHRITIDES</td>
</tr>
</tbody>
</table>
PHYSICAL EXAM OF THE PELVIS

With palpation

<table>
<thead>
<tr>
<th>EXAM/OBSERVATION</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Discoloration, wounds</td>
<td>If on different plane: Leg length discrepancy, sacral torsion</td>
</tr>
<tr>
<td>ASIS's, iliac crests</td>
<td>Both level (same plane)</td>
<td></td>
</tr>
<tr>
<td>Lumbar curvature</td>
<td>Increased lordosis</td>
<td>Flexion contracture</td>
</tr>
<tr>
<td></td>
<td>Decreased lordosis</td>
<td>Paraspinal muscle spasm</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bony structures</td>
<td>Standing: ASIS, Pubic iliac tubercles, PSIS</td>
<td>Unequal side to side 5pelvic obliquity; leg length discrepancy</td>
</tr>
<tr>
<td></td>
<td>Lying: Iliac crest, Ischial tuberosity</td>
<td>Mass: cluneal neuroma</td>
</tr>
<tr>
<td>Soft tissues</td>
<td>Inguinal ligament</td>
<td>Protruding mass: hernia</td>
</tr>
<tr>
<td></td>
<td>Femoral pulse nodes</td>
<td>Diminished pulse: vascular injury; palpable nodes: infection</td>
</tr>
<tr>
<td>Muscle groups</td>
<td>Each group should be symmetric bilaterally</td>
<td></td>
</tr>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward flexion</td>
<td>Standing: bend forward</td>
<td>PSIS’s should elevate slightly (equally)</td>
</tr>
<tr>
<td>Extension</td>
<td>Standing: lean backward</td>
<td>PSIS’s should depress (equally)</td>
</tr>
<tr>
<td>Hip flexion</td>
<td>Standing: knee to chest</td>
<td>PSIS should drop but will elevate in hypomobile SI joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ischial tuberosity should move laterally, will elevate in hypomobile SI joint</td>
</tr>
<tr>
<td>EXAM/OBSERVATION</td>
<td>TECHNIQUE</td>
<td>CLINICAL APPLICATION</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>SENSORY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iliohypogastric nerve (L1)</td>
<td>Suprapubic, lateral buttock thigh</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Ilioinguinal nerve (L1)</td>
<td>Inguinal region</td>
<td>Deficit indicates corresponding nerve/root lesion (e.g. abdominal muscle compression)</td>
</tr>
<tr>
<td>Genitofemoral nerve (L1-2)</td>
<td>Scrotum or mons</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Lateral femoral cutaneous nerve (L2-3)</td>
<td>Lateral hip thigh</td>
<td>Deficit indicates corresponding nerve/root lesion (e.g. Meralgia paresthetica)</td>
</tr>
<tr>
<td>Pudendal nerve (S2-4)</td>
<td>Perineum</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td><strong>MOTOR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral (L2-4)</td>
<td>Hip flexion</td>
<td>Weakness in iliopsoas or corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Inferior Gluteal nerve</td>
<td>External rotation</td>
<td>Weakness in Gluteus maximus or nerve/root lesion</td>
</tr>
<tr>
<td>Nerve to Quadratus femoris</td>
<td>External rotation</td>
<td>Weakness in Short rotators or corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Nerve to Obturator internus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nerve to Piriformis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior Gluteal nerve</td>
<td>Abduction</td>
<td>Weakness in Gluteus medius/minimus, TFL or corresponding nerve/root lesion</td>
</tr>
<tr>
<td><strong>REFLEX</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulbocavernosus</td>
<td>Finger in rectum, squeeze or pull penis (Foley), anal sphincter should contract</td>
<td></td>
</tr>
<tr>
<td><strong>PULSES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral pulse</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIAL TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight leg</td>
</tr>
<tr>
<td>Test/Exam</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Straight leg test</td>
</tr>
<tr>
<td>SI stress</td>
</tr>
<tr>
<td>Trendelenburg sign</td>
</tr>
<tr>
<td>Patrick (FABER)</td>
</tr>
<tr>
<td>Meralgia</td>
</tr>
<tr>
<td>Rectal Vaginal exam</td>
</tr>
</tbody>
</table>
**MUSCLES: ORIGINS AND INSERTIONS**

<table>
<thead>
<tr>
<th>PUBIC RAMI (ASPECT)</th>
<th>GREATER TROCHANTER</th>
<th>ISCHIAL TUBEROUSITY</th>
<th>LINEA ASPERA/POSTERIOR FEMUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectineus (pectineal line/superior)</td>
<td>Piriformis (anterior)</td>
<td>Inferior gemellus</td>
<td>Adductor magnus</td>
</tr>
<tr>
<td>Adductor magnus (inferior)</td>
<td>Obturator internus (anterior)</td>
<td>Quadratus femoris</td>
<td>Adductor longus</td>
</tr>
<tr>
<td>Adductor longus (anterior)</td>
<td>Superior gemellus</td>
<td>Semimembranosus</td>
<td>Adductor brevis</td>
</tr>
<tr>
<td>Adductor brevis (inferior)</td>
<td>Gluteus medius (posterior)</td>
<td>Semitendinosus</td>
<td>Biceps femoris</td>
</tr>
<tr>
<td>Gracilis (inferior)</td>
<td>Gluteus minimus (anterior)</td>
<td>Biceps femoris (LH)</td>
<td>Pectineus</td>
</tr>
<tr>
<td>Psoas minor (superior)</td>
<td>Adductor magnus</td>
<td>Gluteus maximus</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
**ANTERIOR MUSCLES** (also see muscles of the thigh/hip)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIP FLEXORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psoas</td>
<td>T12-L5 vertebrae</td>
<td>Lesser trochanter</td>
<td>Femoral</td>
<td>Flex hip</td>
<td>Covers lumbar plexus</td>
</tr>
<tr>
<td>Iliacus</td>
<td>Iliac fossa</td>
<td>Lesser trochanter</td>
<td>Femoral</td>
<td>Flex hip</td>
<td>Covers anterior ilium</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
GLUTEAL MUSCLES (also see muscles of the thigh/hip)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIP ABDUCTORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensor fascia latae</td>
<td>iliac crest, ASIS</td>
<td>Iliotibial band</td>
<td>Superior Gluteal</td>
<td>Abducts, flex, IR thigh</td>
<td>A plane in anterior approach to hip</td>
</tr>
<tr>
<td>Gluteus medius</td>
<td>ilium between anterior posterior gluteal lines</td>
<td>Greater trochanter</td>
<td>Superior Gluteal</td>
<td>Abduct (IR) thigh</td>
<td>Trendelenburg gait if muscle is out.</td>
</tr>
<tr>
<td>Gluteus minimus</td>
<td>ilium between anterior interior gluteal lines</td>
<td>Anterior greater trochanter</td>
<td>Superior Gluteal</td>
<td>Abduct (IR) thigh</td>
<td>Works in conjunction with medius</td>
</tr>
<tr>
<td>HIP EXTERNAL ROTATORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>ilium, dorsal sacrum</td>
<td>Gluteal tuberosity (femur), ITB</td>
<td>Inferior Gluteal</td>
<td>Extend, ER thigh</td>
<td>Must detach in post. approach to hip</td>
</tr>
<tr>
<td>Piriformis</td>
<td>Anterior sacrum</td>
<td>Superior greater trochanter</td>
<td>Piriformis</td>
<td>ER thigh</td>
<td>Used as landmark</td>
</tr>
<tr>
<td>Obturator externus</td>
<td>Ischiopubic rami, obturator membrane</td>
<td>Trochanteric fossa</td>
<td>Obturator</td>
<td>ER thigh</td>
<td>Muscle actually in medial thigh</td>
</tr>
<tr>
<td>Short Rotators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obturator internus</td>
<td>Ischiopubic rami, obturator membrane</td>
<td>Medial greater trochanter</td>
<td>N. to Obturator internus</td>
<td>ER, abduct thigh</td>
<td>Muscle makes a right turn</td>
</tr>
<tr>
<td>Superior gemellus</td>
<td>Ischial spine</td>
<td>Medial greater trochanter</td>
<td>N. to Obturator internus</td>
<td>ER thigh</td>
<td>Assists obturator internus</td>
</tr>
<tr>
<td>Inferior gemellus</td>
<td>Ischial tuberosity</td>
<td>Medial greater trochanter</td>
<td>N. to Quadratus femoris</td>
<td>ER thigh</td>
<td>Assists obturator internus</td>
</tr>
<tr>
<td>Quadratus femoris</td>
<td>Ischial tuberosity</td>
<td>Intertrochanteric crest</td>
<td>N. to Quadratus femoris</td>
<td>ER thigh</td>
<td>Runs with ascending branch of medial circumflex artery</td>
</tr>
</tbody>
</table>
### LUMBAR PLEXUS

#### ANTERIOR DIVISION

1. **Subcostal (T12):**  
   **Sensory:** Subxyphoid region  
   **Motor:** NONE

2. **Iliohypogastric (L1):**  
   **Sensory:** Above pubis  
   **Motor:** Transversus abdominus, Internal Oblique

3. **Ilioinguinal (L1):**  
   **Sensory:** Inguinal region  
   **Motor:** NONE

4. **Genitofemoral (L1-2):** pierces Psoas, lies on anteromedial surface.  
   **Sensory:** Scrotum or mons  
   **Motor:** Cremaster

5. **Obturator (L2-4):** exits via obturator canal, splits into ant. post. divisions. Can be injured by retractors placed behind the transverse acetabular ligament.  
   **Sensory:** Inferomedial thigh via cutaneous branch of Obturator nerve  
   **Motor:** External oblique, Obturator externus (posterior division)

6. **Accessory Obturator (L2-4):** inconsistent  
   **Sensory:** NONE  
   **Motor:** Psoas

#### POSTERIOR DIVISION

7. **Lateral Femoral Cutaneous (LFCN)(L2-3):** crosses, ASIS, can be compressed at ASIS
### SACRAL PLEXUS

#### ANTERIOR DIVISION

<table>
<thead>
<tr>
<th>Nerve to Quadratus femoris (L4-S1):</th>
<th>Sensory: NONE</th>
<th>Motor: Quadratus femoris, Inferior gemelli</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Nerve to Obturator internus (L5-S2): exits greater sciatic foramen</th>
<th>Sensory: NONE</th>
<th>Motor: Obturator internus, Superior gemelli</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Nerve to coccygeus (S3-4)</th>
<th>Sensory: NONE</th>
<th>Motor: Bulbospongious, Isiocavernosus, Urethral sphincter, Urogenital diaphragm, Sphincter ani externus</th>
</tr>
</thead>
</table>

**Topography:** Medial and slightly anterior view of hemisected pelvis
Motor: Coccygeus
Levator ani

POSTERIOR DIVISION

13. **Superior Gluteal** (L4-S1):

| Sensory: NONE |
| Motor: Gluteus medius |
| Motor: Gluteus minimus |
| Motor: Tensor fascia lata |

14. **Inferior Gluteal** (L5-S2):

| Sensory: NONE |
| Motor: Gluteus maximus |

15. **Nerve to piriformis** (S2):

| Sensory: NONE |
| Motor: Piriformis |

OTHER NERVES (non-plexus)

16. **Cluneal nerves**: branches of lumbar and sacral dorsal rami. Can be injured during bone grafts.

| Sensory: Skin of gluteal region |
| Motor: NONE |

![Diagram of lower back muscles and nerves](image-url)
## ARTERIES

### COURSE

<table>
<thead>
<tr>
<th>BRANCHES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AORTA</strong></td>
<td></td>
</tr>
<tr>
<td>Along anterior vertebral bodies ALL</td>
<td>Common iliacs at L4 Lumbar arteries (4 sets)</td>
</tr>
<tr>
<td>Median sacral artery 5th Lumbar arteries (2)</td>
<td>Unpaired vessel</td>
</tr>
<tr>
<td></td>
<td>Anastomoses with lat. sacral artery</td>
</tr>
<tr>
<td><strong>COMMON ILIACS</strong></td>
<td>Divide into internal external iliacs at S1</td>
</tr>
<tr>
<td><strong>INTERNAL ILIAC</strong></td>
<td>Supplies most of pelvis and the pelvic organs</td>
</tr>
<tr>
<td>Under ureter near SI joint, divides into its divisions at edge of greater sciatic foramen</td>
<td></td>
</tr>
<tr>
<td><strong>ANTERIOR DIVISION</strong></td>
<td>Runs with nerve through foramen</td>
</tr>
<tr>
<td>Obturator</td>
<td>Fovea artery (artery of ligamentum teres in hip)</td>
</tr>
<tr>
<td></td>
<td>Inferior gluteal</td>
</tr>
<tr>
<td>Inferior gluteal</td>
<td>buttocks</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>POSTERIOR DIVISION</td>
<td></td>
</tr>
<tr>
<td>Superior gluteal</td>
<td>Supplies muscles of the buttocks</td>
</tr>
<tr>
<td>Iliolumbar</td>
<td>Supplies iliopsoas and ilium</td>
</tr>
<tr>
<td>Lateral sacral</td>
<td>Supplies sacral roots, meninges, muscles covering sacrum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXTERNAL ILIAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under inguinal ligament over the pubic rami, on the psoas muscle</td>
</tr>
<tr>
<td>Deep circumflex iliac artery</td>
</tr>
<tr>
<td>Inferior epigastric artery</td>
</tr>
<tr>
<td>Femoral artery (under inguinal ligament)</td>
</tr>
</tbody>
</table>

* Other branches of the Internal iliac include: Umbilical, Vaginal/Inferior vesical, Uterine, Middle rectal, Inferior pudendal
OSTEOMETRY

CHARACTERISTICS | OSSIFY | FUSE | COMMENT

FEMUR

- Long bone characteristics
- Proximally: head, neck, greater lesser trochanters
- Neck: bone comprised of tensile compressive groups
- Distally: 2 condyles
  - Lateral: more anterior proximal
  - Medial: larger, more posterior distal

Primary (Shaft)
- Secondary
  1. Distal physis
  2. Head
  3. Greater trochanter
  4. Lesser trochanter

|  |  | 16-18 years | Blood supply

Blood supply
- Head neck: branches of the Medial Lateral circumflex artery (from profunda)
- Shaft: nutrient (from profunda)

Head neck vascularity tenuous:
- increased risk of ischemia in fracture or dislocation.
- Femoral neck weakens with age: susceptible to
Femoral anteversion: 12-14°
Neck/shaft angle: 126°

Bone Architecture in Relation to Physical Stress

Wolff's law. Bony structures orient themselves in form and mass to best resist extrinsic forces (e.g., form and mass follow function)

- Greater trochanteric group
- Secondary tensile group
- Trabecular configuration in proximal femur

- Principal tensile group
- Secondary compressive group
- Ward's triangle
- Trabecular groups confirm to lines of stress in weight bearing
## TRAUMA

### HIP DISLOCATION

#### DESCRIPTION
- High energy trauma (esp MVA-dashboard injury or significant fall.)
- Orthopaedic emergency
- Multiple associated injuries +/- fractures, (e.g. femoral head neck)
- Posterior most common (85%)

#### EVALUATION
- HX: Trauma. Severe pain, Cannot move thigh/hip.
- PE: Thigh position:
  - Post: adducted, flexed, IR
  - Ant: abducted, flexed, ER.
  - Pain (esp. with motion), good neurovascular exam
- XR: AP pelvis, frog lateral (Femoral head is different size) Also femur knee series
- CT: Rule out fracture or bony fragments

#### CLASSIFICATION

| Thompson: Simple, no posterior fragment |
| Thompson: Simple, large posterior fragment |
| Thompson: Comminuted posterior fragment |
| Acetabular fracture |
| Femoral head fracture |
| Epstein: (A, B, C): Superior |
| Epstein: (A, B, C): Inferior |
| A: No associated fracture |
| B: Femoral head fracture |
| C: Acetabular fracture |

#### TREATMENT
- Early reduction essential, then repeat XR neurologic exam
- Posterior:
  - I. Closed reduction abduction pillow
  - II-V. 1. Closed Reduction (open if irreducible)
  - ORIF fracture or excise fragment
- Anterior: closed reduction, ORIF if necessary.

#### COMPLICATIONS:
- Osteonecrosis (AVN) reduced risk with early reduction;
- Sciatic nerve injury (posterior dislocations);
- Femoral artery nerve injury (anterior dislocations);
- Instability recurrence;
- Osteoarthritis;
- Heterotopic ossification
**FEMORAL NECK FRACTURE**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanism:</strong></td>
<td></td>
<td>Garden (4 types):</td>
<td>Early reduction essential</td>
</tr>
<tr>
<td>1. Fall by elderly woman most common;</td>
<td>HX: Fall, Pain, inability to bear weight or walk.</td>
<td>Incomplete fracture; valgus impaction</td>
<td>All fractures:</td>
</tr>
<tr>
<td>2. High velocity injury in young adults</td>
<td>PE: LE shortened, abducted, externally rotated. Pain with &quot;rolling&quot; of leg.</td>
<td>Complete fracture; nondisplaced</td>
<td>Closed (open) reduction then IF of fracture:</td>
</tr>
<tr>
<td>Intracapsular fractures</td>
<td>XR: AP pelvic (+/-IR), groin lateral</td>
<td>Complete fracture, Partial displacement</td>
<td>Young: 3 parallel screws</td>
</tr>
<tr>
<td>Associated with osteoporosis</td>
<td>MR: If symptomatic with negative XR</td>
<td>(varus)</td>
<td>Old: hemi-arthroplasty</td>
</tr>
<tr>
<td>Often caused by medical condition (syncope, etc)</td>
<td></td>
<td>Complete fracture, total displacement</td>
<td>(Stable fracture, type I, may heal without surgery, ORIF because of displacement risk)</td>
</tr>
<tr>
<td>High morbidity complication rate (25%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPLICATIONS:** Osteonecrosis (AVN) incidence increases with fracture type (displacement) +/- late segmental collapse; Nonunion; Hardware failure
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUBTROCHANTERIC FRACTURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall by a more elderly woman most common</td>
<td>• HX: Fall. Pain, inability to bear weight or walk</td>
<td>Evans (based on post-reduction stability) Type I. Stable Type II. Unstable</td>
<td>Nonoperative is very rarely indicated. Operative treatment with sliding compression hip screw and side plate. Early mobilization with partial weight-bearing</td>
</tr>
<tr>
<td>Associated with osteoporosis</td>
<td>• PE: LE shortened, ER. Pain with “log rolling” of leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occurs along or below the intertrochanteric line</td>
<td>• XR: AP pelvis (+/- IR), groin lateral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extracapsular fractures</td>
<td>• MR: If symptomatic with negative XR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stable vascularity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most heal well with proper fixation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMPLICATIONS:** Nonunion/Malunion; Hardware failure or loss of reduction; Infection. Mortality rate, first 6 months after fracture, is 15-25%
### Femoral Shaft Fracture

**Description:** Orthopaedic emergency, high energy injury, multiple associated injuries (many serious), potential source of significant blood loss. Patient should be transported with leg in traction.

**Evaluation:**
- HX: Trauma, pain, swelling deformity
- PE: Deformity, +/- open wound, soft tissue injury; check distal pulses
- XR: AP lateral thigh, knee trauma series.

**Winquist/Hansen (4 types):**
- **Stable**
  - I. No/minimal comminution
  - II. Comminuted: 50% of cortices intact
- **Unstable**
  - III. Comminuted: 50% of cortices intact
  - IV. Complete comminution, no intact cortex

**Classification:**
- I. No/minimal comminution
- II. Comminuted: 50% of cortices intact
- III. Comminuted: 50% of cortices intact
- IV. Complete comminution, no intact cortex

**Treatment:**
- Extensive irrigation of any open fractures
- Operative: Interlocking intramedullary rods (closed)
- Early mobilization with crutch ambulation

**Complications:** Neurovascular injury and/or hemorrhagic shock, Nonunion/Malunion, Hardware failure or loss of reduction, Knee injury (5%).

### Distal Femur Fracture

**Description:**
- Transverse supracondylar fracture
- Intercondylar (T or Y) fracture
- Fracture of single condyle (may occur in frontal or oblique plane)
- Comminuted fracture extending into shaft

**Evaluation:**
- HX: Trauma, pain, swelling, deformity
- PE: Deformity, +/- open wound, soft tissue injury; check distal pulses
- XR: AP lateral thigh, knee trauma series.

**Winquist/Hansen (4 types):**
- **Stable**
  - I. No/minimal comminution
  - II. Comminuted: 50% of cortices intact
- **Unstable**
  - III. Comminuted: 50% of cortices intact
  - IV. Complete comminution, no intact cortex

**Classification:**
- I. No/minimal comminution
- II. Comminuted: 50% of cortices intact
- III. Comminuted: 50% of cortices intact
- IV. Complete comminution, no intact cortex

**Treatment:**
- Operative treatment: Locked IM nail, compression screw, or Zickel nail, +/- bone graft

**Complications:** Nonunion/Malunion; Hardware failure or loss of reduction; Refracture with hardware removal.
Mechanism: direct blow
Metaphysis or epiphysis
Quadriceps or gastrocnemius often displace fragments
Restoration of articular surface is essential to regain normal knee mobility function

HX: Trauma. Cannot bear weight, pain, swelling.
PE: Effusion, tenderness, do good neurovascular exam
XR: Knee trauma series
CT: Better defines fracture
AGRAM: if pulseless

Extraarticular
Supracondylar
Intraarticular
Intercondylar: T or Y Condylar

 +/- aspirate hemarthroses
Undisplaced/extraarticular: reduce, immobilize (less commonly used method)
Displaced/intraarticular: ORIF: plates and screws or intramedullary nails
Early mobilization

COMPLICATIONS: Osteoarthritis and/or pain; Decreased range of motion; Malunion/nonunion; Instability

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
**JOINTS**

<table>
<thead>
<tr>
<th>LIGAMENTS</th>
<th>ATTACHMENTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIP JOINT (Spheroidal/Ball and Socket type)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transverse acetabular</td>
<td>Anteroinferior to posteroinferior acetabulum</td>
<td>Cups the acetabulum</td>
</tr>
<tr>
<td>Labrum</td>
<td>Acetabular rim</td>
<td>Deepens stabilizes acetabulum</td>
</tr>
<tr>
<td><strong>JOINT CAPSULE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pubofemoral (anterior/inferior)</td>
<td>Femoral neck to superior pubic ramus</td>
<td>Covers femoral NECK</td>
</tr>
<tr>
<td>Iliofemoral (anterior) (Y ligament of Bigelow)</td>
<td>AIIS to intertrochanteric line</td>
<td>Strongest, most support</td>
</tr>
<tr>
<td>Ischiofemoral (posterior)</td>
<td>Posterior rim to intertrochanteric crest</td>
<td>Posterior femoral neck only partially covered (weak)</td>
</tr>
<tr>
<td>Zona orbicularis (posterior)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ligament of Teres</td>
<td>Fovea to cotyloid notch</td>
<td>Artery runs in ligament</td>
</tr>
</tbody>
</table>

"JOINTS"
MINOR PROCEDURES

HIP INJECTION OR ASPIRATION

1. Ask patient about allergies
2. Place patient supine, palpate the greater trochanter.
3. Prepare skin over insertion site (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
   - ANTERIOR: Find the point of intersection between a vertical line below ASIS and horizontal line from Greater trochanter. Insert 20 gauge (3 inch/spinal needle) upward slightly medial direction at that point.
   - LATERAL: Insert a 20 gauge (3 inch/spinal needle) superior and medial to greater trochanter until it hits the bone (the needle should be within the capsule which extends down the femoral neck).
5. Inject (or aspirate) local or local/steroid preparation into joint. (The fluid should flow easily if needle is in joint)
6. Dress injection site

TROCHANTERIC BURSA INJECTION

1. Ask patient about allergies
2. Place patient in lateral decubitus position, palpate the greater trochanter.
3. Prepare skin over lateral thigh (iodine/antiseptic soap)
4. Insert 20 gauge needle (at least 1 1/2 inches) into thigh to the bone at the point of most tenderness. Withdraw needle (1—2 mm) so it is just off the bone and in the bursa. Aspirate to ensure needle is not in a vessel.
   - Inject 10 ml of local or 4:1 local/corticosteroid preparation into bursa
5. Dress injection site
<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ANSWER</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AGE</td>
<td>Young</td>
<td>Trauma, developmental disorders</td>
</tr>
<tr>
<td></td>
<td>Middle age, elderly</td>
<td>Arthritis (inflammatory conditions), femoral neck fractures</td>
</tr>
<tr>
<td>2. PAIN</td>
<td>Acute</td>
<td>Trauma, infection</td>
</tr>
<tr>
<td>a. Onset</td>
<td>Chronic</td>
<td>Arthritis (inflammatory conditions)</td>
</tr>
<tr>
<td>b. Location</td>
<td>Lateral hip or thigh</td>
<td>Bursitis, LFCN entrapment, snapping hip</td>
</tr>
<tr>
<td>c. Occurrence</td>
<td>Buttocks/posterior thigh</td>
<td>Consider spine etiology</td>
</tr>
<tr>
<td></td>
<td>Groin/medial thigh</td>
<td>Hip joint or acetabular etiology (less likely to be from pelvis or spine)</td>
</tr>
<tr>
<td></td>
<td>Anterior thigh</td>
<td>Proximal femur</td>
</tr>
<tr>
<td></td>
<td>Ambulation/motion</td>
<td>Hip joint etiology (i.e. not pelvis or spine)</td>
</tr>
<tr>
<td></td>
<td>At night</td>
<td>Tumor, infection</td>
</tr>
<tr>
<td>3. SNAPPING</td>
<td>With ambulation</td>
<td>Snapping hip syndrome, loose bodies, arthritis, synovitis</td>
</tr>
<tr>
<td>4. ASSISTED</td>
<td>Cane, crutch, walker</td>
<td>Use (and frequency) indicates severity of pain condition</td>
</tr>
<tr>
<td>AMBULATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ACTIVITY</td>
<td>Walk distance</td>
<td>Less distance walked and fewer activities no longer performed = more severe</td>
</tr>
<tr>
<td>TOLERANCE</td>
<td>activity cessation</td>
<td></td>
</tr>
<tr>
<td>6. TRAUMA</td>
<td>Fall, MVA</td>
<td>Fracture, dislocation, bursitis</td>
</tr>
<tr>
<td>7. ACTIVITY/</td>
<td>Repetitive use</td>
<td>Femoral stress fracture</td>
</tr>
<tr>
<td>WORK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. NEUROLOGIC</td>
<td>Pain, numbness, tingling</td>
<td>LFCN entrapment, spine etiology</td>
</tr>
<tr>
<td>SYMPTOMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. HISTORY OF</td>
<td>Multiple joints involved</td>
<td>Systemic inflammatory disease</td>
</tr>
<tr>
<td>ARTHRITIDES</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### PHYSICAL EXAM

<table>
<thead>
<tr>
<th>EXAM/OBSERVATION TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Discoloration, wounds</td>
</tr>
<tr>
<td></td>
<td>Gross deformity</td>
</tr>
<tr>
<td>Gait</td>
<td>60% stance, 40% swing</td>
</tr>
<tr>
<td>Antalgic (painful)</td>
<td>Decreased stance phase</td>
</tr>
<tr>
<td>Lurch (Trendelenburg)</td>
<td>Laterally (on WB side)</td>
</tr>
<tr>
<td>Lurch</td>
<td>Posteriorly (hip extended)</td>
</tr>
<tr>
<td>Steppage</td>
<td>More hip knee flexion</td>
</tr>
<tr>
<td>Flat foot</td>
<td>No push off</td>
</tr>
<tr>
<td>Wide</td>
<td>Feet 4 inches apart</td>
</tr>
<tr>
<td>Decreased step size</td>
<td>Less than previous normal</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
</tr>
<tr>
<td>Bony structures</td>
<td>Greater trochanter/bursa</td>
</tr>
<tr>
<td>Soft tissue</td>
<td>Sciatic nerve (hip)</td>
</tr>
</tbody>
</table>
### Soft tissues
- Disc herniation
- Piriformis spasm

### Muscle groups
- Each group should be symmetric bilaterally

---

**EXAM/OBSERVATION**
- **TECHNIQUE**
- **CLINICAL APPLICATION**

#### RANGE OF MOTION

<table>
<thead>
<tr>
<th>EXAM/OBSERVATION</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>Supine: knee to chest</td>
<td>Normal: 130 degrees</td>
</tr>
<tr>
<td></td>
<td>Thomas test: see next page</td>
<td>Rule out flexion contracture</td>
</tr>
<tr>
<td>Extension</td>
<td>Prone: lift leg off table</td>
<td>Normal: 20 degrees</td>
</tr>
<tr>
<td>Abduction/adduction</td>
<td>Supine: leg lateral/medial</td>
<td>Normal: Abd: 40 degrees, Add: 30 degrees</td>
</tr>
<tr>
<td>Internal / External rotation</td>
<td>Seated: foot lateral/medial</td>
<td>Normal: IR: 30 degrees, ER: 50 degrees</td>
</tr>
<tr>
<td></td>
<td>Prone: flex knee leg: in out</td>
<td>Normal: IR: 30 degrees, ER: 50 degrees</td>
</tr>
</tbody>
</table>

#### NEUROVASCULAR

<table>
<thead>
<tr>
<th>EXAM/OBSERVATION</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory</td>
<td>Genitofemoral nerve (L1-2)</td>
<td>Proximal anteromedial thigh</td>
</tr>
<tr>
<td></td>
<td>Obturator nerve (L2-4)</td>
<td>Inferomedial thigh</td>
</tr>
<tr>
<td></td>
<td>Lateral Femoral Cutaneous nerve (L2-3)</td>
<td>Lateral thigh</td>
</tr>
<tr>
<td></td>
<td>Femoral nerve (L2-4)</td>
<td>Anteromedial thigh</td>
</tr>
<tr>
<td></td>
<td>Posterior Femoral Cutaneous nerve (S1-3)</td>
<td>Posterior thigh</td>
</tr>
<tr>
<td>Motor</td>
<td>Obturator nerve (L2-4)</td>
<td>Thigh adduction</td>
</tr>
<tr>
<td></td>
<td>Superior Gluteal nerve (L5)</td>
<td>Thigh abduction</td>
</tr>
<tr>
<td></td>
<td>Femoral nerve (L2-4)</td>
<td>Hip flexion</td>
</tr>
</tbody>
</table>

---

**Internal Rotation**
- Limitation of internal rotation of hip joint may be assessed with patient in prone position because any restriction can be detected and measured easily
Knee extension
Weakness = Quadriceps or corresponding nerve/root lesion.

Inferior Gluteal nerve (L5-S2)
Hip extension
Weakness = Gluteus maximus or nerve/root lesion.

Sciatic:
Tibial portion (L4-S3)
Knee flexion
Weakness = Biceps Long Head or nerve/root lesion.

Peroneal portion (L4-S2)
Knee flexion
Weakness = Biceps Short Head or nerve/root lesion

Reflex
None

Pulses
Femoral

EXAM/OBSERVATION TECHNIQUE    CLINICAL APPLICATION

SPECIAL TESTS

Thomas sign
Supine: one knee to chest
If opposite thigh elevates off table: flexion contracture of that side

Ober
On side: flex abduct hip
Leg should then adduct, if stays in abduction: ITB contracture

Piriformis
On side: adduct hip
Pain in hip/pelvis indicates tight piriformis (compressing sciatic nerve)

Leg length discrepancy
ASIS to medial malleolus
A measured difference of 1cm is positive

90-90 straight leg
Flex hip knee 90°, extend knee
20 degrees of flexion after full knee extension = tight hamstrings

Ely's
Prone: passively flex knee
If hip flexes as knee is flexed: tight rectus femoris muscle

Log roll
Supine, hip extended: IR/ER
Pain in hip is consistent with arthritis
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Test Details</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrick (FABER)</td>
<td>Flex, ABduct, ER hip, then abduct more (figure of 4)</td>
<td>Positive if pain or LE will not continue to abduct below other leg: Hip or SI joint pathology</td>
</tr>
<tr>
<td>Meralgia</td>
<td>Pressure medial to ASIS</td>
<td>Reproduction to pain, burning, numbness: LFCN entrapment</td>
</tr>
<tr>
<td>Ortolani (Peds)</td>
<td>Hips at 90°, abduct hips</td>
<td>A clunk indicates the hip(s) was dislocated and now reduced</td>
</tr>
<tr>
<td>Barlow (Peds)</td>
<td>Hips at 90°, posterior force</td>
<td>A clunk indicates the hip(s) is now dislocated, should reduce with Ortolani</td>
</tr>
</tbody>
</table>

![Ortolani's dislocation test](image1)

- With hips relaxed, pull center of the baby's hips, then let him down. If the hip is dislocated, a clunk will be felt. Test is positive if there is a single clunk or if hip return to normal position happens at a 30° angle. Test repeated with abduction and flexion at a 90° angle. Hip is dislocated if clunk is heard from the dislocated hip. A clunk indicates the hip was dislocated and now reduced.

![Barlow's dislocation test](image2)

- With hips relaxed, pull center of the baby's hips, then let him down. If the hip is dislocated, a clunk will be felt. Test is positive if there is a single clunk or if hip return to normal position happens at a 30° angle. Test repeated with abduction and flexion at a 90° angle. Hip is dislocated if clunk is heard from the dislocated hip. A clunk indicates the hip was dislocated and now reduced.

![Galeazzi's dislocation test](image3)

- With hips relaxed, pull center of the baby's hips, then let him down. If the hip is dislocated, a clunk will be felt. Test is positive if there is a single clunk or if hip return to normal position happens at a 30° angle. Test repeated with abduction and flexion at a 90° angle. Hip is dislocated if clunk is heard from the dislocated hip. A clunk indicates the hip was dislocated and now reduced.
MUSCLES: ORIGINS AND INSERTIONS

<table>
<thead>
<tr>
<th>PUBIC RAMI (ASPECT)</th>
<th>GREATER TROCHANTER</th>
<th>ISCHIAL TUBerosity</th>
<th>LINEA ASPErA/ POSTERIOR FEMUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectineus (pectineal line/sup)</td>
<td>Piniformis (anterior)</td>
<td>Inferior gemellus</td>
<td>Adductor magnus</td>
</tr>
<tr>
<td>Adductor magnus (inferior)</td>
<td>Obturator internus (anterior)</td>
<td>Quadratus femoris</td>
<td>Adductor longus</td>
</tr>
<tr>
<td>Adductor longus (anterior)</td>
<td>Superior gemellus</td>
<td>Semimembranosus</td>
<td>Adductor brevis</td>
</tr>
<tr>
<td>Adductor brevis (inferior)</td>
<td>Gluteus medius (posterior)</td>
<td>Semitendinosus</td>
<td>Biceps femoris</td>
</tr>
<tr>
<td>Gracilis (inferior)</td>
<td>Gluteus minimus (anterior)</td>
<td>Biceps femoris (LH)</td>
<td>Pectineus</td>
</tr>
<tr>
<td>Psoas minor (superior)</td>
<td>Adductor magnus</td>
<td>Gluteus maximus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vastus lateralis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vastus medialis</td>
<td></td>
</tr>
</tbody>
</table>
### MUSCLES: ANTERIOR

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articularis genu</td>
<td>Distal anterior femoral shaft</td>
<td>Synovial capsule</td>
<td>Femoral</td>
<td>Pulls capsule superiorly in extension</td>
<td>May join with vastus intermedius</td>
</tr>
<tr>
<td>Sartorius</td>
<td>ASIS</td>
<td>Proximal medial tibia (Pes anserinus)</td>
<td>Femoral</td>
<td>Flex, ER hip</td>
<td>Can avulse from ASIS (fracture)</td>
</tr>
</tbody>
</table>

**QUADRICEPS**

- Rectus femoris
  - AIIS, superior rim of acetabulum
  - Patella/tibial tubercle
  - Femoral
  - Flex thigh, extend leg
  - Can avulse from AIIS (fracture)

**LEG EXTENSORS**

- Vastus lateralis
  - Greater trochanter, lateral linea aspera
  - Lateral patella, tibial tubercle
  - Femoral
  - Extend leg
  - Oblique fibers can affect Q angle

- Vastus intermedius
  - Proximal femoral shaft
  - Patella; tibial tubercle
  - Femoral
  - Extend leg
  - Covers articularis genu

- Vastus medialis
  - Intertrochanteric line, medial linea aspera
  - Medial patella, tibial tubercle
  - Femoral
  - Extend leg
  - Weak in many patello-femoral disorders.
### MUSCLES: MEDIAL

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obturator externus</td>
<td>Ischiopubic rami, obturator membrane</td>
<td>Trochanteric fossa</td>
<td>Obturator</td>
<td>ER thigh</td>
<td>Tendon posterior to femoral neck</td>
</tr>
<tr>
<td><strong>HIP ADDUCTORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adductor longus</td>
<td>Body of pubis (inferior)</td>
<td>Linea aspera (mid 1/3)</td>
<td>Obturator</td>
<td>Adducts thigh</td>
<td>Tendon can ossify</td>
</tr>
<tr>
<td>Adductor brevis</td>
<td>Body and inferior pubic ramus</td>
<td>Pectineal line, upper linea aspera</td>
<td>Obturator</td>
<td>Adducts thigh</td>
<td>Deep to pectineus</td>
</tr>
<tr>
<td>Adductor magnus</td>
<td>Ischiopubic ramus ischial tuberosity</td>
<td>Linea aspera/adductor tubercle</td>
<td>Obturator/</td>
<td>Adds flex/ extend thigh</td>
<td>2 portions: separate insertions innervation</td>
</tr>
<tr>
<td>Gracilis</td>
<td>Body and inferior pubic ramus</td>
<td>Proximal medial tibia (Pes anserinus)</td>
<td>Obturator</td>
<td>Adds flex (thigh flex, IR leg)</td>
<td>Used in ligament reconstruction (ACL)</td>
</tr>
<tr>
<td><strong>HIP FLEXORS (also iliopsoas)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pectineus</td>
<td>Pectineal line of pubis</td>
<td>Pectineal line of femur</td>
<td>Femoral</td>
<td>Flex and adduct thigh</td>
<td>Part of femoral triangle floor</td>
</tr>
</tbody>
</table>
### MUSCLES: POSTERIOR (HAMSTRINGS)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semitendinosus</td>
<td>Ischial tuberosity</td>
<td>Proximal medial tibia (Pes anserinus)</td>
<td>Sciatic (tibial)</td>
<td>Extend thigh, flex leg</td>
<td>Used in ligament reconstructions (ACL)</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>Ischial tuberosity</td>
<td>Posterior medial tibial condyle</td>
<td>Sciatic (tibial)</td>
<td>Extend thigh, flex leg</td>
<td>A border in medial approach</td>
</tr>
<tr>
<td>Biceps femoris:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Head</td>
<td>Ischial tuberosity</td>
<td>Head of fibula</td>
<td>Sciatic (tibial)</td>
<td>Extend thigh, flex leg</td>
<td>Covers sciatic nerve</td>
</tr>
<tr>
<td>Short Head</td>
<td>Linea aspera, supra condylar line</td>
<td>Fibula, lateral tibia</td>
<td>Sciatic (peroneal)</td>
<td>Extend thigh, flex leg</td>
<td>Shares insertion tendon with Long Head</td>
</tr>
</tbody>
</table>
**NERVES**

**LUMBAR Plexus**

**Anterior Division**

**Genitofemoral** (L1-2): pierces Psoas, lies on anteromedial surface

- **Sensory:** Proximal anteromedial thigh
- **Motor:** NONE (in thigh)

**Obturator** (L2-4): exits via obturator canal, splits into anterior posterior divisions. Can be injured by retractors placed behind the transverse acetabular ligament.

- **Sensory:** Inferomedial thigh: via cutaneous branch of obturator nerve
- **Motor:**
  - Gracilis (anterior division)
  - Adductor longus (anterior division)
  - Adductor brevis (ant/post divisions)
  - Adductor magnus (posterior division)
LUMBAR PLEXUS

POSTERIOR DIVISION

**Lateral Femoral Cutaneous** [LFCN](L2-3): crosses ASIS, can be compressed at ASIS.

<table>
<thead>
<tr>
<th>Sensory</th>
<th>Lateral thigh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>NONE</td>
</tr>
</tbody>
</table>

**Femoral** (L2-4): lies between psoas major and iliacus; Saphenous nerve branches in Femoral Triangle runs under sartorius.

| Sensory: Anteromedial thigh: via anterior/intermediate cutaneous nerves |
|-----------------------------|-----------------------------|
| Psoas                      | Sartorius                   |
| Articularis genu           | QUADRICEPS                  |

<table>
<thead>
<tr>
<th>Motor: Rectus femoris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vastus lateralis</td>
</tr>
<tr>
<td>Vastus intermedius</td>
</tr>
<tr>
<td>Vastus medialis</td>
</tr>
</tbody>
</table>
### SACRAL PLEXUS

#### ANTERIOR DIVISION

**Tibial** (L4-S3): descends (as sciatic) in posterior thigh

| Sensory: | NONE (in thigh) |
| Motor:   | POSTERIOR THIGH  |
|          | Biceps femoris [long head] |
|          | Semitendinosus |
|          | Semimembranosus |

#### POSTERIOR DIVISION

**Common peroneal** (L4-S2): descends (as sciatic) in posterior thigh

| Sensory: | NONE (in thigh) |
| Motor:   | Biceps femoris [short head] |

**Posterior Femoral Cutaneous Nerve [PFCN]** (S1-3)

| Sensory: | Posterior thigh |
| Motor:   | NONE |

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
ARTERIES

<table>
<thead>
<tr>
<th>ARTERY</th>
<th>BRANCHES</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obturator</td>
<td>Anterior posterior branches</td>
<td>Runs through obturator foramen</td>
</tr>
<tr>
<td>Femoral (Superficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral) [SFA]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial circumflex iliac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial epigastric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial external pudendal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep external pudendal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep artery of thigh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Profunda)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descending genicular artery</td>
<td>Anastomosis at knee to supply knee</td>
<td></td>
</tr>
<tr>
<td>Articular branch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saphenous branch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Artery of the thigh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Medial circumflex</td>
<td>Supplies femoral neck</td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Lateral circumflex</td>
<td>Supplies femoral neck</td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Ascending branch</td>
<td>Forms anastomosis at femoral neck</td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Transverse branch</td>
<td>Contributes to anastomosis at femoral neck</td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Descending branch</td>
<td>Contributes to anastomosis at femoral neck</td>
</tr>
<tr>
<td>(Profunda)</td>
<td>Perforators/muscular branches</td>
<td>Supplies femoral shaft and thigh muscles</td>
</tr>
</tbody>
</table>
## Arteries of the Femoral Neck

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obturator: Fovea artery (A. of Ligament Teres)</td>
<td>Runs through ligament of femur head</td>
<td>Relatively minor contribution to femoral head</td>
</tr>
<tr>
<td>Deep Artery of thigh</td>
<td>Branches from Femoral in Femoral triangle.</td>
<td>Supplies anterior medial thigh</td>
</tr>
<tr>
<td>Medial circumflex</td>
<td>Between pectineus ilioptosus and posterior femoral neck</td>
<td>Anastomosis: posterior supply</td>
</tr>
<tr>
<td>Ascending branch</td>
<td>Runs on Quadratus femoris</td>
<td>Can be injured in posterior approach</td>
</tr>
<tr>
<td>Lateral circumflex</td>
<td>Deep to sartorius and rectus femoris</td>
<td>Extracapsular anastomosis at neck</td>
</tr>
<tr>
<td>Ascending branch</td>
<td>To greater trochanter anteriorly</td>
<td>Anastomosis: anterior supply</td>
</tr>
<tr>
<td>Cervical branches</td>
<td>Extracapsular branches of anastomosis</td>
<td>Pierce the capsule</td>
</tr>
<tr>
<td>Retinacular arteries</td>
<td>Intracapsular branches: run along neck, enter bone at base of femoral head</td>
<td>Most of femoral head supply is posterior (at risk in injury: AVN)</td>
</tr>
<tr>
<td>Transverse branch</td>
<td>Extends laterally</td>
<td>Minor contribution to anastomosis</td>
</tr>
<tr>
<td>Descending branch</td>
<td>Under rectus femoris</td>
<td>Minor contribution to anastomosis</td>
</tr>
<tr>
<td>Inferior Superior Gluteal arteries</td>
<td>Branches make small contributions</td>
<td>to femoral neck anastomosis</td>
</tr>
</tbody>
</table>
## DISORDERS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INFLAMMATORY ARTHRITIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Host immunologic response results in synovitis. RA, Lupus, SeroNegative arthropathies, gout, etc.</td>
<td>Hx: Pain, stiffness, +/- other joints involved. PE: Antalgic gait, decreased ROM (especially IR)</td>
<td>XR: AP, frog leg lateral Labs: RF, ESR, CRP ANA, CBC, uric acid, crystals, culture</td>
<td>1. Physical therapy, NSAIDs 2. Cane or crutch 3. Synovectomy (early) 4. Total hip Arthroplasty (late)</td>
</tr>
<tr>
<td><strong>OSTEOARTHRITIS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LATERAL FEMORAL CUTANEOUS NERVE ENTRAPMENT (Meralgia Paresthetica)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nerve trapped near ASIS. Due to activity (hip extension), or clothing (e.g. belt)</td>
<td>Hx: Pain/burning in lateral thigh PE: Decreased sensation on lateral thigh, + Meralgia</td>
<td>XR: AP/lateral of hip: rule out other pathology</td>
<td>1. Remove compressive entity 2. Surgical release: rare</td>
</tr>
<tr>
<td><strong>OSTEONECROSIS (Avascular necrosis: AVN)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Necrosis of femoral head (trabecular bone). Due to vascular disruption. Associated with trauma, Etoh, steroid use, RA. Ficat classification: 4 stages based on sx, XR, bone scan</td>
<td>Hx: Insidious onset dull hip ache PE: With collapse: pain with IR ER Without collapse: discomfort with IR ER</td>
<td>XR: AP, frog leg lateral: femoral head sclerosis MR: Double line sign (T2)</td>
<td>Early: core decompression or vascularized fibular graft Late or collapse: Total hip arthroplasty</td>
</tr>
<tr>
<td><strong>SNAPPING HIP (Iliotibial band)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Women (wide pelvis) most common

<table>
<thead>
<tr>
<th>PE: Adduct hip, then extend: + snap</th>
<th>Out other pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3. Injection for acute bursitis</td>
</tr>
<tr>
<td></td>
<td>4. Surgery rare</td>
</tr>
</tbody>
</table>

**TROCHANTERIC BURSITIS**

- Inflammation of bursa over greater trochanter or gluteal tendons

<table>
<thead>
<tr>
<th>Hx: Lateral hip pain. Cannot sleep on affected side. PE: Point tenderness at greater trochanter</th>
<th>XR: AP pelvis, AP/lateral of hip: rule out spur, OA, calcified tendons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NSAIDs</td>
<td>2. Physical therapy (IT Band stretching)</td>
</tr>
<tr>
<td>3. Steroid injection</td>
<td></td>
</tr>
</tbody>
</table>

---

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
TOTAL HIP ARTHROPLASTY

TIPS ON TOTAL HIPS

GENERAL INFORMATION

Types of implants: cemented, noncemented (press fit porous ingrowth), hybrid
- "Supermetals": cobalt chrome titanium (shaft/head)
- Acetabular cup: Ultra high-molecular weight polyethylene
- Porous ingrowth: best pore size 200-400 microns
- Cemented usually used in elderly patients, noncemented for younger patients

Cement: Polymethylmethacralate

Head size: 26-28mm is optimal

INDICATIONS

Arthritis of hip: common etiologies: OA, RA, AVN
Most patients complain of pain, worsening over time (wakes them from sleep), and decreased ability to ambulate.
Patient should have appropriate radiographic evidence of arthritis
It is preferable when the patient is elderly (needs only one replacement)

OSTEOARTHRITIS

1. Joint space narrowing
2. Sclerosis
3. Subchondral cysts
4. Osteophyte formation

RHEUMATOID ARTHRITIS

1. Joint space narrowing
2. Periarticular osteoporosis
3. Joint erosions
4. Ankylosis

Failed conservative treatment: activity modification, weight loss, physical therapy/strengthening, NSAIDs, ambulation assistance (cane used on unaffected side, walker, etc.), injections.

Other: Fractures, tumors, developmental disorders (DDH, etc.)

CONTRAINDICATIONS

- Young, active patient (will wear out replacement many times)
- Medically unstable (e.g. severe cardiopulmonary disease)
- Neuropathic joint
- Any infection

ALTERNATIVES

- Considerations: Age, activity level, overall health
- Osteotomy: Femoral or pelvic; not common in U.S.

1. Arthrodesis/Fusion: good for young patients/laborers, unilateral disease, no other joint disease (e.g. spine, knee). Fuse with hip in slight flexion

PROCEDURE

- Posterior or lateral approach usually used
- Femoral component should be in valgus ("Thou shalt not Varus")
- Acetabular cup at 45°

COMPLICATIONS

Failure of Implant

1. Loosening (#1 complication in cemented joints)
2. Varus alignment
3. Implant breakage (patients: active, heavy, young, will wear out prosthetic)

Hip thigh pain post-operatively (#1 complication in noncemented joints)

Deep Venous Thrombosis (DVT)/Pulmonary emboli: patients should be anticoagulated (Heparin/warfarin) postoperatively
• Infection: often leads to removal of prothesis (Staph #1 cause)
• Dislocation: posterior are most common (abduction pillow can help prevent)
• External iliac/Femoral artery and vein injury with anterior/superior quadrant screw
  Obturator nerve, artery, vein injury with anterior/inferior quadrant screw.  
  Posterior screw placement is preferable
• Nerve injury (sciatic: peroneal portion) by retractors: Foot drop
• Heterotopic ossification: one dose prophylactic XRT can help prevent it.
• Osteolysis: Macrophage response; due to polyethylene wear debris
TIPS ON TOTAL HIPS

Total Hip Replacement

Final position of cap 15° to 20°
Lateral inclination and 17° anteversion

Total prosthesis inserted
into femoral canal to ensure
flush (i.e., flush with articular surface of femoral neck)

Reduction of hip with prosthesis in place.

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
PEDIATRIC DISORDERS

DEVELOPMENTAL DYSPLASIA

- Capsule/ligament laxity, or Acetabular roof abnormal: hip does not develop correctly
  Associated with: First female, breech delivery, + family health, decreased intrauterine space conditions
- Early diagnosis and treatment essential (3mo)
- Poor outcomes if diagnosis delayed

Hx: Twins, other risk factors. Often unnoticed by parents.
PE: + Barlow (dislocation), + Ortalani (relocation), + Galeazzi tests. Decreased abduction
XR: In older patients US: if PE not conclusive

Goal: maintain femoral head in the acetabulum (concentric reduction):
1. Pavlik harness (3mo)
2. Closed reduction cast (6-18mo)
3. Osteotomy (18mo)

Post reduction films essential
• COMPLICATIONS: Osteonecrosis (femoral head)

FEMORAL ANTEVERSION

- Internal rotation of femur, femoral anteversion does not decrease properly
- #1 cause of intoeing

Hx: Usually presents 3-6 yrs
PE: Femur IR (IR 65°), patella is medial, intoeing gait

1. Most spontaneously resolve
2. Derotational osteotomy if it persists past age 10 (mostly cosmetic)
## LEGG-CALVE-PERTHES DISEASE

- Osteonecrosis of femoral head
- Idiopathic, vascular etiology (hypercoaguable/sludging)
- Associated with: + family history, breech birth
- Catteral classification: 4 stages
- Poor prognosis: after age 9 or with large femoral head involvement

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPLICATIONS</th>
</tr>
</thead>
</table>
| Hc Boys(4:1) usually 4-8 yo, unilateral thigh or knee pain limp | The femoral head must revascularize | Based on age:  
5 yrs: observation NSAIDs  
5-8 yrs: concentric containment: abduction brace or osteotomy  
9+ yrs: operative treatment often fails (many need THA as adult) |

## SLIPPED CAPITAL FEMORAL EPIPHYSIS (SCFE)

- Proximal femoral epiphysis falls off femur (posterior) head in acetabulum
- Obese adolescents
- Early diagnosis and treatment essential

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPLICATIONS</th>
</tr>
</thead>
</table>
| Hc 11-14 yo, often obese, slow onset hip, thigh, knee pain, +/- limp | Do not attempt reduction  
1. Non weight-bearing  
2. Percutaneous pinning | COMPLICATIONS:  
Osteonecrosis, chondrolysis, osteoarthritis, decreased ROM |

**Hx:** Boys(4:1) usually 4-8 yo, unilateral thigh or knee pain limp

**PE:** Decreased abduction, no point tenderness on exam

**XR:** AP pelvis, frog lateral (density of the femoral head is indicative; crescent sign: subchondral fx)

**COMPLICATIONS:** Osteonecrosis, chondrolysis, osteoarthritis, decreased ROM
Surgical Approaches

**Posterior (Southern) Approach to Hip Joint**

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Hip Arthroplasty</td>
<td>Split gluteus maximus (inferior gluteal n)</td>
<td>1. Sciatic nerve</td>
<td>Superior and inferior gluteal arteries need to be controlled.</td>
</tr>
<tr>
<td>ORIF</td>
<td></td>
<td>2. Inferior gluteal artery</td>
<td>The short external rotators must be detached to access the joint.</td>
</tr>
<tr>
<td>Posterior acetabulum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior hip dislocations</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lateral (Harding) Approach to Hip**

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Dangers</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Hip Arthroplasty (not used for revisions)</td>
<td>Split gluteus medius (superior gluteal n)</td>
<td>1. Superior gluteal artery</td>
<td>No osteotomy of greater trochanter required. Leads to earlier mobilization.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Femoral nerve</td>
<td>Less exposure than posterior approach, thus not used for revision THA.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Femoral Artery vein</td>
<td></td>
</tr>
</tbody>
</table>

**Lateral Approach to Thigh**

<table>
<thead>
<tr>
<th>Uses</th>
<th>Internervous Plane</th>
<th>Branch of Lateral femoral circumflex artery</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractures</td>
<td>Split vastus lateralis (and intermedius)</td>
<td></td>
<td>Incision can be large or small; it is made along the line between greater trochanter and lateral condyle.</td>
</tr>
<tr>
<td>Tumors</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Femoral nerve
2. Superior lateral geniculate artery

Arteries (#1 2 at left) encountered if incision extended proximally or distally, ligate them.
CHAPTER 8 – LEG/KNEE

TOPOGRAPHIC ANATOMY
OSTEOLOGY

TIBIA

- Long bone characteristics
  - Primary: Body 7 wks (fetal) 18 years
  - Ossification site at the tibial tuberosity can be confused with a fracture.

- Wide proximal end (plateau) articulates with the femoral condyles
  - Secondary 18-20 years
  - Traction (quadriceps) apophysitis at the tibial tuberosity: Osgood Schlatter disease

- Distal end (plafond) cups the talus
  - 1. Proximal epiphysis 9 mo
  - Primary weight-bearing bone in leg

- Medial malleolus is distal end
  - 2. Distal epiphysis 1 yr

- IT Band inserts on Gerdy's tubercle
  - 3. Tibial tuberosity

FIBULA

- Long bone characteristics
  - Primary: Body 8 wks (fetal) 20 years
  - Common peroneal nerve runs across the neck, injured in fractures (foot drop)

- Distal end (lateral malleolus) is lateral wall of ankle mortise.
  - Secondary 18-22 years
  - Used to determine “lateral” on radiographs

- 1. Proximal epiphysis 1-3 yr
### Characteristics

#### Patella

- **Largest sesamoid bone in the body**
  - Primary (single center)
  - 3 years
  - 11-13 years
  - Failure to fuse: Bipartite patella (can be confused with patella fracture).

- **Two facets (lateral is larger)**

- **Triangular in cross-section**

- **Very thick articular cartilage (bearing heavy loads)**

- **Functions:**
  1. Enhances quadriceps pull
  2. Protects knee
PATELLA FRACTURE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanism: direct indirect: (e.g. fall, dashboard or kicking injury) Pull of quadriceps and patella tendons displace most fractures If intact, retinaculum resists displacement Do not confuse with bipartite patella</td>
<td>HX: Trauma. Pain, cannot extend knee, swelling. PE: &quot;Dome&quot; effusion. Tenderness, +/- palpable defect. Inability to extend knee. XR: Knee trauma series</td>
<td>Descriptive location: Nondisplaced Transverse Vertical Stellate Inferior/superior pole Comminuted</td>
<td>Nondisplaced or comminuted: cylinder cast for 6 wks Displaced(2-3mm): ORIF (e.g. tension bands) to restore articular surface Severely comminuted: may require patellectomy</td>
</tr>
</tbody>
</table>

COMPLICATIONS: Osteoarthritis and/or pain, Decreased motion and/or strength; Osteonecrosis; Refracture

TIBIAL PLATEAU FRACTURE

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
</table>
### KNEE DISLOCATION

- Rare: Ortho emergency
- Usually high energy injury
- Ligaments other soft tissue are disrupted
- High incidence of associated fracture neurovascular injury

| HX: Trauma. Pain, inability to bear weight. |
| PE: Effusion, deformity, pain, +/- distal pulses peroneal nerve function |
| XR: AP/lateral |
| AGRAM: ID arterial injury |
| MR: Ligament injury |

**By position:**
- Anterior
- Posterior
- Lateral
- Medial
- Rotatory: Anteromedial or anterolateral.

**COMPLICATIONS:** Neurovascular: Popliteal artery, peroneal nerve injury; Decreased motion; Instability

**Early reduction essential Post reduction neurologic exam and x-rays.**

**Immobilize (cast):** 6-8 wks (not if ligaments torn)

**Open:** If irreducible, vascular injury (+/- prophylactic fasciotomy), early repair of ligaments if needed.

---

**Type of dislocation:**
- Anterior
- Posterolateral
- Lateral
- Medial
- Rotational

**Type of injury:**
- Soft tissue or lateral tibial plateau
- Split fracture of lateral condyle plus depression of tibial plateau
- Compression of lateral tibial plateau without split fracture
- Complex split fracture of medullary tibial plateau and fibula
- Open fracture involving both tibial plateau with syndesmosis
- V-update of lateral tibial plateau w/ recession of fibular head fracture

**Dislocation of knee joint:**
- Anterior
- Posterolateral
- Lateral
- Medial
- Rotational
### TIBIA SHAFT FRACTURE

**DESCRIPTION**
- Common long bone fracture
- Young adults
  - Often tibia/fibula fracture or tibia fracture/dislocation combination injuries
- Tenuous blood supply; union is a problem.
- Up to 5% residual angulation is acceptable

**EVALUATION**
- HX: Trauma.
  - Cannot bear weight, pain, swelling.
- PE: Swelling, deformity, +/- tense compartments open wound. Palpatate pulse
  - XR: AP/lateral leg, + knee and ankle series
  - AGRAM: if pulseless

**CLASSIFICATION**
- Descriptive:
  - Location
  - Displaced/comminuted
  - Type: transverse, spiral oblique
  - Rotation/angulation

**TREATMENT**
- Stable, non or minimally displaced, closed injury: Long leg cast 4-6 wks then shorter cast
- Unstable, displaced, comminuted injury: ORIF Intramedullary nails (external fixation for severe open fractures)

**COMPLICATIONS:** Malunion/nonunion: especially mid-distal 1/3; Compartment syndrome; Decreased motion; Hardware failure; Neurovascular injury; Reflex Sympathetic Dystrophy (RSD)

### MAISONNEUVE FRACTURE

**DESCRIPTION**
- Complete syndesmosis disruption with diastasis proximal fibula fracture
- Variant of ankle fracture deltoid ligament rupture
- Unstable fracture

**EVALUATION**
- HX: Trauma.
  - Ankle pain, +/- knee pain.
- PE: Ankle pain, swelling, +/- knee signs.
- XR: Knee series with each ankle fracture

**TREATMENT**
- Reduce and stabilize syndesmosis with a screw

**COMPLICATIONS:** Ankle instability; Ankle arthritis

### PILON (DISTAL TIBIA) FRACTURE

**DESCRIPTION**
- Intraarticular: through distal articular/WB surface.
- Commination common
- Associated soft tissue injury

**EVALUATION**
- HX: Trauma.
  - Cannot bear weight, pain, swelling
- PE: Effusion, tenderness, do good neurovascular exam

**CLASSIFICATION**
- Ruedi-Allgower (3 types):
  - I. Non or minimally displaced.
  - II. Displaced: articular

**TREATMENT**
- Nondisplaced: Long leg cast NWB for 6 wks
- Displaced/Comminuted: ORIF: plates screws +/-...
tissue injuries
Articular surface repair is difficult essential
Healing is often slow

<table>
<thead>
<tr>
<th>PE</th>
<th>surface incongruous. III. Comminuted articular surface</th>
<th>bone grafting Severe comminuted: external fixation</th>
</tr>
</thead>
</table>

XR: AP/lateral (obliques)
CT: Needed: better image of articular surface

COMPLICATIONS: Post-traumatic Osteoarthritis (almost 100% in comminuted fractures); Decreased motion; Malunion/nonunion
KNEE JOINTS

**SUPPORT** | **ATTACHMENTS** | **COMMENTS**
---|---|---
**FEMORAL/TIBIAL: CONDYLOID**
**ANTERIOR**
Patellofemoral joint | See page 212 | Prevents anterior translation, tight in flexion, must reconstruct if injured
Anterior cruciate (ACL) | Tibial eminence to medial aspect of lateral femoral condyle | 
Transverse meniscal ligament | Anterior menisci | Meniscus support stability
**MEDIAL**
Meniscus | Between femoral condyle tibial plateau | More crescentic than lateral
Capsule (III) | Surrounds joint | Minimal support
Medial collateral (MCL) | Medial epicondy to tibia (II) meniscus (III) | Superficial (II) and Deep (III) portion
Coronary ligament (III) | Meniscus to medial tibia | Stabilizes meniscus
Semimembranous membrane (II) | Attach to posterior tibial condyle | 
Pes anserinus tendons (I) | Medial tibial condyle | Tendinitis can occur at insertion
**LATERAL**
Meniscus | Between femoral condyle tibial plateau | More circular than medial
Popliteus muscle tendon | Proximal tibia | Intraarticular tendon
Capsule (III) | Surrounds joint | Minimal support
Arcuate ligament (III) | Posterolateral femoral condyle to fibular head | Covers popliteus tendon
Fabellofibular ligament (III) | Fabella to fibula | Variable
Lateral collateral (LCL) | Lateral femoral condyle to | Prevents varus angulation
<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps muscle tendon (I)</td>
<td>Prevents varus angulation</td>
</tr>
<tr>
<td>Iliotibial band (I)</td>
<td>If tight, ITB syndrome can occur</td>
</tr>
<tr>
<td><strong>POSTERIOR</strong></td>
<td></td>
</tr>
<tr>
<td>Capsule (III)</td>
<td>Surrounds joint</td>
</tr>
<tr>
<td>Ligament of Humphrey</td>
<td>Posterior lateral meniscus to medial femoral condyle</td>
</tr>
<tr>
<td>Posterior cruciate (PCL)</td>
<td>Tibial sulcus to anterior medial femoral condyle</td>
</tr>
<tr>
<td>Ligament of Wrisberg</td>
<td>Posterior lateral meniscus to medial femoral condyle</td>
</tr>
<tr>
<td>Oblique popliteal ligament</td>
<td>Semimembranous to lateral femoral condyle</td>
</tr>
<tr>
<td>Gastrocnemius/plantaris muscle</td>
<td>Origin: posterior medial lateral femoral condyles</td>
</tr>
</tbody>
</table>

**Diagrams:**
- Diagram of knee structures and ligaments.
- Diagram of posterior view of knee joint showing key structures.
- Diagram of posterior meniscal and cruciate ligaments.
<table>
<thead>
<tr>
<th>Quadriceps tendon</th>
<th>Attach on superior patellar pole</th>
<th>Superior extensor mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patellar ligament (tendon)</td>
<td>Inferior patella pole to tibial tuberosity</td>
<td>Inferior extensor mechanism</td>
</tr>
<tr>
<td>Medial lateral retinaculum</td>
<td>Quadriceps extensions to patella, then to tibial condyles</td>
<td>Stabilizes patella in motion. Can affect Q angle if tight</td>
</tr>
<tr>
<td>(quadriceps oblique fibers) (II)</td>
<td>Patella to femoral condyles</td>
<td>Stabilizes patella</td>
</tr>
<tr>
<td>Medial lateral patellofemoral ligaments (II)</td>
<td>Patella to tibial condyles</td>
<td>Stabilizes patella</td>
</tr>
<tr>
<td>Medial lateral patellotibial ligaments</td>
<td>Patella to tibial condyles</td>
<td>Stabilizes patella</td>
</tr>
</tbody>
</table>

**PROXIMAL TIBIOFIBULAR : Plane**

<table>
<thead>
<tr>
<th>Anterior ligament of head of fibula</th>
<th>Fibula head to lateral tibia</th>
<th>Broader than posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior ligament of head of fibula</td>
<td>Fibula head to lateral tibia</td>
<td>Weaker than anterior</td>
</tr>
</tbody>
</table>

**OTHER STRUCTURES**

| Intersosseous membrane | Lateral tibia to medial fibula | Strong; runs length of leg |

- Three compartments in the knee: Medial, Lateral, Patellofemoral
- Meniscus: Made of fibrocartilage. Function: 1) Protects articular cartilage (increases weight bearing surface area, 2) Stabilizes by deepening facet, 3) Load transmission
- Peripheral 1/3 vascular (geniculate arteries): can be repaired; Inner 2/3 supplied by synovial fluid: must debride in injured
- There are three layers of support in the knee: I, II, III (noted in parentheses next to structure)
- Posterolateral corner complex: Arcuate ligament, popliteus, posterolateral capsule
- Muscles attaching at the pes anserinus: sartorius, gracilis, semitendinosus
MINOR PROCEDURES: KNEE

**Knee.** Needle inserted horizontally at medial or lateral margin of patella to pass beneath patella. 20-gauge needle used for most joints.

### STEPS

<table>
<thead>
<tr>
<th>ARTHOCENTESIS/INJECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ask patient about allergies</td>
</tr>
<tr>
<td>2. Place patient supine, knee extended, palpate the lateral patella and lateral distal femur.</td>
</tr>
<tr>
<td>3. Prepare skin over the knee (iodine/antiseptic soap)</td>
</tr>
<tr>
<td>4. Anesthetize skin locally (quarter size spot)</td>
</tr>
<tr>
<td>5. Insert an 18 gauge needle laterally into the suprapatella pouch (between the patella and femur) proximal to the joint. Aspirate fluid from joint (or inject 3-5cc of local/steroid preparation). Fluid should flow easily if needle is in joint.</td>
</tr>
<tr>
<td>6. If suspicious of infection, send fluid for GS culture.</td>
</tr>
<tr>
<td>7. Dress injection site</td>
</tr>
</tbody>
</table>
**HISTORY**

**QUESTION** | **ANSWER** | **CLINICAL APPLICATION**
---|---|---
1. **AGE** | Young | Trauma: fractures, ligamentous or meniscal injury
Middle age, elderly | Arthritis

2. **PAIN**
a. **Onset** | Acute | Trauma: fracture, dislocation, soft tissue (ligament/meniscus) injury, septic bursitis
Chronic | Arthritis, infection, tendinitis/bursitis, tumor

b. **Location**
Anterior | Quadricep or patellar tear or tendinitis, prepatellar bursitis, patellofemoral arthritis
Posterior | Meniscus tear (posterior horn), Baker's cyst, popliteal aneurysm
Lateral | Meniscus tear (jointline), collateral ligament injury, arthritis, ITB friction syndrome
Medial | Meniscus tear (jointline), collateral ligament injury, arthritis, pes bursitis

c. **Occurrence**
Night pain | Tumor, infection
With activity | Etiology of pain likely from joint

3. **STIFFNESS**
Without locking | Arthritis, effusion (trauma, infection)
With locking or catching | Loose body, meniscal tear (especially bucket handle), arthritis, synovial plica

4. **SWELLING**
Within joint | Infection, trauma
Acute (post injury) | Acute (hours): ACL injury; Subacute (day): meniscus injury
Acute (without injury) | Infection: prepatellar bursitis, septic joint

5. **INSTABILITY**
Giving away/collapse | Cruciate ligament injury, extensor mechanism injury

6. **TRAUMA**
Mechanism: valgus force | MCL injury (+/- terrible triad: MCL, ACL, medial meniscus injuries)
Varus force | LCL injury
Flexion/posterior force | PCL injury (e.g. dashboard injury)
Contact injury | Non-contact: ACL injury, Contact: multiple ligaments
<table>
<thead>
<tr>
<th>Table of Contents</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popping noise</td>
<td>Cruciate ligament injury (especially ACL), osteochondral fracture</td>
</tr>
<tr>
<td>NONE</td>
<td>Degenerative and overuse etiology</td>
</tr>
<tr>
<td>7. ACTIVITY</td>
<td>Agility sports Cruciate and/or collateral ligament injury</td>
</tr>
<tr>
<td>Running, cycling, climbing</td>
<td>Patellofemoral etiology</td>
</tr>
<tr>
<td>Squatting</td>
<td>Meniscus tear</td>
</tr>
<tr>
<td>Walking</td>
<td>Distance able to ambulate equates with severity of arthritic disease</td>
</tr>
<tr>
<td>8. NEUROLOGIC SYMPTOMS</td>
<td>Pain, numbness, tingling Neurologic disease, trauma</td>
</tr>
<tr>
<td>9. SYSTEMIC COMPLAINTS</td>
<td>Fevers, chills Infection, septic joint</td>
</tr>
<tr>
<td>10. HISTORY OF ARTHRITIDES</td>
<td>Multiple joints involved Rheumatoid Arthritis, gout, etc.</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### PHYSICAL EXAM

<table>
<thead>
<tr>
<th>EXAM</th>
<th>TECHNIQUE/FINDINGS</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSPECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gait</td>
<td>Observe patella tracking</td>
<td>Abnormal patella tracking can lead to patellofemoral problems</td>
</tr>
<tr>
<td>Flexed knee gait</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Anterior | Genu valgum (knock knee)  
Genu varum (bow leg) | Normal: 7 degrees valgus; varus or valgus deformity with ligamentous or osseous deficiency |
<p>| Swelling | | Effusion (arthritis, trauma, infection/inflammation), bursitis (prepatellar, infrapatellar) |
| Posterior | Swelling, mass | Effusion (arthritis), Baker’s cyst |
| Lateral | Back knee, high/low riding patella | Genu recurvatum (PCL injury), patella alta (patellar instability) |
| Musculature | Atrophy | Vastus medialis atrophy: can lead to patellofemoral problems |
| <strong>PALPATION</strong> | | |
| Bony structures | Patella: medial lateral aspects | Tenderness at distal pole: tendinitis (Jumpers knee) |
| Tibial tubercle | | Tenderness with Osgood-Schlatter disease |
| Soft tissues | Compress suprapatellar pouch (“milk” knee) | Ballotable patella (effusion): arthritis, trauma, infection |
| Prepatellar/infrapatellar bursae | Edematous or tender bursae indicate correlating bursitis |
| Pes anserine bursa | Tenderness indicates bursitis |
| Plica (medial to patella) | Thickened, tender plica is pathologic |
| Medial jointline MCL | Tenderness: medial meniscus tear or MCL injury |
| Lateral jointline LCL | Tenderness: lateral meniscus tear or LCL injury |
| Iliotibial band (anterolateral knee) | Pain or tightness is pathologic |
| Popliteal fossa | Mass consistent with Baker’s cyst, popliteal aneurysm |
| Compartments of leg (anterior, posterior, lateral) | Firm or tense compartment: Compartment syndrome |</p>
<table>
<thead>
<tr>
<th>EXAM</th>
<th>TECHNIQUE/FINDINGS</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion extension</td>
<td>Supine: knee to chest, then straight</td>
<td>Normal: Flex 0 to 125-135°, Extend 0 to 5-15°; Extensor lag (final 20° difficult); weak quadriceps; Decreased extension with effusion</td>
</tr>
<tr>
<td></td>
<td>Note patellar tracking, pain, crepitus</td>
<td>Abnormal tracking leads to anterior knee pain; pain crepitus: arthritis</td>
</tr>
<tr>
<td>Tibial IR ER</td>
<td>Stabilize femur, rotate tibia</td>
<td>Normal: 10-15° IR ER</td>
</tr>
<tr>
<td><strong>NEUROVASCULAR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral nerve (L4)</td>
<td>Medial leg (Medial cutaneous nerves)</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Peroneal nerve (L5)</td>
<td>Lateral leg (common superficial)</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Tibial nerve (S1)</td>
<td>Posterior leg (Sural nerves)</td>
<td>Deficit indicates corresponding nerve/root lesion</td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral nerve (L2-4)</td>
<td>Knee extension</td>
<td>Weakness = Quadriceps or nerve/root lesion</td>
</tr>
<tr>
<td>Sciatic: Tibial (L4-S3)</td>
<td>Knee flexion</td>
<td>Weakness = Biceps (LH) or nerve/root lesion</td>
</tr>
<tr>
<td>Peroneal (L4-S2)</td>
<td>Knee flexion</td>
<td>Weakness = Biceps (SH) or nerve/root lesion</td>
</tr>
<tr>
<td>Tibial nerve (L4-S3)</td>
<td>Foot plantarflexion</td>
<td>Weakness = TP, FHL, FDL or nerve/root lesion</td>
</tr>
<tr>
<td>Peroneal (deep n.) (L4-S2)</td>
<td>Foot dorsiflexion</td>
<td>Weakness = TA, EHL, EDL or nerve/root lesion</td>
</tr>
</tbody>
</table>

*Acute Anterior Compartment Syndrome*
### Reflex

| L4       | Patellar | Hypoactive/absence indicates L4 radiculopathy |

### Pulse

| Popliteal |

### EXAM TECHNIQUE/FINDINGS CLINICAL APPLICATION

#### SPECIAL TESTS

<table>
<thead>
<tr>
<th>EXAM</th>
<th>TECHNIQUE/FINDINGS</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q (quadriceps) angle</td>
<td>ASIS to mid-patella to tibia tubercle</td>
<td>Normal: 13° male, 18° female; Increased angle: PF Syndrome, subluxation</td>
</tr>
<tr>
<td>Patella grind</td>
<td>Extend knee: fire quads, compress patella</td>
<td>Pain: patellofemoral joint pathology, patella chondromalacia</td>
</tr>
<tr>
<td>Patella apprehension</td>
<td>Relax knee: push patella lateral</td>
<td>Pain/apprehension: subluxation; Medial retinaculum injury</td>
</tr>
<tr>
<td>McMurray</td>
<td>Flex/ER leg/valgus force, then extend knee</td>
<td>Pop/click on extension indicates medial meniscal tear</td>
</tr>
<tr>
<td></td>
<td>Flex/IR leg/varus force, then extend knee</td>
<td>Pop/click on extension indicates lateral meniscal tear</td>
</tr>
<tr>
<td>Apley compression</td>
<td>Prone: knee 90°, compress rotate tibia</td>
<td>Pain/popping: meniscal injury, arthritis</td>
</tr>
<tr>
<td>Ligament Stability Tests</td>
<td>Lateral force: knee at: 1) 30°, 2) 0°</td>
<td>Laxity at: 1) 30°: MCL, at 2) 0°: MCL/PCL/posterior capsule injury</td>
</tr>
<tr>
<td>Valgus stress</td>
<td>Medial force: knee at 1) 30° 2) 0°</td>
<td>Laxity at: 1) 30°: LCL, at 2) 0° LCL/PCL/posterior capsule injury</td>
</tr>
<tr>
<td>Varus stress</td>
<td>Flex knee 30°: anterior force on tibia</td>
<td>Laxity/displacement: ACL injury (most sensitive exam for ACL)</td>
</tr>
<tr>
<td>Lachman</td>
<td>Flex knee 90°: anterior force on tibia</td>
<td>Laxity/displacement: ACL injury</td>
</tr>
<tr>
<td>Anterior drawer</td>
<td>Flex knee 90°: posterior force on tibia</td>
<td>Posterior translation: PCL injury</td>
</tr>
<tr>
<td>Posterior drawer</td>
<td>Flex knee 90°: posterior force on tibia</td>
<td></td>
</tr>
</tbody>
</table>

**Q angle** formed by intersection of lines from anterior superior iliac spine and from tibial tuberosity through midpoint of patella. Large Q angle predisposes to patellar subluxation.

**Apprehension (Fairbank) test**

As examiner displaces patella laterally, patient feels pain and forcefully contracts quadriceps femoris muscle.

**Posterior sag sign.** Leg drops backward.
<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posterior sag</strong></td>
<td>Supine: hip 45°/knee 90°: lateral view</td>
<td>Posterior translation of tibia on femur: PCL injury</td>
</tr>
<tr>
<td><strong>Quadriiceps active</strong></td>
<td>Supine: flex knee 90°, fire quadriceps</td>
<td>Posterior translated tibia will translate anterior when quadriceps fire: PCL injury</td>
</tr>
<tr>
<td><strong>Pivot shift</strong></td>
<td>Supine: extend knee, IR, valgus force on proximal tibia, then flex</td>
<td>Clunk with flexion: AnteroLateral Rotary Instability (ALRI): ACL and/or posterior capsule injury</td>
</tr>
<tr>
<td><strong>Reverse pivot shift</strong></td>
<td>Supine: knee at 45°, ER, valgus force on proximal tibia, extend</td>
<td>Clunk with extension: PosteroLateral Rotary Instability (PLRI): PCL and/or Posterolateral corner injury</td>
</tr>
<tr>
<td><strong>Slocum</strong></td>
<td>Knee 90°, ER foot 15°, anterior force</td>
<td>Displacement: AnteroMedial Rotary Instability</td>
</tr>
<tr>
<td><strong>Posterior lateral drawer</strong></td>
<td>Knee 90°, ER foot 30°, anterior force</td>
<td>Displacement: AnteroLateral Rotary Instability (ALRI): ACL injury</td>
</tr>
<tr>
<td><strong>Posterior medial drawer</strong></td>
<td>Knee 90°, IR foot 30°, posterior force</td>
<td>Displacement: PosteroLateral Rotary Instability (PLRI): PCL/corner</td>
</tr>
<tr>
<td><strong>Prone ER at 30° 90°</strong></td>
<td>Prone: ER both knees at: 1)30°, 2)90°</td>
<td>Increased ER at: 1) 30: PL corner, 2) 90: PCL PL corner injury</td>
</tr>
</tbody>
</table>
Foot-chill test for anterolateral knee instability.

Patient supine and relaxed. Examiner lifts heel of foot to flex hip 90°. Keeping knee fully extended, grasp knee with other hand, placing thumb beneath head of fibula. Examiner applies strong internal rotation to tibia and places arch of foot against pubic tubercle. Maneuver flexes hip about 25°; examiner then pushes medially with posterior hand and pulls with palm of hand to produce a resistive force at knee.
### MUSCLES: ANTERIOR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibialis anterior [TA]</td>
<td>Lateral tibia, interosseous membrane</td>
<td>Medial cuneiform, base of 1st metatarsal</td>
<td>Deep peroneal</td>
<td>Dorsiflex invert foot</td>
<td>Test L4 motor function</td>
</tr>
<tr>
<td>Extensor hallucis longus [EHL]</td>
<td>Medial fibula, interosseous membrane</td>
<td>Base of distal phalanx of great toe</td>
<td>Deep peroneal</td>
<td>Dorsiflex extend great toe</td>
<td>Test L5 motor function</td>
</tr>
<tr>
<td>Extensor digitorum longus [EDL]</td>
<td>Lateral tibia condyle proximal fibula</td>
<td>Base of middle distal phalanges (4 toes)</td>
<td>Deep peroneal</td>
<td>Dorsiflex extend lateral 4 toes</td>
<td>Single tendon divides into four tendons</td>
</tr>
<tr>
<td>Peroneus tertius</td>
<td>Distal fibula, interosseous membrane</td>
<td>Base of 5th metatarsal</td>
<td>Deep peroneal</td>
<td>Dorsiflex Evert foot</td>
<td>Often adjoined to the EDL</td>
</tr>
</tbody>
</table>
### MUSCLES: LATERAL COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroneus longus</td>
<td>Proximal lateral fibula</td>
<td>Medial cuneiform, base of 1st MT (plantarly)</td>
<td>Superficial peroneal</td>
<td>Evert, plantar flex foot</td>
<td>Test S1 motor function. Runs under the foot</td>
</tr>
<tr>
<td>Peroneus brevis</td>
<td>Distal lateral fibula</td>
<td>Base of 5th metatarsal</td>
<td>Superficial peroneal</td>
<td>Evert foot</td>
<td>Can cause avulsion fx at base of 5th MT</td>
</tr>
</tbody>
</table>
### MUSCLES: SUPERFICIAL POSTERIOR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrocnemius</td>
<td>Lateral and medial femoral condyles</td>
<td>Calcaneus (via Achilles tendon)</td>
<td>Tibial</td>
<td>Plantarflex foot</td>
<td>Test S1 motor function Has two heads</td>
</tr>
<tr>
<td>Soleus</td>
<td>Posterior fibular head/soleal line of tibia</td>
<td>Calcaneus (via Achilles tendon)</td>
<td>Tibial</td>
<td>Plantarflex foot</td>
<td>Fuses to gastrocnemius at Achilles tendon</td>
</tr>
<tr>
<td>Plantaris</td>
<td>Lateral femoral supracondylar line</td>
<td>Calcaneus</td>
<td>Tibial</td>
<td>Plantarflex foot</td>
<td>Short muscle belly is proximal, has a long tendon.</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
MUSCLES: DEEP POSTERIOR COMPARTMENT

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popliteus</td>
<td>Lateral condyle</td>
<td>Proximal posterior tibia</td>
<td>Tibial</td>
<td>Flex (IR) knee</td>
<td>Anterior distal to LCL on femur</td>
</tr>
<tr>
<td>Flexor hallucis longus [FHL]</td>
<td>Posterior fibula</td>
<td>Base of distal phalanx of great toe</td>
<td>Tibial</td>
<td>Plantarflex great toe</td>
<td>Test S1 motor function</td>
</tr>
<tr>
<td>Flexor digitorum longus [FDL]</td>
<td>Posterior tibia</td>
<td>Bases of distal phalanges of 4 toes</td>
<td>Tibial</td>
<td>Plantarflex lateral 4 toes</td>
<td>At ankle, tendon is just anterior to tibial artery.</td>
</tr>
<tr>
<td>Tibialis posterior [TP]</td>
<td>Posterior, intersosseous membrane, tibia, fibula</td>
<td>Navicular tuberosity, cuneiform, MTs</td>
<td>Tibial</td>
<td>Plantarflex invert foot</td>
<td>Tendon can degenerate rupture: 2° pes planus</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
### MUSCLES: CROSS SECTIONS

#### Cross section just above middle of leg

<table>
<thead>
<tr>
<th>ANTERIOR</th>
<th>LATERAL</th>
<th>SUPERFICIAL POSTERIOR</th>
<th>DEEP POSTERIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibialis anterior [TA]</td>
<td>Peroneus longus</td>
<td>Gastrocnemius</td>
<td>Popliteus</td>
</tr>
<tr>
<td>Extensor hallucis longus [EHL]</td>
<td>Peroneus brevis</td>
<td>Soleus</td>
<td>Flexor hallucis longus [FHL]</td>
</tr>
<tr>
<td>Extensor digitorum longus [EDL]</td>
<td>Plantaris</td>
<td>Flexor digitorum longus [FDL]</td>
<td></td>
</tr>
<tr>
<td>Peroneus tertius</td>
<td></td>
<td>Tibialis posterior [TP]</td>
<td></td>
</tr>
</tbody>
</table>

#### NEUROVASCULAR

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep peroneal nerve</td>
<td>Superficial peroneal nerve</td>
<td>NONE</td>
<td>Tibial nerve</td>
</tr>
<tr>
<td>Anterior tibial artery and vein</td>
<td></td>
<td>Posterior tibial artery and vein</td>
<td></td>
</tr>
</tbody>
</table>
NERVES

LUMBAR PLEXUS

POSTERIOR DIVISION

1. **Femoral** (L2-4):
   - Sensory: Medial leg: via medial cutaneous nerve (Saphenous N)
   - Motor: NONE (in leg)

SACRAL PLEXUS

ANTERIOR DIVISION

2. **Tibial** (L4-S3): descends between heads of gastrocnemius to medial malleolus
   - Sensory: Postrolateral proximal calf: via Medial sural
     - Posterolateral distal calf: via Sural
   - Motor: SUPERFICIAL POSTERIOR COMPARTMENT OF LEG
     - Soleus: via nerve to soleus
     - Plantaris
     - Gastrocnemius
     - DEEP POSTERIOR COMPARTMENT OF LEG
     - Popliteus: via nerve to popliteus
     - Tibialis posterior [TP] (Tom)
     - Flexor digitorum longus [FDL] (Dick)
     - Flexor hallucis longus [FHL] (Harry)
3. **Common peroneal** (L4-S2): in groove between biceps lateral head of Gastrocnemius. Wraps around fibular head, deep to peroneus longus, then divides. Can be injured in lateral approach to the knee.

**Sensory:**
- Proximal lateral leg: via Lateral sural
- Distal lateral leg: via superficial peroneal

**Motor:**
- **ANTERIOR COMPARTMENT of LEG:**
  - **Deep Peroneal Nerve**
    - Tibialis anterior [TA]
    - Extensor hallucis longus [EHL]
    - Extensor digitorum longus [EDL]
    - Peroneus tertius

- **LATERAL COMPARTMENT of LEG:**
  - **Superficial Peroneal Nerve**
    - Peroneus longus
    - Peroneus brevis
**ARTERIES**

### COURSE

<table>
<thead>
<tr>
<th>BRANCHES</th>
<th>SUPPLY/COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POPLITEAL</strong></td>
<td></td>
</tr>
<tr>
<td>Through popliteal fossa. Terminates at the popliteus muscle.</td>
<td>All four arteries anastomose around knee patella (supply meniscus)</td>
</tr>
<tr>
<td>Superior Inferior Medial Geniculate</td>
<td></td>
</tr>
<tr>
<td>Superior Inferior Lateral Geniculate</td>
<td></td>
</tr>
<tr>
<td>Middle Geniculate</td>
<td>Cruciate ligaments synovium</td>
</tr>
<tr>
<td>Anterior Posterior Tibial</td>
<td>Terminal branches</td>
</tr>
<tr>
<td><strong>ANTERIOR TIBIAL</strong></td>
<td></td>
</tr>
<tr>
<td>Supplies muscles of the ANTERIOR COMPARTMENT</td>
<td></td>
</tr>
<tr>
<td>Anterior Tibial recurrent</td>
<td>Supplies knee</td>
</tr>
<tr>
<td>Anterior Medial malleolar</td>
<td>Supplies ankle</td>
</tr>
<tr>
<td>Anterior Lateral malleolar</td>
<td>Supplies ankle</td>
</tr>
<tr>
<td>Dorsalis Pedis</td>
<td>Terminal branch in foot</td>
</tr>
<tr>
<td><strong>POSTERIOR TIBIAL</strong></td>
<td></td>
</tr>
<tr>
<td>Supplies muscles of the POSTERIOR COMPARTMENT</td>
<td></td>
</tr>
<tr>
<td>Posterior Tibial recurrent</td>
<td>Supplies the knee</td>
</tr>
<tr>
<td><strong>PERONEAL</strong></td>
<td></td>
</tr>
<tr>
<td>From popliteal, through posterior compartment with tibial nerve to behind medial malleolus (between FDL, FHL).</td>
<td></td>
</tr>
<tr>
<td>Posterior medial</td>
<td>LATERAL COMPARTMENT</td>
</tr>
<tr>
<td>Branch</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Malleolar</td>
<td>Perforating/muscular branches</td>
</tr>
<tr>
<td>Medial calcaneal</td>
<td></td>
</tr>
<tr>
<td>Medial Lateral plantar</td>
<td>Terminal branches in sole</td>
</tr>
<tr>
<td>PERONEAL</td>
<td>Supplies muscles of the LATERAL COMPARTMENT</td>
</tr>
<tr>
<td>From posterior tibial between tibialis posterior and FHL.</td>
<td></td>
</tr>
<tr>
<td>Posterior lateral malleolar</td>
<td>Terminal branch</td>
</tr>
<tr>
<td>Lateral calcaneal Artery</td>
<td></td>
</tr>
<tr>
<td>DISORDERS</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>ANTERIOR FAT PAD SYNDROME (Hoffa disease)</strong></td>
<td></td>
</tr>
<tr>
<td>• Fat pad (under patellar tendon) is pinched (2° to trauma)</td>
<td>Hx: Intermittent anterior knee pain</td>
</tr>
<tr>
<td>PE: +/- click with motion</td>
<td>1. RICE, activity modification</td>
</tr>
<tr>
<td>2. Surgical excision (rare)</td>
<td></td>
</tr>
<tr>
<td><strong>ARTHRITIS: INFLAMMATORY</strong></td>
<td></td>
</tr>
<tr>
<td>• Synovitis (pannus formation) destroys articular cartilage and joint</td>
<td>Hx: Any age (disorder dependent), female, male, multiple joints, AM pain.</td>
</tr>
<tr>
<td>PE: +/- warm, effusion, crepitus</td>
<td>Labs: RF, ESR, CRP, ANA, CBC, crystals, culture</td>
</tr>
<tr>
<td>1. Early: medical management</td>
<td></td>
</tr>
<tr>
<td>Late:</td>
<td></td>
</tr>
<tr>
<td>a) Conservative: like OA</td>
<td></td>
</tr>
<tr>
<td>b) Operative:</td>
<td></td>
</tr>
<tr>
<td>1. Synovectomy</td>
<td></td>
</tr>
<tr>
<td>2. Total knee</td>
<td></td>
</tr>
<tr>
<td><strong>ARTHRITIS: OSTEOARTHRITIS</strong></td>
<td></td>
</tr>
<tr>
<td>• Primary or posttraumatic</td>
<td>Hx: Elderly, pain (worse with activity or weight bearing), stiffness, sticking/grinding.</td>
</tr>
<tr>
<td>1. NSAIDs, Physical Therapy</td>
<td></td>
</tr>
<tr>
<td>• Loss or damage to articular cartilage</td>
<td>PE: Effusion, jointline tenderness, +/- angular deformity (varus #1) or contracture.</td>
</tr>
<tr>
<td>2. Injection, activity modification (cane)</td>
<td></td>
</tr>
<tr>
<td>• Knee (Medial compartment) #1 site</td>
<td>2. osteophytes</td>
</tr>
<tr>
<td>3. Fusion (young/worker)</td>
<td></td>
</tr>
<tr>
<td>• All 3 compartments are possible</td>
<td>3. subchondral sclerosis</td>
</tr>
<tr>
<td>4. High tibial osteotomy (young, 1 compartment disease)</td>
<td></td>
</tr>
<tr>
<td>sites</td>
<td>4. bony cysts</td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
</tr>
</tbody>
</table>

**BAKER’S CYST**
- Posterior knee (popliteal fossa)
  - Hx: Stiffness, +/- knee tenderness
  - XR: AP/lateral: normal
- Arises from MM or hamstring tendon (may communicate)
  - PE: Mass in popliteal fossa
  - MR or aspiration: confirm diagnosis
- Aspiration initially
- Surgical resection for recurrence or pain

**BURSITIS: PREPATELLAR (Housemaid’s knee)**
- Continuous irritation of bursa leads to inflammation
  - Hx: Pain with activity
  - XR: AP/lateral: normal rule out infection (common problem)
- Most common bursitis in knee
  - PE: “egg” shaped swelling over patella
  - 1. NSAID, knee pads, injection
  - 2. Bursal removal (rare)
  - 3. Treat infection if present

**BURSITIS: PES ANSERINE**
- Bursa under tendon insertion inflamed (overuse, runner, etc.)
  - Hx: Pain in medial knee
  - XR: AP/lateral: normal +/- OA, rule out tumor
  - PE: Pes anserine tenderness
  - 1. NSAID, activity modification, stretch
  - 2. Partial excision (rare)
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Hx</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHONDROMALACIA: PATELLOFEMORAL SYNDROME [PFS]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Damage or softening of the patellar articular cartilage.</td>
<td>Hx: Anterior knee pain, worse with sitting (theater sign), and/or stairs</td>
<td>XR: AP/lateral/sunrise to evaluate alignment. Rule out patellofemoral OA</td>
<td>1. Physical therapy: quadricep strengthening/stretching</td>
</tr>
<tr>
<td>• Multiple etiologies: trauma, dislocation, malalignment leads to patellofemoral OA</td>
<td>PE: +/- VMO atrophy, valgus deformity, high Q angle, patellar apprehension, + crepitus</td>
<td></td>
<td>2. Orthosis if patella subluxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Lateral release (early)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Tibial tuberosity realignment</td>
</tr>
</tbody>
</table>

| **COMPARTMENT SYNDROME** |
| • Increased pressure in closed space | Hx: 5 P's: pain, parathesias, pulseless, pallor, paralysis. | Compartment pressures: 40 mmHg (normal: 0-10 mmHg) | 1. Fasciotomy within 4 hours (Usually two incisions) |
| • From: trauma, (e.g. fracture, burn, vascular injury, overexertion) | PE: Firm compartments (check all three) | | 2. Debride nonviable soft tissue. |
| • Results in nerve injuries soft tissue necrosis | | | |

| **ILIOTIBIAL BAND FRICTION SYNDROME** |
| • ITB rubs on lateral femoral condyle | Hx: Pain with activity | XR: AP/lateral: normal Rule out tumor | 1. NSAI, activity modification, stretching |
| • Common in runners, cyclists | PE: Lateral femoral condyle TTP (knee at 30° flexion) | | 2. Partial excision (rare) |
### Meniscus Injury: Tear

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H/P</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young: trauma/twisting injury</td>
<td>Hx: Pain, catching/locking (esp. bucket-handle tears)</td>
<td>XR: AP (extension 30° flexion)/lateral/sunrise, +/- arthrocentesis</td>
<td>1. Conservative for minor symptoms</td>
</tr>
<tr>
<td>Old: Degeneration/squat injury</td>
<td>PE: Effusion, jointline tenderness, + McMurray test</td>
<td></td>
<td>2. Debride (inner 2/3 lesion)</td>
</tr>
<tr>
<td>Seen with ACL injuries</td>
<td></td>
<td></td>
<td>3. Repair (outer 1/3 or longitudinal lesion)</td>
</tr>
<tr>
<td>Medial lateral (cysts develop)</td>
<td></td>
<td></td>
<td>Improved results with ACL repair</td>
</tr>
</tbody>
</table>

### Osteochondritis Dissecans

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H/P</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subchondral bone injury</td>
<td>Hx: Insidious onset knee pain</td>
<td>XR: AP/lateral: shows radiolucency, +/- fragment or loose body</td>
<td>1. Often spontaneously heals in children</td>
</tr>
<tr>
<td>Unknown etiology: AVN, repetitive microtrauma</td>
<td>PE: Crepitus on flexion extension, femoral condyle tender to palpation</td>
<td></td>
<td>2. Adults: drill lesion vs. bone graft/chondroplasty</td>
</tr>
<tr>
<td>Lateral aspect of medial femoral condyle #1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Plica

- **Synovial tissue (embryonic remnant)** thickens and rubs the medial femoral condyle.

- **Medial patellar plica**
  - PE: Palpable plica, jointline tenderness

- **Compression of patella due to tight lateral retinaculum**

- **Patellar Instability**
  - Spectrum: malalignment-recurrent subluxation-instability-dislocation
  - Usually lateral, leads to OA

### Patellar Compression Syndrome

- **Hx:** Anterior knee pain
- **XR:** AP/lateral: normal

- PE: Lateral patella (facet) tender to palpation

### Patellar Instability

- **Hx:** Knee buckles, +/- pain
- **XR:** AP/lateral/sunrise: Lateral displacement of the patella, +/- patella alta

- PE: +/- genu valgum, increased Q angle, VMO atrophy, + patellar apprehension

### Treatment

- **PLICA**
  - 1. NSAIDs
  - 2. Activity modification
  - 3. Arthroscopic debridement

- **Patellar Compression Syndrome**
  - 1. Quadriceps strengthening
  - 2. Lateral release of retinaculum

- **Patellar Instability**
  - 1. PT: VMO strengthening
  - 2. Orthosis for subluxation
  - 3. Lateral release, realignment procedures (especially for MMS)

**Miserable Malalignment Syndrome (MMS):**
- Associated with femoral anteversion, increased Q angle, genu valgum
# Patellar Tendinitis: Jumper's Knee

- Seen in jumpers (e.g., basketball, volleyball players)
- Hx: Sports, anterior knee pain
- XR: AP/lateral: normal
- PE: Patella: inferior pole tender to palpation
- MR: Increased signal in inferior pole
- Treatment:
  1. NSAIDs, strengthen quadriceps [no steroid injection-tendon rupture]
  2. Debride tendon (rare)

## Patellar Tendon (Ligament) Rupture

- Direct trauma (also systemic/metabolic disorders)
- Hx: Young, history of trauma
- XR: AP/lateral: relative patella alta
- Primary surgical repair
- PE: Decreased or no active extension, + palpable defect

## Quadriceps Tendon Rupture

- Result of minor trauma
- Hx: Older, cannot actively extend knee
- XR: AP/lateral: relative patella baja
- Primary surgical repair
- PE: Palpable defect or sulcus

## Tumors

- #1 in Adolescents: Osteosarcoma; #1 in Adults: Chondrosarcoma; #1 benign (young adult): Giant cell

---

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
## DISORDERS: LIGAMENT INJURIES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>H P</th>
<th>WORK-UP/FINDINGS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTERIOR CRUCIATE (ACL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Twisting injury, often no contact</td>
<td>Hx: &quot;Popping,&quot; swelling</td>
<td>XR: AP/lateral/sunrise: +/- capsular avulsion</td>
<td>1. Closed chain exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Associated with MCL meniscus tear (all 3 = Terrible Triad)</td>
<td>PE: Effusion. + Lachman, anterior drawer and pivot shifts tests (Lachman most sensitive)</td>
<td>Arthrocentesis (+ /-): 70% have hemarthrosis</td>
<td>2. Reconstruction needed (usually after several weeks of rehabilitation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Segond fracture: avulsion fx</td>
<td></td>
<td>MR: confirms diagnosis</td>
<td></td>
</tr>
<tr>
<td><strong>POSTERIOR CRUCIATE (PCL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Anterior force on flexed knee (e.g. dashboard)</td>
<td>Hx: Pain, unable to ambulate</td>
<td>XR: AP/lat/sunrise: +/- avulsion fracture</td>
<td>1. Non-operative: crutches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Also with other ligament injuries</td>
<td>PE: + posterior drawer, posterior sag, quad active tests</td>
<td>MR: confirms diagnosis</td>
<td>2. Quadriceps strengthening (Complication: OA)</td>
</tr>
<tr>
<td><strong>MEDIAL COLLATERAL (MCL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Valgus force (football clip)</td>
<td>Hx: Medial knee pain</td>
<td>XR: AP/lateral: possibly an avulsion</td>
<td>1. Hinged knee brace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Graded 1, 2 (partial), 3 (complete)</td>
<td>PE: Laxity and/or pain with valgus stress (at 30° flexion)</td>
<td></td>
<td>2. Physical therapy: early ROM strengthening</td>
</tr>
<tr>
<td><strong>LATERAL COLLATERAL (LCL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Varus force (isolated, rare)</td>
<td>Hx: Trauma. Pain swelling</td>
<td>XR: AP/lateral: possibly an avulsion</td>
<td>1. Nonoperative: see MCL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Associated with other ligament and peroneal nerve injuries</td>
<td>PE: Laxity pain with varus stress (at 30°). Test for foot drop</td>
<td></td>
<td>2. Surgical for grade III (usually combination injury)</td>
</tr>
</tbody>
</table>

Isolated PCL, MCL, and LCL injuries are primarily treated non-operatively; operative repair is
used when these injuries occur in combination.

<table>
<thead>
<tr>
<th>POSTEROLATERAL CORNER COMPLEX (PLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Often with PCL injury</strong></td>
</tr>
<tr>
<td><strong>LCL torn</strong></td>
</tr>
<tr>
<td><strong>Popliteofibular ligament torn</strong></td>
</tr>
</tbody>
</table>
1st-degree sprain. Localized joint pain and tenderness but no joint laxity

2nd-degree sprain. Detectable joint laxity plus localized pain and tenderness

3rd-degree sprain. Complete disruption of ligaments and gross joint instability
# TOTAL KNEE ARTHROPLASTY

## KEYS TO TOTAL KNEES

### GENERAL INFORMATION

- Implants: unlike hip, all are cemented (to reduce complications with loosening)
  - Cement: Polymethylmethacralate
  - Femoral condylar and tibia components are metallic
  - Tibial component surface plate: Polyethylene

### INDICATIONS

End stage DJD: results in disabling pain in knee secondary to arthritis in 2+ compartments (medial lateral patellofemoral).

- Common etiologies: OA, RA, AVN
- Most patients complain of PAIN, worsening over time (wakes them from sleep), and decreased ability to ambulate
- Patient should have appropriate radiographic evidence of arthritis

<table>
<thead>
<tr>
<th>OSTEOARTHRITIS</th>
<th>RHEUMATOID ARTHRITIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Joint space narrowing</td>
<td>1. Joint space narrowing</td>
</tr>
<tr>
<td>2. Sclerosis</td>
<td>2. Periarticular osteoporosis</td>
</tr>
<tr>
<td>4. Osteophyte formation</td>
<td>4. Ankylosis</td>
</tr>
</tbody>
</table>

1. It is preferable that the patient is elderly (needs only one replacement)

2. Failed conservative treatment: activity modification, weight loss, orthosis, physical therapy/strengthening, NSAIDs, ambulation assistance (cane, walker, etc.), injections.

### CONTRAINDICATIONS

- Young, active patient (will wear out replacement many times)
- Knee extensor mechanism dysfunction
- Medically unstable (e.g. severe cardiopulmonary disease)
- Neuropathic joint
- Any infection
**TOTAL KNEE ARTHROPLASTY**

**KEYS TO TOTAL KNEES**

**ALTERNATIVES**

- Considerations: Age, activity level, overall health
  - Osteotomy: for unicompartmental disease, young, active (not in elderly patients)
    - Medial compartment (varus deformity): high tibial osteotomy
    - Lateral compartment (valgus deformity): distal femoral osteotomy
  - Arthrodesis/Fusion: totally destroyed, neuropathic, or septic joint
  - Unicompartment arthroplasty: for unicompartment disease. Only in selected patients not eligible for osteotomy.

**PROCEDURE**

- Medial parapatellar approach used (lateral parapatellar for severe valgus deformity)
  - ACL is sacrificed
    - Using specialized guides, the distal femur and proximal tibia are removed and replaced with metallic/plastic components.
  - Underside of patella also replaced.
  - Flexion and extension gap should be equal

**COMPLICATIONS**

- Infection: often leads to removal of prosthesis (Staph #1)
- Loosening of components
- Patellofemoral joint pain
- Decreased ROM (usually from inadequate postoperative physical therapy)
- Patella fracture
- Superolateral geniculate artery is at risk
- Fat embolism
- Peroneal nerve palsy
- Deep Venous Thrombosis (DVT)/Pulmonary emboli: patients should be anticoagulated (Heparin/warfarin) postoperatively
**PEDIATRIC DISORDERS**

**Bow Leg and Knock-knee**

Two brothers, younger (left) with bowleg, older (right) with knock-knee. In both children, limbs eventually became normally aligned without corrective treatment.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENU VARUM: BOW LEGS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal: neonate to 2 yrs old</td>
<td>Hx: Parents observe deformity</td>
<td>1. Most resolve spontaneously with normal development</td>
</tr>
<tr>
<td>Etiology:</td>
<td>PE: Measure tibiofemoral angle</td>
<td>2. Night bracing rarely required</td>
</tr>
<tr>
<td>1. Blount's disease</td>
<td>XR: Only large deformity or if concerned about dysplasia.</td>
<td>3. Osteotomy if persistent (15°)</td>
</tr>
<tr>
<td>2. Rickets (nutritional)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Skeletal dysplasia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Trauma</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GENU VALGUM: KNOCK KNEES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal for 2 yrs to 4 yrs</td>
<td>Hx: Parents observe deformity</td>
<td>1. Most resolve spontaneously with normal development</td>
</tr>
<tr>
<td>Adult: 5-10° valgus is normal</td>
<td>PE: Measure tibiofemoral angle</td>
<td>2. Surgery if persists past age 10</td>
</tr>
<tr>
<td>Etiology:</td>
<td>XR: Only large deformity or if concerned about dysplasia.</td>
<td></td>
</tr>
<tr>
<td>1. Rickets (renal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Skeletal dysplasia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Trauma</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OSGOOD SCHLATTER DISEASE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Osteochondritis/traction apophysitis of tibial tubercle (at 2° ossification center)</td>
<td>Hx: Early adolescent. Knee pain worse after activity</td>
<td>1. Activity restriction/modification</td>
</tr>
<tr>
<td>Condition</td>
<td>Clinical Presentation</td>
<td>Imaging Findings</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Patellar Tendon Ossification</td>
<td>Pain, swelling at patellar tubercle</td>
<td>XR: Knee AP/lateral: may show heterotopic ossification</td>
</tr>
<tr>
<td>Tibial Torsion</td>
<td>Congenital IR of tibia (associated with intrauterine position)</td>
<td>Hx: 1-2 yo, often tripping, no pain</td>
</tr>
<tr>
<td>Tibial Torsion</td>
<td>Often bilateral</td>
<td>PE: Negative foot to thigh angle (normal 10-30°), with knee/patella pointed forward, intoeing gait observed</td>
</tr>
</tbody>
</table>

---

![Ossicallesis Tendon Lesion](image)

- Normal osteochondral tissue to ossification of tubercle
- Ossicallesis Tendon Lesion: ossification of patellar tendon area, leaving patellar tendon hypoplastic
- High power magnification of involved area

![Tibial Torsion](image)

- Congenital IR of tibia
- Hx: 1-2 yo, often tripping, no pain
- Will resolve spontaneously (between 24-48 months)
- Often bilateral
- PE: Negative foot to thigh angle (normal 10-30°), with knee/patella pointed forward, intoeing gait observed

---

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
SURGICAL APPROACHES

**KNEE: MEDIAL PARAPATELLAR APPROACH**

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVIOUS PLANE</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ligament reconstruction</td>
<td>No planes: Capsule is under skin</td>
<td>1. Infrapatellar branch of Saphenous Nerve</td>
<td>1. Most commonly used approach</td>
</tr>
<tr>
<td>2. Total knee arthroplasty</td>
<td></td>
<td>2. Most/best exposure</td>
<td></td>
</tr>
<tr>
<td>3. Meniscectomy</td>
<td></td>
<td>3. Neuroma may develop from cutaneous nerves</td>
<td></td>
</tr>
</tbody>
</table>

**LEG/TIBIA: POSTEROLATERAL APPROACH** (Harmon)

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVIOUS PLANE</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
</table>

**ARTHROSCOPY PORTALS**

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVIOUS PLANE</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anteromedial</td>
<td>Just above joint line, 1 cm inferior to patella</td>
<td>Anterior horn of medial meniscus</td>
<td>Used to view lateral compartment</td>
</tr>
<tr>
<td></td>
<td>1 cm medial to patellar ligament</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Anterolateral</td>
<td>Just above joint line, 1 cm inferior to patella</td>
<td>Anterior horn of lateral meniscus</td>
<td>1. Used to view medial compartment, ACL, and menisci</td>
</tr>
<tr>
<td></td>
<td>1 cm lateral to patellar ligament</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Suprolateral</td>
<td>2.5 cm above joint line, lateral to quadricep tendon</td>
<td></td>
<td>Used to view patellofemoral articulation, patella tracking,</td>
</tr>
<tr>
<td></td>
<td>1 cm inferior to patella</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Posteromedial

- Flex knee to 90°, 1 cm posterior to femoral condyle
- Used to view PCL, posterior horns of menisci
CHAPTER 9 - FOOT/ANKLE

- TOPOGRAPHIC ANATOMY
- OSTEOLOGY
- TRAUMA
- ANKLE JOINTS
- FOOT JOINTS
- OTHER STRUCTURES
- MINOR PROCEDURES
- HISTORY OF THE FOOT/ANKLE
- PHYSICAL EXAM
- MUSCLES: DORSUM
- MUSCLES: FIRST PLANTAR LAYER
- MUSCLES: SECOND PLANTAR LAYER
- MUSCLES: THIRD PLANTAR LAYER
- MUSCLES: FOURTH PLANTAR LAYER
- NERVES
- ARTERIES
- DISORDERS
- PEDIATRIC DISORDERS
- SURGICAL APPROACHES TO THE ANKLE
OSTEOLOGY

CHARACTERISTICS | OSSIFY | FUSE | COMMENT
--- | --- | --- | ---
See leg chapter for Tiba and Fibula

TALUS

- Head (anterior-navicular)
  - Neck: susceptible to fracture
  - Body/trochlea: in ankle mortise
  - Lateral process
  - Posterior process: medial lateral tubercles

Primary: Body | 7mo. (fetal) | 13-15 years | Talus is only tarsal bone to articulate with tibia and fibula. No muscular attachments.
- AVN a concern due to retrograde blood supply from branches of posterior tibial dorsalis pedis arteries
- Weight from tibia is transmitted through the trochlea
- FHL runs between medial lateral tubercle of posterior process
- Unfused lateral tubercle: Os trigonum, not a fracture

- Talus is only tarsal bone to articulate with tibia and fibula. No muscular attachments.
- AVN a concern due to retrograde blood supply from branches of posterior tibial dorsalis pedis arteries
- Weight from tibia is transmitted through the trochlea
- FHL runs between medial lateral tubercle of posterior process
- Unfused lateral tubercle: Os trigonum, not a fracture
<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>OSSIFY</th>
<th>FUSE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CALCANEUS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Multiple facets: posterior largest</td>
<td>Primary: Body</td>
<td>6 mo. (fetal)</td>
<td>13-15 years</td>
</tr>
<tr>
<td>Sustentaculum tali: has the middle facet; supports talar neck</td>
<td>Secondary: Tubercle</td>
<td>9 year</td>
<td>13-15 years</td>
</tr>
<tr>
<td>- Largest tarsal bone; posterior support for longitudinal arch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- FHL runs under sustentaculum tali; spring ligament attaches to it</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Painful spurs can develop on tuberosity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NAVICULAR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- &quot;Boat-shaped&quot;</td>
<td>Primary:</td>
<td>4 years</td>
<td>13-15 years</td>
</tr>
<tr>
<td>Tuberosity (medial)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Tibialis posterior inserts on to the tuberosity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Articulates with talus, cuneiforms, cuboid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Shape of tarsals create transverse arch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CUNEIFORMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Three bones</td>
<td>Primary:</td>
<td>3 years</td>
<td>13-15 years</td>
</tr>
<tr>
<td>- Medial: largest</td>
<td></td>
<td>4 years</td>
<td></td>
</tr>
<tr>
<td>- Intermediate: shorter than others</td>
<td></td>
<td>1 year</td>
<td></td>
</tr>
<tr>
<td>- Lateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2nd MT is in &quot;recess&quot; of short intermediate bone; can lead to fracture of it's base, unstable TMT joint.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Peroneus longus partially inserts on plantar aspect of med. cuneiform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHARACTERISTICS</td>
<td>OSSIFY</td>
<td>FUSE</td>
<td>COMMENT</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>CUBOID</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tuberosity inferiorly</td>
<td>Primary: Birth</td>
<td>13-15 yrs</td>
<td>Most lateral tarsal bone Peroneus longus tendon passes through groove on inferior surface</td>
</tr>
<tr>
<td>• Cuboid groove inferiorly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>METATARSALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Long bone characteristics</td>
<td>Primary: Shaft, Secondary: Epiphysis</td>
<td>9 wks (fetal), 5-8 yrs</td>
<td>Birth 14-18 years</td>
</tr>
<tr>
<td>• Base of 2nd MT in tarsal “recess” Anterior support of longitudinal arch of the foot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PHALANGES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Great toe has only two phalanges</td>
<td>Primary: Body</td>
<td>10 wks (fetal)</td>
<td>14-18</td>
</tr>
<tr>
<td>Great toe has two sesamoid bones</td>
<td>Secondary: Epiphysis</td>
<td>2-3 yrs</td>
<td>Ossification of each tarsal bone occurs from a single center</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------</td>
<td>---------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Borders of ankle mortise: Superior: tibia (plafond), medial: medial malleolus (tibia), lateral: lateral malleolus (fibula)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tarsal Tunnel: A fibroosseous tunnel formed by the posterior medial malleolus, medial walls of calcaneus and talus, and flexor retinaculum. Contents: Tendons (TP, FDL, FHL), Posterior Tibial artery, Tibial nerve (can be compressed in tunnel)</td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
**Lauge-Hansen Classification of Ankle Fractures**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANKLE FRACTURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very common in all ages</td>
<td>HX: Trauma. Pain, swelling PE: Effusion, intense tenderness at 1 or both malleoli +/- proximal fibula. Check posterior tibial pulse and tibial nerve function</td>
<td>Lauge-Hansen – 4 types with subdivided stages</td>
<td>Dislocation: immediately reduce Stable/nondisplaced: short leg cast 4-6 weeks Unstable/displaced: ORIF, repair articular surface fibular length, +/- need for syndesmosis screw</td>
</tr>
<tr>
<td>Malleoli and/or talar dome are involved</td>
<td>XR: Ankle trauma series CT: Good for intraarticular fractures needing repair</td>
<td>SA: supination/adduction stage I, II</td>
<td></td>
</tr>
<tr>
<td>1 malleolus fx: stable; 2 malleoli and/or ligaments injured: unstable</td>
<td></td>
<td>SER: supination/external rotation: stages I-IV</td>
<td></td>
</tr>
<tr>
<td>Perfect symmetrical mortise reduction required</td>
<td></td>
<td>PA: supination/abduction stages I, II, III</td>
<td></td>
</tr>
<tr>
<td>Also must correct fibular length</td>
<td></td>
<td>PER: supination/external rotation: stages I-IV</td>
<td></td>
</tr>
</tbody>
</table>
**DESCRIPTION**

- Most common tarsal fracture
  - Mechanism: large axial load (e.g. high fall or jump)
  - Must rule out spine injury
  - Subtalar joint affected
    - Most fractures are intraarticular (worse prognosis)

**EVALUATION**

- HX: Trauma. Cannot bear weight, pain, swelling.
- PE: Tender to palpation. Check Tibial nerve function, pulses arch swelling.
- XR: AP/lateral (+/- Harris) and spine films
- CT: Needed to better define fx

**CLASSIFICATION**

- Extraarticular: Body
  - Tuberosity
  - Anterior/medial process
- Intraarticular: Nondisplaced
  - Tongue-type
  - Joint depression
  - Comminuted

**TREATMENT**

- Extraarticular: Cast.
- ORIF if unstable
- Displaced/intraarticular:
  - ORIF: plates and screws
  - +/- bone graft
- Severely comminuted:
  - Closed treatment.

**COMPLICATIONS:**

- Osteoarthritis: subtalar
- Decreased motion
- Malunion/nonunion
- Compartment syndrome
- Sural nerve injury
Fracture of Talar Neck

### Evaluation

- **HX:** Trauma. Cannot bear weight, pain, swelling.
- **PE:** Tender to palpation. Check Tibial nerve function, pulses, arch swelling.
- **XR:** AP/lateral (+/- Canale)
- **CT:** Usually not needed

### Classification

- **Hawkins types [neck] predicts osteonecrosis:**
  - I. Nondisplaced
  - II. Displaced; subtalar subluxation/dislocation
  - III. Displaced; talar body dislocation
  - IV. Talar head (+/- body) dislocation

### Treatment

- **Type I:** Cast 2 months. Many prefer ORIF to reduce risk of displacement.
- **Type II, III, IV:** ORIF emergently to avoid necrosis +/- bone graft. Early ROM.

### Complications

- Osteoarthritis: ankle and subtalar joints; Osteonecrosis of body (incidence decreased with ORIF); Delayed union/nonunion
Injury to Tarsometatarsal (Lisfranc) Joint Complex

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>CLASSIFICATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIDFOOT FRACTURES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Involves tarsal bones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Usually high energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Midtarsal joint injuries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• result from fractures of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>adjacent bones.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cuneiform cuboid fractures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• are rare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 2nd MT in tarsal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recess: fracture of its</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>base destabilizes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT joint, dislocation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>may result.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HX: Trauma. Dorsal pain.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE: Swelling, severe pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at Midtarsal or TMT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>joint increases with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>midfoot motion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XR: AP/lateral/oblique, +/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>foot stress filmMed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd MT and middlecuneiform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>should align CT/MR:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>if unsure of fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Midtarsal: Nondisplaced: cast.
Other: ORIF
Navicular: Reduce, +/- PCP.
Many require ORIF
Lisfranc injury: Close reduce fracture and/or dislocation (+/- PCP).
ORIF: if displaced or irreducible-most

COMPLICATIONS: Neurovascular injury: Dorsalis pedis artery; Compartment syndrome; Decreased motion; Post-traumatic osteoarthritis or chronic pain.
**DESCRIPTION**

Common injuries: most are benign.

Fracture at metaphyseal/diaphyseal junction of 5th MT (Jones fracture) is not benign

Base of 5th MT avulsion fracture [PB]: benign

Toe fx: usually stub injury 5th toe most common

**EVALUATION**

HX: Pain with weight bearing, swelling

PE: Swelling, ecchymosis, bony pain (increases with motion)

XR: MT: AP/lateral/oblique Toe: AP only

**CLASSIFICATION**

Metatarsal:

- Head
- Neck
- Shaft
- Base (esp. of 5th)

Phalanges:

- Shaft
- Joint injuries

**TREATMENT**

Metatarsal Fractures:
- Undisplaced: hard soled shoe or walking cast.
- Displaced/angled: ORIF
- 5th MT Jones fx: Cast and NWB 6 weeks vs. ORIF

Phalange Fractures:
- Great toe: Reduce, PCP joint injuries.
- Others: splint or buddy tape

**COMPLICATIONS:**

- Neurovascular injury: Dorsalis pedis artery; Osteoarthritis/pain; Decreased motion; Nonunion, especially in 5th Metatarsal (Jones) fracture; Deformity
ANKLE JOINTS

INFERIOR TIBIOFIBULAR

<table>
<thead>
<tr>
<th>LIGAMENTS</th>
<th>ATTACHMENTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNDESMOSIS:</td>
<td>Distal tibia/fibula support: must be stabilized if disrupted</td>
<td></td>
</tr>
<tr>
<td>Anterior/inferior tibiofibular [AITFL]</td>
<td>Distal anterior tibia fibula</td>
<td>Oblique, connects bones anteriorly</td>
</tr>
<tr>
<td>Posterior/inferior tibiofibular [PITFL]</td>
<td>Distal posterior tibia fibula</td>
<td>Weaker, posterior support of mortise</td>
</tr>
<tr>
<td>Inferior transverse ligament</td>
<td>Inferior deep to PITFL</td>
<td>Strong posterior support of mortise</td>
</tr>
<tr>
<td>Interesseous ligament</td>
<td>Lateral tibia to med. fibula</td>
<td>A continuation of interosseous membrane, strong support; torn in Maisonneuve fracture</td>
</tr>
</tbody>
</table>

• Syndesmosis widening seen on radiographs if both the AITFL and PITFL are ruptured

ANKLE (mortise/talus) (Ginglymus/hinge type)

Capsule: Tibia to talus Extends to interosseous ligament

MEDIAL: Deltoid ligament (4 parts)

Medial malleolus to: Strong medial support: fewer sprains.

Navicular tuberosity

Sustentaculum tali Oriented vertically

Tibiocalcaneal

Sustentaculum tali

Posterior tibiotalar

Medial tubercle of talus Thickest part of deltoid ligament

Anterior tibiotalar

Talus Minimal support
<table>
<thead>
<tr>
<th><strong>LATERAL:</strong></th>
<th><strong>Lateral malleolus to:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior talofibular [ATFL]</td>
<td>Neck of talus</td>
</tr>
<tr>
<td>Calcaneofibular [CFL]</td>
<td>Calcaneus</td>
</tr>
<tr>
<td>Posterior talofibular [PTFL]</td>
<td>Posterior process (talus)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LATERAL:</strong></th>
<th><strong>Weaker lateral support: more sprains</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior talofibular [ATFL]</td>
<td>Neck of talus</td>
</tr>
<tr>
<td>Calcaneofibular [CFL]</td>
<td>Calcaneus</td>
</tr>
<tr>
<td>Posterior talofibular [PTFL]</td>
<td>Posterior process (talus)</td>
</tr>
</tbody>
</table>

*Weaker lateral support: more sprains.*

- Anterior talofibular ([ATFL])
  - Neck of talus
  - Weak, most often sprained, positive anterior drawer test when ruptured
- Calcaneofibular ([CFL])
  - Calcaneus
  - Stabilizes subtalar joint
- Posterior talofibular ([PTFL])
  - Posterior process (talus)
  - Strong, seldom torn
## FOOT JOINTS

**JOINT**  | **LIGAMENTS** | **COMMENTS**
--- | --- | ---
**INTERTARSAL**

**Subtalar** (talocalcaneal) Allows inversion/eversion of foot (e.g. walking on uneven surface)

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Ligament</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial talocalcaneal</td>
<td>Medial tubercle to sustentaculum talii</td>
<td></td>
</tr>
<tr>
<td>Lateral talocalcaneal</td>
<td>Deep to calcaneofibular ligament</td>
<td></td>
</tr>
<tr>
<td>Posterior talocalcaneal</td>
<td>Short; Posterior process to calcaneus</td>
<td></td>
</tr>
</tbody>
</table>
| Intertarsal talocalcaneal | Strong; in sinus tarsus | Also supported by the ligaments of the ankle (see ankle joints)

**Transverse/Midtarsal** (Chopart's Joint): assists subtalar joint with inversion/eversion

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Ligament</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talonavicular</td>
<td>Plantar calcaneonavicular (Spring)</td>
<td>Sustentaculum talii to navicular: plantar support for head of talus; Strong.</td>
</tr>
<tr>
<td>Dorsal talonavicular</td>
<td>Dorsal support</td>
<td></td>
</tr>
<tr>
<td>Calcaneonavicular (Bifurcate 1)</td>
<td>Lateral support</td>
<td></td>
</tr>
<tr>
<td>Calcaneocuboid (Bifurcate 2)</td>
<td>Stabilizes two rows of tarsus</td>
<td></td>
</tr>
<tr>
<td>Dorsal calcaneocuboid</td>
<td>Dorsal support</td>
<td></td>
</tr>
<tr>
<td>Plantar calcaneocuboid (short plantar)</td>
<td>Strong plantar support</td>
<td></td>
</tr>
<tr>
<td>Calcaneocuboid MT (long plantar)</td>
<td>Additional plantar support</td>
<td></td>
</tr>
</tbody>
</table>

**Cuboideonavicular, Cuneonavicular, Intercuneiform, Cuneocuboid**

Each of these four joints have dorsal, plantar, and interosseous ligaments, each bearing the name of the corresponding joint

These joints are small, have little motion or clinical significance. Share a common articular capsule.

Plantar ligaments are stronger than the dorsal ligaments

**TARSOMETATARSAL** (Lisfranc) Gliding type

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Ligament</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal, plantar, interosseous, tarsometatarsals (TMT) ligaments</td>
<td>Medial cuneiform to 2nd metatarsal: Lisfranc's ligament</td>
<td></td>
</tr>
</tbody>
</table>

**INTERMETATARSAL**

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Ligament</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal, plantar, interosseous MT</td>
<td>Strengthen transverse arch</td>
<td></td>
</tr>
<tr>
<td>Deep transverse metatarsal</td>
<td>Connect the MT heads</td>
<td></td>
</tr>
</tbody>
</table>

**METATARSOPHALANGEAL** Ellipsoid/condyloid type

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Ligament</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantar plate and Intersesamoid</td>
<td>Part of weight bearing surface</td>
<td></td>
</tr>
<tr>
<td>Collateral</td>
<td>Strong</td>
<td></td>
</tr>
</tbody>
</table>

Deep transverse metatarsal ligaments add support to this joint
INTERPHALANGEAL Ginglymus/hinge type

<table>
<thead>
<tr>
<th>Plantar plate</th>
<th>Similar to the IP joints of the hand</th>
</tr>
</thead>
</table>

Collateral

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
OTHER STRUCTURES

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>FUNCTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior extensor retinaculum</td>
<td>Covers tendons, nerves vessels of anterior compartment at the ankle</td>
<td>Distal fibula to medial tibia</td>
</tr>
<tr>
<td>Inferior extensor retinaculum</td>
<td>Surrounds covers tendons, etc. of the anterior compartment in the foot</td>
<td>“Y” shaped; calcaneus to medial malleolus and navicular</td>
</tr>
<tr>
<td>Flexor retinaculum</td>
<td>Covers tendons of posterior compartment</td>
<td>Medial malleolus to calcaneus. Roof of tarsal tunnel.</td>
</tr>
<tr>
<td>Superior Inferior peroneal retinaculum</td>
<td>Covers tendons sheaths of the lateral compartment at the hindfoot</td>
<td>Superior: Lateral malleolus to calcaneus Inferior: Inferior extensor retinaculum to calcaneus</td>
</tr>
<tr>
<td>Plantar Aponeurosis (Plantar fascia)</td>
<td>Supports longitudinal arch</td>
<td>Inflamed: plantar fascitis. Can develop nodules</td>
</tr>
</tbody>
</table>
MINOR PROCEDURES

### STEPS

#### ANKLE ARTHROCENTESIS

1. Ask patient about allergies
2. Plantarflex foot, palpate medial malleolus and sulcus between it and the tibialis anterior tendon. Use the visible EHL tendon if TA is not palpable.
3. Prepare skin over ankle joint (iodine/antiseptic soap)
4. Anesthetize skin locally (quarter size spot)
5. Insert 20 gauge needle perpendicularly into the sulcus/ankle joint (medial to the tendon, inferior to distal tibia articular surface, lateral to medial malleolus). Aspirate fluid. If suspicious for infection, send fluid for Gram Stain and culture. The fluid should flow easily if needle is in joint.
6. Dress injection site

#### DIGITAL BLOCK

1. Same as in hand. See Hand chapter.

---

**Great toe digital block**

Needle positioned down both sides of base of toe and across top

![Diagram of foot and digital block injection](image-url)
**HISTORY OF THE FOOT/ANKLE**

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>ANSWER</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AGE</td>
<td>Young</td>
<td>Sprain, fractures</td>
</tr>
<tr>
<td></td>
<td>Middle age, elderly</td>
<td>Overuse injuries, arthritis, gout</td>
</tr>
<tr>
<td>2. PAIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Onset</td>
<td>Acute (less common)</td>
<td>Fracture, stress fracture</td>
</tr>
<tr>
<td></td>
<td>Chronic</td>
<td>Most foot ankle disorders are chronic</td>
</tr>
<tr>
<td>b. Location</td>
<td>Ankle</td>
<td>Fracture, osteoarthritis, instability, posterior tibial tendinitis</td>
</tr>
<tr>
<td></td>
<td>Hindfoot</td>
<td>Plantar fascitis, fracture, retrocalcaneal bursitis, Achilles tendinitis</td>
</tr>
<tr>
<td></td>
<td>Midfoot</td>
<td>Osteoarthritis of tarsal joints, fracture</td>
</tr>
<tr>
<td></td>
<td>Forefoot</td>
<td>Hallux rigidus, fractures, metatarsalgia, Morton's neuroma, bunions, gout</td>
</tr>
<tr>
<td></td>
<td>Bilateral</td>
<td>Consider systemic illness, RA</td>
</tr>
<tr>
<td>c. Occurrence</td>
<td>Morning pain</td>
<td>Plantar fascitis (improves with stretching/walking)</td>
</tr>
<tr>
<td></td>
<td>With activity</td>
<td>Overuse type injuries</td>
</tr>
<tr>
<td>3. STIFFNESS</td>
<td>Without locking</td>
<td>Ankle sprain, RA</td>
</tr>
<tr>
<td>With locking</td>
<td>Loose body</td>
<td></td>
</tr>
<tr>
<td>4. SWELLING</td>
<td>Yes</td>
<td>Fracture, arthritis</td>
</tr>
<tr>
<td>5. TRAUMA</td>
<td>Mechanism/foot position</td>
<td>Inversion: ATFL injury/sprain</td>
</tr>
<tr>
<td></td>
<td>Bear weight?</td>
<td>Yes: less severe injury; No: more severe (rule out fracture)</td>
</tr>
<tr>
<td>6. ACTIVITY/OCCUPATION</td>
<td>Sports, repetitive motion</td>
<td>Achilles tendinitis, overuse injuries</td>
</tr>
<tr>
<td></td>
<td>Standing all day</td>
<td>Overuse injuries</td>
</tr>
<tr>
<td>7. SHOE TYPE</td>
<td>Tight/narrow toe box</td>
<td>Hallux valgus (bunion, overwhelmingly seen in women)</td>
</tr>
<tr>
<td>8. NEUROLOGIC SYMPTOMS</td>
<td>Pain, numbness, tingling</td>
<td>Tarsal tunnel syndrome</td>
</tr>
<tr>
<td>9. HISTORY OF SYSTEMIC DISEASE</td>
<td>Manifestations in foot</td>
<td>Diabetes mellitus, gout, peripheral vascular disease, RA, Reiter's syndrome</td>
</tr>
</tbody>
</table>
### PHYSICAL EXAM

<table>
<thead>
<tr>
<th>EXAM</th>
<th>TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot (standing/weight-bearing)</td>
<td>Anterior view</td>
<td>Alignment/rotational deformities, toe deformities, bunions</td>
</tr>
<tr>
<td></td>
<td>Posterior view</td>
<td>Minimal valgus is normal, &quot;pump bump&quot; exostosis</td>
</tr>
<tr>
<td></td>
<td>Superior view</td>
<td>Bunion, bunionette</td>
</tr>
<tr>
<td>Foot (supine/sitting/non-WB)</td>
<td>Medial view</td>
<td>Flat foot (pes planus); high arch foot (pes cavus)</td>
</tr>
<tr>
<td></td>
<td>Inferior/plantar view</td>
<td>Callus, warts, ulcers (especially in diabetic foot)</td>
</tr>
<tr>
<td>Swelling</td>
<td>Foot and ankle</td>
<td>Swelling sign of infection, trauma (bilateral): cardiovascular etiology</td>
</tr>
<tr>
<td>Color</td>
<td>Change WB to non-WB</td>
<td>If foot changes color: pink to RED: arterial insufficiency</td>
</tr>
<tr>
<td>Shoes</td>
<td>All aspects of the shoe</td>
<td>Abnormal wear may indicate disease (e.g. scuffed toe, drop foot)</td>
</tr>
<tr>
<td>EXAM</td>
<td>TECHNIQUE</td>
<td>CLINICAL APPLICATION</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td><strong>PALPATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bony structures</td>
<td>1st MTP joint (MT head)</td>
<td>Bunion, bursitis, callus; pain: gout, sesamoiditis, tendinitis</td>
</tr>
<tr>
<td></td>
<td>Other MTP joint (MT head)</td>
<td>Pain: metatarsalgia, Freiberg's infraction, fracture, tailor's bunion (5th MT head)</td>
</tr>
<tr>
<td></td>
<td>Tarsal bones (Talus)</td>
<td>Tenderness suggests fracture, osteonecrosis, osteochondritis</td>
</tr>
<tr>
<td></td>
<td>Calcaneus</td>
<td>Pain: fracture. Posterior: bursitis (pump bump); Plantar: spur, plantar fascitis; Medial pain: nerve entrapment</td>
</tr>
<tr>
<td></td>
<td>Both malleoli</td>
<td>Pain indicates fracture, syndesmosis injury in leg</td>
</tr>
<tr>
<td>Soft tissue</td>
<td>Skin</td>
<td>Cool: peripheral vascular disease. Swelling: trauma or infection vs. venous insufficiency</td>
</tr>
<tr>
<td></td>
<td>Between metatarsal heads</td>
<td>Mass pain: neuroma</td>
</tr>
<tr>
<td></td>
<td>Medial ankle ligaments</td>
<td>Pain suggests ankle sprain (Deltoid ligament)</td>
</tr>
<tr>
<td></td>
<td>Tendons at med. malleolus</td>
<td>Pain indicates tendinitis, rupture (sprain)</td>
</tr>
<tr>
<td></td>
<td>Lateral ankle ligaments</td>
<td>Pain suggests ankle sprain ATFL, CFL, PTFL (rare)</td>
</tr>
<tr>
<td></td>
<td>Peroneal tendons (lateral malleolus)</td>
<td>Pain indicates tendinitis, rupture/sprain, dislocation</td>
</tr>
<tr>
<td></td>
<td>Achilles tendon</td>
<td>Pain: tendinitis. Defect suggests Achilles rupture</td>
</tr>
<tr>
<td><strong>RANGE OF MOTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankle: dorsi/plantarflex</td>
<td>Stabilize subtalar joint</td>
<td>Normal: Plantarflex 50°, Dorsi flex (extend) 25°</td>
</tr>
<tr>
<td>Subtalar: inversion/eversion</td>
<td>Stabilize tibia</td>
<td>Normal: Invert 5-10°, Evert 5°</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Midtarsal: adduction/abduction</td>
<td>Stabilize heel/hindfoot</td>
<td>Normal: Adduct 20°, abduct 10°</td>
</tr>
<tr>
<td>Great toe:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTP: flex/extend</td>
<td>Stabilize foot</td>
<td>Normal: Flex 75°, extend 75°. Decreased in hallux rigidus</td>
</tr>
<tr>
<td>IP: flex/extend</td>
<td>Stabilize foot</td>
<td>Normal: Flex 90, extend 0°</td>
</tr>
</tbody>
</table>

Pronation: dorsiflexion, eversion, abduction. Supination: plantarflexion, inversion, adduction

---

<table>
<thead>
<tr>
<th>EXAM TECHNIQUE</th>
<th>CLINICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NEUROVASCULAR</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sensory</strong></td>
<td></td>
</tr>
<tr>
<td>Saphenous (L4)</td>
<td>Med. foot (med. cutaneous)</td>
</tr>
<tr>
<td>Tibial nerve (L4)</td>
<td>Plantar foot (calcaneal/plantar)</td>
</tr>
<tr>
<td>Superficial Peroneal (L5)</td>
<td>Dorsal foot</td>
</tr>
<tr>
<td>Deep Peroneal (L5)</td>
<td>1st dorsal web space</td>
</tr>
<tr>
<td>Sural nerve (S1)</td>
<td>Lateral foot</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
</tr>
<tr>
<td>Deep Peroneal nerve (L4)</td>
<td>Foot inversion/dorsiflexion</td>
</tr>
<tr>
<td>Deep Peroneal nerve (L5)</td>
<td>Great toe extension (dorsiflex)</td>
</tr>
<tr>
<td>Tibial nerve (S1)</td>
<td>Great toe plantarflexion</td>
</tr>
<tr>
<td>Superficial Peroneal (S1)</td>
<td>Foot eversion</td>
</tr>
<tr>
<td><strong>Reflex</strong></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>Achilles reflex</td>
</tr>
<tr>
<td>Upper Motor Neuron</td>
<td>Babinski reflex</td>
</tr>
<tr>
<td><strong>Pulses</strong></td>
<td></td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>Decreased pulses: trauma or vascular compromise, peripheral vascular disease</td>
</tr>
<tr>
<td>Posterior tibial</td>
<td></td>
</tr>
</tbody>
</table>

**SPECIAL TESTS**

<p>| Anterior drawer | Hold tibia, anterior force to calcaneus | Anterior translation: Anterior Talofibular Ligament (ATFL) rupture (sprain) |
| Talar tilt | Hold tibia, invert ankle | Increased laxity compared to contralateral: CFL/ATFL sprain |
| Eversion/abduct stress | Hold tibia, evert/abduct Ankle | Increased laxity compared to contralateral: Deltoid ligament sprain |
| “Too many toes” sign | Standing, view foot posteriorly | “Too many toes” (more seen laterally than other side): acquired flat foot |</p>
<table>
<thead>
<tr>
<th>Test</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squeeze</td>
<td>Compress distal tibia/fibula</td>
<td>Pain indicates a syndesmosis injury</td>
</tr>
<tr>
<td>Heel lift</td>
<td>Standing, raise onto toes</td>
<td>Heel into varus is normal. Decreased lift with posterior compartment pathology</td>
</tr>
<tr>
<td>Tinel's sign at the Ankle</td>
<td>Tap nerve posterior to medial malleolus</td>
<td>Tingling/parathesia is positive for posterior tibial nerve entrapment</td>
</tr>
<tr>
<td>Compression</td>
<td>Squeeze foot at MT heads</td>
<td>Pain, numbness, tingling: interdigital neuroma (Morton's)</td>
</tr>
<tr>
<td>Thompson</td>
<td>Prone: feet hang, squeeze calf</td>
<td>Absent plantar flexion indicates Achilles tendon rupture</td>
</tr>
<tr>
<td>Homans' sign</td>
<td>Knee extended: passively dorsiflex foot</td>
<td>Pain in calf suggestive of deep venous thrombophlebitis (DVT)</td>
</tr>
</tbody>
</table>
**MUSCLES: DORSUM**

<table>
<thead>
<tr>
<th><strong>MUSCLE</strong></th>
<th><strong>ORIGIN</strong></th>
<th><strong>INSERTION</strong></th>
<th><strong>NERVE</strong></th>
<th><strong>ACTION</strong></th>
<th><strong>COMMENT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensor hallucis brevis</td>
<td>Dorsal calcaneus</td>
<td>Base of proximal phalanx</td>
<td>Deep peroneal</td>
<td>Extends great toe</td>
<td>Assists EHL with its action</td>
</tr>
<tr>
<td>EHB</td>
<td></td>
<td>of Great toe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extensor digitorum brevis</td>
<td>Dorsal calcaneus</td>
<td>Base of proximal phalanx</td>
<td>Deep peroneal</td>
<td>Extends toes</td>
<td>Injury can result in dorsal hematoma</td>
</tr>
<tr>
<td>EDB</td>
<td></td>
<td>4 lateral toes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUSCLE</td>
<td>ORIGIN</td>
<td>INSERTION</td>
<td>NERVE ACTION</td>
<td>COMMENT</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>--------------</td>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td>Abductor hallucis</td>
<td>Calcaneal tuberosity medial process</td>
<td>Through med. sesamoid to proximal phalanx of great toe</td>
<td>Medial plantar</td>
<td>Abducts great toe Supports longitudinal arch medially.</td>
<td></td>
</tr>
<tr>
<td>Flexor digitorum brevis [FDB]</td>
<td>Calcaneal tuberosity medial process</td>
<td>Sides of middle phalanges: lateral 4 toes</td>
<td>Medial plantar</td>
<td>Flex lateral 4 toes Supports longitudinal arch</td>
<td></td>
</tr>
<tr>
<td>Abductor digiti minimi [ADM]</td>
<td>Calcaneal tuberosity medial lateral processes</td>
<td>Lateral base of proximal phalanx: 5th toe</td>
<td>Lateral plantar</td>
<td>Abducts small toe Supports longitudinal arch laterally</td>
<td></td>
</tr>
</tbody>
</table>
### MUSCLES: SECOND PLANTAR LAYER

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadratus plantae</td>
<td>Medial and lateral plantar calcaneus</td>
<td>Lateral FDL tendon</td>
<td>Lateral plantar</td>
<td>Assists FDL with toe flexion</td>
<td>Two heads/bellies join on FDL tendon</td>
</tr>
<tr>
<td>Lumbricals</td>
<td>Separate FDL tendons</td>
<td>Proximal phalanges, extensor expansion</td>
<td>1. Medial plantar 2-4. Laterral plantar</td>
<td>Flex MTP joint, extend IP joint</td>
<td>1st lumbrical attaches to 1 FDL tendon</td>
</tr>
</tbody>
</table>

Tendons of FHL and FDL also pass through in the second layer.

Medial and lateral plantar nerves are terminal branches of the Tibial nerve: they run in the 2nd layer.
<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE ACTION</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor hallucis brevis [FHB]</td>
<td>Cuboid, lateral cuneiform</td>
<td>Through sesamoids to proximal phalanx of great toe</td>
<td>Medial plantar</td>
<td>Assist great toe flexion</td>
<td>Sesamoid bones attach to each tendon</td>
</tr>
<tr>
<td>Adductor hallucis</td>
<td>Oblique: base 2-4 MT  Transverse: Lateral 4 MTP</td>
<td>Through lateral sesamoid to proximal phalanx of great toe</td>
<td>Lateral plantar</td>
<td>Adducts great toe</td>
<td>Supports transverse arch. 2 heads have different orientations</td>
</tr>
<tr>
<td>Flexor digiti minimi brevis [FDMB]</td>
<td>Base of 5th metatarsal</td>
<td>Base of proximal phalanx small toe</td>
<td>Lateral plantar</td>
<td>Flex small toe</td>
<td>Small, relatively insignificant muscle</td>
</tr>
</tbody>
</table>
MUSCLES: FOURTH PLANTAR LAYER

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>NERVE</th>
<th>ACTION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantar interossei (3)</td>
<td>Med. 3, 4, 5th MTs</td>
<td>Medial proximal phalanges: toes 3-5</td>
<td>Lateral plantar</td>
<td>Adduct toes (PAD)</td>
<td>Attachment to MT is medial for all 3</td>
</tr>
<tr>
<td>Dorsal interossei (4)</td>
<td>Adjacent MT shafts</td>
<td>Proximal phalanges: toes 2-5</td>
<td>Lateral plantar</td>
<td>Abduct toes (DAB)</td>
<td>Larger than the plantar interossei muscles</td>
</tr>
</tbody>
</table>

Peroneus longus and Tibialis posterior tendons pass through the fourth layer.

Medial and lateral plantar nerves are terminal branches of the Tibial nerve.

PAD = 5 Plantar ADduct, DAB 5 = Dorsal ABduct; the second digit is used as the reference point for abduction/adduction in the foot.
NERVES

LUMBAR PLEXUS

POSTERIOR DIVISION

1. **Femoral** (L2-4): Saphenous nerve branches in proximal thigh, descends in superficial medial leg, then anterior to medial malleolus in foot.

   Sensory: Medial foot: via medial cutaneous nerve (Saphenous nerve)

   Motor: NONE (in foot or ankle)

SACRAL PLEXUS

ANTERIOR DIVISION

2. **Tibial** (L4-S3): behind medial malleolus, splits on plantar surface

   Sensory: Medial heel: via Medial calcaneal

   Medial plantar foot: via Medial plantar

   Lateral plantar foot: via Lateral plantar

   Motor: FIRST PLANTAR LAYER of FOOT

   Abductor hallucis: Medial plantar

   Flexor digitorum brevis [FDB]: Medial plantar

   Abductor digiti minimi: Lateral plantar

   SECOND PLANTAR LAYER of FOOT

   Quadratus plantae: Lateral plantar

   Lumbricals: Medial Lateral plantar

   THIRD PLANTAR LAYER of FOOT

   Flexor hallucis brevis [FHB]: Medial plantar

   Adductor hallucis: Lateral plantar

   Flexor digiti minimi brevis [FDMB]: Lateral plantar

   FOURTH PLANTAR LAYER of FOOT

   Dorsal interosseous: Lateral plantar

   Plantar interosseous: Lateral plantar

POSTERIOR DIVISION

3. **Common peroneal** (L4-S2): Superficial peroneal divides into intermediate and medial dorsal cutaneous branches in leg. Deep peroneal divides under extensor retinaculum into medial lateral branches.

   Sensory: Lateral foot: via Sural (lateral calcaneal dorsal cutaneous).

   Dorsal foot: Superficial peroneal.

   Dorsal (med.) (Med. dorsal cutaneous branch).
1st/2nd interdigital space: Deep peroneal (med. branch)

Motor:

**FOOT: Deep Peroneal (Lateral branch)**

- Extensor hallucis brevis [EHB]
- Extensor digitorum brevis [EDB]
**ARTERIES**

Blood supply of talus. Because of profuse intraosseous anastomoses, avascular necrosis commonly occurs only when surrounding soft tissue is damaged, as in types II and III fractures of talar neck.

### Artery Table

<table>
<thead>
<tr>
<th>Artery to the Tarsal Sinus</th>
<th>Dorsalis pedis and Peroneal arteries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artery to the Tarsal Canal</td>
<td>Posterior tibial artery</td>
</tr>
<tr>
<td>Deltoid artery</td>
<td>Posterior tibial artery, supplies medial body</td>
</tr>
<tr>
<td>Capsular ligamentous vessels</td>
<td>Multiple sources</td>
</tr>
<tr>
<td>Interosseous anastomosis</td>
<td>Extensive, protects against AVN</td>
</tr>
</tbody>
</table>

### Artery Table - Course

<table>
<thead>
<tr>
<th>Artery</th>
<th>Course</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Medial Malleolar</td>
<td>Under TA EHL tendons to medial malleolus</td>
<td>From Anterior tibial artery, supplies medial malleolus</td>
</tr>
<tr>
<td>Anterior Lateral Malleolar</td>
<td>Under EDL tendon to lateral malleolus</td>
<td>From Anterior tibial artery, supplies lateral malleolus</td>
</tr>
<tr>
<td>Posterior Medial Malleolar</td>
<td>Under tendons of TP and FDL, not FHL, to medial malleolus</td>
<td>From Posterior tibial artery, supplies medial malleolus</td>
</tr>
<tr>
<td>Posterior Lateral Malleolar</td>
<td>Under Peroneus longus/brevis tendons to lateral malleolus</td>
<td>From Peroneal artery, supplies lateral malleolus</td>
</tr>
<tr>
<td>Perforating and communicating branches</td>
<td>Anastomosis with anterior lateral malleolar and posterior tibial arteries</td>
<td>From Peroneal artery, contributes supply to lateral malleolus</td>
</tr>
</tbody>
</table>

An anastomosis occurs at each malleolus between the above arteries.
<table>
<thead>
<tr>
<th>ARTERY</th>
<th>COURSE</th>
<th>BRANCHES</th>
<th>COMMENT/SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Calcaneal</td>
<td>with Lateral calcaneal nerve (Sural nerve)</td>
<td>NONE</td>
<td>From Peroneal artery; supplies heel</td>
</tr>
<tr>
<td>Medial Calcaneal</td>
<td>with Medial calcaneal nerve (Tibial nerve)</td>
<td>NONE</td>
<td>From Posterior tibial artery; supplies heel</td>
</tr>
<tr>
<td>Lateral plantar</td>
<td>Between quadratus plantae FDB, runs w/ lateral plantar nerve</td>
<td>Deep plantar arch</td>
<td>Larger terminal branch of Posterior tibial artery</td>
</tr>
<tr>
<td>Medial plantar</td>
<td>Between Abductor hallucis FDB runs with medial plantar nerve</td>
<td>Superficial branch 1 proper plantar digital Deep branch</td>
<td>Smaller terminal branch of Posterior tibial artery; supplies medial Great toe Anastomose with plantar MT artery</td>
</tr>
<tr>
<td>Dorsalis Pedis</td>
<td>Dorsum of foot with medial branch of deep peroneal nerve</td>
<td>Supplies dorsum of foot via:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>Medial Tarsal</td>
<td>No branches</td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>Lateral Tarsal</td>
<td>No branches</td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>Arcuate artery</td>
<td>3 Dorsal MT arteries branch off</td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>Deep Plantar</td>
<td>Descends to deep plantar arch</td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>1st dorsal metatarsal</td>
<td>Terminal branch of dorsalis pedis</td>
</tr>
<tr>
<td></td>
<td>Dorsalis Pedis</td>
<td>3 dorsal digital arteries</td>
<td>Supply dorsal great toe</td>
</tr>
<tr>
<td>ARTERY</td>
<td>COURSE</td>
<td>BRANCHES</td>
<td>COMMENT/SUPPLY</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Medial Tarsal</td>
<td>Across tarsals, under EHL tendon</td>
<td>NONE</td>
<td>Supplies dorsum of foot (can be 2 or 3 of these arteries).</td>
</tr>
<tr>
<td>Lateral Tarsal</td>
<td>Across tarsals with lateral branch of Deep peroneal nerve</td>
<td>NONE</td>
<td>Supplies EDB, lateral tarsal bones, anastomoses laterally</td>
</tr>
<tr>
<td>Arcuate</td>
<td>Across bases of metatarsals, under extensor tendons</td>
<td>2nd, 3rd, 4th dorsal MT artery 7 dorsal digital arteries</td>
<td></td>
</tr>
<tr>
<td>Deep plantar</td>
<td>Descends between 1st 2nd MT’s</td>
<td>Deep plantar arch</td>
<td>Anastomosis with Lateral calcaneal</td>
</tr>
<tr>
<td>Deep plantar arch</td>
<td>On plantar interosseous muscles in 4th layer of foot.</td>
<td>4 posterior perforating</td>
<td>Join dorsal metatarsal arteries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>1 Common/proper plantar digital</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Most lateral artery in foot toes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>4 plantar metatarsal</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>4 anterior perforating</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Join dorsal metatarsal arteries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>4 Common plantar digital</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>8 Proper plantar digital</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Supplies the distal tip of phalanx</td>
</tr>
</tbody>
</table>

Total of 4 Dorsal Metatarsal arteries leading to 10 dorsal digital arteries. They do not reach the distal tip of the digit.

Total of 4 Plantar Metatarsal arteries leading to 10 proper plantar digital arteries via common plantar digital arteries.

Each digit has 2 dorsal digital and 2 proper plantar digital arteries. Dorsal branch of proper plantar digital artery supply distal tip.
## Disorders

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-Up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Achilles Tendinitis</strong></td>
<td>• Occurs at or above insertion of Achilles tendon</td>
<td></td>
<td>1. Rest, NSAID, heel lift 2. Excise bone or bursa (rare)</td>
</tr>
<tr>
<td></td>
<td>Hx/PE: Heel pain, worse with push off. Tender to palpation</td>
<td>XR: Standing lateral: spur at Achilles insertion</td>
<td></td>
</tr>
<tr>
<td><strong>Achilles Tendon Rupture</strong></td>
<td>• &quot;Weekend warriors.&quot; Middle age men in athletics.</td>
<td></td>
<td>Casting (in equinus) vs. surgical repair</td>
</tr>
<tr>
<td></td>
<td>Hx: &quot;hit with bat&quot; sensation PE: Defect, + Thompson test</td>
<td>XR: Standing AP/lateral: usually normal</td>
<td></td>
</tr>
<tr>
<td><strong>Acquired Flat Foot (Posterior Tibialis Dysfunction)</strong></td>
<td>• Tibialis posterior tendon dysfunction: tears or degeneration  • No arch support results in valgus foot</td>
<td></td>
<td>1. Orthosis 2. Activity modification 3. Calcaneal osteotomy and FDC transfer 4. Arthrodesis</td>
</tr>
<tr>
<td></td>
<td>Hx: Pain and swelling PE: + &quot;too many toes&quot; sign, no heel varus on toe rise</td>
<td>XR: Standing AP/lateral: middle foot sag</td>
<td></td>
</tr>
<tr>
<td><strong>Ankle Instability</strong></td>
<td>• Multiple recurrent sprains  • Also neurologic etiology decreased proprioception</td>
<td></td>
<td>1. PT: strengthen peroneals 2. Surgical reconstruction if condition persists</td>
</tr>
<tr>
<td></td>
<td>Hx: Inversion instability esp. on uneven ground PE: + anterior drawer talar tilt test</td>
<td>XR: AP/lateral/stress view: gapping laterally</td>
<td></td>
</tr>
<tr>
<td><strong>Ankle Sprain</strong></td>
<td>• #1 musculoskeletal injury  • Lateral 90% - ATFL alone 60%, with syndesmosis 5%  • Inversion most common mechanism</td>
<td></td>
<td>1. RICE, NSAIDs 2. Immobilize grade III 3. PT ROM exercises 4. Surgery: athletes or severe injury</td>
</tr>
<tr>
<td></td>
<td>Hx: &quot;Pop,&quot; pain, swelling, +/- ability to bear weight PE: + Anterior drawer, +/- talar tilt test</td>
<td>XR: only if cannot bear weight or + bony point tenderness</td>
<td></td>
</tr>
<tr>
<td><strong>Arthritis: OA/DJD</strong></td>
<td>• Can occur in any joint  • Associated with trauma, obesity, overuse activity</td>
<td></td>
<td>1. NSAID, activity modification, orthosis 2. Fusion/arthroplasty (rare)</td>
</tr>
<tr>
<td></td>
<td>Hx/PE: Older, pain at affected joint.</td>
<td>XR: Standing AP/lateral: classic OA findings</td>
<td></td>
</tr>
<tr>
<td><strong>Charcot Joint: Neuropathic Joint</strong></td>
<td>• Neurologic disease results in decreased sensation  • Joint destroyed/deformed by fx undetected by patient</td>
<td></td>
<td>1. Immobilize (skin checks) 2. Bony excision or fusion</td>
</tr>
<tr>
<td></td>
<td>Hx/PE: Patient is insensate-no pain. Red, warm, swollen joint</td>
<td>XR: Standing AP/lateral: fractures (callus or unhealed), joint destroyed</td>
<td></td>
</tr>
<tr>
<td><strong>Claw Toe</strong></td>
<td>• Deformity: MTP extended,PIP flexed. Usually all toes  • Etiology: Neurologic disease</td>
<td></td>
<td>1. Shoes with extra deep toe box 2. Surgical reconstruction: based on</td>
</tr>
<tr>
<td></td>
<td>Hx: Toe pain PE: Toe deformity, +/- callus corn, neurologic exam</td>
<td>XR: Standing AP/lateral/IMR/EMG/lab: to rule out neurologic disease</td>
<td></td>
</tr>
</tbody>
</table>
### Neurologic disease
(e.g. Charcot-Marie-Tooth)

### CORN
- Two types: 1. Hard
  2. Soft
- Hyperkeratosis: pressure on bones (5th toe #1)
- Interdigital maceration

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
</table>

### DIABETIC FOOT: NEUROPATHIC FOOT
- Neuropathy leads to unperceived injury (ulcer, infection)
- Vascular insufficiency leads to decreased healing

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hx: Burning tingling, +/- pain PE: +/- skin changes, ulcers, deformity, swelling, warmth</td>
<td>XR: Standing AP/lateral: rule out osteomyelitis or Charcot joint Do Ankle Brachial Index</td>
<td>1. Skin care (prevention) 2. Protective shoe 3. Treat ulcers, infections 4. Amputation if necessary</td>
<td></td>
</tr>
</tbody>
</table>

### GOUT (Podagra)
- Purine metabolism defect
- Urate crystals create synovitis
- Great toe most common site

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
</table>

### Hallux Rigidus

- Achilles Tendinitis
- Charcot Foot

<table>
<thead>
<tr>
<th>Description</th>
<th>History/Physical Exam</th>
<th>Work-up/Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achilles tendon with inflammation at insertion into calcaneal tuberosity</td>
<td>Lateral view shows bone damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Clinical Findings</td>
<td>Imaging Findings</td>
<td>Treatment Options</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------</td>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>DJD of MTP of Great toe</td>
<td>Often post traumatic</td>
<td>Middle age. Painful, stiff</td>
<td>1. NSAID, stiff sole shoe 2. Arthroplasty/fusion</td>
</tr>
<tr>
<td>Bone of MTP of Great toe</td>
<td>Often post traumatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hx: Middle age. Painful, stiff</td>
<td>PE: MTP Tender to palpation, decreased ROM</td>
<td>XR: Standing AP/lateral OA findings at 1st MTP</td>
<td></td>
</tr>
<tr>
<td>XR: Standing AP: measure: 1. Distal MT Articulation Angle (normal 10°) 2. Inter MT angle (9°) 3. Hallux Valgus angle (15°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HALLUX VALGUS (Bunion)</td>
<td>Great toe valgus; MTP bursitis</td>
<td>Multiple etiologies: genetic, flat feet, narrow shoes, RA 10:1 women (shoes)</td>
<td>1. Shoes: wide toe box 2. Refractory cases: multiple corrective surgical procedures based on deformity and severity</td>
</tr>
<tr>
<td>Hx: Great toe pain, worse when wearing shoes</td>
<td>PE: Hallux Valgus angle (15°)</td>
<td>XR: Standing AP/lateral: PIP deformity</td>
<td></td>
</tr>
<tr>
<td>1. NSAID, stiff sole shoe 2. Arthroplasty/fusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAMMER TOE</td>
<td>Toe PIP flexion deformity</td>
<td>Associated with trauma, Hallux Valgus (shoes)</td>
<td>1. Extra deep shoe toe box 2. Surgery: resect or fuse PIP</td>
</tr>
<tr>
<td>Hx: Hallux Valgus angle (15°)</td>
<td>PE: Hallux Valgus angle (15°)</td>
<td>XR: Standing AP/lateral: PIP deformity</td>
<td></td>
</tr>
<tr>
<td>1. Shoe modification 2. FDL release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MALLET TOE</td>
<td>Lesser toe DIP flexion deformity</td>
<td>2nd toe most common</td>
<td></td>
</tr>
<tr>
<td>Hx: Hallux Valgus angle (15°)</td>
<td>PE: Hallux Valgus angle (15°)</td>
<td>XR: Standing AP/lateral: DIP deformity</td>
<td></td>
</tr>
<tr>
<td>1. Shoe modification 2. FDL release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>METATARSALGIA</td>
<td>Metatarsal head pain</td>
<td>Etiology: flexor tendinitis, ligament rupture, callus (#1)</td>
<td>1. Metatarsal pads 2. Modify shoes 3. Treat underlying cause</td>
</tr>
<tr>
<td>Hx/PE: Pain under MT head (2nd MT most common)</td>
<td></td>
<td>XR: Standing AP/lateral: look for short MT</td>
<td></td>
</tr>
<tr>
<td>1. Metatarsal pads 2. Modify shoes 3. Treat underlying cause</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORTON'S NEUROMA (Interdigital)</td>
<td>Fibrosis of irritated nerve</td>
<td>Usually between 2nd 3rd metatarsals 5:1 female(shoes)</td>
<td>1. Wide toe shoes, steroid injections, MT pads 2. Nerve excision</td>
</tr>
<tr>
<td>Hx: Plantar MT pain</td>
<td>PE: Plantar MT pain, +/- numbness, + compression test</td>
<td>XR: Standing AP/lateral: usually normal, not helpful</td>
<td></td>
</tr>
<tr>
<td>1. Wide toe shoes, steroid injections, MT pads 2. Nerve excision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLANTAR FASCITIS</td>
<td>Inflammation and/or degeneration of fascia. Female 2:1 Associated with obesity</td>
<td>Hx: AM pain, improves with ambulation or stretching</td>
<td>1. Stretching, NSAID 2. Heel cup 3. Splint (night), casting</td>
</tr>
<tr>
<td>Hx: Plantar fascia to palpation</td>
<td>PE: Medial plantar calcaneus tender to palpation</td>
<td>XR: Standing lateral: +/- calcaneal bone spur</td>
<td></td>
</tr>
<tr>
<td>1. Stretching, NSAID 2. Heel cup 3. Splint (night), casting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLANTAR WARTS</td>
<td>Hyperkeratosis Due to Papilloma virus</td>
<td>Histopathology if necessary</td>
<td>1. Pads vs. freeze or debride lesion</td>
</tr>
<tr>
<td>Hx/PE: Painful plantar lesions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RETROCALCANEAL BURSITIS: HAGLUND'S DISEASE</td>
<td>Bursitis at insertion of Achilles tendon on calcaneus</td>
<td>Hx: Pain on posterior heel PE: Red, tender to palpation, &quot;pump bump&quot;</td>
<td>1. NSAID, heel lift, casting 2. Excise bone/bursa (rare)</td>
</tr>
<tr>
<td>Hx: Pain on posterior heel PE: Red, tender to palpation, &quot;pump bump&quot;</td>
<td>PE: Achilles insertion</td>
<td>XR: Standing lateral: spur at Achilles insertion</td>
<td></td>
</tr>
<tr>
<td>1. NSAID, heel lift, casting 2. Excise bone/bursa (rare)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHEUMATOID ARTHRITIS</td>
<td>Synovitis destroys joints</td>
<td>More common in females</td>
<td>1. Medical management 2. Custom molded shoes</td>
</tr>
<tr>
<td>Hx: Forefoot: pain, swelling PE: Red, tender, +/- deformity to Hallux</td>
<td>PE: Medial plantar calcaneus tender to palpation</td>
<td>XR: AP/lateral: joint destroyed Lab: positive</td>
<td></td>
</tr>
<tr>
<td>1. Medical management 2. Custom molded shoes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>HISTORY/PHYSICAL EXAM</td>
<td>WORK-UP/FINDINGS</td>
<td>TREATMENT</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------</td>
<td>------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>TARSAL TUNNEL SYNDROME</td>
<td>• Tibial nerve trapped by flexor retinaculum and/or tendons</td>
<td>HR/PE: Pain, tingling, burning on sole (made worse with activity)</td>
<td>1. NSAID, steroid injection 2. Surgical release (must follow plantar nerves also)</td>
</tr>
</tbody>
</table>
## Pediatr Dsrds 

**Metatarsus Adductus**
- **Description**: Forefoot adduction (varus)
- **Evaluation**: #1 pediatric foot disorder
- **Associated with**: Intrauterine position or other disorders
- **Treatment/Complications**: Most spontaneously resolve with normal development, serial casting, rarely, midfoot osteotomies

**Talipes Equinovarus: Clubfoot**
- **Description**: Congenital, boys, 50% bilateral, genetic environment factors, idiopathic or associated with other disorders (neuromuscular, etc.), 4 deformities with soft tissue contractures
- **Evaluation**: Deformity at birth
- **Treatment/Complications**: Manipulation and casting 2-4 mo., surgical correction (release, lengthening, etc.) with post operative casting

**Complication**: recurrence of deformity
### PES PLANUS: CONGENITAL FLATFOOT

- Normal in infants (up to 6 yo)
- No longitudinal arch
- Ankle everted (valgus)
- Classified:
  1. Rigid (tarsal coalition/vertical talus)
  2. Flexible (variant of normal)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPlications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hx: Usually adolescent, 1/2 foot pain</td>
<td>Flexible: 1. Asymptomatic: no treatment 2. Symptomatic: arch supports, stretching</td>
<td>Rigid: Treat underlying condition (see tarsal coalition)</td>
</tr>
<tr>
<td>PE: Rigid: always flat Flexible: only flat when WB</td>
<td>XR: AP/lateral: may see coalition/or vertical talus in rigid foot</td>
<td></td>
</tr>
</tbody>
</table>

### PES CAVUS: HIGH ARCH FOOT

- High arch due to muscle imbalance in immature foot (T. A. and peroneus longus)
- Ankle flexed: causes pain
- Must rule out neuromuscular disease (e.g. Charcot-Marie-Tooth)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPlications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hx: 8-10 yrs, ankle pain</td>
<td>1. Braces/inserts/AFO as needed (used with mixed results) 2. Various osteotomies 3. Tendon transfer balance</td>
<td></td>
</tr>
<tr>
<td>PE: Toe walking, tight heel cord decreased ankle dorsiflexion</td>
<td>XR: AP/lateral foot and ankle EMG/NCS: test for weakness MR: spine: r/o neuromuscular disease</td>
<td></td>
</tr>
</tbody>
</table>

### TARSAL COALITION

- Connection (fibrous, cartilage then bony) of two tarsals
- #1 Calcaneus/navicular (13-16yo)
- #2 Talus/calcaneus (9-13yo)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>EVALUATION</th>
<th>TREATMENT/COMPlications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE: Stiff, decreased ROM (subtalar), flatfoot (peroneal spasm)</td>
<td>XR: AP/lateral/oblique: coalitions can be</td>
<td></td>
</tr>
</tbody>
</table>
- Flatfoot deformity results
  seen
  CT: often necessary to confirm PE
### Surgical Approaches to the Ankle

**Anterolateral Approach to Ankle Joint**

![Ankle Diagram](image)

<table>
<thead>
<tr>
<th>USES</th>
<th>INTERNERVOUS PLANE</th>
<th>DANGERS</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fusions/triple arthrodesis</td>
<td>Peroneals [Superficial peroneal]</td>
<td>Deep peroneal nerve</td>
<td>Can access hindfoot</td>
</tr>
<tr>
<td>3. Intertarsal joint access</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com
CHAPTER 10 – BASIC SCIENCE

BONES

Bone function
- Attachment of muscles
- Protection of organs
- Reservoir of minerals for body
- Hematopoiesis site

Bone Forms
- Long bones: Form by enchondral ossification, except clavicle. Have a physis at each end (except in hand and foot). 4 parts: epiphysis, physis, metaphysis, diaphysis. Length is derived from the growing physis.
- Flat bones: Form by intramembranous ossification, (e.g., pelvis).

Physeal Anatomy
- Divided into multiple zones

Reserve zone
- Matrix production and storage

Proliferative zone
- Cell proliferation, matrix production

Hypertrophic zone
- Broken into 3 zones, calcification of matrix

STRUCTURE

<table>
<thead>
<tr>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment of muscles</td>
</tr>
<tr>
<td>Protection of organs</td>
</tr>
<tr>
<td>Reservoir of minerals for body</td>
</tr>
<tr>
<td>Hematopoiesis site</td>
</tr>
</tbody>
</table>

Bone function
- Long bones: Form by enchondral ossification, except clavicle. Have a physis at each end (except in hand and foot). 4 parts: epiphysis, physis, metaphysis, diaphysis. Length is derived from the growing physis.
- Flat bones: Form by intramembranous ossification, (e.g., pelvis).

Physeal Anatomy
- Divided into multiple zones

Reserve zone
- Matrix production and storage

Proliferative zone
- Cell proliferation, matrix production

Hypertrophic zone
- Broken into 3 zones, calcification of matrix
Microscopic Bone Types

- **Woven**: Immature bone; normal in infants, also found in callus tumors
- **Lamellar**: Mature bone; well organized, normal both cortical cancellous after age 4

Structural Bone Types

- **Cortical (compact)**: 80% of bone, highly organized (osteon), blood supply in havensian canal. Volkman’s canal has vessels connecting osteons.
- **Cancellous (spongy/trabecular)**: 20% of bone, crossed lattice structure, higher bone turnover
### Cell Types

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoblasts</td>
<td>Make bone (secrete matrix, collagen, GAG, stimulated by PTH)</td>
</tr>
<tr>
<td>Osteoclasts</td>
<td>Resorb bone (giant cells, mineralized bone found only in Howship's lacunae)</td>
</tr>
<tr>
<td>Osteocytes</td>
<td>Maintain bone (90% of cells, inhibited by PTH)</td>
</tr>
</tbody>
</table>

### Bone Composition

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic matrix (40%)</td>
<td>Produced by osteoblasts—becomes osteocytes when trapped in matrix</td>
</tr>
<tr>
<td>Collagen (Type I)</td>
<td>90% of matrix, gives strength. Mineralization occurs at gaps at the end of each collagen fiber</td>
</tr>
<tr>
<td>Proteoglycan</td>
<td>Glycosaminoglycans structure (GAGs)</td>
</tr>
<tr>
<td>Non-collagen protein</td>
<td>Osteonectin is most abundant</td>
</tr>
<tr>
<td>Inorganic (60%)</td>
<td>Mineralized portion</td>
</tr>
<tr>
<td>Calcium Hydroxyapatite</td>
<td>Adds strength to bone, found in the collagen gaps</td>
</tr>
</tbody>
</table>

### Types of Ossification

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enchondral</td>
<td>Bone replaces a cartilage template in long bones</td>
</tr>
<tr>
<td>Intramembranous</td>
<td>Mesenchymal template in flat bones and clavicle</td>
</tr>
<tr>
<td>STRUCTURE</td>
<td>COMMENT</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Fracture Types</strong></td>
<td>Point tenderness and swelling are common findings</td>
</tr>
<tr>
<td><strong>Open vs. closed</strong></td>
<td>Break in skin is open. Gustilo classification (grade I, II, III A, B, C)</td>
</tr>
<tr>
<td><strong>Direction</strong></td>
<td>Transverse, spiral, oblique, comminuted</td>
</tr>
<tr>
<td><strong>Displacement</strong></td>
<td>Displaced or nondisplaced</td>
</tr>
</tbody>
</table>
| **Other** | - Salter-Harris—fracture involving an open physis in adults, growth plate in children.  
- Greenstick—only one cortex disrupted  
- Torus—one cortex impacted, but intact  
- Pathologic results—from bone tumor/disease |
**Stages of Bone Healing**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflammation</td>
<td>Hematopoietic cells, fibroblasts, osteoprogenitor cells</td>
</tr>
<tr>
<td>Repair</td>
<td>Callus formation (hard or soft), woven bone formation (enchondral)</td>
</tr>
<tr>
<td>Remodeling</td>
<td>Lamellar bone replaces woven, bone assumes normal shape, and repopulation of the marrow</td>
</tr>
</tbody>
</table>

**Bone Healing Factors**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals</td>
<td>Calcium, Phosphate</td>
</tr>
</tbody>
</table>
**Normal Calcium and Phosphate Metabolism**

- **Parathyroid Hormone (PTH)** increases production of 1,25(OH)₂D₃, which promotes Ca²⁺ reabsorption from the distal tubule of the nephron.
- 1,25(OH)₂D₃ promotes absorption of Ca²⁺ and P from distal tubule.
- PTH decreases production of 1,25(OH)₂D₃, which inhibits Ca²⁺ reabsorption, inhibits P reabsorption.
- PTH is necessary for normal function of bone.

**Regulation of Calcium and Phosphate Metabolism**

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Parathyroid Hormone (PTH)</th>
<th>1,25(OH)₂D₃</th>
<th>Calcitonin</th>
</tr>
</thead>
<tbody>
<tr>
<td>From chief cells of parathyroid glands</td>
<td>From proximal tubule of kidney</td>
<td>From parafollicular cells of thyroid gland</td>
<td></td>
</tr>
<tr>
<td>Elevated PTH</td>
<td>Elevated serum Ca²⁺</td>
<td>Decreased serum P₁</td>
<td></td>
</tr>
<tr>
<td>Decreased serum Ca²⁺</td>
<td>Decreased PTH</td>
<td>Elevated serum Ca²⁺</td>
<td></td>
</tr>
<tr>
<td>Decreased serum P₁</td>
<td>Elevated serum Ca²⁺</td>
<td>Decreased serum P₁</td>
<td></td>
</tr>
</tbody>
</table>

- No direct effect
- Acts indirectly on bone by stimulating production of 1,25(OH)₂D₃ in kidney.
- Strongly stimulates intestinal absorption of Ca²⁺ and P₁.

<table>
<thead>
<tr>
<th>Intestine</th>
<th>Kidney</th>
<th>Bone</th>
<th>Net effect on calcium and phosphate concentrations in extracellular fluid and serum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulates 1,25(OH)₂D₃ in intestinal cells (causes increase of 1,25(OH)₂D₃) which increases renal reabsorption of filtered Ca²⁺promotes parathyroid hormone secretion of P₁</td>
<td>Stimulates osteoclastic resorption of bone</td>
<td>Stimulates recruitment of osteoblasts</td>
<td>?</td>
</tr>
<tr>
<td>Increases osteoclastic resorption of bone</td>
<td>Stimulates osteoclastic resorption of bone</td>
<td></td>
<td>Increases osteoclastic resorption of bone</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

- Increased serum calcium
- Decreased serum phosphate
<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Hormones</strong></td>
<td>Parathyroid hormone (PTH), Vitamin D, Calcitonin (see fig.__)</td>
</tr>
<tr>
<td><strong>Other Hormones</strong></td>
<td></td>
</tr>
<tr>
<td>Estrogen</td>
<td>Inhibits bone resorption</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>Increases bone loss</td>
</tr>
<tr>
<td>Thyroid hormone</td>
<td>Normal levels promote bone formation, increased levels enhance resorption</td>
</tr>
<tr>
<td>Growth hormone</td>
<td>Promotes bone formation</td>
</tr>
</tbody>
</table>

**Metabolic Disorders**

- **Hypercalcemia**: Symptoms: constipation, nausea, abdominal pain, confusion, stupor, coma
  - Increased urine calcium, decreased serum phosphate, “brown tumors” result
  - 1° hyperparathyroidism
  - 2° hyperparathyroidism: Malignancy #1, Multiple Endocrine Neoplasm (MEN) syndromes
- **Hypocalcemia**: Symptoms: hyperreflexia, tetany + Chvostek’s/Trousseau’s sign, papilledema, prolonged QT interval
  - 1° hypoparathyroidism: Hair loss, vitiligo
- **Renal osteodystrophy**: Chronic renal failure, “Rugger jersey” spine
- **Rickets/osteomalacia**: Decreased/failed mineralization, Vitamin D deficiency
- **Osteoporosis**: Decreased bone mass, elderly
- **Scurvy**: Vitamin C deficiency results in defective collagen
- **Osteopetrosis**: Increased bone density due to reduced osteoclast activity
- **Paget’s Disease**: Simultaneous osteoblast osteoclast activity results in dense, but more brittle bones
### Cartilage

**Several types:**

- **Hyaline:** Articular surfaces, physeal plates
- **Fibrocartilage:** Annulus fibrosis, meniscus, pubic symphysis
- **Elastic:** Nose, ears

**Function:** Distribute load over large surface, low friction motion surface

**Components:** Water, collagen type II, proteoglycans, chondrocytes

**Water content:** Decreases with age, increases in osteoarthritis

**Osteoarthritis**

**#1 form of arthritis,** articular cartilage defect/damage.

Primary, "wear and tear"; or secondary, (e.g., posttraumatic.)

Often found in hands and weight-bearing joints, knees #1 site

**Classic radiographic findings:**

1. Osteophytes
2. Subchondral cysts
3. Subchondral sclerosis
4. Joint space narrowing

### Inflammatory Arthritis

**Rheumatoid, SLE, spondyloarthopathy, gout**

**Rheumatoid Arthritis**

Immune disorder targeting the synovium. Chronic synovitis and pannus formation lead to articular surface and joint destruction.

3: 1 women, associated with HLA-DR4, +RF, increased ESR/CRP

Multiple joints affected: MCPs: ulnar deviation, feet: claw toe common

Findings: morning stiffness, nodules, radiographs:

1. Bone erosions (periarticular)
2. Osteopenia
3. Swelling

**Reiter’s Syndrome**

Triad: Urethritis, conjunctivitis, asymmetric arthritis; + HLA-B27

**Gout**

Mono-sodium urate crystals in the joint induce an inflammatory reaction.

Old men, great toe #1 site, elevated uric acid levels often seen

Crystals: negatively birefringent

**Ligaments**

Attach one bone to another

**Ligament bone attachment**

1. Ligament to fibrocartilage
2. Fibrocartilage to calcified fibrocartilage, (most injuries occur here)
3. Calcified fibrocartilage to bone (Sharpey’s fibers)

**Sprain**

Tear of a ligament.

**Grade I**

Stretching of, or minor tear in, ligament; no laxity

**Grade II**

Incomplete tear, laxity is evident (usually swelling)
<table>
<thead>
<tr>
<th>Grade III</th>
<th>Complete tear, increased laxity (swelling/hematoma)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ligament Strength</strong></td>
<td>Relative strength difference between ligament and one predict injury</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>Stronger than physis. Injury will occur at physis first</td>
</tr>
<tr>
<td>Adult</td>
<td>Bone stronger than ligament. Ligament will rupture first</td>
</tr>
<tr>
<td>Geriatrics</td>
<td>Ligament stronger than bone. Bone will fracture first</td>
</tr>
</tbody>
</table>

### Comparison of Osteogenesis and Osteolysis

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteogenesis</td>
<td>New bone production</td>
</tr>
<tr>
<td>Osteolysis</td>
<td>Bone resorption</td>
</tr>
</tbody>
</table>

### Age of onset

- **Pediatrics**: Growth plate dominance
- **Adult**: Bone stronger than ligament
- **Geriatrics**: Ligament stronger than bone

### Pathology

- **Pediatrics**: Stressed by distal growth plate, more affected by females, increasing ligament flexibility
- **Adult**: Stressed by ligament, often at corner of joint, ligament becomes taut, microfractures appear
- **Geriatrics**: Stressed by ligament, microfractures appear

### Signs

- **Pediatrics**: Limb deformity, knee pain, increased laxity
- **Adult**: Knee pain, instability
- **Geriatrics**: Knee pain, instability

### Echocardiography

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteogenesis</td>
<td>Normal</td>
</tr>
<tr>
<td>Osteolysis</td>
<td>Signal-to-noise ratio</td>
</tr>
</tbody>
</table>

### Laboratory findings

<table>
<thead>
<tr>
<th>Test</th>
<th>Pediatric</th>
<th>Adult</th>
<th>Geriatric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Ca++</td>
<td>Normal</td>
<td>Low to normal</td>
<td>Low to normal</td>
</tr>
<tr>
<td>ALP</td>
<td>Normal</td>
<td>High in normal</td>
<td>High in normal</td>
</tr>
<tr>
<td>Calcium</td>
<td>Normal</td>
<td>Low to normal</td>
<td>Low to normal</td>
</tr>
<tr>
<td>Bone scintigraphy</td>
<td>Normal</td>
<td>Low to normal</td>
<td>Low to normal</td>
</tr>
</tbody>
</table>

*Copyright © 2008 Elsevier Inc. All rights reserved. - www.mdconsult.com*
## NERVES

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cellular Anatomy</strong></td>
<td></td>
</tr>
<tr>
<td>Neuron</td>
<td>Cell body. Dendrites receive signal, axon conveys signal</td>
</tr>
<tr>
<td>Glial cells</td>
<td>Schwann cells produce myelin to cover the axon</td>
</tr>
<tr>
<td><strong>Microanatomy</strong></td>
<td></td>
</tr>
<tr>
<td>Afferent fibers (axon)</td>
<td>Transmits sensory signals from peripheral nerve endings to the CNS Cell bodies are in the dorsal root ganglion (DRG)</td>
</tr>
<tr>
<td>Efferent fibers (axon)</td>
<td>Transmits motor signals from CNS via ventral horn/ventral root to peripheral muscles.</td>
</tr>
<tr>
<td>Endoneurium</td>
<td>Surrounds each individual fiber (axon)</td>
</tr>
<tr>
<td>Fascicles</td>
<td>Group of endoneurium coated fibers</td>
</tr>
<tr>
<td>Perineurium</td>
<td>Surrounds each fascicle</td>
</tr>
<tr>
<td>Peripheral nerve</td>
<td>Groups of fascicles, blood vessels, and connective tissue</td>
</tr>
<tr>
<td>Epineurium</td>
<td>Surrounds the groups of fascicles (nerves)</td>
</tr>
<tr>
<td><strong>Nerve Injuries</strong></td>
<td>Based on microanatomy</td>
</tr>
<tr>
<td>Neuropraxia</td>
<td>Conduction disruption, axon intact; resolves in days to weeks</td>
</tr>
<tr>
<td>Axonotmesis</td>
<td>Axon disrupted, endoneurium intact allows axon regeneration; recovery is slow, growth 1mm/day, but usually full</td>
</tr>
<tr>
<td>Neurotmesis</td>
<td>Nerve transection, recovery requires surgical repair</td>
</tr>
<tr>
<td><strong>Poliomyelitis</strong></td>
<td>Viral destruction of ventral horn (motor) cells resulting in weakness/paralysis, but normal sensation. Vaccine for prevention.</td>
</tr>
<tr>
<td><strong>Nerve Conduction</strong></td>
<td>Facilitated by myelin coating on axon (larger/coated fibers are faster)</td>
</tr>
<tr>
<td>Resting potential</td>
<td>Maintained by a polar difference between intra/extracellular environments</td>
</tr>
<tr>
<td>Action potential</td>
<td>Change in permeability of Na+ ions depolarizes cell.</td>
</tr>
<tr>
<td>Nodes of Ranvier</td>
<td>Gaps between Schwann cells that facilitate conduction</td>
</tr>
<tr>
<td><strong>Nerve Conduction Studies (NCS)</strong></td>
<td>Stimuli is given and followed by surface electrodes. Latency (delay) and amplitude (strength of signal) are measured.</td>
</tr>
<tr>
<td>Conduction velocities, 50m/s are abnormal</td>
<td></td>
</tr>
<tr>
<td><strong>Guillain-Barré Syndrome</strong></td>
<td>Ascending motor weakness/paralysis. Caused by demyelination of peripheral nerves following viral illness. Most self-limiting.</td>
</tr>
<tr>
<td><strong>Charcot-Marie-Tooth</strong></td>
<td>Autosomal dominant disorder. Demyelinating disorder affecting motorsensory nerves. Onset 5-15yrs, peroneal muscles first, then hand foot intrinsics. Can result in cavus foot, claw toe, intrinsic minus hand.</td>
</tr>
<tr>
<td><strong>Neuromuscular junction</strong></td>
<td>Axon of motor neuron synapses with the muscle (motor end plate)</td>
</tr>
<tr>
<td><strong>Neurotransmitter</strong></td>
<td>Acetylcholine stored in axon crosses synaptic cleft and binds to receptors on sarcoplasmic reticulum and depolarizes</td>
</tr>
<tr>
<td><strong>Pharmacologic agents</strong></td>
<td>Nondepolarizing agents (e.g., vecuronium) competently bind Ach receptor</td>
</tr>
<tr>
<td><strong>Toxins/nerve gas</strong></td>
<td>Depolarizing agents (e.g. succinylcholine) bind short term to Ach receptor</td>
</tr>
<tr>
<td><strong>Myasthenia gravis</strong></td>
<td>Toxins/nerve gas: also bind these receptors competitively; treat with anticholinesterase agents (increase Ach levels in cleft)</td>
</tr>
<tr>
<td><strong>Motor Unit</strong></td>
<td>All the muscles innervated by a single motor neuron</td>
</tr>
</tbody>
</table>
Physiology of Neuromuscular Junction

Acetylcholine (ACH) formed at nerve terminal is hydrolyzed by Choline acetyltransferase.

ACh binds to receptors of postsynaptic membrane at apex of terminal folds, causing channels to open for inward flow of K+ and outward flow of Na+, which results in depolarization and initiation of action potential.

ACh is hydrolyzed by acetylcholinesterase (AChE) promptly, thereby terminating its activity.

Cholinergic receptors serve terminal to be recycled.
### MUSCLES (SKELETAL)

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Muscle</td>
<td>Smooth, cardiac, skeletal</td>
</tr>
<tr>
<td>Skeletal</td>
<td>Voluntary control, have an origin and insertion</td>
</tr>
<tr>
<td>Anatomy</td>
<td>Muscles cells have two types of contractile filaments: actin, myosin</td>
</tr>
<tr>
<td>Muscle</td>
<td>Comprised of multiple bundles or fascicles; surrounded by epimysium</td>
</tr>
<tr>
<td>Bundle/Fascicle</td>
<td>Comprised of multiple muscle fibers (cells); surrounded by perimysium</td>
</tr>
<tr>
<td>Fiber (cell)</td>
<td>Comprised of multiple myofibril; surrounded by endomysium</td>
</tr>
<tr>
<td>Myofibril</td>
<td>Comprised of multiple sarcomeres, end to end; no surrounding tissue</td>
</tr>
<tr>
<td>Sarcomere</td>
<td>Comprised of interdigitated thick and thin filaments; organized into bands. Z line to Z line defines the sarcomere. A band: length of thick filaments, does not change with contraction. I band, H zone, and sarcomere length all shorten with contraction</td>
</tr>
<tr>
<td>Myosin</td>
<td>Thick filament: have “heads” that bind ATP and attach to thin filaments</td>
</tr>
<tr>
<td>Actin</td>
<td>Thin filaments: fixed to Z bands; associated with troponin and tropomyosin</td>
</tr>
<tr>
<td>Troponin</td>
<td>Associated with actin and tropomyosin, binds Ca++ ions</td>
</tr>
<tr>
<td>Tropomyosin</td>
<td>Long molecule, lies in helical groove of actin and blocks myosin binding</td>
</tr>
</tbody>
</table>

#### Contraction
- Initiated when Acetylcholine binds to receptors on sarcoplasmic reticulum and depolarizes them.
- Depolarization causes a release of Ca++ which then binds to troponin molecules. This binding causes the tropomyosin to move and the “charged” head (ATP bound) of myosin can bind to actin.
- Breakdown of ATP causes contraction of filaments, (shortening of sarcomere), and the release of the myosin from the actin filament.

#### Electromyography (EMG)
- Intramuscular electrodes used to evaluate muscle function.
- Increased frequency, decreased duration, decreased amplitude indicate myopathy; opposite findings indicative of neuropathy.

#### Types of Contraction
- **Isometric**: Muscle fires against increasing resistance, muscle length is constant
- **Isotonic**: Resistance is constant through contraction
- **Isokinetic**: Muscle contracts at a constant speed
- **Eccentric**: Muscle lengthens when it fires; can cause injury
- **Concentric**: Muscle shortens when it fires

#### Strength
- Related to cross sectional area of muscle

#### Duchene Muscular Dystrophy
- X-linked recessive disorder affecting boys. Progressive, noninflammatory process affecting proximal muscles (increased CPK). Birth and development to age 3-5 usually normal, then weakness, clumsy walking, + Gower's sign (uses hands to rise from floor) and calf pseudohypertrophy. Most wheelchair bound by 15. Multiple associated deformities, contractures, scoliosis, etc.
**STRUCTURE** | **COMMENT**
--- | ---
Compartments | Muscles are located within confined fibroosseous/fascial spaces
Compartment Syndrome | Multiple causes of increased compartment pressures. Increased pressures and decreased perfusion resulting in myonecrosis.
 | 5 P's: Pain, parathesias, paralysis, pallor, pulselessness (not all needed for diagnosis). Firm tense compartments on exam. Fasciotomy within 6 hours needed. Contracture can result.
Musculotendinous | Weakest portion of muscular attachment to bone (injuries occur here)
Junction | Muscle strain is a partial tear of this unit
Tendon Anatomy | Attaches muscles to bones
Fibril | Type I collagen grouped into microfibrils, then subfibrils, then fibrils, surrounded by endotenon
Fascicle | Fibroblasts and fibrils surrounded by peritenon
Tendon | Groups of fascicles surrounded by epitenon
Vascular Tendon | Vascular paratenon surrounds tendon to supply vascularity; no sheath
Avascular Tendon | These tendons are in a sheath, have a vincula to supply vascularity
Tendon bone Junction | 1. Tendon to fibrocartilage
2. Fibrocartilage to calcified fibrocartilage (Sharpey's fibers)
3. Sharpey's fibers to bone.
Osteomyelitis
Bacterial infection of bone or bone marrow. *Staph. aureus* #1 organism.

**COMMENT**

Hematogenous spread most common. Classified as acute, subacute, or chronic.

Pain, swelling, increased WBC, ESR, positive blood cultures. XR shows radiolucencies, +/-sequestrum (dead cortical bone), involucrum (periosteal new bone). Bone scan helps diagnosis. 1D abscess/sequestra, IV antibiotics followed by a course of oral antibiotics

Septic Joint
Infection of joint space (and synovium). *Staph. aureus* #1 organism.

Hematogenous or extension of osteomyelitis common routes. Knee #1, hip #2 most common sites. Painful, warm swollen joint.

Requires aspiration/surgical drainage IV antibiotics.

Tetanus
Neuroparalytic disorder caused from exotoxin from *Clostridium tetani*

Vaccine prophylaxis: Tetanus and diphtheria toxoid (Td); Tetanus immunoglobulin (TIG)

Previously vaccinated (5yrs), clean wound: no treatment
Previously vaccinated (5yrs), clean or dirty wound: 0.5mg Td
Unknown vaccination status or "dirty" wound: Td and TIG
### IMAGING

<table>
<thead>
<tr>
<th>STUDY</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray (plain film)</td>
<td>Standard study, multiple views needed, shows bones well, but soft tissues poorly. The joint above and below a fracture should always receive plain films.</td>
</tr>
<tr>
<td>CT</td>
<td>Best study for bony anatomy. Soft tissue seen, but not as well as MRI. Often used for comminuted fractures and preoperative planning.</td>
</tr>
<tr>
<td>MRI</td>
<td>Best study for soft tissues including intervertebral discs, ligaments, tendons. Also highly sensitive for osteonecrosis; T1 images weighted for fat (good for normal anatomy), T2 images weighted for water (better for pathology). Also used for preoperative planning.</td>
</tr>
<tr>
<td>Bone scan</td>
<td>Radioactive isotope injected into blood. Imaging of the whole body allows visualization of areas of increased uptake. Good for identifying tumor, fractures, infections, and heterotopic bone activity (HO).</td>
</tr>
<tr>
<td>Arthrography</td>
<td>Contrast injected into joint followed by plain films to evaluate capsular integrity (e.g. used for rotator cuff tears)</td>
</tr>
<tr>
<td>Myelography</td>
<td>Contrast injected into epidural space; evaluates disc herniation, cord tumors</td>
</tr>
<tr>
<td>Discography</td>
<td>Contrast injected into nucleus pulposus to evaluate disc degeneration. Not a common procedure.</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>Good for evaluating rotator cuff pathology</td>
</tr>
</tbody>
</table>
ABBREVIATIONS USED IN THIS BOOK

A

Abd    abduct

AC     acromioclavicular

ACL    anterior cruciate ligament

ADM    abductor digitiminimi

AGRAM  arthrogram

AIIS   anterior inferior iliac spine

AIN    anterior interosseus nerve

ALL    anterior longitudinal ligament

AMBRI  atraumatic, multidirectional, bilateral instability

ANA    antinuclear antibody

Ant.   anterior

AP     anteroposterior

APB    abductor pollicis brevis

APC    anterior-posterior compression

APL    abductor pollicis longus

ASIS   anterior superior iliac spine

AVN    avascular necrosis

B

BR     brachioradialis

C

Ca++   ion calcium

CBC    complete blood cell count
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHL</td>
<td>extensor hallucis longus</td>
</tr>
<tr>
<td>EIP</td>
<td>extensor indicis proprius</td>
</tr>
<tr>
<td>EMG</td>
<td>electromyogram</td>
</tr>
<tr>
<td>EPB</td>
<td>extensor pollicis brevis</td>
</tr>
<tr>
<td>EPL</td>
<td>extensor pollicis longus</td>
</tr>
<tr>
<td>ER</td>
<td>external rotation</td>
</tr>
<tr>
<td>ESR</td>
<td>erythrocyte sedimentation rate</td>
</tr>
<tr>
<td>F</td>
<td>flexor</td>
</tr>
<tr>
<td>FCR</td>
<td>flexor carpi radialis</td>
</tr>
<tr>
<td>FCU</td>
<td>flexor carpi ulnaris</td>
</tr>
<tr>
<td>FDB</td>
<td>flexor digitorum brevis</td>
</tr>
<tr>
<td>FDL</td>
<td>flexor digitorum longus</td>
</tr>
<tr>
<td>FDMB</td>
<td>flexor digiti minimi brevis</td>
</tr>
<tr>
<td>FDP</td>
<td>flexor digitorum profundus</td>
</tr>
<tr>
<td>FDS</td>
<td>flexor digitorum superficialis</td>
</tr>
<tr>
<td>FHB</td>
<td>flexor hallucis brevis</td>
</tr>
<tr>
<td>FHL</td>
<td>flexor hallucis longus</td>
</tr>
<tr>
<td>FPB</td>
<td>flexor pollicis brevis</td>
</tr>
<tr>
<td>FPL</td>
<td>flexor pollicis longus</td>
</tr>
<tr>
<td>Fx</td>
<td>fracture</td>
</tr>
<tr>
<td>G</td>
<td></td>
</tr>
<tr>
<td>GAG</td>
<td>glycosaminoglycans</td>
</tr>
<tr>
<td>GI</td>
<td>gastrointestinal</td>
</tr>
<tr>
<td>GU</td>
<td>genitourinary</td>
</tr>
</tbody>
</table>
MCL  medial collateral ligament
MCP  metacarpophalangeal
MDI  multidirectional instability
Med.  medial
MF  middle finger
MRI  magnetic resonance imaging
MT  metatarsal
MVA  motor vehicle accident
N  nerve
N.  nerve
NCS  nerve conduction study
NSAID  non-steroidal anti-inflammatory drug
OA  osteoarthritis
OP  opponens pollicis muscle
ORIF  open reduction, internal fixation
PAD  palmar adduct
PCL  posterior cruciate ligament
PCP  percutaneous pinning
PE  physical examination
PFCN  posterior femoral cutaneous nerve
PFS  patellofemoral syndrome
PIN  posterior interosseus nerve