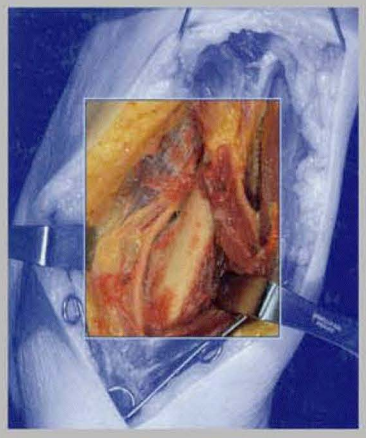
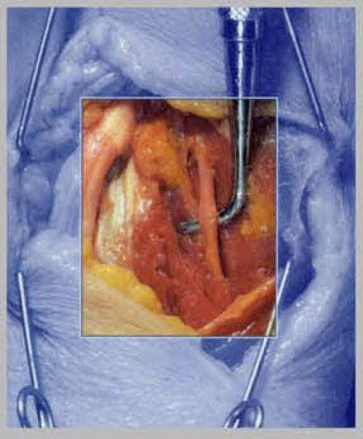
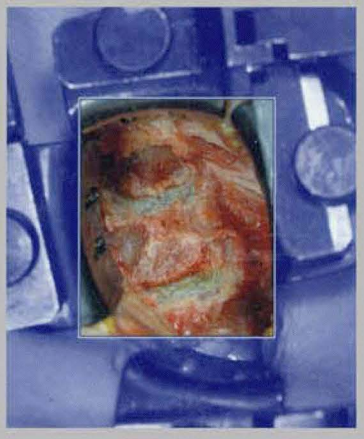
Atlas of Orthopaedic Surgical Exposures



Christopher Jordan
Edwin Mirzabeigi

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Atlas of Orthopaedic Surgical Exposures

Christopher Jordan, M.D.
Director of the Surgical Anatomy Lab
Rancho Los Amigos National
Rehabilitation Center
Downey, California

Edwin Mirzabeigi, M.D.
Research Associate
NYU-Hospital for Joint Diseases
New York, New York

2000
Thieme
New York • Stuttgart

Thieme New York
333 Seventh Avenue
New York, NY 10001

Executive Editor: Jane Pennington
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Library of Congress Cataloging-in-Publication Data is available from the publisher.

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Printed in Italy
5 4 3 2 1

TNY ISBN 0-86577-776-4
GTV ISBN 3-13-124451-8

This book is dedicated to Jacqueline Perry, M.D. who has been a mentor and a friend, and who stimulated our interest in surgical anatomy. For decades she has helped keep alive the anatomy lab at the Rancho Los Amigos National Rehabilitation Center that allowed residents to practice surgical approaches and procedures before going to the operating room.

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CONTRIBUTORS

Frances Sharpe, M.D.
Staff Orthopaedic Surgeon
Kaiser Permanente Fontana
Los Angeles County/University of Southern California Medical School
Los Angeles, California

Milan Stevanovic, M.D.
Associate Professor of Clinical Orthopaedics
Hand and Microsurgery
Keck School of Medicine
University of Southern California
Los Angeles, California

Michael L. Reyes, M.D.
Resident Physician
Department of Orthopaedic Surgery
Los Angeles County/University of Southern California Medical Center
Los Angeles, California

Larry Khoo, M.D.
Resident Physician
Department of Neurosurgery
Los Angeles County/University of Southern California Medical Center
Los Angeles, California

PREFACE

This book grew out of my frustration as a resident and also my love of surgical anatomy. As a resident, I would frequently go to the library to review the anatomy of a surgical approach prior to a case. I would refresh my memory about the location of all the critical structures and the landmarks I should be looking for during the approach. Then in the operating room, I would find that the anatomy I was actually looking at was not the same as that pictured in the books. Most of the books were simply drawings. The few photographic atlases that were available used embalmed specimens, which had different colors and all were predissected. In reality, once you are deep to the subcutaneous tissue, you generally have a sheet of fascia covering everything so that all those landmarks so clearly depicted in anatomy books are, in fact, not visible until you dissect them out. The whole point of doing a surgical approach, however, is not to dissect them out but to simply go directly to where you want to go. This book is also a photographic atlas but it uses fresh cadaver specimens so that the colors are not distorted. Additionally, there is no attempt to separate out structures. For some of the approaches, therefore, the pictures do not look as pretty as they do in other books, but they are much more realistic and accurately depict what you see. The text describes the landmarks and how to avoid trouble for each approach.

This book then will give you, the reader, an accurate depiction of what you can expect to find as you go through an approach. It should, therefore, better prepare you for your surgery. One of my favorite surgical mottoes is that a good surgeon can get out of trouble but a better surgeon stays out of trouble. A large part of staying out of trouble is knowing where to go and where not to go. Ideally, you would expose the layers of an approach like turning pages of a book with sure and efficient dissection. This book will be an important tool in teaching you how to do that. The difference between a good fast surgeon and a good slow surgeon is knowledge of anatomy. Your interest in surgical anatomy is to be commended. Your feedback on how to improve this book would be appreciated.

Christopher Jordan, M.D.

SECTION
I

SHOULDER

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DELTOPECTORAL APPROACH

USES

This approach can be used for any anterior shoulder surgery, including capsular shift and dislocation procedures, proximal humeral fracture work, shoulder prosthetic replacement, and long head of the biceps tendon repair.

ADVANTAGES

The approach is through an internervous plane between the deltoid and pectoralis major. The incision can be expanded proximally or distally as needed.

DISADVANTAGES

For anterior shoulder surgery, this approach is clearly the best, and it has no significant disadvantages.

STRUCTURES AT RISK

Superiorly, the major structure at risk is the acromial branch of the thoracoacromial artery, which is in the medial aspect of the coracoacromial ligament. Inferiorly, the musculocutaneous nerve comes out and enters the biceps approximately 5 cm distal to the coracoid. This structure is usually not cut, but it can be retracted and damaged with the retraction. The axillary nerve is also at risk. This crosses the inferior aspect of the capsule of the shoulder. A retractor placed below the subscapularis and the capsule puts this nerve in grave danger. The cephalic vein can also be damaged if it is not identified and protected as the deltopectoral groove is being developed.

TECHNIQUE

The incision is in the deltopectoral groove and is usually placed directly over one of the axillary skin folds to provide a more cosmetic incision. If the procedure is a capsular shift procedure, then typically most of the incision will be toward the axilla and hardly noticeable. If a more extensive exposure is needed, the incision can be carried all the way from the clavicle to the deltoid insertion.

When working deep to the subcutaneous tissue, it is important to identify the cephalic vein and the deltopectoral groove. The fascia of these two muscles is conjoined, and so frequently there is a small amount of exploration necessary to find that interval. The clue to finding it is usually an indentation, which is occasionally present, or some fat between the muscles. Another clue is the difference in fiber orientation, with the deltoid being more vertical and the pectoralis major being more horizontal. That difference is usually more apparent distally than proximally.

Once the groove is identified and the cephalic vein is identified, usually it is retracted laterally along with the deltoid. However, it can be retracted medially if it looks like that retraction would require the ligation of fewer tributaries or put less stretch on the vein.

Once the vein is identified and protected, you can use your finger to develop a plane between the two muscles and develop the plane underneath the deltoid for a short distance. When these two muscles are separated, you will see the fascia overlying the biceps and the coracobrachialis. This fascia is split in between the two heads of the biceps, retracting the short head medially and the long head laterally. At that point, the subscapularis will be in view and is identified by its muscular layer and the transverse direction of the fibers. You must also be aware that the musculocutaneous nerve enters the coracobrachialis muscle from its medial side and will exit through it and the short head of the biceps on its way down the arm. Aggressive retraction on the short head of the biceps in a medial direction can damage the nerve, and it is important to remember to look for the nerve and protect it. The musculocutaneous nerve has been known to pierce through the short head of the biceps within 5 cm of the coracoid process. Typically, it is much further distal than that, but you must be on the lookout for a more proximal position of the nerve.

Once the subscapularis is identified, then it needs to be separated from the shoulder capsule. Typically, only the upper three-quarters of the muscle is removed, with the lower one-quarter being left intact to act as protection for the axillary nerve. Also, usually the muscle is cut in an oblique fashion, running from superficial lateral toward medial deep, which gives you better tissue to sew into at the time of closure. The subscapularis muscle is usually adherent to the capsule. You will usually need to separate the muscle off of the capsule, either by sharp dissection or with an elevator.

Once that is done, then the capsule can be opened either transversely, if the goal is simply to shift it superiorly, or in a T-fashion, for an imbrication if the goal is to tighten and imbricate the capsule.

TRICKS

The major trick is to find the deltopectoral groove and take whichever vein seems easiest (typically laterally). The coracoid is the best landmark for the short head of the biceps; split the fascia in that direction, which will get you into the interval between the two heads. Another useful trick is to put a stay-suture in the subscapularis prior to cutting it free from the humeral head so that it does not retract out of the way. Finally, feel the shoulder joint and the glenoid edge prior to doing the capsulotomy, so you can place it correctly for whatever procedure you are attempting to do. This is especially important when attempting to do instability procedures.

HOW TO TELL IF YOU ARE LOST

It is relatively easy to be off a little medially or laterally when looking for the deltopectoral groove. The cephalic vein is the best landmark, so simply spread until you see it. There is no good way to tell if you are lost medially or laterally.

The coracoid is an excellent landmark to prevent your drifting too far medially when splitting the biceps fascia. It is difficult to get lost too far laterally because you can feel the humerus, and because the deltoid muscle gets in the way. It is possible to open the capsule too far laterally, making it difficult to get medial enough to actually see the glenoid. You need to be at least 1 cm medial to the subscapularis insertion into the humeral head to be in the correct place. Superiorly, it is easy to avoid getting lost because of the clavicle and acromioclavicular joint, which limits your upward mobility.

Inferiorly, the blood vessels of the humeral circumflex artery and vein are visible on the inferior border of the subscapularis. You should not be cutting in that area. If you see those fairly obvious blood vessels, stay superior to them.

FIGURE 1–1 The skin incision running from the axilla in the skin crease.

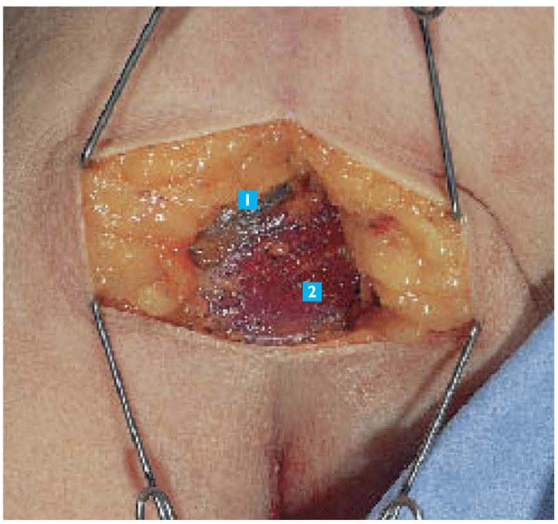

FIGURE 1–2 The subcutaneous tissue with the underlying deltoid or pectoralis major muscle. If you look on the edge of the fat, you will see a hint of the cephalic vein.

1 Cephalic Vein
2 Pectoralis Major
3 Deltoid
4 Fascia Over Biceps
5 Short Head of Biceps
6 Fascia Over Subscapularis
7 Humeral Head
8 Subscapularis and Capsule
9 Humeral Neck
10 Axillary Nerve

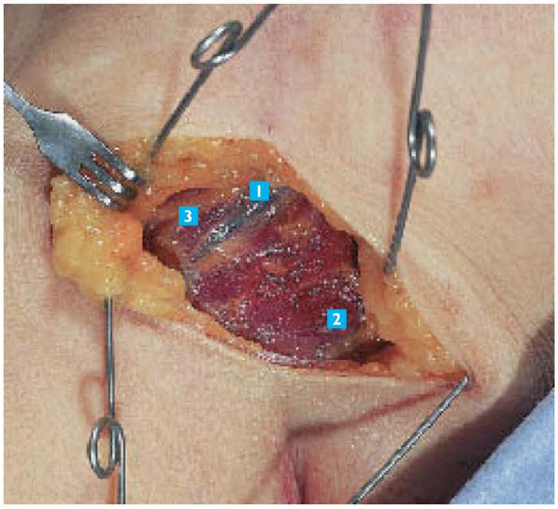

FIGURE 1–3 The cephalic vein.

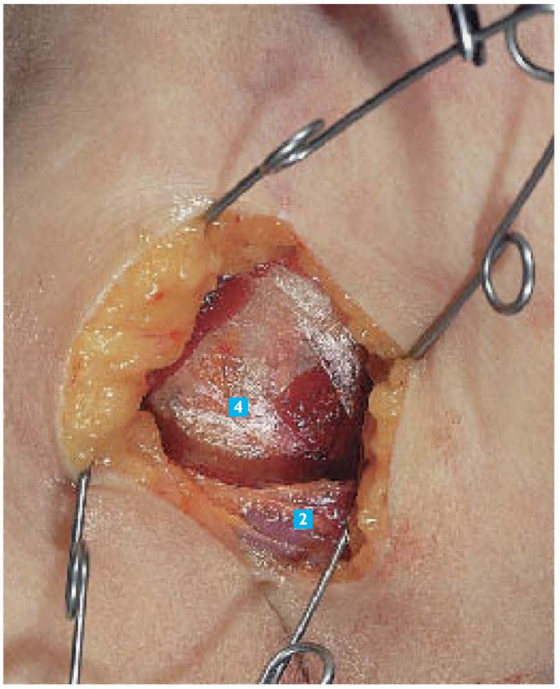

FIGURE 1–4 The cephalic vein retracted, the pectoralis major is medial and the deltoid lateral, exposing the fascia overlying the short head of the biceps.

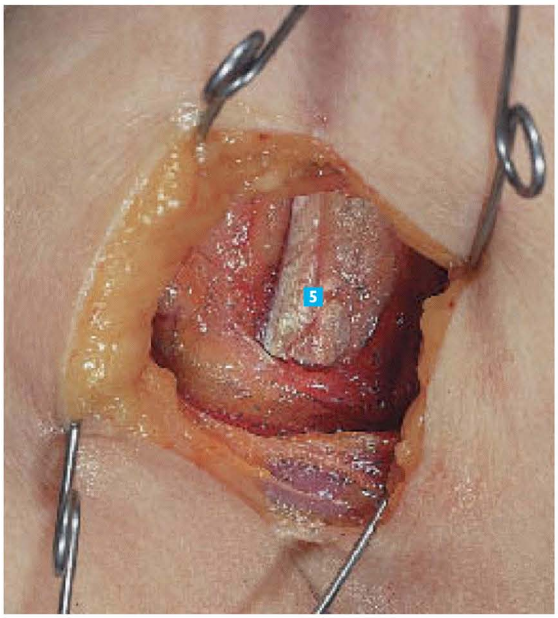

FIGURE 1–5 The fascia split, exposing the short head of the biceps.

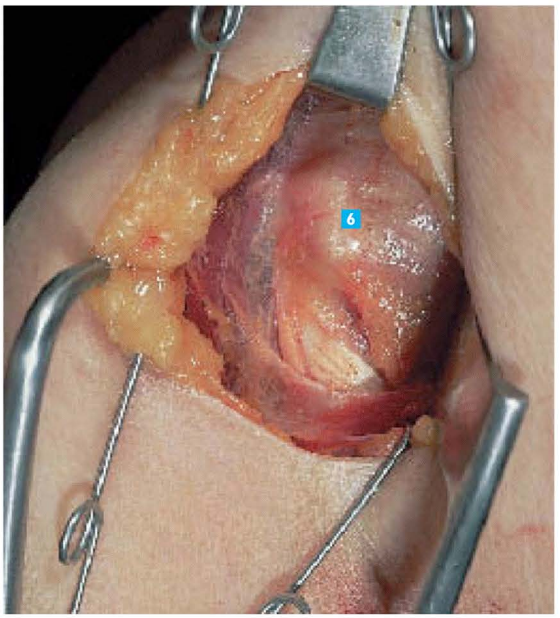

FIGURE 1–6 The biceps retracted with the latissimus dorsi coming up from the bottom and the subscapularis coming across from the top.

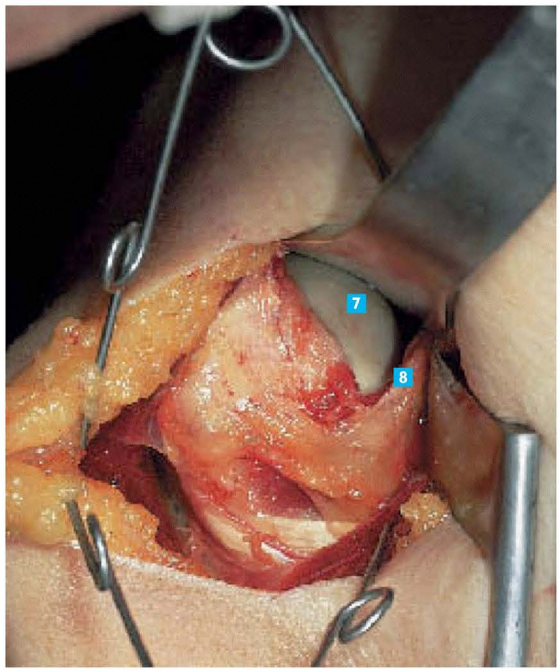

FIGURE 1–7 The capsule open revealing the humeral head and the shoulder joint itself.

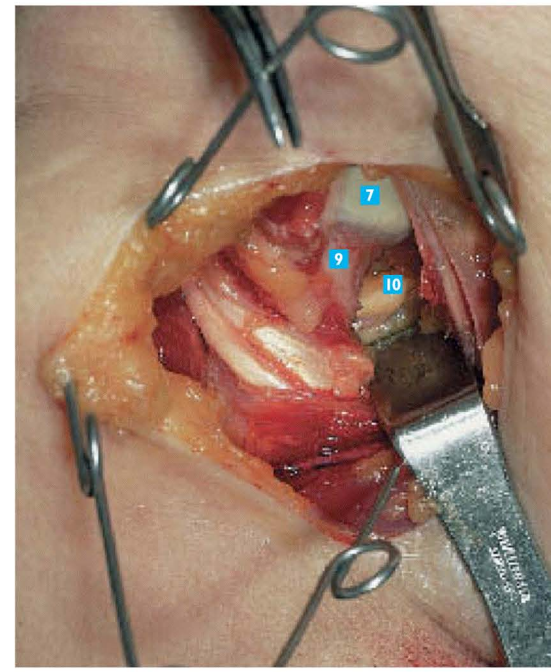

FIGURE 1–8 The subscapularis tendon released in its entirety, with the axillary nerve running on its inferior edge somewhat more posteriorly.

1 Cephalic Vein
2 Pectoralis Major
3 Deltoid
4 Fascia Over Biceps
5 Short Head of Biceps
6 Fascia Over Subscapularis
7 Humeral Head
8 Subscapularis and Capsule
9 Humeral Neck
10 Axillary Nerve

Posterior Approach

USES

This approach is used primarily for posterior capsular shift procedures. It would also be useful for scapular neck osteotomies and posterior dislocations, as well as for open reductions and internal fixations of the glenoid.

ADVANTAGES

For posterior dislocators, this is the only suitable approach.

DISADVANTAGES

This approach is made more difficult by the size of the muscles overlying the bone and shoulder capsule. Also, the neurovascular structures at the inferior aspect of the incision must be protected.

STRUCTURES AT RISK

The major structure at risk is the neurovascular bundle coming through the quadrilateral space. This should be well inferior to the intended approach. If you are too far superomedial, the suprascapular nerve to the infraspinatus, which wraps around the base of the spine of the scapula, could be damaged.

TECHNIQUE

The incision usually starts 1 cm superior and 1.0 to 1.5 cm medial to the posterolateral corner of the acromion. This bony prominence is palpable even in heavy or well-muscled patients. It is useful to place a needle into the shoulder joint to help guide the medial or lateral placement of the incision. The incision goes through the subcutaneous tissue down to the deltoid muscle. In some patients the deltoid can be retracted in its entirety anteriorly. In most patients, the incision ends up splitting the fibers of the deltoid in line with the fibers. It is important when doing so to be aware that there may be branches of the axillary nerve coming back toward this posterior corner of the deltoid, which should be avoided. Once you are deep to the deltoid, you will see the fibers of the infraspinatus. It is easy to tell them apart because the orientation of the fibers is at 90 degrees to those of the deltoid.

At that point, the shoulder joint is usually palpable. The infraspinatus can either be taken off of the area of its insertions, similar to what is done to the subscapularis when approaching the shoulder from the anterior, or it can be split in line with its fibers, which is less destructive. It is very important to stay superior to the teres minor. It is often difficult to find the interval between the infraspinatus and the teres minor. The lower border of the teres, however, is usually visible. Stay 1.5 cm to 2.0 cm proximal to that. Deep to the infraspinatus, you will encounter the shoulder capsule. The posterior capsule is much thinner than the anterior capsule in most patients and can be almost paper-thin and translucent. The capsule is then opened to enter the shoulder joint itself.

Both Campbell and Hoppenfeld describe an approach with an incision along the scapular spine. That approach requires taking the deltoid off the scapula. The approach described here is also described by Tibone (*The Shoulder*, Lippincott-Raven, 1997) and is less destructive.

TRICKS

The major trick for proper placement of the incision, if the goal is to do a posterior capsular shift, is to place a needle into the shoulder joint like you would do for shoulder arthroscopy. This will then identify where the incision needs to be from the medial or lateral standpoint. The other trick is to identify the infraspinatus by its fiber orientation. Finally, beware of fat at the inferior portion of the teres minor because that will usually indicate the area of the neurovascular bundle.

HOW TO TELL IF YOU ARE LOST

Because of the thickness of the overlying musculature and the depth of the bones, it is relatively easy to drift too far in one direction or another with this approach, which would require extending the approach to give you access back to where you want to be.

The main way to tell if you are lost is to palpate deep to the deltoid. The shoulder is usually palpable through the infraspinatus. The infraspinatus is then split in line with its fibers. If you are too superior or inferior, again you can adjust the area through which the fibers are split. There is no significant interval between the infraspinatus and the teres minor.

If you are lost superiorly, you will simply run into the acromion, which will be easily palpable and will be in your way, making it obvious that you are too superior. If you are lost inferiorly, you will see the fat in the quadrilateral space. Be very careful if you see this fat.

FIGURE 2–1 The skin incision.

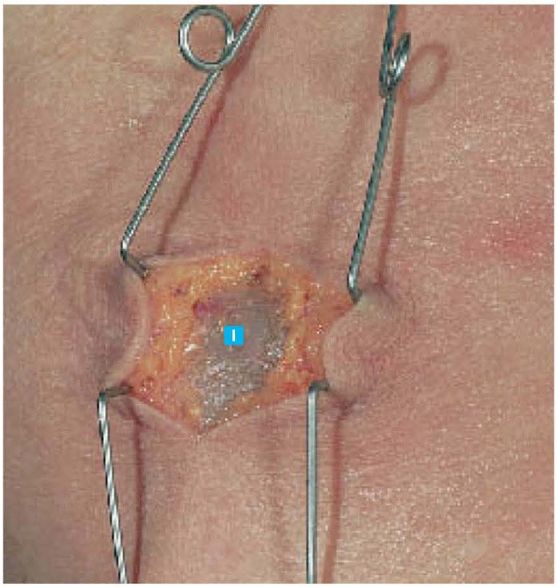

FIGURE 2–2 The deltoid muscle and the fascia underlying the subcutaneous fat.

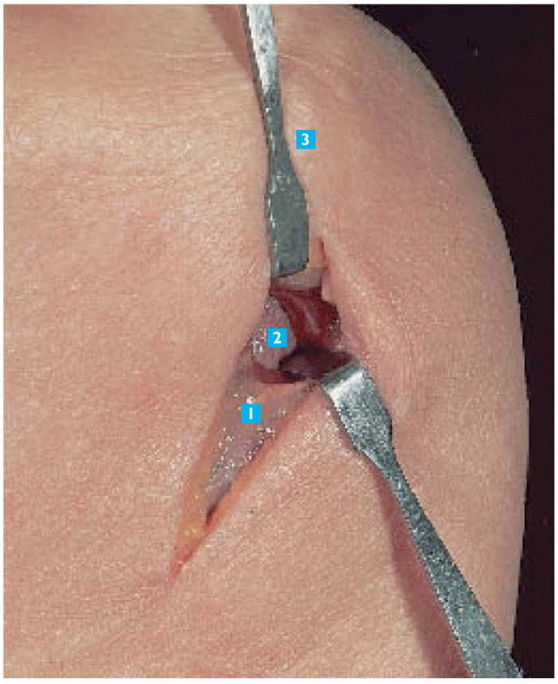

FIGURE 2–3 The deltoid muscle split.

1 Fascia Over Deltoid
2 Infraspinatus
3 Posterior Lateral Acromion Border
4 Deltoid
5 Capsule
6 Humeral Head

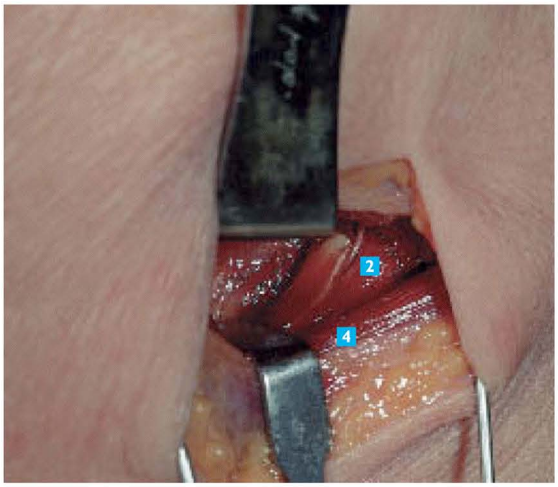

FIGURE 2–4 A close-up of the infraspinatus fibers.

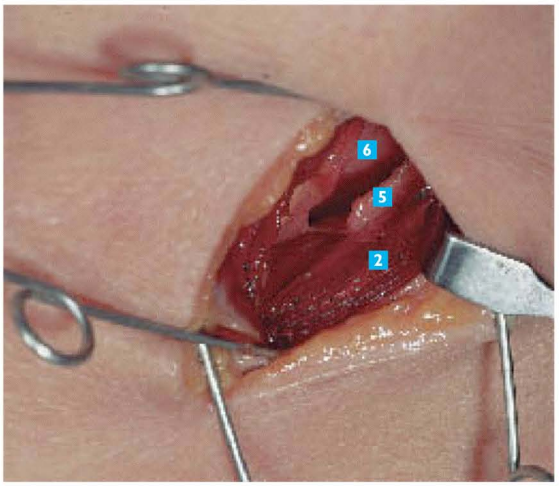

FIGURE 2–5 The capsule opened and the humeral head in the depth of the incision.

DELTOID SPLITTING APPROACH

USES

This approach is used for anterior acromioplasties if they are done open. It is usually used for rotator cuff repairs and for fractures of the humerus where a rod(s) will be started proximally in the region of the greater tuberosity. Hoppenfeld calls this the lateral approach.

ADVANTAGES

This approach is easy, as it comes directly down on the pathology and can also be extended anteriorly and posteriorly by taking the deltoid off of the acromion subperiosteally.

DISADVANTAGES

This approach is limited inferiorly by the axillary nerve, which usually crosses below, 5 cm distal to the acromion. If the axillary nerve is cut, the entire anterior deltoid will be denervated and shoulder flexion will be markedly impaired. The nerve has been seen as high as within 4 cm of the acromion.

STRUCTURES AT RISK

The only significant structure at risk is the axillary nerve, but it is not a problem as long as distal splitting of the deltoid is limited to the safe zone.

TECHNIQUE

The incision usually starts 1 cm proximal, that is, superior, to the lateral edge of the acromion, crosses the edge of the acromion, and proceeds distally. A so-called saber incision can be made from anterior to posterior, 1 cm distal to the edge of the acromion. Once deep to the skin, the approach is the same. The incision should not go beyond 5 cm distal to the lateral edge of the acromion. Splitting the deltoid more distally than that puts the axillary nerve at risk. The subcutaneous tissue is split. The fascia overlying the deltoid is split and its fibers are separated. The bursa is then encountered, which can be split or resected. This brings you down on the rotator cuff tendons. For greater exposure, you can subperiosteally take the deltoid off anteriorly or posteriorly.

TRICKS

Subperiosteal stripping of the deltoid allows this approach to be extended anteriorly or posteriorly and provides greater exposure. Distal splitting of the deltoid down to the axillary nerve also provides greater exposure. Any distal splitting beyond 4 cm should be done with the use of a nerve stimulator guiding the dissection, so that the axillary nerve going to the anterior deltoid is not inadvertently transected.

Repair of the deltoid is critical. It should be done through drill holes in the acromion if it has been stripped off. If it was simply split, it can be closed loosely with absorbable sutures. If an acromioplasty is done, it is important to avoid overthinning the acromion so that it fractures.

HOW TO TELL IF YOU ARE LOST

The main way of getting lost with this approach is being too far anterior or posterior for the pathology you are trying to fix. If the shoulder was arthroscoped prior to the open procedure, a suture can be placed percutaneously into the rotator cuff tear, so you come directly down on the tear. If you are too far superior, you will hit the acromion and that will be obvious.

FIGURE 3–1 The skin incision, which starts 1 cm medial to the edge of the acromion and proceeds distally for approximately 4 cm.

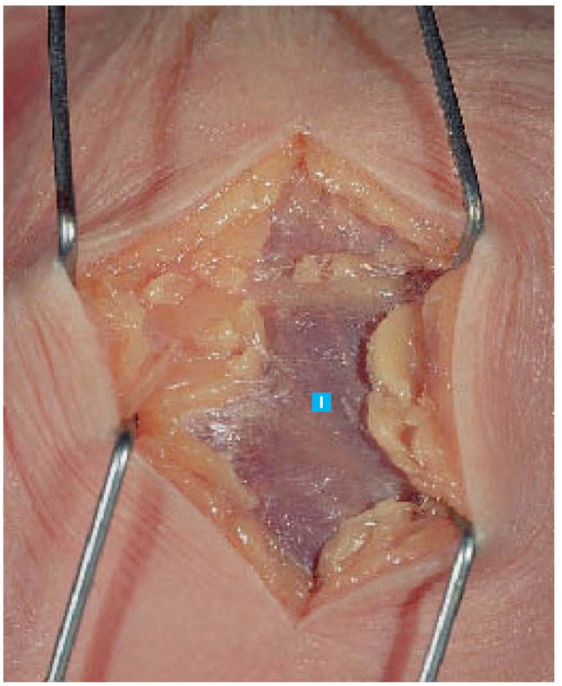

FIGURE 3–2 The subcutaneous tissue split with the deltoid underneath it.

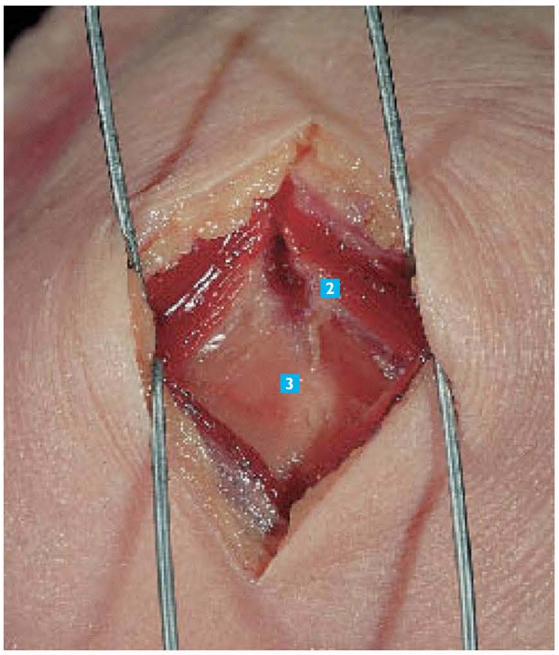

FIGURE 3–3 The deltoid split with the underlying bursa now apparent.

1 Deltoid
2 Deltoid Split
3 Bursa
4 Rotator Cuff Tendon
5 Subcromial Space

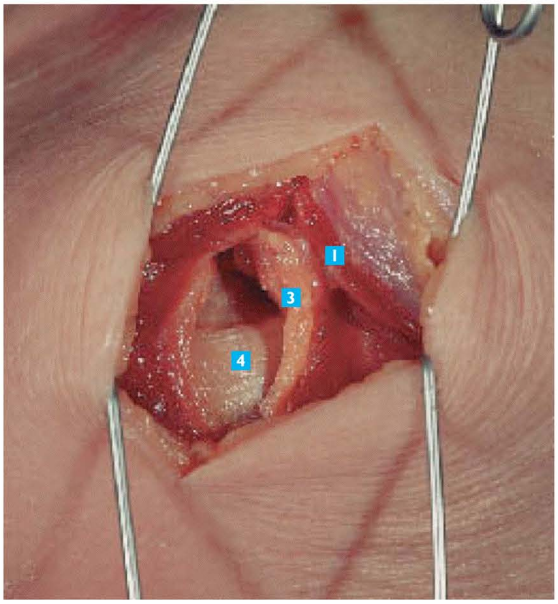

FIGURE 3–4 The bursa split with the rotator cuff visible underneath it.

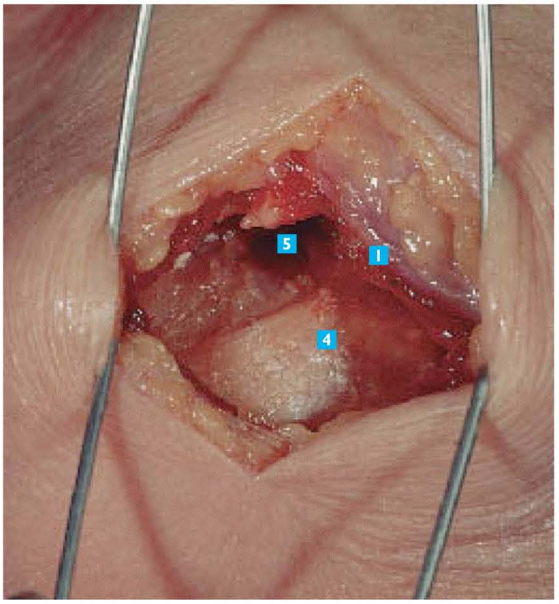

FIGURE 3–5 The view of the subacromial space when the bursa is resected. The rotator cuff is seen in the bottom of the figure.

1 Deltoid
2 Deltoid Split
3 Bursa
4 Rotator Cuff Tendon
5 Subcromial Space

TRANSACROMIAL APPROACH

USES

This approach is used for repair of massive rotator cuff tears that require more exposure than can be obtained with an acromioplasty.

ADVANTAGES

This approach gives an excellent view of the entire supraspinatus muscle and tendon, and of the rest of the rotator cuff as it inserts into the humeral head. It is possible to obtain this wide exposure without stripping the deltoid off of the acromion.

DISADVANTAGES

Because it splits the acromion in two, this approach requires an extra step in the surgery to internally fix the acromion. If the acromion goes on to nonunion, the patient will experience pain with the use of the shoulder.

STRUCTURES AT RISK

The deltoid is split with this approach and if it is split more than 4 cm distally, the axillary nerve is at risk.

If the bone split is too anterior, there is the risk of damage to the clavicle. If it is too posterior, there is the risk of splitting into the spine of the scapula.

TECHNIQUE

The technique is the same as that for the deltoid splitting approach (see Case 3). The incision, however, is carried more medially, usually to the medial aspect of the acromion. This V-shaped space between the posterior aspect of the clavicle and the spine of the scapula is usually easy to palpate. It represents the medial edge of the acromion. The incision is carried down through the subcutaneous tissue. The acromion is palpated. The soft tissues over the acromion are split down to the bone in one layer. A chisel or saw is then used to cut through the acromion. A lamina spreader is used to retract the fragments anteriorly and posteriorly.

Repair of the acromion can be done with small screws if an acromioplasty is not done. If an acromioplasty is done, the anterior acromial piece is usually too thin to hold screws, in which case tension band wires are the most efficient way to solve this problem.

TRICKS

The major trick is to be sure to cut through the acromion in the middle and that this cut does not drift into the lateral clavicle and acromioclavicular joint or posteriorly into the spine of the scapula. This cut is done by feeling the V formed by the posterior border of the clavicle and the anterior border of the spine of the scapula and cutting to the apex of the V.

HOW TO TELL IF YOU ARE LOST

It is practically impossible to get lost with this approach, because the goal of this approach is to split the acromion, which is palpable.

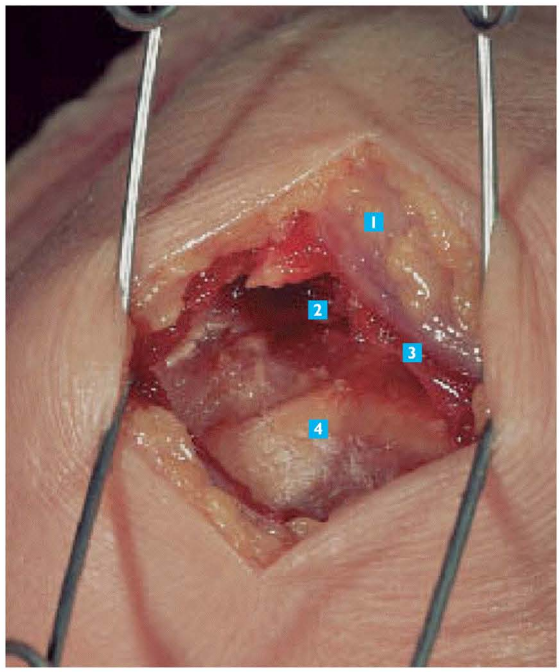

FIGURE 4–1 The deltoid splitting approach, already done. The soft tissues are still overlying the acromion.

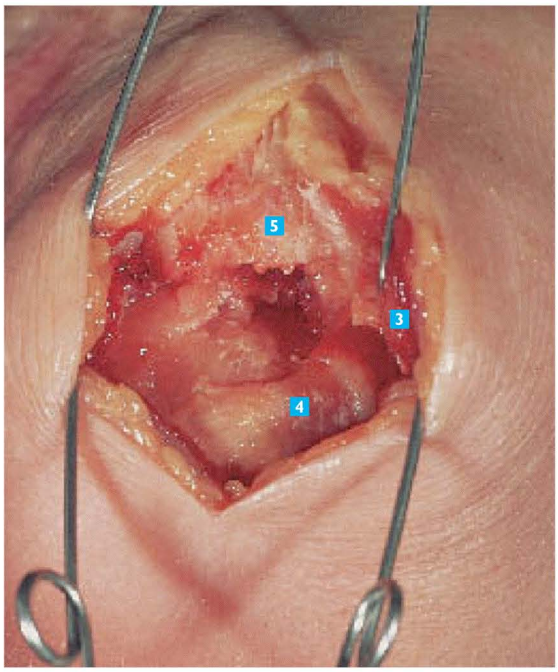

FIGURE 4–2 The soft tissues cleaned off of the acromion.

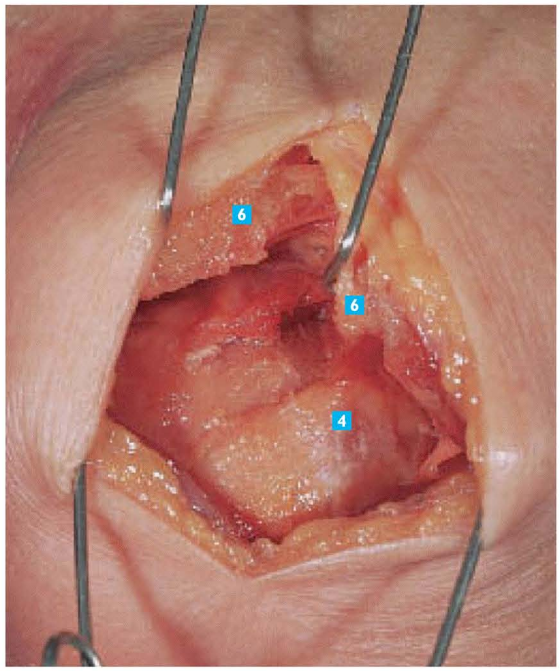

FIGURE 4–3 The acromion split, with the rotator cuff visible.

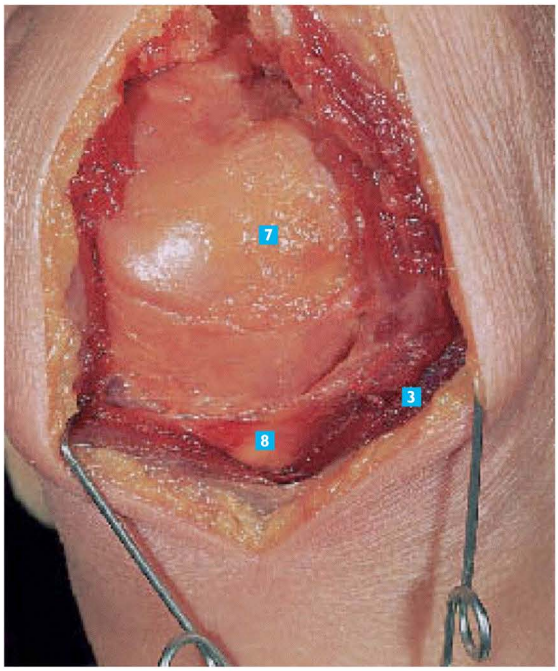

FIGURE 4–4 The fat around the axillary nerve. At this point we are more than 5 cm distal to the acromial edge.

1. Acromion Area
2. Subacromial Space
3. Deltoid
4. Rotator Cuff Tendon
5. Acromion
6. Acromion Split
7. Cuff and Humeral Head
8. Fat Around Axillary Nerve

Superior Approach to the Suprascapular Nerve

USES

This approach is used primarily to release the suprascapular notch in cases of suprascapular nerve entrapment. It also allows exposure of the lateral portion of the trapezius and the supraspinatus muscle belly.

ADVANTAGES

By approaching the nerve from the posterior side, we avoid all the vascular structures anteriorly and the brachial plexus. Also, this approach allows the branch of the nerve to the infraspinatus to be freed simply by taking the posterior deltoid off of the spine of the scapula and coming down onto the region of the nerve.

DISADVANTAGES

For the purposes for which it is intended, this approach does not have disadvantages.

STRUCTURES AT RISK

Posteriorly, there are no significant structures at risk. The trapezius is lifted off of the spine of the scapula subperiosteally to promote the ease of the repair. If the repair of the trapezius is not done carefully, the potential for its avulsion exists.

The suprascapular artery will not uncommonly pass superior to the suprascapular ligament while the nerve goes underneath it. You cannot indiscriminately release the ligaments until you are sure that there is no artery at risk. If there is, be sure to gently retract it out of the way before releasing the ligament.

TECHNIQUE

The incision is made just superior to the scapular spine and typically is 6 or 7 cm in length. You go through the subcutaneous tissue until you encounter the fascia overlying the trapezius muscle. Palpate the spine of the scapula and strip the trapezius muscle along with its periosteum off of the scapula. As you are moving anteriorly through the trapezius, be aware of the orientation of the fibers. When you come to the fibers running medially and laterally, you are looking at the supraspinatus muscle and you want to stay on top of that muscle. Strip as much trapezius as necessary to obtain adequate visualization.

Once the supraspinatus is clearly in view, palpate the base of the coracoid and move slightly medially until you can feel the ligament overlying the suprascapular notch. This ligament is frequently covered with fat. If there is a large amount of fat between the two muscles, then remove it or retract it so you can see the supraspinatus and the suprascapular ligament. Remember that the artery will sometimes pass on top of the ligament, whereas the nerve will be below it.

Once the ligament is identified, it can be transected with a scalpel or, for better control, a Kerrison rongeur can be used.

TRICKS

The major trick to this approach is to identify the interval between the trapezius and the supraspinatus. There is usually fat between these two muscles, and the fiber orientation is different.

The second trick is to feel the base of the coracoid and then go medial to that to feel the suprascapular notch. Finally, be aware of the fact that the artery may cross over the top of the ligament, and take care not to injure it.

HOW TO TELL IF YOU ARE LOST

It is hard to get lost inferiorly with this approach because the incision starts above the spine of the scapula, and the spine is easily palpable.

It is possible to be too far medial or lateral. If your goal is to free up the suprascapular notch, it is important to realize it is approximately 1 cm medial to the coracoid base, so that the approach can be adjusted once you are deep to the trapezius and the coracoid base is then palpable.

It is also possible to be too deep and separate the supraspinatus muscle off of the spine of the scapula and its fossa along with the trapezius. Coming in underneath the supraspinatus muscle does put the suprascapular nerve at risk. It is important, therefore, to clearly identify the plane between the trapezius and the supraspinatus. The fiber orientation is different for the two muscles, and so if you see fibers running straight medial to lateral, you are looking at the supraspinatus, not the trapezius.

FIGURE 5–1 The skin incision superior to the spine of the scapula.

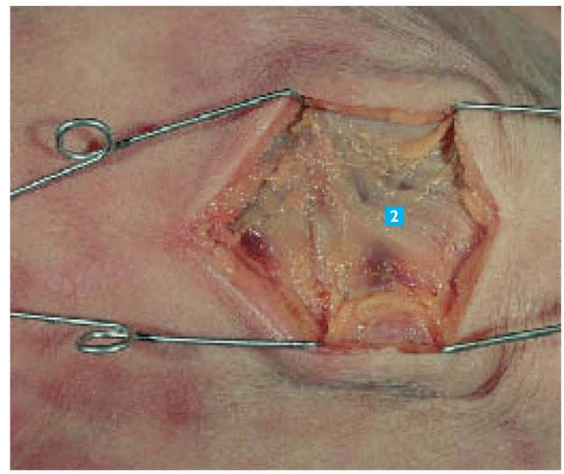

FIGURE 5–2 The trapezius muscle approaching the spine of the scapula.

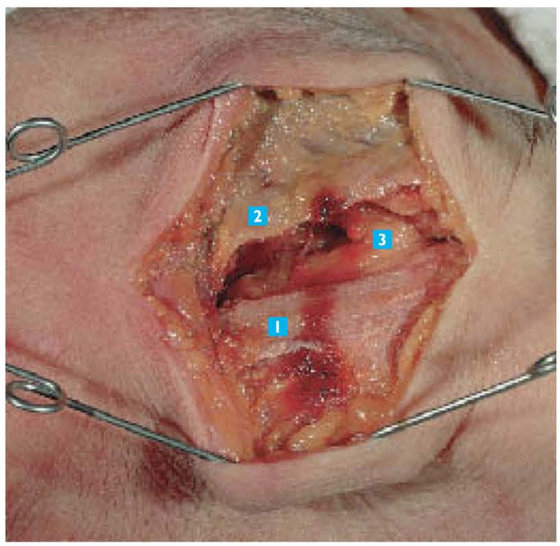

FIGURE 5–3 The spine of the scapula and the trapezius muscle being separated from it. Note that there is a large amount of fat beneath the trapezius, which is usually a good clue to the interval between the trapezius and the supraspinatus.

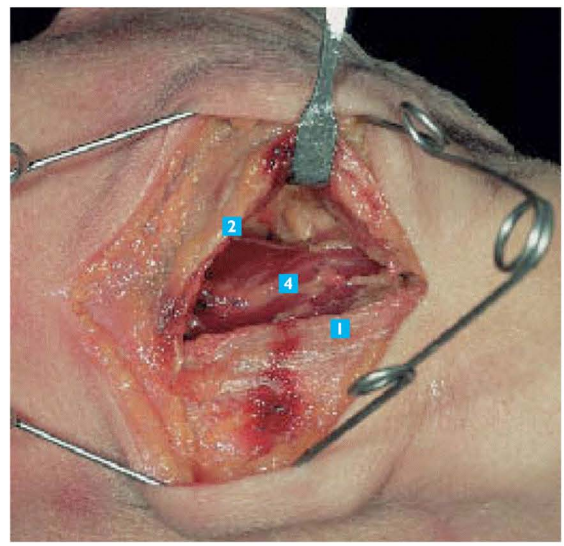

FIGURE 5–4 The fat cleared out of the way. The trapezius is retracted anteriorly. The muscle belly of the supraspinatus is clearly visible.

1 Spine of Scapula
2 Trapezius
3 Fat Above Supraspinatus
4 Supraspinatus
5 Vessel Over Top of Ligament
6 Suprascapular Ligament
7 Suprascapular Nerve in Notch
8 Cut End of Ligament

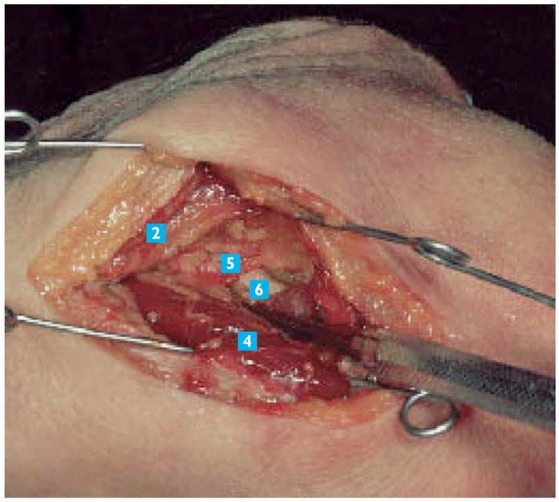

FIGURE 5–5 The supraspinatus being held in a posterior direction. The trapezius is retracted anteriorly. The suprascapular ligament is clearly visualized. Note the artery coming over the top of the ligament.

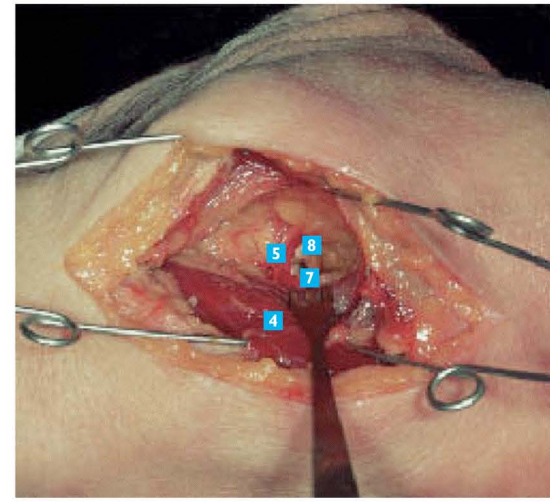

FIGURE 5–6 The view after the ligament has been cut. The suprascapular nerve is clearly visible now that the ligament has been transected.

Acromioclavicular Joint Approach

USES

This approach is used only to access the acromioclavicular joint for lateral clavicle resection or for acromioclavicular joint repair.

ADVANTAGES

The approach comes directly down on the area of interest through an area that has no significant neurovascular structures.

DISADVANTAGES

This is a limited-exposure approach that is difficult to extend in a medial direction, if that is needed.

STRUCTURES AT RISK

There are no significant structures at risk if this approach is done properly. If you are operating too inferior to the joint, the deltoid muscle and its attachment to the clavicle could be damaged.

TECHNIQUE

A 4-cm incision is made starting approximately 1 cm posterior to the acromioclavicular joint and coming anteriorly, paralleling the joint surface and directed toward the coracoid. It is carried through the subcutaneous tissue. The deltoid fibers will be seen approaching the clavicle. At that point, the transverse fibers of the capsule should be visible and the location of the joint can be identified. If the goal of surgery is to resect the lateral clavicle, there is no need for any further anterior dissection. Split the capsule fibers in line with their fibers along the superior clavicle and strip subperiosteally off the lateral clavicle so that it can be resected for a distance of 1 cm. This will create a flap of periosteum attached to the trapezius and another to the deltoid, simplifying closure.

If there is an acromioclavicular joint separation and the goal is to repair that, then the first structure identified will usually be the lateral end of the clavicle because it is protruding superiorly. In this case also the capsule will be torn. For these patients, you need to strip the deltoid off of the anterior clavicle for a distance of approximately 3 cm, which then allows you to see the coracoacromial ligament, which in turn should lead you to the coracoid. In these patients, the coracoclavicular ligaments will be torn, but they would normally be coming off of the superior medial side of the coracoid. If your repair includes some ligature under the coracoid and around the clavicle, then the deltoid needs to be stripped off the clavicle for a distance of 1 or 2 cm medial to the coracoid. The coracoid should be approached directly and you should stay subperiosteal on the coracoid and be very cautious anytime you are on the medial side of the coracoid. This exposure will also allow you to resect the coracoacromial ligament off the acromion if it is going to be used in the repair of the acromioclavicular joint.

TRICKS

The major trick with this approach is feeling the acromioclavicular joint and paralleling the incision over the top of it. It is important to remember that the acromioclavicular joint is not always exactly vertical. It will sometimes angle in a medial or lateral direction, as it goes superiorly. If you do not find the joint with an initial attempted opening of the capsule, you can identify it with a needle. That will tell you where it is located. You would then reflect your capsule in that direction until you can see the joint. If you are approaching the coracoacromial ligament or the coracoclavicular ligament, it is important to reflect the deltoid subperiosteally so that its reattachment is more effective. Once that is reflected, you lift it anteriorly, which will show the underlying ligaments.

HOW TO TELL IF YOU ARE LOST

It is practically impossible to get lost with this approach. If you are too far anterior, you will see the fibers of the deltoid. If you are too far posterior, you will see the fibers of the trapezius coming in from the back. If you are too far lateral, again you will run into the fibers of the deltoid as they approach the lateral acromion. If you are too far medial, you will see the shaft of the clavicle.

Once you are deep to the deltoid muscle, again it is difficult to get lost posteriorly because you will simply run into the clavicle. It is possible to be too far medial or lateral. It is very dangerous to be too far medial because the vascular structures are quite close to the clavicle medial to the coracoid. If you see anything that looks like a blood vessel, you are lost medially. If you are more than 2 cm lateral to the acromioclavicular joint while underneath the deltoid, you are lost laterally. The coracoid is actually medial to the acromioclavicular joint.

FIGURE 6–1 The skin incision, which is an incision paralleling the acromioclavicular joint over the top of the joint. It is typically centered over the joint and is usually 4 or 5 cm in length.

FIGURE 6–2 The subcutaneous fat.

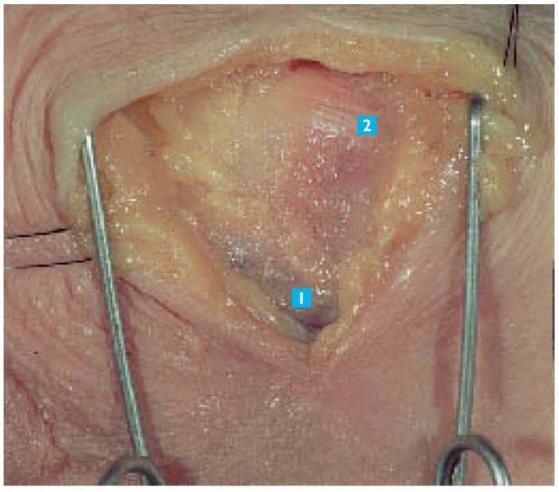

FIGURE 6–3 The transverse fibers of the dorsal capsule of the acromioclavicular joint.

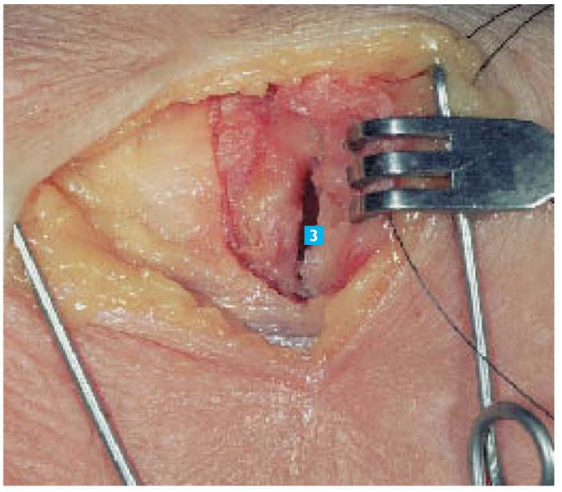

FIGURE 6–4 The capsule open, exposing the acromioclavicular joint.

1 Deltoid
2 Capsule
3 Acromioclavicular Joint
4 Clavicle
5 Acromion
6 Coracoacromial Ligament
7 Coracoid
8 Coracoclavicular Ligament
9 Coracoacromial Ligament from Base of Coracoid (this is an anatomic variant)

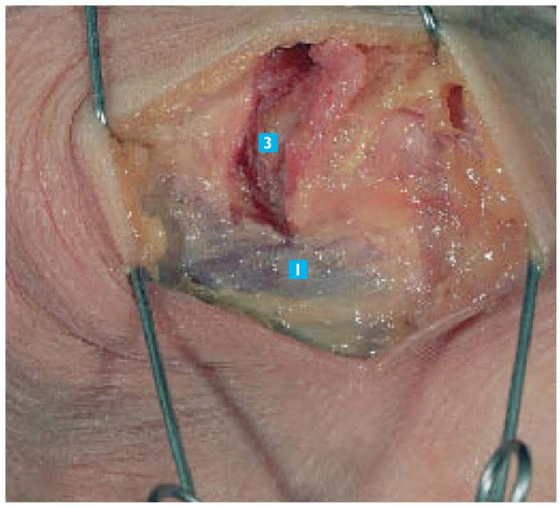

FIGURE 6–5 The anterior extension of this approach, if you were going to go down to the coracoid for a reconstruction of the coracoclavicular ligament. The deltoid is seen attaching to the clavicle.

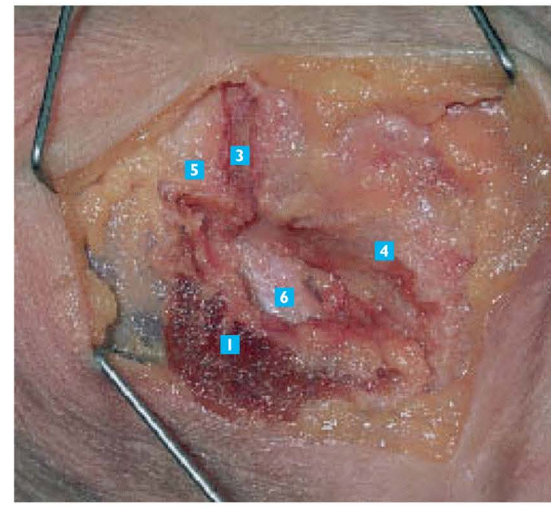

FIGURE 6–6 The coracoacromial ligament running transversely across the approach. The deltoid muscle has been dissected off of the clavicle and is retracted anteriorly.

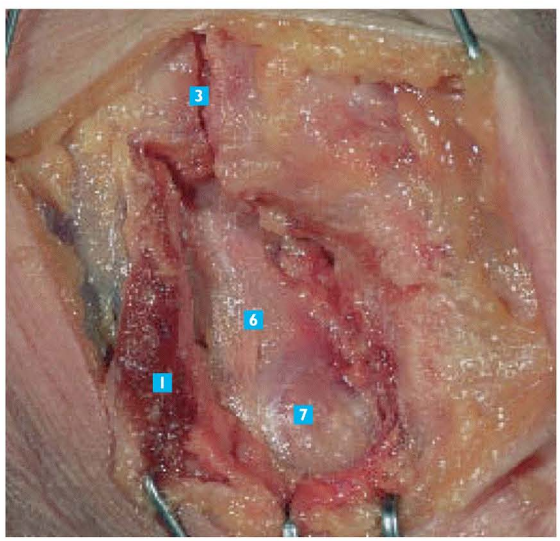

FIGURE 6–7 The coracoid just at the end of the retractor. The acromioclavicular joint is at the top.

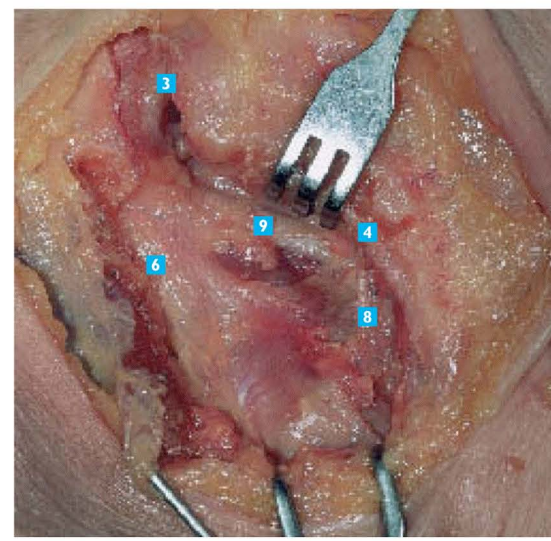

FIGURE 6–8 The coracoacromial ligament running transversely, and the coracoclavicular ligament on the edge of the picture, running up toward the clavicle. The prominence in the picture is the tip of the coracoid process itself.

1. Deltoid
2. Capsule
3. Acromioclavicular Joint
4. Clavicle
5. Acromion
6. Coracoacromial Ligament
7. Coracoid
8. Coracoclavicular Ligament
9. Coracoacromial Ligament from Base of Coracoid (this is an anatomic variant)

SECTION
II

UPPER ARM

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ANTEROMEDIAL APPROACH

USES

This approach is useful exposure of the musculocutaneous nerve, or access to the anterior or medial humerus. It is a distal extension of the deltopectoral groove approach.

ADVANTAGES

This approach allows access to the medial side of the humerus without coming directly over the neurovascular bundle.

DISADVANTAGES

Because the anterior humerus is overlaid by the biceps and brachioradialis, this approach requires either splitting or retracting large muscles.

STRUCTURES AT RISK

The musculocutaneous nerve, which crosses from medial to lateral, innervating the biceps and the brachialis muscle and continuing down as the lateral antebrachial cutaneous nerve of the forearm, can be damaged in the more proximal part of this approach. The musculocutaneous nerve runs along the undersurface of the biceps in the region of the pectoralis major insertion and then innervates the biceps and the brachialis before moving in a lateral direction. If you are splitting the biceps down the middle, or retracting it in a medial direction and cutting down to the humerus, it is possible that you will damage this nerve.

The medial neurovascular bundle is potentially at risk with this approach. These structures lie just medial to the humerus and perhaps slightly posterior to it. They are clearly posterior to the biceps. By approaching the humerus through the biceps fascia, you have a layer protecting the neurovascular bundle.

TECHNIQUE

An incision is made, usually on the anterior medial aspect of the arm, just on the medial side of the biceps and carried through the subcutaneous tissue. The biceps can be retracted either medially or laterally. In the upper end of the approach in the region of the tendinous portion of the long head of the biceps, it is retracted medially. In the midshaft, it is retracted laterally. If the goal is to reach the proximal biceps for tenodesis, then you need to carry the incision into the deltopectoral groove area, retracting the deltoid laterally and the pectoralis medially. The biceps tendon will be seen underneath those muscles, directly anterior to the humerus.

If the goal is to reach the medial humerus in the midshaft region, then the biceps would be retracted laterally. The brachialis would be split as much as is necessary for the exposure. Ideally, the brachialis could also be retracted in its entirety in a lateral direction.

Care must be taken when in the proximal portion of the incision not to damage the musculocutaneous nerve. The nerve typically comes from underneath the coracobrachialis muscle and enters the biceps 5 to 10 cm distal to the coracoid. It can be easily identified at the level of the pectoralis major insertion by lifting the biceps anteriorly. The nerve is typically about the size of a shoelace and runs on the under surface of the biceps. By the time you reach the midshaft humerus, the nerve is already well into the muscle and moving laterally. Retraction of the muscles laterally then takes the nerve with it, providing protection for the nerve.

TRICKS

The major trick to this approach is identifying the biceps. Once you know where it is, opening its fascia and retracting it laterally and continuing the approach toward the humerus will keep you safely away from the more medial neurovascular bundle.

The other trick concerns the musculocutaneous nerve. In the midhumerus, the biceps and brachialis can be retracted laterally, but in the proximal arm in the region of the pectoralis major, it is probably safer to retract them medially, taking the nerve toward the medial side with the muscle.

If the dissection to the anterior humerus is proximal to where the nerve exits the coracobrachialis and comes underneath the biceps, then medial retraction is the wiser choice. Medial retraction is generally done for a proximal biceps tendon tenodesis. Remember that the musculocutaneous nerve can be within 5 cm of the coracoid process as it courses from medial to lateral.

HOW TO TELL IF YOU ARE LOST

As with many approaches, it is difficult to get lost when you are coming directly down on the bone. The key

landmark is the medial border of the biceps. Once you have that retracted out of the way, then the neurovascular structures are medial and posterior to it and should be protected. The brachialis muscle, which is surprisingly big, underlies the biceps, and sometimes it is difficult to tell one from the other. It is not usually necessary to do so, however, and you can simply approach directly onto the humerus.

If you are lost too far medially, you will encounter the neurovascular structures. Care must be taken with this approach because you are trying to come along the medial border of the biceps so that you can protect the musculocutaneous nerve by retracting it laterally, which is what puts the main neurovascular structures at risk. Staying inside the biceps fascia provides protection. If you are not inside the biceps fascia, you are lost.

FIGURE 7–1 The skin incision.

FIGURE 7–2 The underlying coracobrachialis deep to the subcutaneous tissue. The area at the bottom of the coracobrachialis muscle, which looks to be more yellow in color and perhaps fatty, is the region of the neurovascular bundle, and should be avoided.

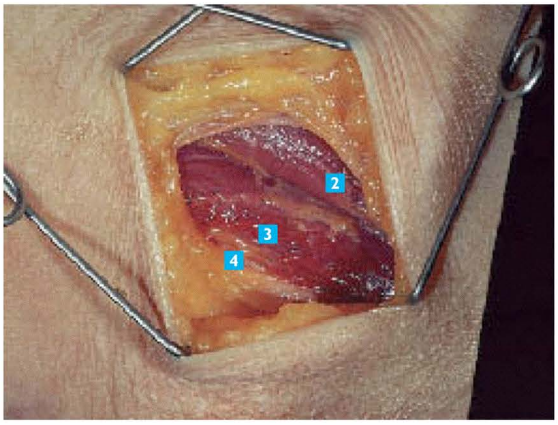

FIGURE 7–3 The coracobrachialis fascia open. The lower border of the coracobrachialis is apparent, as is the area of the neurovascular bundle immediately inferior to the coracobrachialis. This is the correct interval to go down to the humerus, because the coracobrachialis provides protection from the neurovascular bundle.

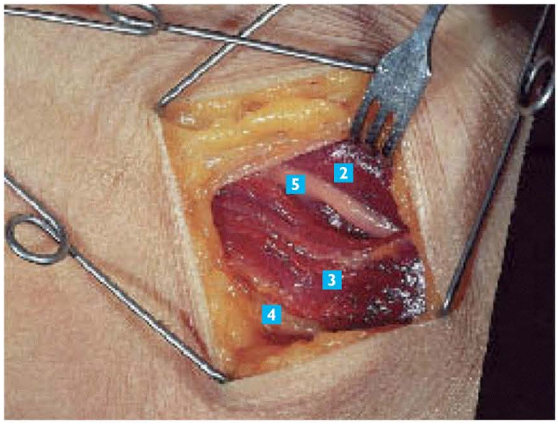

FIGURE 7–4 The biceps being retracted anteriorly. The musculocutaneous nerve is on the undersurface of the biceps and is easily identified in this location.

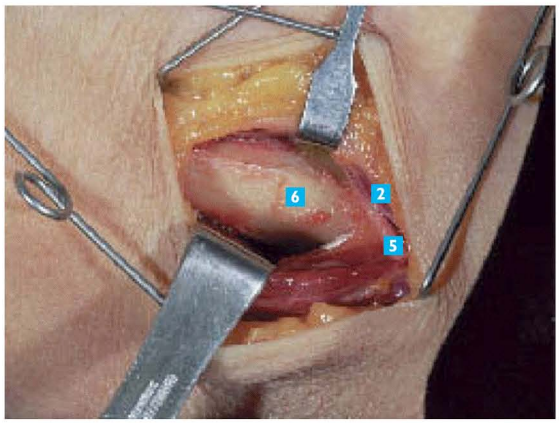

FIGURE 7–5 The coracobrachialis and neurovascular bundle retracted posteriorly and the musculocutaneous nerve and biceps retracted anteriorly, exposing the shaft. This dissection can then be carried as far distally as is necessary in that same plane because the musculocutaneous nerve is already safe and out of the way.

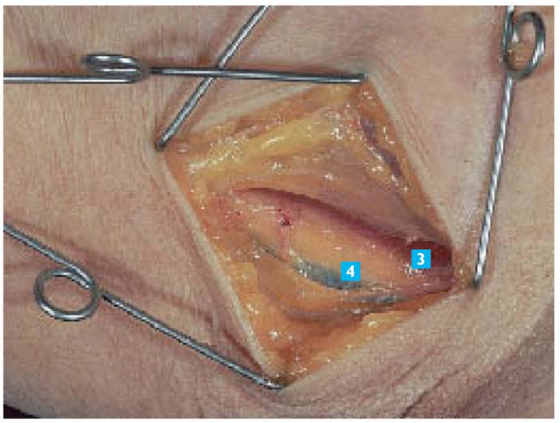

FIGURE 7–6 The interval between the coracobrachialis and the main neurovascular bundle. If, as you are making this approach, this is the picture that you see, then you are going too far in a posterior direction, which is a great risk. This risk is avoided by proceeding far enough laterally that you can tell the biceps from the coracobrachialis muscle.

1 Fascia Over Biceps and Coracobrachialis
2 Biceps
3 Coracobrachialis
4 Neurovascular Bundle
5 Musculocutaneous Nerve
6 Humerus

LATERAL APPROACH TO THE HUMERUS

USES

This approach is used primarily for fracture work.

ADVANTAGES

This approach is internervous because the anterior musculature of the biceps and brachialis is innervated by the musculocutaneous nerve and the triceps is innervated by the radial nerve. Campbell and Hoppenfeld describe this approach as the anterolateral approach to the humerus, and both describe splitting the brachialis muscle. But splitting the brachialis muscle risks denervating the lateral half of the muscle by cutting the small nerves crossing laterally.

DISADVANTAGES

For fractures of the midshaft, this is an excellent approach. However, if the fracture line extends distally, then this approach provides poor visualization to the posterior aspect of the humerus where internal fixation will frequently need to be placed.

STRUCTURES AT RISK

The major structure at risk with this approach is the radial nerve, which crosses from posterior to anterior in the region of the junction of the middle and distal thirds. This nerve must be identified in all plating of the humerus and protected. The key landmark for finding the radial nerve is the fibers of the brachioradialis. Since these fibers come in perpendicular to the shaft of the humerus, they can generally be fairly easily differentiated from the fibers of the biceps or triceps. The nerve crosses around the lateral aspect of the humerus just proximal to the muscle origin.

TECHNIQUE

A straight midline lateral approach is used through the subcutaneous tissue. The biceps is identified anteriorly, the triceps posteriorly, and the usually easy palpable interval between them is developed. The humerus is generally palpable at that point. In the region of the deltoid insertion laterally, you can cut straight down on the humerus. Once you are at the area of the midhumerus, care needs to be taken to identify the radial nerve before cutting directly down on the bone. Once the humerus is exposed, the appropriate procedure can be done. The brachialis can be reflected in its entirety medially with a Bennett retractor.

TRICKS

As just stated, the deltoid insertion on the lateral humerus is a guide to the interval between the biceps and triceps. The other major trick with this approach is to identify the fibers of the brachioradialis, because they act as a warning sign for the radial nerve. If you are working proximal to where the radial nerve crosses lateral to the humerus, a Bennett retractor posterior to the humerus protects the radial nerve.

HOW TO TELL IF YOU ARE LOST

It is possible to be too far anterior or posterior with this approach, especially in overweight patients who do not have much muscle definition. It is difficult to tell whether you are lost anteriorly or posteriorly because both the biceps and the triceps fibers are running parallel to the humerus. The main thing to do is feel the humerus. The deltoid insertion is a good landmark more proximally. It is in the interval between the biceps and the triceps. Once you find that insertion, you will also find the interval between those muscles, which will guide you directly to the humerus.

FIGURE 8–1 The skin incision.

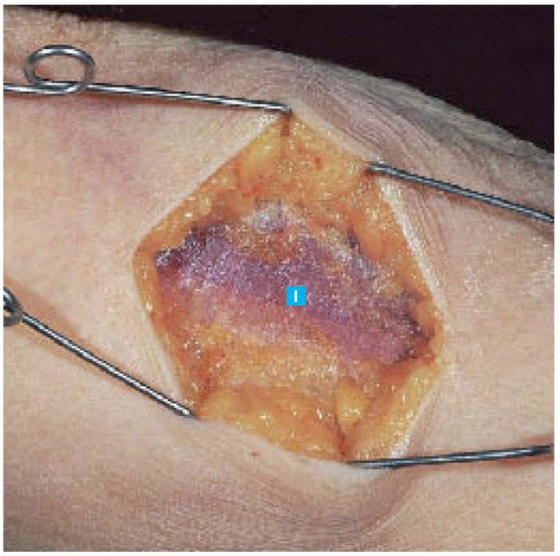

FIGURE 8–2 The subcutaneous tissue spread showing the underlying muscle. The posterior aspect of the biceps is visible.

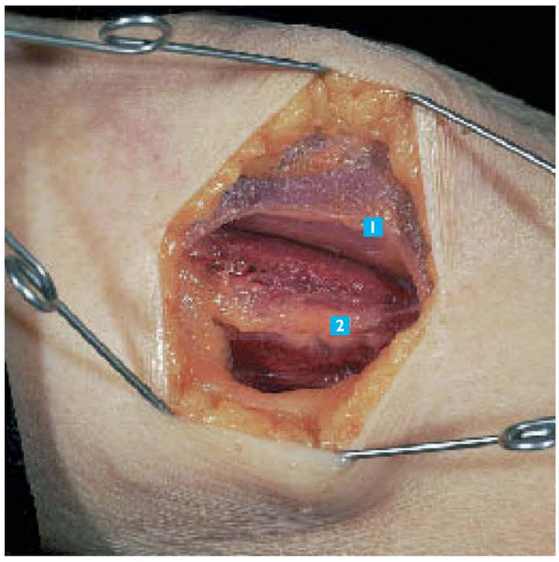

FIGURE 8–3 The interval between the biceps and triceps developed so that there is ready access to the humeral shaft.

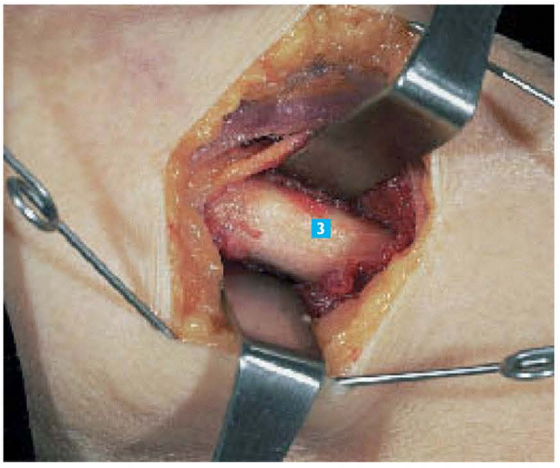

FIGURE 8–4 The biceps anterior to the brachialis origin and the triceps posterior.

1 Biceps
2 Triceps
3 Humerus
4 Radial Nerve
5 Deltoid Insertion

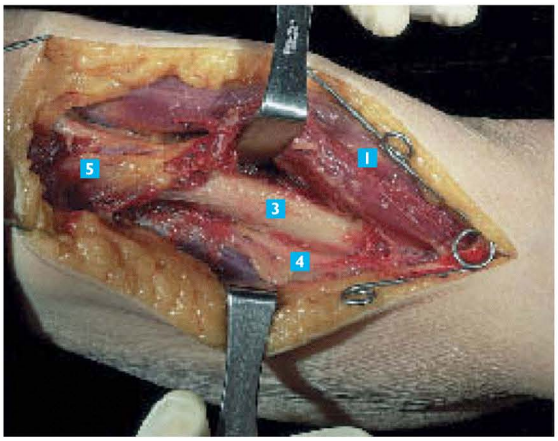

FIGURE 8–5 The dissection proceeding proximally, showing the fibers of the deltoid coming in obliquely along with the white deltoid insertion.

1 Biceps
2 Triceps
3 Humerus

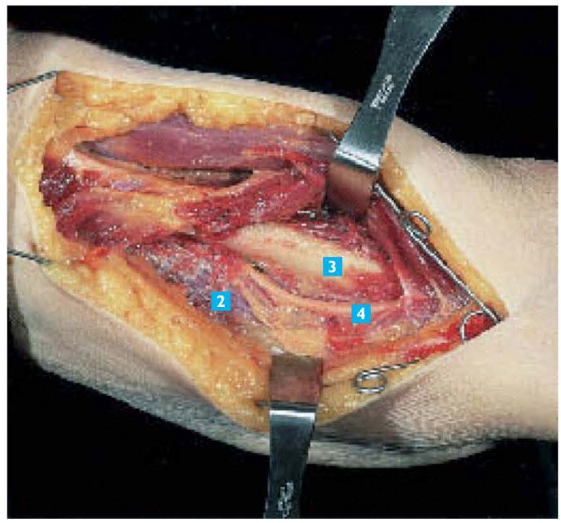

FIGURE 8–6 The incision extended distally, showing the radial nerve as it starts to wrap around the humerus coming from posterior to anterior at the junction of the middle and distal thirds.

4 Radial Nerve
5 Deltoid Insertion

Posterior Approach to the Distal Humerus

USES

This approach is used primarily for fracture work in the distal humerus. It is occasionally used for radial nerve explorations.

ADVANTAGES

If you are distal to where the radial nerve comes behind the humerus, this is a safe approach in an area that is devoid of nerves or arteries. It provides the best visualization of the distal humerus. There is a saying that the front door to the elbow is in the back. It is the preferred approach for supracondylar and intracondylar fractures of the distal humerus. Campbell calls this the posterior lateral approach to the elbow.

DISADVANTAGES

The upper end of the approach can place the radial nerve at risk. It also provides no access to the anterior aspect of the humerus or elbow. At its most distal extent, the ulnar nerve can also be damaged as it passes behind the medial epicondyle.

STRUCTURES AT RISK

The radial nerve is the major structure at risk with this approach. It typically crosses the back of the humerus several centimeters proximal to the brachioradialis origin. Once the nerve is lateral to the humerus, it will then go underneath the brachioradialis and enter the forearm protected by that muscle. If the dissection is carried proximal to the junction of the middle and distal thirds, then the radial nerve is at risk and the dissection needs to be done very carefully as you go proximally.

In the exposure of the medial and lateral pillars of the distal humerus, the ulnar nerve can be damaged on the medial side. It will cross from anterior to posterior behind the medial epicondyle. It is usually necessary to identify the medial epicondyle and to transpose it anteriorly when doing complex fractures of the distal humerus. It is important to remember the location of this nerve and to protect it with this dissection. Because the triceps is split in line with its fibers, there is usually no functional problem with that muscle postoperatively.

TECHNIQUE

This procedure is done with the patient lying face down or at least with the opposite side down and the arm supported on a bolster, so that the posterior portion of the humerus is facing upward. At that point, the midline incision is made. It is carried through the subcutaneous tissue and through the triceps in line with its fibers down to the humerus. As you approach the elbow, either the triceps is reflected off of the olecranon or an olecranon osteotomy is done. This then allows the triceps to be retracted in its entirety exposing the back of the distal humerus. The radial nerve is usually not encountered in the approaches to the distal humerus. It will be seen underneath, that is, deep to the triceps, as you go more proximally. For the distal medial dissection, the ulnar nerve needs to be identified and separated from its underlying tissues and allowed to fall in an anterior direction.

TRICKS

There are no special tricks with this approach except to protect the nerves.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost in this approach because it is a midline approach. The major way you can get lost is by being too far proximal or distal for the pathology, and then you simply need to extend your incision.

FIGURE 9–1 The skin incision starting 10 cm from the olecranon and going distally.

FIGURE 9–2 The subcutaneous tissue spread with the fibers of the triceps running toward the olecranon.

FIGURE 9–3 The triceps split with the humerus seen in the depth of the incision.

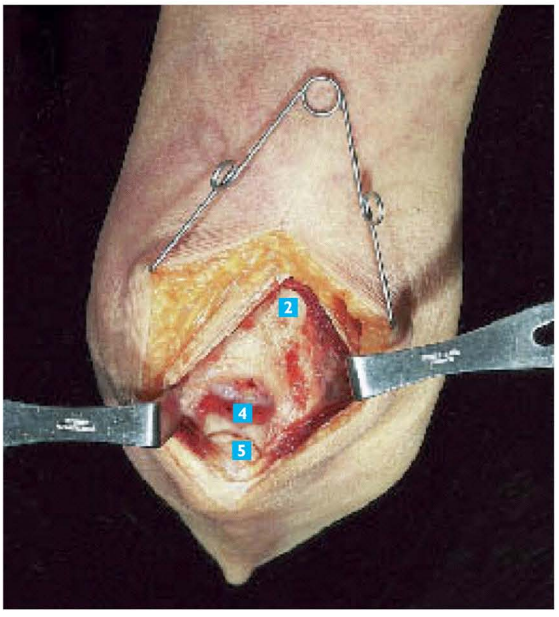

FIGURE 9–4 The tissue retracted such that the olecranon and posterior elbow joint are visible. The olecranon fossa has also been cleaned out and is visible.

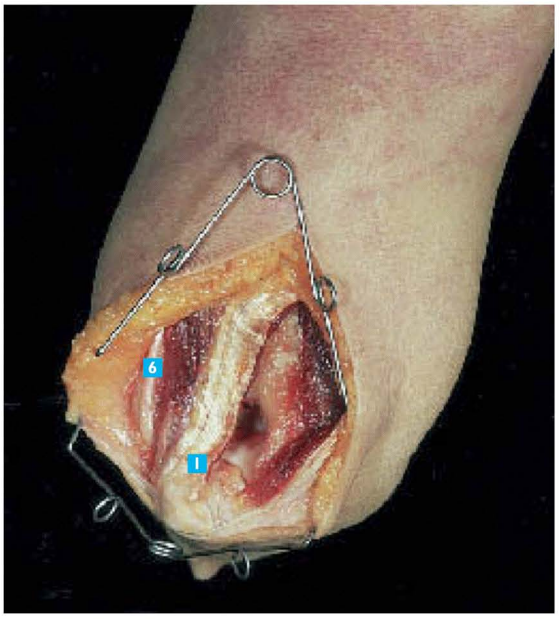

FIGURE 9–5 The ulnar nerve on the ulnar side. This is at risk if the triceps is going to be retracted completely off the distal humerus.

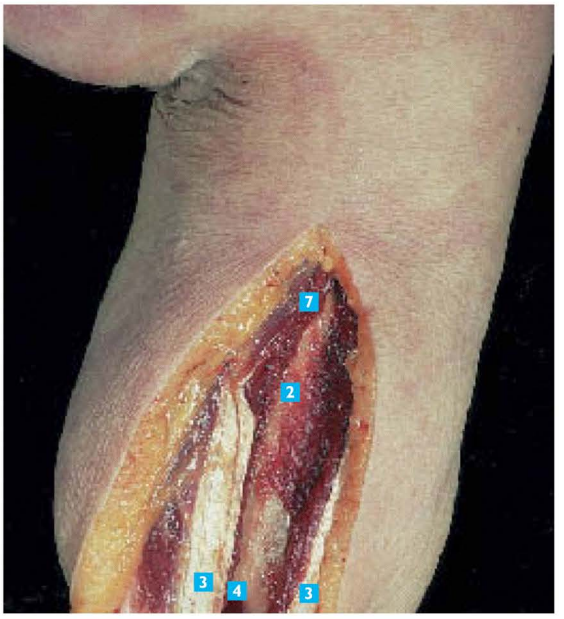

FIGURE 9–6 The proximal extension of the dissection with the radial nerve just barely visible.

FIGURE 9–7 The radial nerve now more thoroughly exposed as the overlying triceps is split.

1 Triceps
2 Humerus
3 Triceps Split
4 Olecranon Fossa
5 Olecranon
6 Ulnar Nerve
7 Radial Nerve

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SECTION III

ELBOW

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ANTEROLATERAL APPROACH

USES

This approach is useful for biceps tendon repairs. (Sometimes just the middle part of the approach is needed for biceps repair.) It can also be used for coranoid process open-reduction internal fixation. Additionally, it may be used for exploration of radial tunnel.

ADVANTAGES

This approach can be extended proximally and distally as necessary. By staying lateral to the biceps tendon, it stays in the internervous plane between the median and radial nerves.

DISADVANTAGES

There are important structures at risk with this approach and great care must be taken to identify and protect them.

STRUCTURES AT RISK

Laterally, the structure at risk is the radial nerve. This nerve enters the forearm underneath the brachioradialis muscle, which is the first muscle identified with this approach. The anterior edge of that muscle should be dissected and the nerve will be found on the inner border of the muscle. It should be retracted out of the way and protected.

The brachial artery and the median nerve are at risk if you are dissecting medial to the biceps tendon. As long as you stay lateral to those tendons, there is no significant risk.

The recurrent branch of the radial artery is at risk with this approach if you are dissecting distally. It will need to be clamped and sacrificed, which can be done without any major problem for the patient.

TECHNIQUE

A curved incision is made starting 5 or 6 cm proximal to the elbow flexor crease along the lateral side down to the lateral elbow joint, crossing the flexor crease at an angle almost parallel to the crease, going over to the medial side, and then going distally. This incision is carried through the subcutaneous tissue. The brachioradialis is identified and its anterior border developed so that the radial nerve can be identified and protected.

The muscle just medial to the brachioradialis is the brachialis muscle, and it is traced distally. The biceps tendon sheath is anterior to the brachialis and, once opened, the tendon of the biceps is identified and traced distally. If the surgery is being done for a biceps tendon rupture, then it is frequently necessary to work proximally along the brachialis until you encounter the retracted end of the biceps. This may require a fairly long proximal extension of the incision. If the surgery is to free up the radial nerve, dissection along the brachialis and biceps is not necessary.

If the purpose of the surgery is to reattach an avulsed biceps tendon, then follow the brachialis down to the ulna and go just lateral to that. Obviously, if the biceps is avulsed, you cannot trace it down to its insertion. By tracing the brachialis, you will stay lateral to the median nerve and brachial artery and you can then feel the bicipital tuberosity.

TRICKS

The key to this approach is finding the fat between the brachialis and brachioradialis. Once you are deep to the subcutaneous tissue, any fat between muscles is a warning sign that there are nerves or arteries close by. Therefore, if you find the fat between the brachialis and brachioradialis, it will lead you to the radial nerve. Similarly, medial to the biceps tendon, the fat will guide you to the neurovascular structures. Except for radial nerve release, generally speaking, the fat is used as a warning sign of where not to go. The key to protecting the median neurovascular structures is staying lateral to the biceps tendon.

HOW TO TELL IF YOU ARE LOST

The fiber orientation of the muscles will guide you to them. The brachioradialis runs from proximal to the elbow in a straight line toward the radial styloid, whether the elbow is flexed or extended. With the elbow flexed, the tendons of the brachialis and biceps will be at a 60- or 70-degree angle, or perhaps greater, to the fiber direction of the brachioradialis. If you dissect too far proximally along the brachioradialis, you will not see the brachialis muscle well. You should, however, see the fat in the gap between those two muscles and you will come in through the fat.

If you are lost medially, the artery will be closest to the biceps tendon. The median nerve will be medial to that. If you do not see the biceps tendon, then go back proximally until you find muscle and work your way along the muscle distally.

When coming in from the lateral side, if you retract the brachioradialis and radial nerve laterally, the first muscle you see will be the brachialis. It starts slightly more laterally and crosses to insert more medially, and the biceps goes the other direction.

FIGURE 10–1 The skin incision.

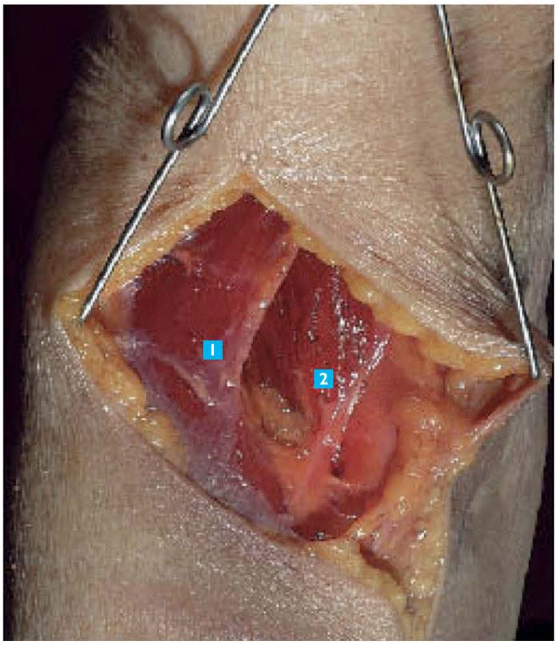


FIGURE 10–2 The brachioradialis muscle and the brachialis muscle. Seen between the two is some fat, which is always the warning sign that there may be a nerve or artery close by. Note that the gap between the biceps and brachioradialis is covered by overlying fascia and is not apparent immediately.

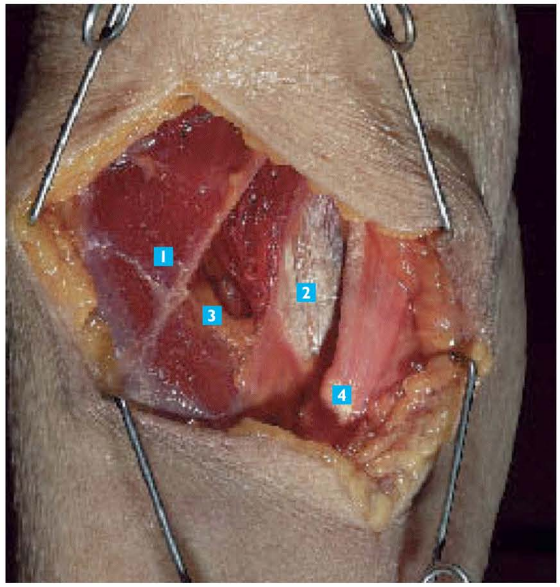


FIGURE 10–3 The fascia overlying the brachialis muscle has been split. You can see clearly the fat around the radial nerve and you can see anteriorly the biceps tendon.

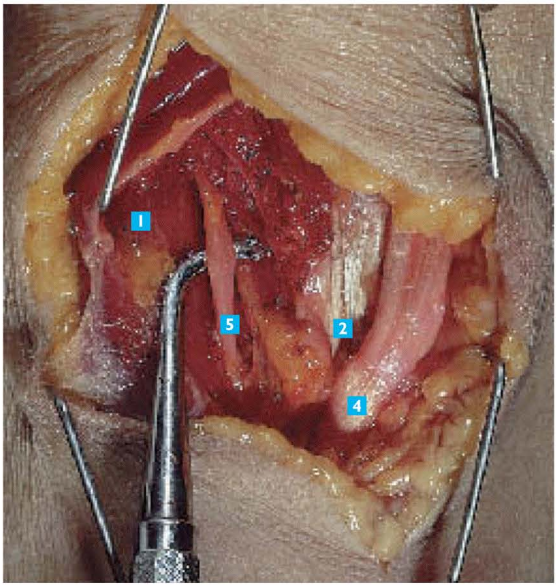


FIGURE 10–4 The radial nerve, which has now been identified underneath the brachioradialis muscle and just lateral to the brachialis muscle. The fat that is overlying it has been removed, making the nerve's location more obvious.

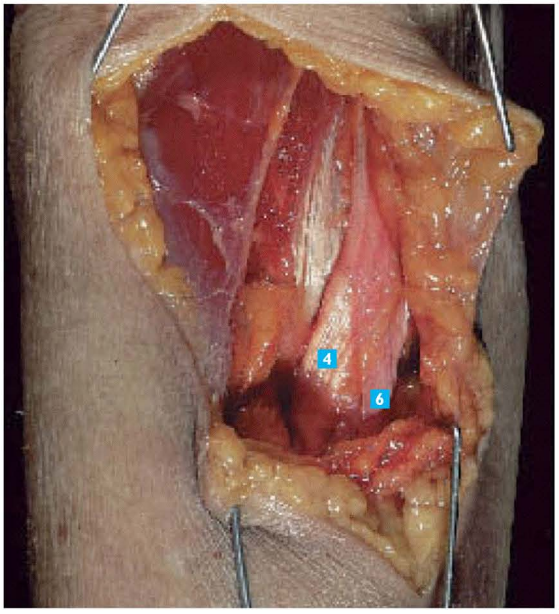


FIGURE 10–5 The lacertus fibrosis of the biceps anteriorly. All of the medial neurovascular structures will be medial to this area.

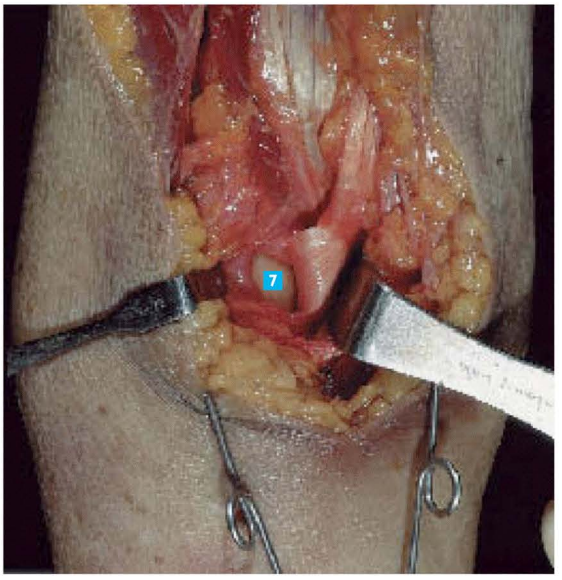


FIGURE 10–6 The bicipital tuberosity, tracing the tendon down to its insertion on the radius. This is facilitated by rotation of the forearm.

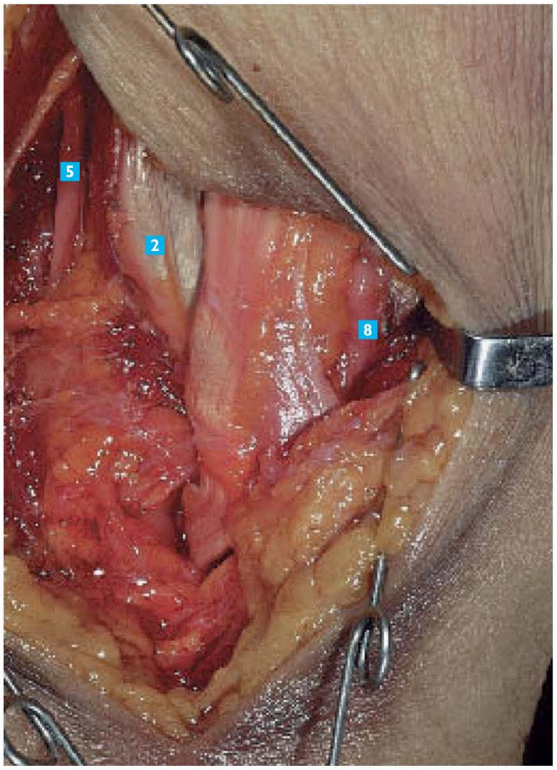


FIGURE 10–7 The medial neurovascular structures encased in their fat just medial to the biceps tendon.

1 Brachioradialis
2 Brachialis
3 Fat Around Radial Nerve
4 Biceps
5 Radial Nerve
6 Lacertus Fibrosis
7 Bicipital Tuberosity
8 Median Nerve and Brachial Artery

POSTEROLATERAL APPROACH

USES

This approach is the lateral equivalent of the approach to the ulnar nerve. The incision stays behind the lateral epicondyle and thus is useful for fractures of the capitellum and for open reductions and internal fixation of the distal humerus and the radial head. The exposure is useful for lateral ligament repairs around the elbow and for contracture releases around the elbow. This approach is a combination of Hoppenfeld's lateral approach to the distal humerus and the posterolateral approach to the radial head. Campbell calls it the lateral and lateral J approach.

ADVANTAGES

This approach gives a good view of the lateral elbow and capitellum area. Also, by staying somewhat posterior, the radial nerve is less at risk.

DISADVANTAGES

It is difficult to visualize the posterior aspect of the humerus for comminuted fractures through this approach. The approach, therefore, is limited to either fractures of the capitellum or two-part supracondylar fractures. The approach is difficult to extend proximally or distally because of the radial nerve.

STRUCTURES AT RISK

The major structure at risk is the radial nerve. The radial nerve wraps around the humerus, and at the junction of the middle and distal thirds of the humerus the nerve is usually posterior. From there, it comes along the lateral border to enter the forearm anteriorly. The radial nerve can be transected if the brachioradialis is stripped off of its humeral origin because the nerve will have to come around the humerus right along the proximal edge of this muscle.

The blood supply to the capitellar fragment can be destroyed if all the soft tissue attaching to that lateral piece is removed. The blood supply to the capitellum is quite precarious and, especially in children, the soft tissue attachments need to be handled gently.

TECHNIQUE

The incision is centered on the lateral epicondyle and 1 cm posterior to it. It is carried as far proximal or distal as necessary. The incision goes through the subcutaneous tissue. The tissue plane between the brachioradialis anteriorly and the triceps posteriorly is developed. The fascia is split starting at the lateral epicondyle and proceeding in that interval along the humerus proximally. It is critical not to carry sharp dissection into or underneath the brachioradialis muscle. The dissection should be done bluntly. When the elbow capsule is identified, it can be opened as in the anconeus approach (see Case 12). Once the posterior aspect of the humerus is identified, the bone can be exposed safely.

TRICKS

The major trick is to identify the humerus by palpating the lateral epicondyle and following the bone proximally, exposing the anterior and posterior sides of the humerus as needed. The radial nerve wraps around the lateral edge of the humerus approximately 6 cm proximal to the lateral epicondyle. It is protected by the brachioradialis muscle so that as soon as the more posterior fibers of the brachioradialis are identified, there should be no further stripping along the humerus. If, for some reason, you need to expose the humerus more proximally along its lateral border, then the radial nerve should be identified underneath the brachioradialis muscle prior to exposing the humerus.

HOW TO TELL IF YOU ARE LOST

There is no difficulty in identifying that you are lost too far posteriorly. You will simply run into the triceps with its fibers parallel to the humerus if you are lost in the proximal part of the incision. If you see the longitudinal fibers of the triceps, but are not seeing its anterior edge, you are too far posterior. You will run into the subcutaneous portion of the ulna in the distal part of the incision if you are too posterior.

The landmark anteriorly is the brachioradialis muscle. This is an important landmark because the radial nerve enters the forearm just underneath this muscle. With the elbow flexed, which is usually the way the procedure is done, the brachioradialis runs from a position 4 cm proximal to the lateral epicondyle down toward the distal radius in a straight line. If you see fibers running in that direction, you are too far anterior.

FIGURE 11–1 The skin incision.

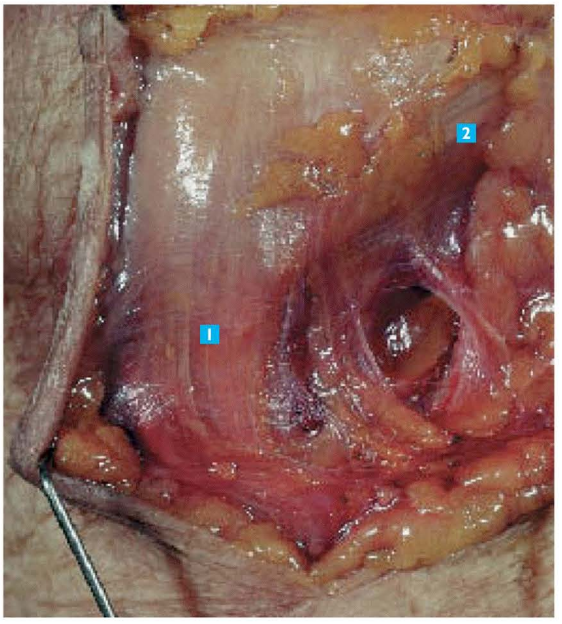


FIGURE 11–2 The triceps running along the humerus posteriorly. The fibers of the brachioradialis are perpendicular to the triceps.

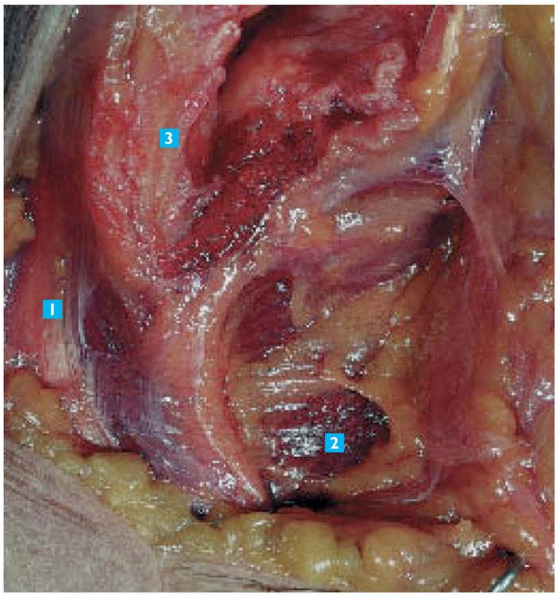


FIGURE 11–3 The brachioradialis coming into the humerus. This is a large muscle with a broad insertion into the humerus spanning 4 cm or more.

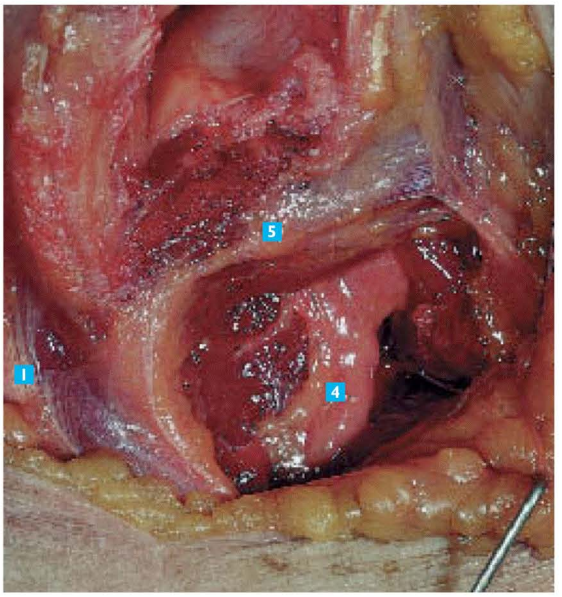
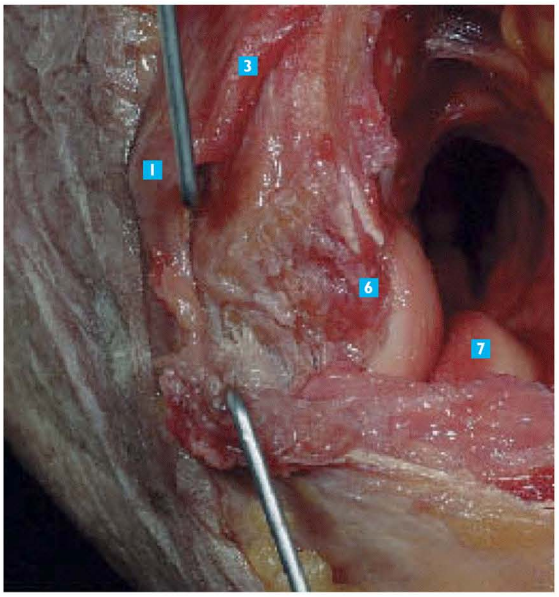


FIGURE 11–4 The brachioradialis lifted anteriorly exposing the radial nerve just underneath it. The nerve has not yet divided at this point.

1. Triceps
2. Brachioradialis
3. Humerus
4. Radial Nerve
5. Brachioradialis Lifted Anteriorly
6. Capitellum
7. Radial Head



1 Triceps
2 Brachioradialis
3 Humerus
4 Radial Nerve
5 Brachioradialis Lifted Anteriorly
6 Capitellum
7 Radial Head

FIGURE 11–5 The nerve and brachioradialis retracted anteriorly. The triceps is posterior. The capitellum is easily visualized, as is the radial head.

POSTEROLATERAL/ANCONEUS APPROACH

USES

This approach to the radial head is easy and safe. It is generally used for radial head resections or open reduction internal fixation of radial head fractures.

ADVANTAGES

This approach is easy.

DISADVANTAGES

This approach is limited to the radial head or capitellum. It is not suitable for proximal or distal extension.

STRUCTURES AT RISK

It is difficult to get lost with this exposure. The radial nerve is at risk anteriorly, but you would need to be far anterior to reach it. The posterior interosseous branch in the supinator muscle is at risk if the dissection is carried distal to the annular ligament. Pronation of the forearm moves this nerve farther away from the approach.

TECHNIQUE

The incision starts at the lateral epicondyle and then proceeds at a 45-degree angle in relation to the axis of the humerus toward the ulna. After splitting the subcutaneous tissue, the oblique fibers of the anconeus are identified. The capsule is opened along the anterior aspect of those fibers, exposing the radial head and the capitellum.

TRICKS

The only significant trick to this approach is finding the interval between the anconeus and the extensor musculature by looking at the fiber orientation. As you come to the superficial fascia, the anconeus fibers run obliquely toward the ulna, whereas the extensor muscles run parallel to the ulna down the forearm.

HOW TO TELL IF YOU ARE LOST

If you are too far posterior, you will split the fibers of the anconeus. If you run into the longitudinal fibers of the triceps, you are far posterior. Anteriorly, you will see longitudinal fibers of the extensor origin running parallel to the ulna. As long as you see the anterior edge of the oblique fibers and stay out of the longitudinal fibers, this is an easy approach.

FIGURE 12–1 Skin incision and lateral epicondyle is at the top.

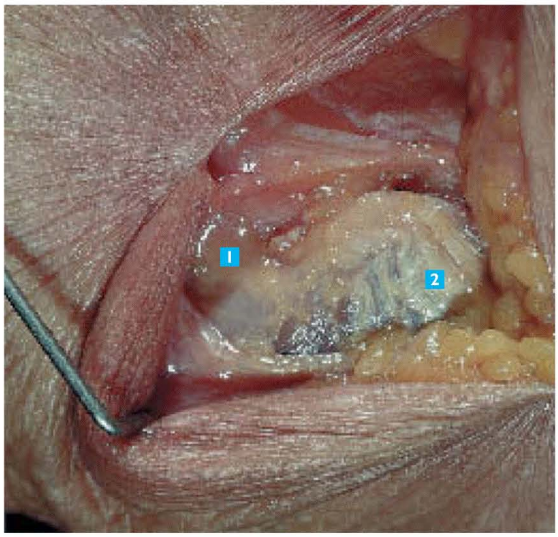


FIGURE 12–2 The subcutaneous tissue retracted out of the way and the fibers of the anconeus running from the area of the lateral epicondyle down toward the ulna. The fiber orientation is critical for identifying the muscle versus the extensors.

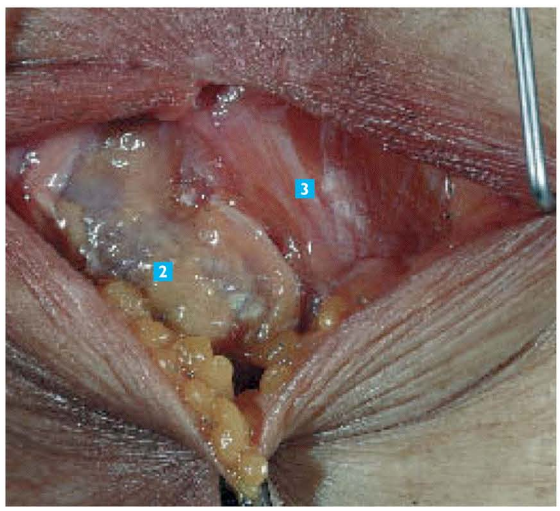


FIGURE 12–3 The anconeus retracted in a posterior direction, exposing the soft tissue overlying the elbow.

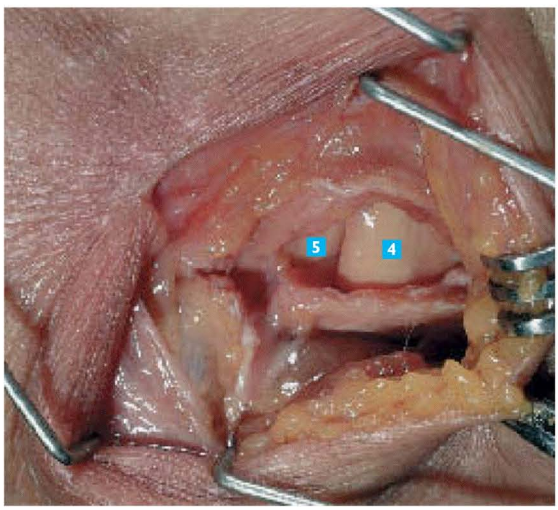


FIGURE 12–4 The elbow open. The capitellum and radial head are clearly visible.

1 Lateral Epicondyle
2 Anconeus
3 Elbow Capsule
4 Radial Head
5 Capitellum

Posteromedial Approach to the Ulnar Nerve

USES

This approach is used primarily for neurolysis of the ulnar nerve or anterior transposition of the nerve; however, this is a common enough procedure that this approach needs to be mastered. The approach can also be used for medial collateral ligament repairs of the elbow and coronoid fracture fixation. Campbell describes this approach combined with an osteotomy of the medial epicondyle.

ADVANTAGES

The posteromedial approach provides good visualization of the nerve and is easily extended proximally and distally.

DISADVANTAGES

This approach does not allow good access to the anterior or posterior elbow joint.

STRUCTURES AT RISK

If not done carefully, the ulnar nerve can be damaged. The motor branches of the ulnar nerve come off the nerve posteriorly. The branch to the flexor carpi ulnaris muscle can come off proximal to the elbow joint and must be avoided. When doing an anterior transposition of the ulnar nerve, the sensory branch going into the elbow joint frequently is not long enough to be salvaged. The motor branches to the flexor carpi ulnaris muscle must be saved. It is very helpful if this surgery is done with the patient not paralyzed and with the nerve stimulator used to identify the motor branches, which can be very small. A pure motor nerve has a small number of axons in it and so may not appear very nervelike. Sensory nerves have sensory axons for each sensory modality and are bigger and easier to identify. It is a pure motor nerve that is mistaken for other tissue and is at risk.

TECHNIQUE

A 10- or 12-cm incision is made, usually centered on the medial epicondyle and just 1 cm behind it. It is carried through subcutaneous tissue. The fascia overlying the muscles is split. This exposes the triceps posteriorly and the flexor carpi ulnaris tendon running off the medial epicondyle and going distally. The intermuscular septum is usually palpated at this point. The nerve is identified just behind the intermuscular septum and in front of the triceps muscle. This is done by blunt dissection. Once the nerve is identified, the cubital tunnel can be opened by placing a hemostat or some other blunt instrument to protect the nerve, while the overlying soft tissues are cut. Once the nerve has been freed through the entire course of the cubital tunnel, it is then necessary to free it up from its underlying soft tissues to prepare it for anterior transfer.

The anterior transfer is the dangerous part of the procedure, in terms of damage to the nerve. The motor branches to the flexor carpi ulnaris may actually leave the nerve proximal to the elbow joint and you should be aware of that possibility. All dissection along the nerve should be done anteriorly. There is usually a sensory branch going from the nerve directly into the elbow joint, which is so short that it needs to be sacrificed. Prior to doing that, it should be stimulated with a muscle stimulator to make sure you are not dealing with a motor branch to the flexor carpi ulnaris. I think that this procedure is best done under general anesthesia without muscle paralysis, so that the muscle stimulator can be used and a good response from the muscles is elicited.

Once the nerve has been freed, the intermuscular septum is split down to the humerus so that it does not act as a sharp band around which the nerve has to bend. At that point, the surgeon must decide whether to create a subcutaneous or a submuscular tunnel. If a submuscular tunnel is created, it is done by splitting the tendinous portion of the flexor carpi ulnaris origin.

TRICKS

The key is to find the nerve proximally. It is just posterior to the intermuscular septum, which is usually palpable. Then by staying on the anterior border of the nerve, there is less risk of damage to the motor branches.

HOW TO TELL IF YOU ARE LOST

The triceps fibers run longitudinally posteriorly and are easy to identify. Thus, if you see those fibers you are too far posterior. If you are too far anterior, you will run into the median nerve and the brachial artery. The median nerve is medial to the artery and is easy to identify. It may be confused with the ulnar nerve. It clearly does not go behind the medial epicondyle. Also, the nerve stimulator will easily differentiate between the median and the ulnar nerves.

FIGURE 13–1 The skin incision. The olecranon is clearly visible. The medial epicondyle is not visible but it is palpable. (Proximal is to the right.)

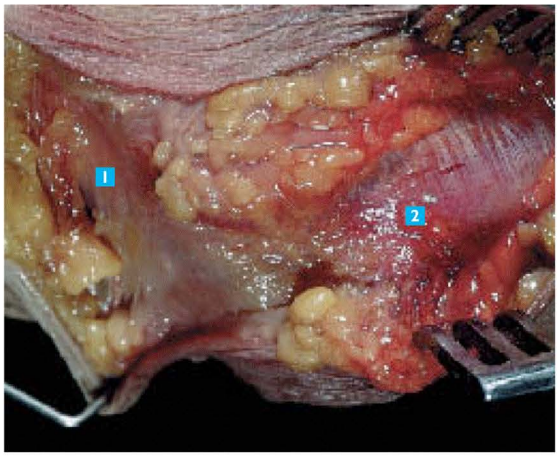


FIGURE 13–2 The muscle of the flexor carpi ulnaris origin and the triceps posteriorly proximal. Until you are deep to this layer, the nerve is not at risk.

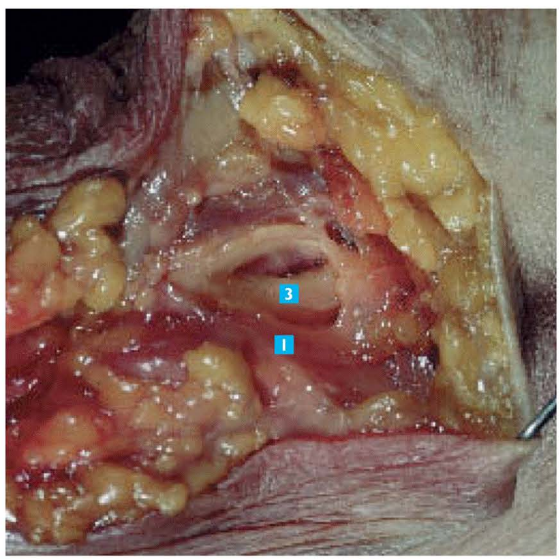


FIGURE 13–3 The nerve. The medial epicondyle is anterior. The nerve is visible. You can also see the triceps tendon with its muscle attached. Once the nerve is identified, it is simply traced distally. This is usually done by placing a hemostat or some other blunt instrument underneath the tissue of the cubital tunnel, holding the nerve down and protecting it while that tissue is cut. This figure demonstrates how similar a nerve can appear to the surrounding tissues, not like in textbooks where it is cleaned up and dissected free. This figure and Fig. 13–4 show that in reality it sometimes can be difficult to tell a nerve from other structures.

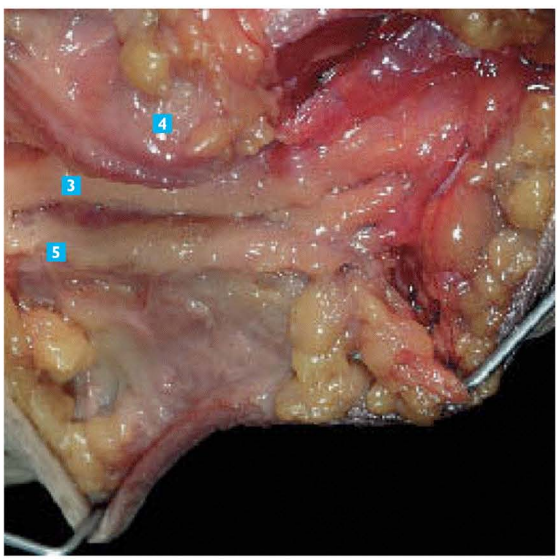
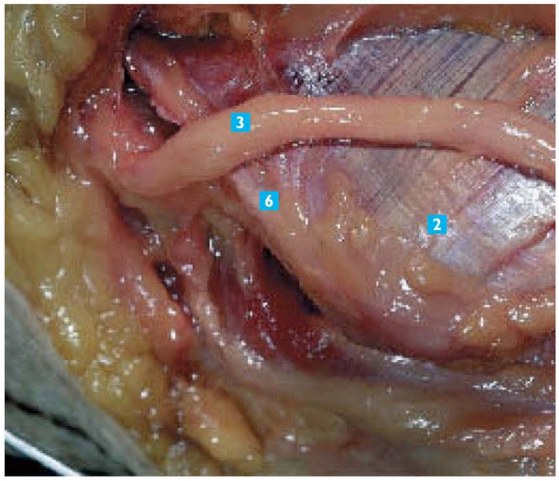


FIGURE 13–4 The nerve dissected down into the flexor carpi ulnaris area. It is important to split the muscle far enough distally that the nerve can be brought up on top without a sharp bend.



1 Triceps
2 Flexor Carpi Ulnaris
3 Ulnar Nerve
4 Medial Epicondyle
5 Fascia Over Nerve
6 Intermuscular Septum

FIGURE 13–5 The nerve lying on top of the flexor muscle origin. The nerve can be left here either in a subcutaneous tunnel or in a submuscular tunnel by splitting the fascia and laying it in a channel created in the muscle. This is generally what is done because it takes the tension off of the nerve a bit more effectively by creating a straighter course for the nerve. Additionally, it creates a soft bed for the nerve. It is also important to split the intermuscular septum. This figure shows the nerve lying over the sharp edge of that septum, which would need to be transected so that the bend, demonstrated here in the nerve, would not be present following the completed procedure.

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SECTION IV

FOREARM

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Thompson Approach to the Proximal Radius

USES

This approach is used primarily for plating of radius fractures.

ADVANTAGES

The approach through the dorsolateral aspect of the forearm makes patient positioning easy. When used for plating both bone fractures of the forearm, the arm does not need to be repositioned for the ulnar plate.

DISADVANTAGES

The major disadvantage is that this approach puts the radial nerve at considerable risk.

STRUCTURES AT RISK

The major structure at risk is the posterior interosseous (deep branch of the radial nerve), which enters the supinator and then goes down the arm to innervate the other dorsal musculature. Because this approach comes down directly over the midportion of the muscle belly, great care must be taken to identify the nerve and gently retract it.

Vigorous retraction on the brachioradialis can also damage the sensory branch of the radial nerve.

TECHNIQUE

With the forearm pronated, an incision is made starting just anterior to the lateral epicondyle and proceeding distally toward the middle of the wrist. The incision is carried through the subcutaneous tissue. The interval between the extensor carpi radialis brevis and the extensor digitorum communis is identified and developed. Once you are deep to those muscles, the supinator is immediately apparent. The radial nerve, however, is not seen because it is within the substance of the muscle, and it must be carefully identified and freed. It is usually necessary to split the fibers of the supinator to protect the nerve. If possible, the proximal radius can be supinated so that the supinator muscle can be stripped off of the radius right at its insertion. With fractured forearms, however, this is usually difficult, and positioning the wrist does not change the position of the proximal fragment. Care must be taken when stripping the supinator. According to Hoppenfeld, 25% of the time the posterior interosseous nerve is actually on the undersurface of the supinator, not within its muscle belly, and is in direct contact with the proximal radius in the region of the radial neck. Aggressive stripping can then damage the nerve. Once the supinator is off of the radius, the pronator teres is seen coming in from the opposite side. If necessary, it too can be taken off subperiosteally.

TRICKS

The major trick is identifying the gap between the extensor carpi radialis brevis and the extensor digitorum communis. Proximally, they both come off of the lateral epicondyle and there is no gap. The trick, therefore, is to find the gap distally and to trace it proximally.

The other trick for exposure is to try to supinate the proximal radius so that the supinator muscle can be stripped off of the bone as close to its insertion as possible.

HOW TO TELL IF YOU ARE LOST

It is easy to get lost when looking for the gap between the extensor carpi radialis brevis and the extensor digitorum communis. It is actually not critical that you be exactly in the plane between them. Going between the two wrist extensors also exposes the supinator and proximal radius, but risks denervating the extensor carpi radialis brevis.

If you are lost too far posterolaterally, you will run into the ulna, which is very clear. If you are lost too far dorsolaterally, you will see the brachioradialis or extensor carpi radialis longus. By gently tugging on the muscle, you can usually identify them.

FIGURE 14–1 The skin incision starting just anterior to the lateral epicondyle and proceeding distally.

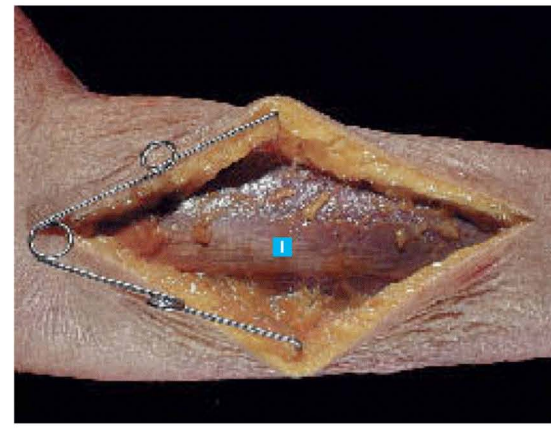

FIGURE 14–2 The extensor muscle mass underneath the subcutaneous tissue.

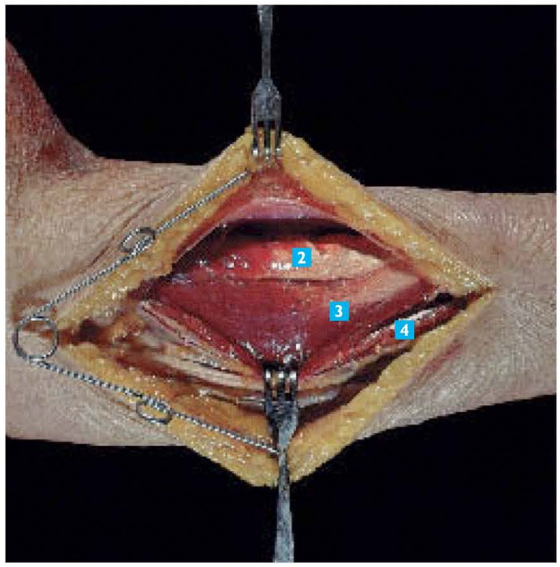

FIGURE 14–3 The brachioradialis, the wrist extensors, and the extensor digitorum communis. The interval developed is between the wrist extensors and extensor digitorum communis.

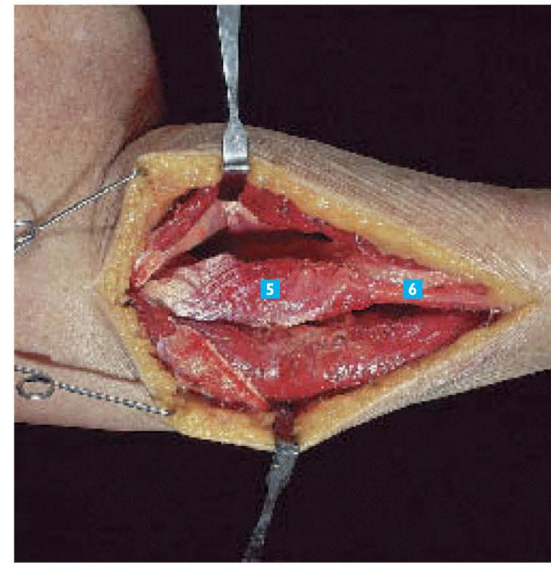

FIGURE 14–4 The supinator muscle with the other muscles retracted out of the way. The fibers are clearly seen. The posterior interosseous nerve is in the muscle at this point. Its exit going down the radius can also be seen in this figure.

1. Extensor Mass
2. Brachioradialis
3. Wrist Extensors
4. Extensor Digitorum Communis
5. Supinator
6. Posterior Interosseus Nerve
7. Supinator Retracted
8. Radius
9. Pronator Teres Insertion
10. Posterior Interosseus Nerve Entering Supinator
11. Radial Neck
12. Sensory Branch of Radial Nerve

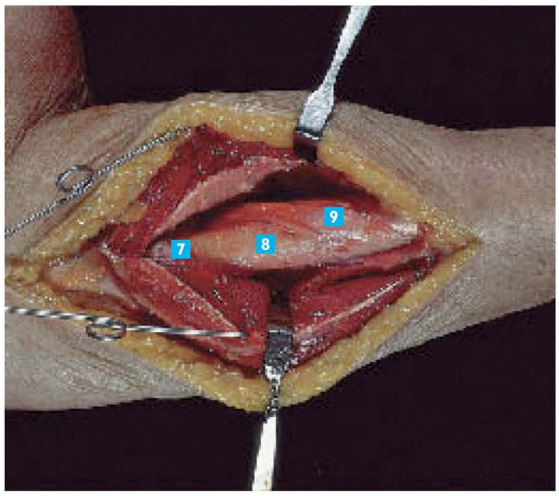

FIGURE 14–5 The supinator and nerve retracted out of the way. The radial shaft is now apparent. The pronator teres insertion is well seen.

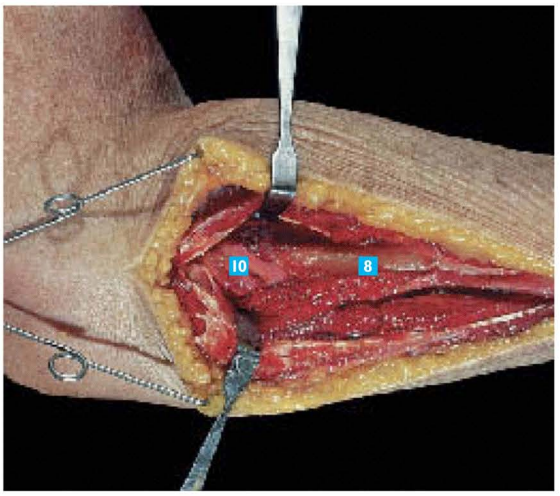

FIGURE 14–6 More proximal dissection where the posterior interosseous nerve going into the supinator is apparent.

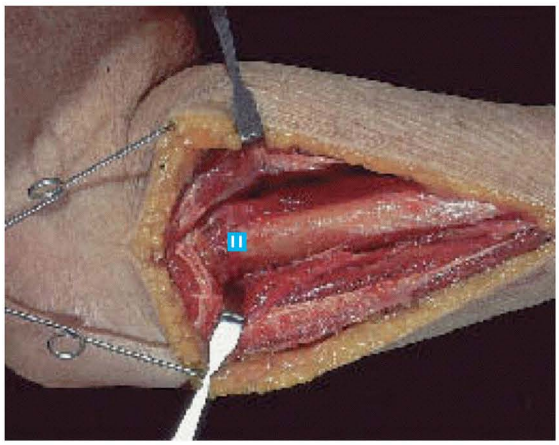

FIGURE 14–7 The dissection being carried proximally into the radial neck area so that the upper portion of the radius could be plated if necessary.

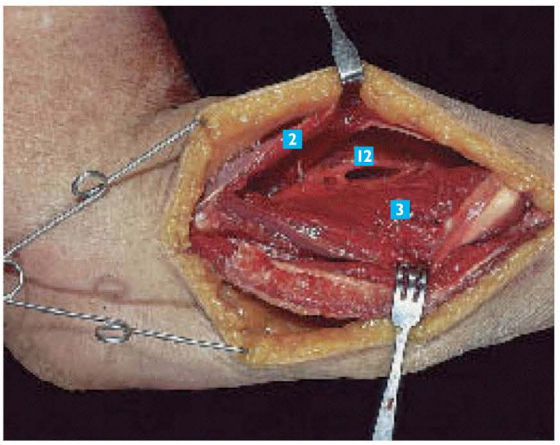

FIGURE 14–8 What the picture will look like if you get lost too far anteriorly on your approach. Not only will you not see a clear gap, but you will see the sensory branch of the radial nerve running underneath the brachioradialis, which is your clue that you are too far anterior.

ANTEROLATERAL (INTERNERVOUS) APPROACH

USES

This approach is used primarily for plating the proximal radius. It is an alternative approach to the dorsolateral approaches. Campbell refers to this approach as the Henry approach and describes it as starting proximal to the elbow. The description here starts at the elbow.

ADVANTAGES

This is an internervous approach with everything on the lateral side being radial nerve innervated and everything on the medial side being median nerve innervated. It is also an approach that easily allows proximal and distal extension.

DISADVANTAGES

There are no major disadvantages to this approach except lack of surgeon familiarity with it.

STRUCTURES AT RISK

The major structure at risk is the radial nerve if you get lost too far to the lateral side. The key to finding the radial nerve is identifying the brachioradialis and looking underneath it. The posterior interosseous nerve will enter the supinator approximately 3 cm distal to the head of the radius. These muscles need to be identified, and the nerves can be easily avoided.

There is a vascular leash of one or more vessels of the radial recurrent artery, which crosses the incision. Plating on the most proximal portion of the radius, these blood vessels will almost certainly have to be ligated.

On the medial side, the median nerve and brachial artery are potentially at risk. They are medial to the biceps tendon, which is easily palpable. As long as you stay lateral to the tendon, the artery and nerve are safe.

TECHNIQUE

The incision starts at the lateral aspect of the elbow flexor crease, which places it approximately 2 cm proximal to the elbow joint itself. It is just to the medial side of the brachioradialis, which is usually palpable. The incision is carried through the subcutaneous tissue. The fibers of the brachioradialis are identified by their longitudinal orientation. They are gently retracted laterally until the radial nerve on the muscle's undersurface is identified so it can be retracted. This retraction needs to be very gentle or you will damage the posterior interosseous nerve as it enters the supinator. Once that is done, the biceps tendon is exposed. This becomes the medial extent of your dissection. The interval between the biceps and the brachioradialis is developed and carried into the forearm. At the deeper level, you will be developing the interval between the pronator teres and the supinator.

At that point, the forearm is supinated, which will expose the most medial and distal portions of the supinator insertion. These portions are stripped directly off of the radius, retracting that muscle and the posterior interosseous nerve in a posterolateral direction, which takes the tension off of the nerve and provides excellent exposure for the radius. The recurrent radial artery and its branches to the brachioradialis are usually encountered and need to be ligated.

At this point, the dissection can be carried proximally into the elbow joint or distally down the forearm. The next structure attaching to the radius is the pronator teres insertion, which inserts distal to the supinator tendon.

TRICKS

The major trick is to retract the brachioradialis in a lateral direction and find the radial nerve underneath. The second trick is to supinate the forearm and strip the supinator off of the radius, such that the posterior interosseous nerve is protected by the muscle belly of the supinator.

HOW TO TELL IF YOU ARE LOST

If you just see muscle and do not see the radial nerve underneath the brachioradialis, you are probably lost in a lateral direction and are developing the interval between the brachioradialis and the wrist extensors. The brachioradialis is loose at the level of the elbow joint and you should clearly see its medial border. If you are lost too far medially, you will see the biceps tendon. The lacertus fibrosis from the biceps frequently needs to be transected, but you should clearly see the lateral border of the biceps and not be dissecting along its medial border. If you are lost too far proximally or distally, rotation of the forearm will identify the area of the radial head and bicipital tuberosity.

FIGURE 15–1 The skin incision starting at the lateral aspect of the elbow flexor crease and going distally.

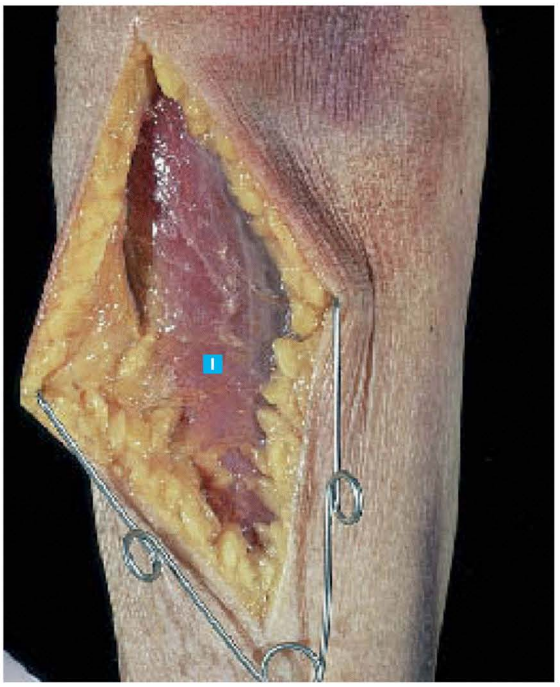

FIGURE 15–2 The brachioradialis underneath the subcutaneous tissue. This is the first muscle encountered. You should be able to see the fibers running longitudinally, paralleling the forearm.

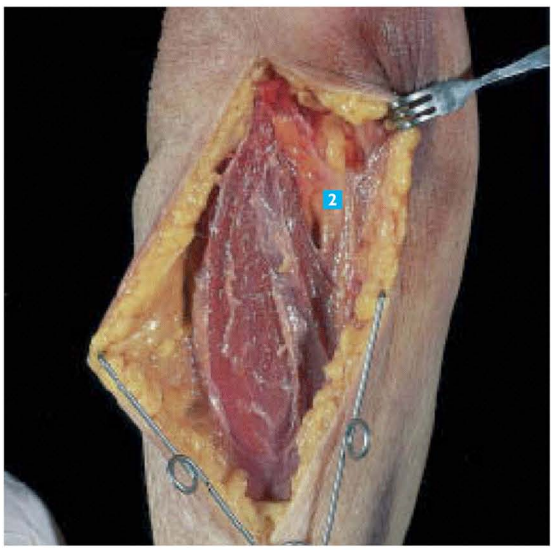

FIGURE 15–3 The fat underneath the brachioradialis at the level of the elbow joint. This is your clue that you are in the area of the radial nerve.

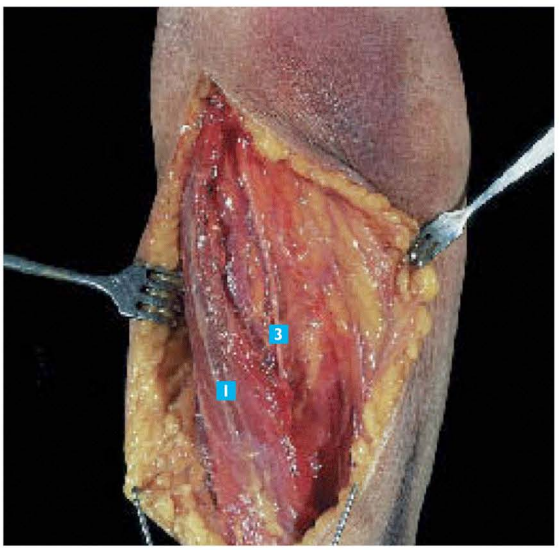

FIGURE 15–4 The muscle being retracted. The sensory branch of the radial nerve is seen in the fat underneath the muscle. The nerve is paralleling the muscle at this point.

1 Brachioradialis
2 Nerve in Fat Under Muscle
3 Sensory Branch of Radial Nerve
4 Recurrent Branches of Radial Artery
5 Radial Nerve Area
6 Supinator
7 Radius
8 Pronator Teres

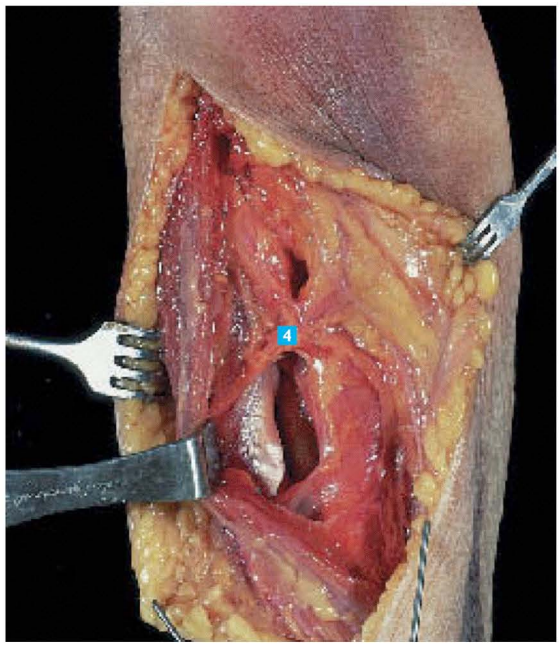

FIGURE 15–5 The blood vessels crossing from medial to lateral. This is the only structure that needs to be transected with this approach.

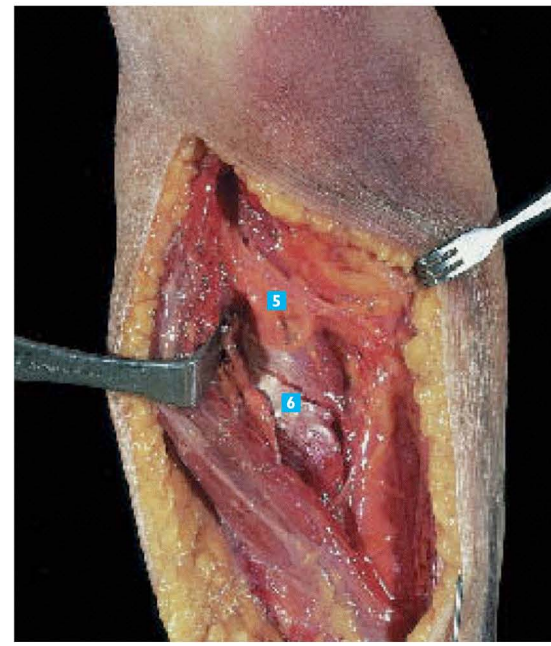

FIGURE 15–6 The brachioradialis and superficial sensory branch retracted laterally, exposing the supinator underneath. The deep branch of the radial nerve is not yet apparent, but it is found just proximal to the supinator and going into that muscle.

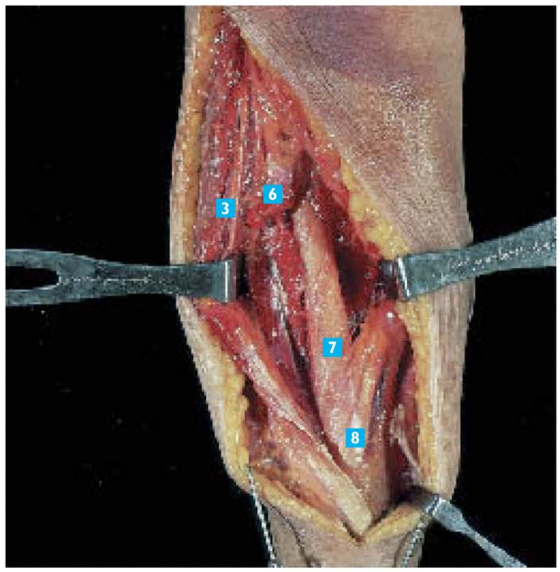

FIGURE 15–7 The supinator retracted in a radial direction, having been freed from the radius. The pronator teres is seen distally and the shaft of the radius is apparent. This incision could be carried more proximally to expose the radial head at the elbow or distally as far as necessary.

1 Brachioradialis
2 Nerve in Fat Under Muscle
3 Sensory Branch of Radial Nerve
4 Recurrent Branches of Radial Artery
5 Radial Nerve Area
6 Supinator
7 Radius
8 Pronator Teres

MIDLINE APPROACH

USES

This is a utilitarian approach that is useful for all tendon work, nerve repair, and artery repair work in the arm. It is also useful for fracture repair work on the distal radius that entails using a volar plate.

ADVANTAGES

This is an extensile exposure that can be extended as far as necessary in either direction.

DISADVANTAGES

The major disadvantage is that the neurovascular structures of the forearm are at risk with this approach, and they must be identified and protected.

STRUCTURES AT RISK

The median nerve is the major structure at risk with this midline approach. The nerve is underneath the sublimis tendon throughout most of its course through the forearm, but comes to the surface in the distal forearm along the radial side of the sublimis tendons. It gives off the palmar cutaneous branch typically on its radial side, which runs parallel to the nerve and proceeds to the skin of the palm over the thenar eminence.

On the radial side of the flexor carpi radialis is the radial artery. This artery is usually out of the way and is protected by retracting the flexor carpi radialis tendon and artery in a radial direction.

On the ulnar side of the forearm, just inside the flexor carpi ulnaris tendon and muscle, is the ulnar artery and nerve. These structures are at risk any time the profundis tendons are exposed. They need to be identified and protected prior to opening the fascia of the profundis muscle.

In the very depth of the wound, the anterior interosseous nerve runs along the interosseous membrane. It is the nerve supply to the flexor pollicis longus and to the pronator quadratus, both of which are very important muscles. There should be no dissection or stripping done of the tissue on the anterior aspect of the interosseous membrane, to prevent injury to this nerve. All stripping should be done directly over the radius itself.

TECHNIQUE

A straight midline incision is made, typically centered over the palmaris longus tendon, and it is carried through the subcutaneous tissue. The tendon of the palmaris longus is identified and retracted in either direction, whichever seems convenient. The fascia on its underlying surface is what covers the flexor digitorum sublimis muscles. This fascia should be opened in the midline on the proximal end of the incision in the region where the reddish coloration of the muscles is clearly visible. This is a safe area in which to open this fascia. If you are too far distal, you risk damaging the median nerve. Once the sublimis is mobilized, it is possible to see the median nerve on its undersurface coming up to the superficial layers at the wrist joint itself.

To expose the flexor digitorum profundis tendons, it is usually easier to retract the median nerve and sublimis in a radial direction, and the ulnar neurovascular structures and the flexor carpi ulnaris in an ulnar direction. This retraction exposes the profundis muscle and tendons.

If the goal is to place a volar plate on the radius, then the median nerve along with all of the other neurovascular structures, except the radial artery, are retracted in an ulnar direction. Care must be taken not to damage the palmar cutaneous nerve. The pronator quadratus then needs to be stripped from its insertion onto the radius to expose the bone itself.

TRICKS

The major trick to entering the forearm safely is to identify the palmaris longus and to come through the skin directly over that tendon. The tendon can be sacrificed without any functional loss to the patient. The fascia overlying the sublimis is opened over the muscle. As long as you can clearly see the reddish color of the muscle, you will not have to worry about damaging the median nerve.

The trick to protecting the radial artery is to realize that it is moving in a dorsoradial direction and to take it in that direction when retracting. Taking the flexor carpi radialis in that direction also provides some protection for the radial artery.

The main trick to protecting the ulnar neurovascular structures is to approach the flexor carpi ulnaris from the subcutaneous side. Because the nerve and artery are underneath the muscle, this puts the muscle between you and the nerve as you make your approach.

HOW TO TELL IF YOU ARE LOST

Getting lost medially or laterally is fairly common with this approach because there are so many tendons in view. The main way to tell if you are too far to one side or the other is to grasp the tendon gently and pull on it and see what moves. That should give you an idea what structure you are looking at. It is no problem if you are too far one way or another. You simply come back to the midline and find what structure you are looking for. If you see an artery on either the medial or the ulnar side, you are too far in that direction unless your goal is to repair that artery.

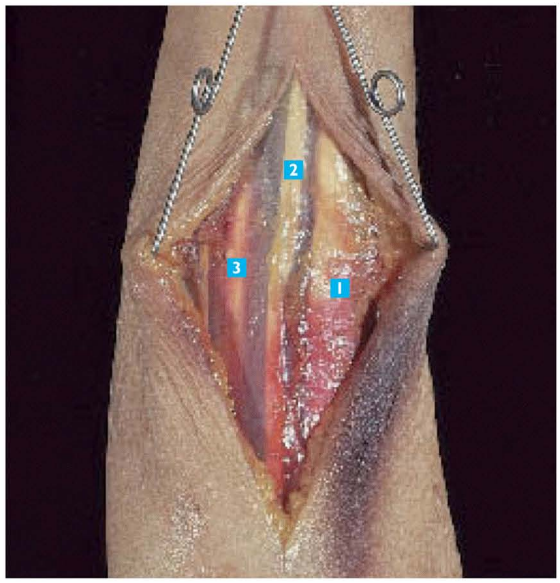

FIGURE 16–1 The skin and subcutaneous tissue incised in the midline forearm approach. The skin incision is in the midline of the forearm and carried as far proximally and distally as necessary to expose the structures of interest.

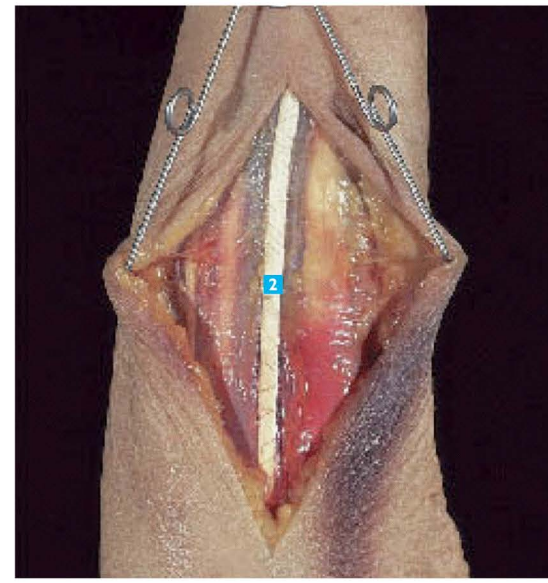

FIGURE 16–2 The fascia being split over the palmaris longus tendon. Entering the forearm by splitting the fascia over the tendon is the safest way to avoid any damage to the median nerve.

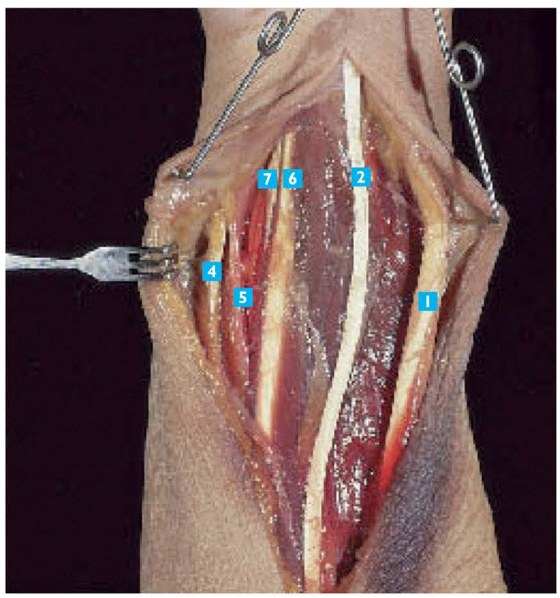

FIGURE 16–3 The flexor carpi radialis tendon on the right side. The muscle seen to the sides of the palmaris longus is not the flexor carpi ulnaris, but rather tendons of the flexor digitorum sublimis. The flexor carpi ulnaris is on the far side. The tissue just to the inside of it is the ulnar neurovascular bundle.

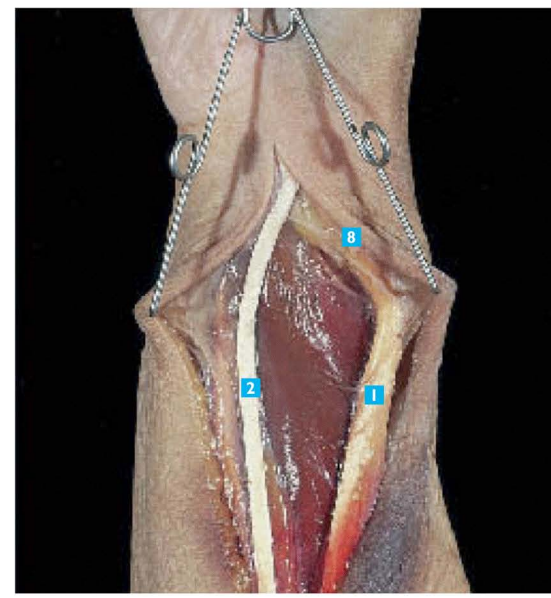

FIGURE 16–4 The palmaris longus tendon retracted ulnarward and the flexor carpi radialis tendon retracted radially. The muscle is the flexor digitorum sublimis. Notice that in the distal radial corner is an area of fat. This is the warning sign that the median nerve is close by.

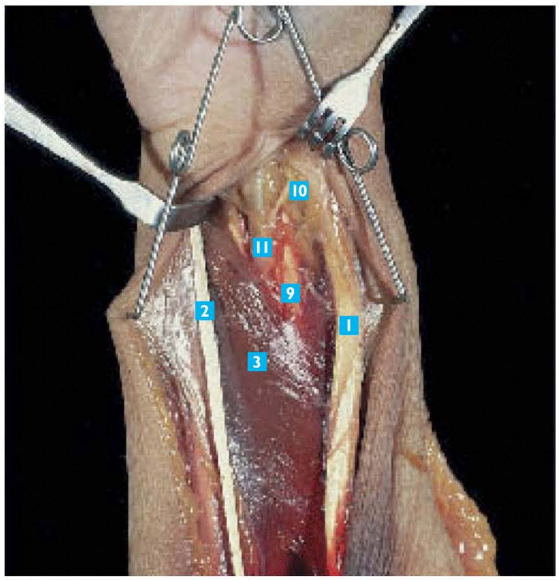

FIGURE 16–5 The flexor digitorum sublimis retracted ulnarward exposing the median nerve coming from underneath it. With any anterior approach to the forearm, as long as you are superficial to that muscle, the nerve is protected. Also note coming off of the radial side of the median nerve is the palmar cutaneous branch of that nerve. Because it comes off the radial side, it is generally safer to retract the median nerve radially if that is possible.

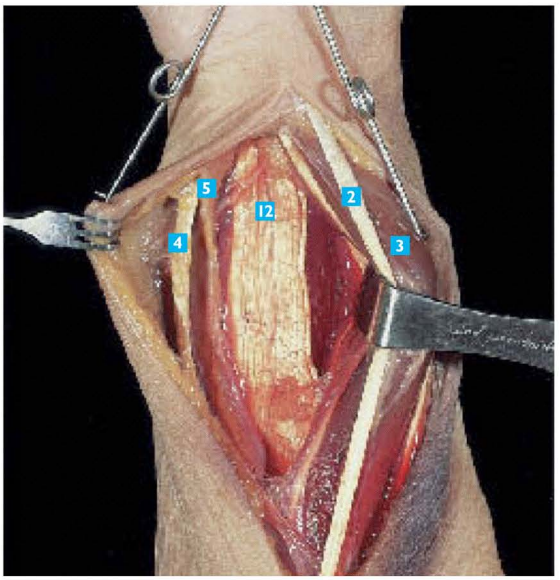

FIGURE 16–6 The flexor digitorum sublimis retracted in a radial direction along with the median nerve. This exposes the tendon of the flexor digitorum profundis. Also well seen just to its ulnar side is the ulnar neurovascular bundle, and ulnar to that is the tendon of the flexor carpi ulnaris. The flexor carpi ulnaris should be approached from the subcutaneous side to protect the neurovascular bundle.

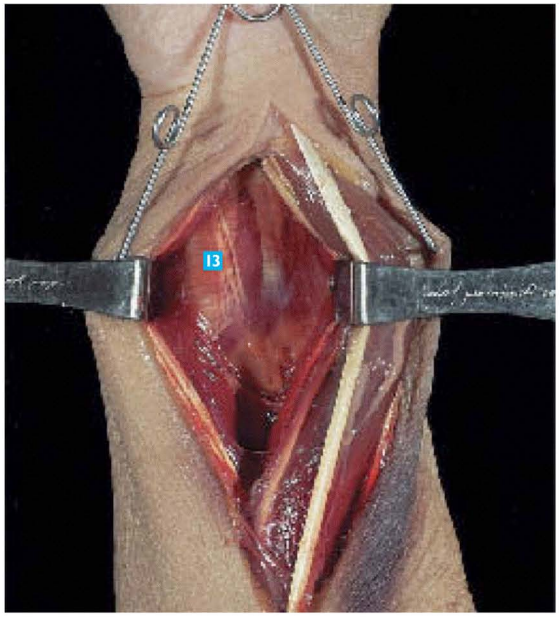

FIGURE 16–7 The view with the flexor digitorum profundis retracted radially and the ulnar neurovascular bundle and flexor carpi ulnaris retracted ulnarward, exposing the pronator quadratus.

1. Flexor Carpi Radialis
2. Palmaris Longus
3. Flexor Digitorum Sublimis
4. Flexor Carpi Ulnaris
5. Ulnar Nerve and Artery
6. Flexor Digitorum Sublimis to 4th Finger
7. Flexor Digitorum Sublimis to 5th Finger
8. Fat Around Median Nerve
9. Flexor Digitorum Sublimis Tendon to 3rd Finger
10. Palmar Cutaneous Branch
11. Median Nerve
12. Flexor Digitorum Profundus
13. Pronator Quadratus
14. Flexor Pollicis Longus
15. Palmar Cutaneous Nerve
16. Radial Artery

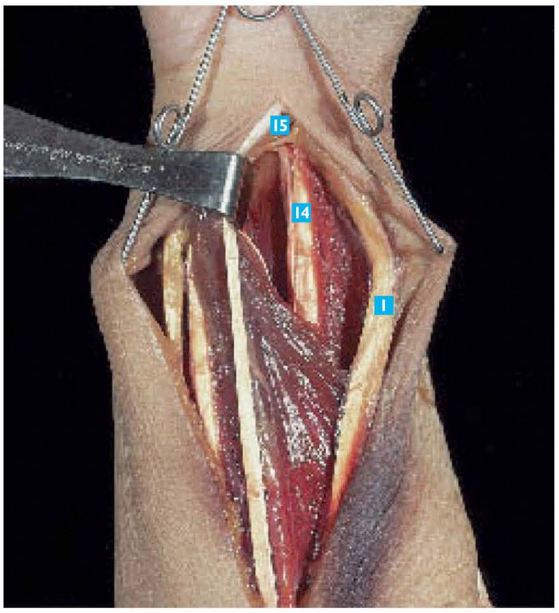

FIGURE 16–8 The sublimis and profundis retracted in an ulnar direction. The flexor pollicis longus is seen running along the radial side deep to the flexor carpi radialis. Note that the palmar cutaneous branch is at some risk with the median nerve being retracted in an ulnar direction. If you are retracting more proximally, traction on the nerve should not be a problem.

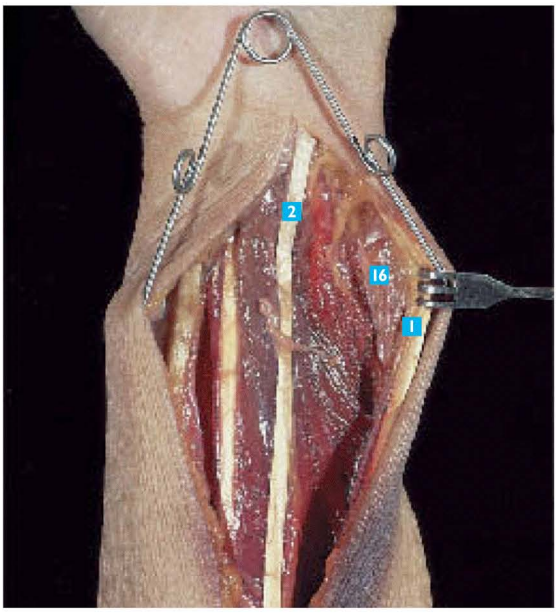

FIGURE 16–9 The dissection to the radial artery. The flexor carpi radialis can be retracted in either direction; it can be pulled in an ulnar direction as easily as the radial direction seen here. The radial artery should be retracted in a dorsal radial direction because that is the direction it is going when it leaves the forearm. There is not a significant color distinction between this artery and the structures around it.

1. Flexor Carpi Radialis
2. Palmaris Longus
3. Flexor Digitorum Sublimis
4. Flexor Carpi Ulnaris
5. Ulnar Nerve and Artery
6. Flexor Digitorum Sublimis to 4th Finger
7. Flexor Digitorum Sublimis to 5th Finger
8. Fat Around Median Nerve
9. Flexor Digitorum Sublimis Tendon to 3rd Finger
10. Palmar Cutaneous Branch
11. Median Nerve
12. Flexor Digitorum Profundus
13. Pronator Quadratus
14. Flexor Pollicis Longus
15. Palmar Cutaneous Nerve
16. Radial Artery

SECTION V

WRIST

Frances Sharpe, M.D.
Milan Stevanovic, M.D.

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DORSAL APPROACH

USES

This approach is useful for wrist fusions, fracture fixation, and tenosynovectomy of the tendons.

ADVANTAGES

This midline approach can be extended as far proximally or distally as necessary.

DISADVANTAGES

There are no disadvantages to this approach.

STRUCTURES AT RISK

The tendons are at risk, but they are usually large and apparent, and easy to avoid. One structure at risk that is less apparent is the terminal branch of the posterior interosseous nerve, which gives articular branches to the dorsal wrist capsule. This nerve runs deep to the extensor tendons at the radial side of the fourth compartment. Inadvertent injury to this nerve has been reported to result in painful neuroma and may be a cause of dorsal wrist pain.

TECHNIQUE

An incision is made just to the ulnar side of Lister's tubercle and can cross the wrist in a straight line. It is carried through the subcutaneous tissue. The tendons of the extensor digitorum communis are usually easily apparent and you typically retract them to the ulnar side. The dorsal wrist capsule can be opened longitudinally in a T-, H-, or U-shaped incision, which should provide exposure to the distal radius and all carpal bones. If necessary, this incision can be extended out onto the metacarpals for fusion procedures.

Deep to the extensor tendons (on the radial side of the base of the fourth compartment) is the posterior interosseous nerve. At this level, the nerve only gives off articular branches to the dorsal wrist capsule. The nerve can be left alone and usually does not get in the way of the dissection. In some cases, however, the nerve is isolated and divided (posterior interosseous neurectomy) to denervate the wrist for pain control. It can also be harvested for use as a nerve graft. Usually 1.5 to 2.0 cm of nerve graft can be harvested.

TRICKS

The major trick is to stay just to the ulnar side of Lister's tubercle, so that you are in the interval between the third and fourth compartments. Typically, the carpal bone that is in view when you open the wrist capsule is the lunate. The scapholunate ligament is generally in line with Lister's tubercle. The lunotriquetral ligament lies very ulnar to the capsular incision.

HOW TO TELL IF YOU ARE LOST

It is almost impossible to get lost with this approach. Palpation should guide you to where you want to go. If you are lost too far proximally or distally, you simply extend the incision. If you end up being too far medial or lateral for whatever structure in the wrist you are interested in, you extend the incision so you can undermine back to the area of the interest. If you see the distal radial ulnar joint or the triangular fibrocartilage complex, you are generally too far ulnarward.

FIGURE 17–1 A: The outline of the skin incision and landmarks. B: The skin incision centered over the dorsum of the wrist.

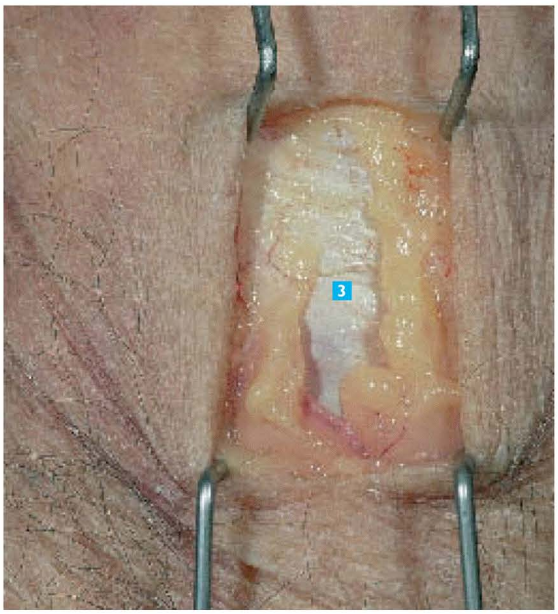

FIGURE 17–2 The extensor retinaculum underneath the subcutaneous fat.

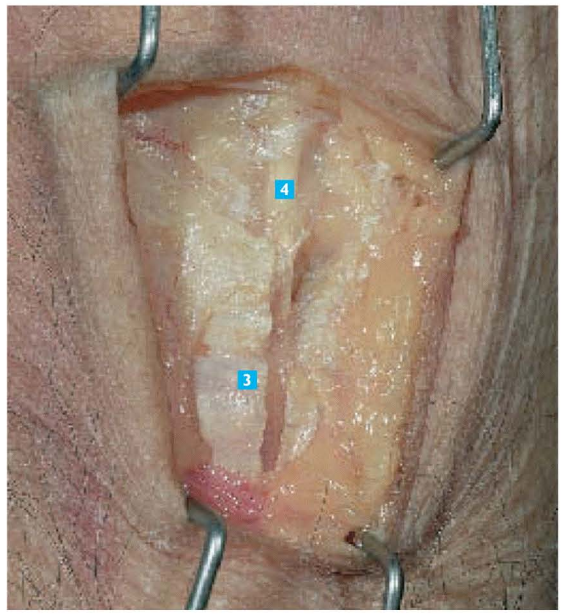

FIGURE 17–3 The retinaculum split with one of the extensor tendons seen below the opened retinaculum.

1. Lister's Tubercle
2. Incision Between 3rd and 4th Extensor Compartments
3. Extensor Retinaculum
4. Extensor Digitorum Communis
5. Tendons
6. Wrist Capsule
7. Posterior Interosseos Nerve
8. Lunate
9. Scaphoid
10. Scapholunate Ligament
11. Radius
12. Extensor Pollicus Longus
13. Extensor Digitorum Communis

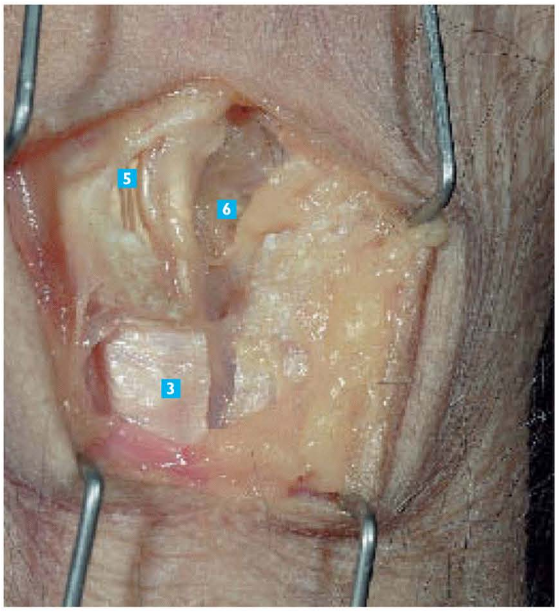

FIGURE 17–4 The dorsal wrist capsule.

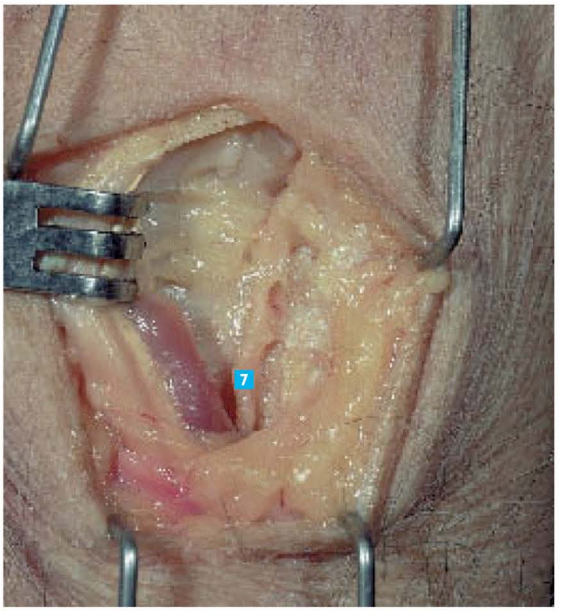

FIGURE 17–5 The posterior interosseos nerve into the wrist.

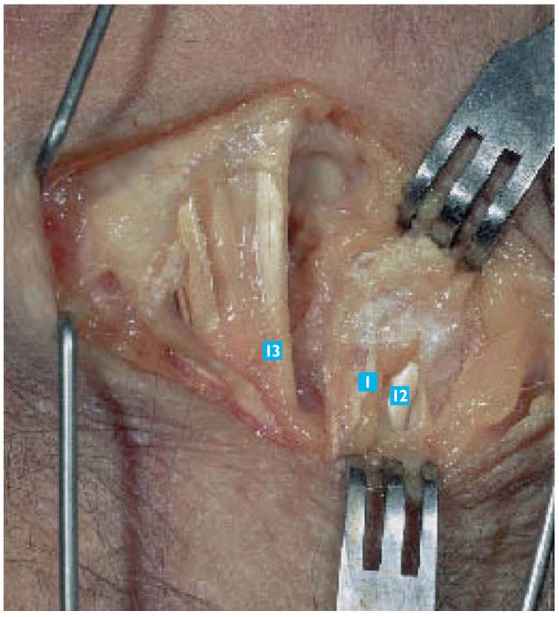

FIGURE 17–6 The interval between the finger extensor tendons and the extensor pollicis longus, whose sheath has been opened so you can see it as it wraps around Lister's tubercle.

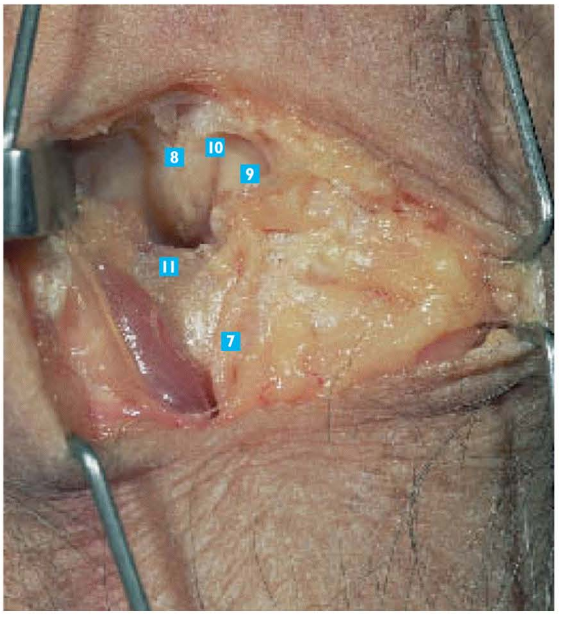

FIGURE 17–7 The capsule opened.

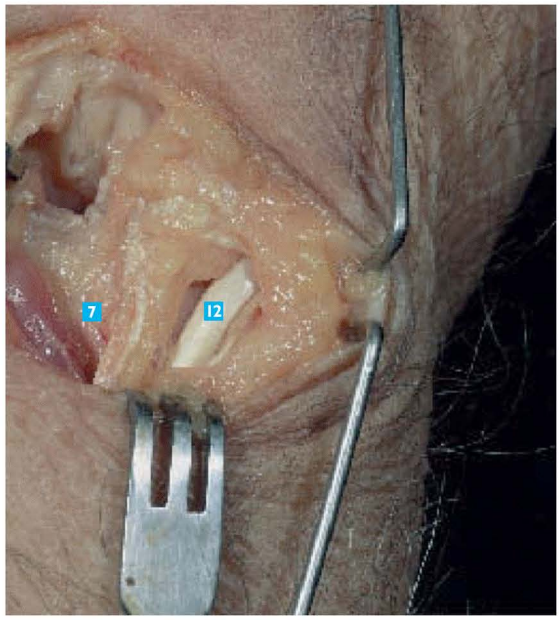

FIGURE 17–8 The relationship between the nerve and the tendon.

1. Lister's Tubercle
2. Incision Between 3rd and 4th Extensor Compartments
3. Extensor Retinaculum
4. Extensor Digitorum Communis
5. Tendons
6. Wrist Capsule
7. Posterior Interosseos Nerve
8. Lunate
9. Scaphoid
10. Scapholunate Ligament
11. Radius
12. Extensor Pollicus Longus
13. Extensor Digitorum Communis

De Quervain's Approach to the Thumb Abductor Tendons

USES

This is a single-use approach used to release the first dorsal extensor compartment in De Quervain's tendinitis, releasing the abductor pollicis longus and extensor pollicis brevis tendons.

ADVANTAGES

This is a direct approach to the pathology.

DISADVANTAGES

This approach is not easily extended if other pathology is identified.

STRUCTURES AT RISK

The main structure, other than the tendons themselves, is the superficial sensory branch of the radial nerve, whose branches are typically seen in the incision.

TECHNIQUE

A 2- to 3-cm incision is made over the radial side of the forearm and carried through the dermis only. It is very important to use blunt dissection beyond that to identify the sensory branches of the radial nerve. Once those branches are protected, you will then have identified the extensor retinaculum deep to those branches, and the tendon sheath can be opened for several centimeters proximally and distally.

TRICKS

The approach is designed to release the extensor pollicis brevis and the abductor pollicis longus tendon. The abductor pollicis longus often has two or more splits. This can fool the surgeon into thinking he has identified both tendons. This confusion will cause the surgeon to leave the extensor pollicis brevis tendon unreleased, and as a result the patient will continue to have symptoms. These tendons run in different sheaths, and so two tendon sheaths need to be opened for this procedure. The abductor pollicis longus and extensor pollicis brevis run in separate sheaths in more than 70% of surgical cases. This procedure frequently requires opening two separate sheaths.

HOW TO TELL IF YOU ARE LOST

It is difficult to be lost with this procedure if the incision is over the radial side of the distal forearm. If you are too far dorsal, you will encounter the wrist extensor tendons. You will also encounter superficial to them the extensor pollicis longus, which is not part of the pathology. If you encounter a tendon that when tugged upon extends the interphalangeal (IP) joint of the thumb, you are too far to the dorsum. (In some cases, the extensor pollicis brevis extends the IP joint of the thumb. So do not use this landmark exclusively to determine which tendon you are releasing.)

It is also possible to be too far volar, in which case, you will encounter the radial artery.

FIGURE 18–1 (Left) The landmarks and skin incision (dotted line). (Right) The skin incision, typically 2 to 3 cm long. It is generally made transverse to the long axis of the forearm.

FIGURE 18–2 The underlying sensory nerves, which are medially in the subcutaneous tissue.

FIGURE 18–3 The tendon sheath of the abductors opened, exposing the tendons. Notice the longitudinal splitting of the abductor pollicis longus into multiple slips. These should not be confused with the extensor pollicis brevis tendon.

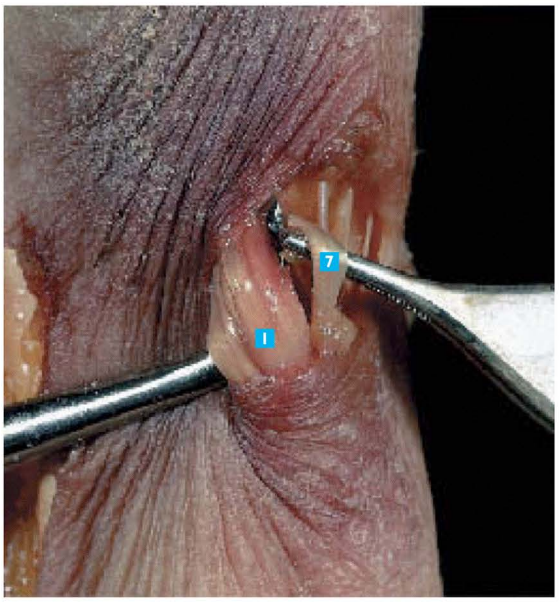

FIGURE 18–4 The extensor pollicis brevis as distinct tendons separate from the abductor pollicis longus. It is critical that this tendon be identified so that the sheath can be released. If that is not done, the patient will likely have persistent symptoms.

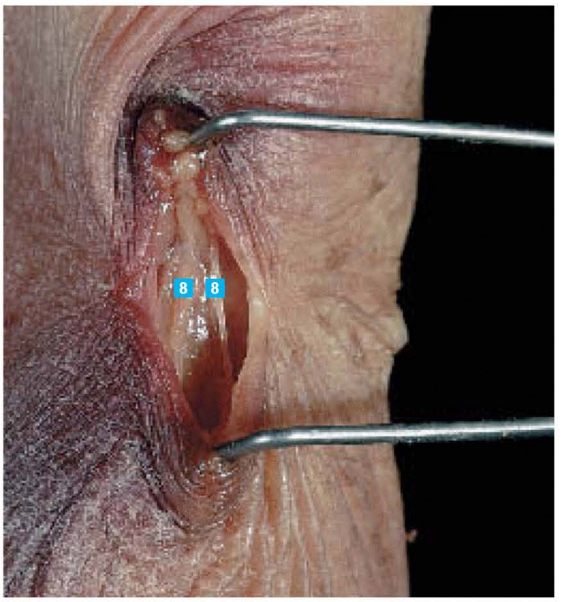

FIGURE 18–5 The incision expanded to demonstrate the sensory nerves more clearly.

1. Abductor Pollicis Longus
2. Radial Styloid
3. Transverse Surgical Incision
4. Superficial Radial Nerve
5. Abductor Tendon Under Fascia
6. Multiple Slips of Abductor Pollicis Longus Tendon
7. Extensor Pollicis Brevis
8. Sensory Nerves

CARPAL TUNNEL APPROACH

USES

This approach is used for open carpal tunnel releases. It is also used to treat fracture of the hook of the hamate. It is further used as an extension of the forearm approaches to the volar aspect of the distal radius and volar aspect of the wrist such as might be needed in distal radius fractures or wrist dislocations.

ADVANTAGES

The approach is through the internervous area between the median and ulnar nerves. There are no vascular structures at risk if done correctly, and the incision heals well with little scarring. This approach is easy to extend proximally or distally as needed.

DISADVANTAGES

The palmar cutaneous branch of the median nerve supplies sensation to the base of the thenar area. It is a superficial structure that can be injured in this approach. If injured, it can form a neuroma and cause disabling pain in the palm.

STRUCTURES AT RISK

The palmar cutaneous branch of the median nerve is the most commonly injured structure. It comes off of the median nerve either in the midline or on the radial side.

The major disaster with the carpal tunnel approach is if the patient has a congenital abnormality of the motor branch to the thenar muscles that is not recognized, resulting in the branch being cut. This injury used to be called the million-dollar injury because of the size of the malpractice awards to compensate for the disability that results when the thenar muscles no longer function. Typically, the motor branch of the thenar muscles comes off the median nerve along the radial side just distal to the transverse carpal ligament and is, for the most part, out of the way if you are staying along the ulnar side of the canal. There are, however, multiple congenital abnormalities of this nerve that have been described and that put the branch at greater risk. Anything that is encountered coming through the transverse carpal ligament from its deep side should be very carefully dissected. There are typically no structures that penetrate the transverse carpal ligament.

If the dissection is carried too far distally, the superficial palmar arch is at risk. It is avoided by identifying the distal end of the transverse fibers, releasing them, and not doing any further cutting distally. Spreading of the soft tissues to identify the superficial palmar arch coming off of the ulnar artery is acceptable.

TECHNIQUE

The incision typically parallels the thenar flexor crease, approximately 2 mm to its ulnar side. Once the subcutaneous tissue is split, the palmar fascia is identified, cutting only transverse fibers. The flexor retinaculum should be split proximally for a distance of several centimeters, because occasionally it can be part of the impingement causing the carpal tunnel syndrome. Once the transverse carpal ligament is split, the median nerve can be visualized.

TRICKS

The major trick is to avoid all of the potential traps. The major way of avoiding damage to the median nerve is to stay along the ulnar side of the carpal canal when going through the transverse carpal ligament. Stay just radial to the hook of the hamate, which is usually easily palpable with a hemostat placed underneath the transverse carpal ligament in the carpal canal. You can then cut right down on the hemostat.

The trick to avoiding the palmar cutaneous branch of the median nerve is to stay to the ulnar side of the nerve.

The major trick to avoiding the superficial palmar arch is to identify the distal fibers of the transverse carpal ligament and not go distal to that with any dissection.

HOW TO TELL IF YOU ARE LOST

Once you have cut the flexor retinaculum proximal to the wrist, you should palpate the transverse carpal ligament with a hemostat or other similar blunt instrument and feel the grittiness of the transverse fibers. You should also feel the hook of the hamate from inside the carpal canal and then start your transection with the nerve protected. Once you are deep to the superficial fat and the palmar fascia, any further fat that is encountered distally indicates you are already distal to the end of the ligament and are putting the superficial palmar arch at great risk.

If the hook of the hamate is not just to the ulnar side of your transection, you are lost too far medially.

If you do not see multiple tendons once you go through the fascia, you have gone to the ulnar side of the hook of the hamate and are actually opening Guyon's canal. Proximally there is no risk of getting lost.

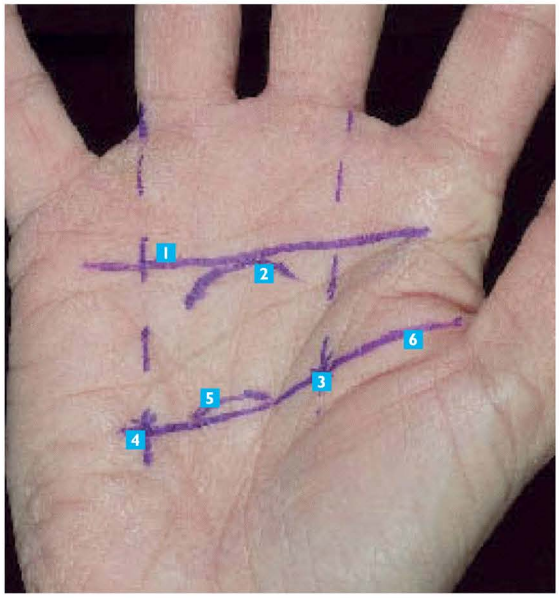

FIGURE 19–1 (Top Left) The general landmarks for surgical approaches to the hand. Kaplan's cardinal line proceeds from the ulnar border of the thumb proximal phalanx. The landmark is the deep palmar arch. At the intersection of Kaplan's line with a line following the ulnar border of the ring finger lies the hook of the hamate. At the intersection of Kaplan's line with a line extended along the radial border of the long finger lies the motor recurrent branch of the median nerve. The transverse palmar crease is the landmark for the superficial palmar arch. (Top Right) The skin incision for carpal tunnel release. The incision can be extended obliquely and ulnarly across the wrist crease. (Bottom Left) The skin incision follows the thenar flexor crease about 5 mm to its ulnar side.

1 Transverse Palmar Crease
2 Superficial Palmar Arch
3 Recurrent Branch of Median Nerve Entry Into Thenar Muscles
4 Hook of Hamate
5 Deep Palmar Arch
6 Kaplan's Cardinal Line
7 Palmar Fascia
8 Fat and Loose Connective Tissue Under Palmar Fascia
9 Palmaris Brevis
10 Fibers of Palmaris Brevis
11 Proximal End of Transverse Carpal Ligament
12 Fatty and Connective Tissue Overlying Transverse Carpal Ligament
13 Transverse Carpal Ligament
14 Flexor Tendons
15 Thenar Muscle Origin
16 Cut Edge of Transverse Carpal Ligament
17 Median Nerve
18 Fat Overlying Ulnar Artery
19 Palmaris Longus
20 Common Digital Nerves
21 Motor Recurrent Branch of Median Nerve
22 Sensory Branches of Median Nerve to Thumb
23 Flexor Pollicis Longus

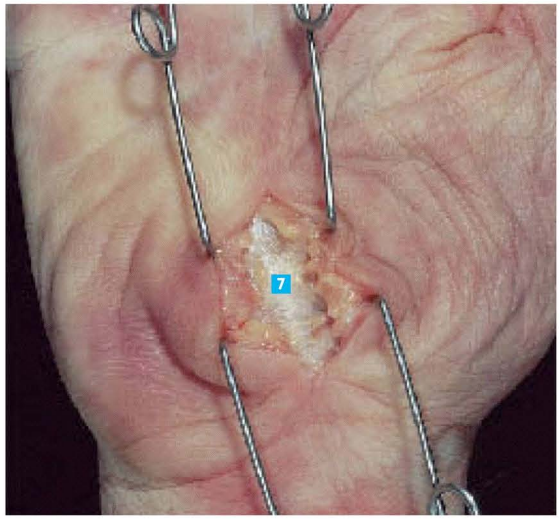

FIGURE 19–2 The palmar fascia after the fat has been separated from it.

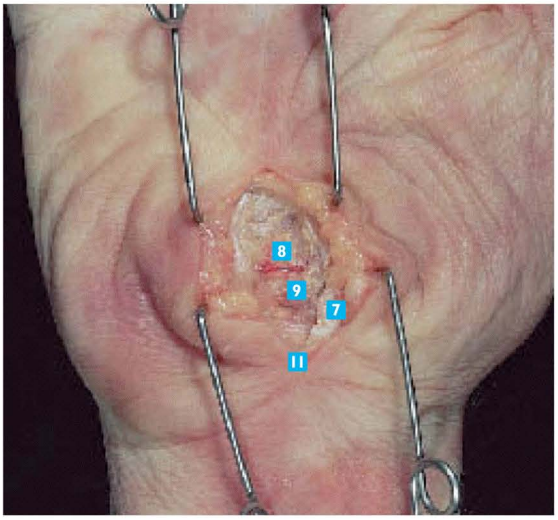

FIGURE 19–3 The palmaris brevis and the transverse carpal ligament. The proximal end of the ligament is visible.

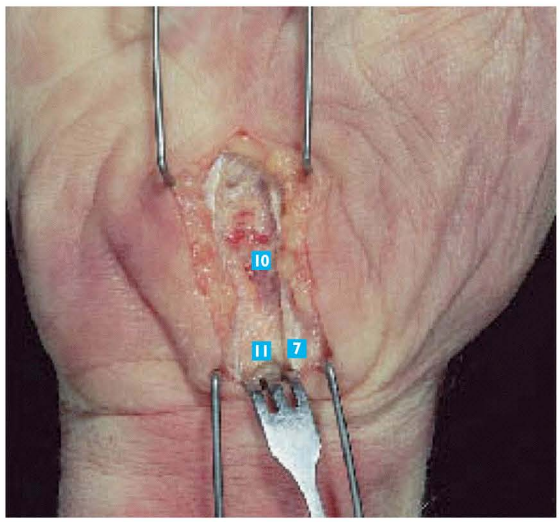

FIGURE 19–4 The skin being retracted proximally. You can see the palmar fascia and the proximal border of the transverse carpal ligament. The fibers of the palmaris brevis are also visible. Proximally just at the end of the Senn retractor, you can see the flexor retinaculum, which is continuous with the transverse carpal ligament. This will need to be transected proximally for several centimeters in the carpal tunnel release.

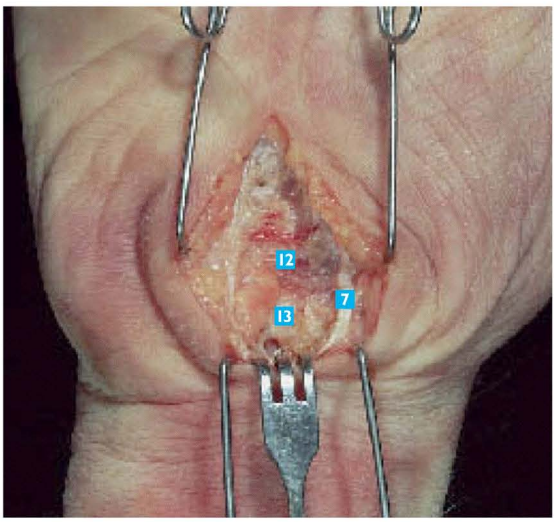

FIGURE 19–5 The transverse carpal ligament, clearly visible.

1. Transverse Palmar Crease
2. Superficial Palmar Arch
3. Recurrent Branch of Median Nerve Entry Into Thenar Muscles
4. Hook of Hamate
5. Deep Palmar Arch
6. Kaplan's Cardinal Line
7. Palmar Fascia
8. Fat and Loose Connective Tissue Under Palmar Fascia
9. Palmaris Brevis
10. Fibers of Palmaris Brevis
11. Proximal End of Transverse Carpal Ligament
12. Fatty and Connective Tissue Overlying Transverse Carpal Ligament
13. Transverse Carpal Ligament
14. Flexor Tendons
15. Thenar Muscle Origin
16. Cut Edge of Transverse Carpal Ligament
17. Median Nerve
18. Fat Overlying Ulnar Artery
19. Palmaris Longus
20. Common Digital Nerves
21. Motor Recurrent Branch of Median Nerve
22. Sensory Branches of Median Nerve to Thumb
23. Flexor Pollicis Longus

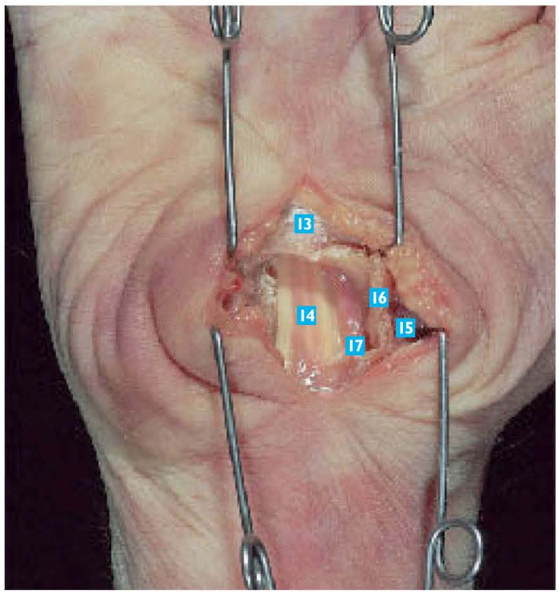

FIGURE 19–6 The transverse carpal ligament after transection. The flexor tendons and the median nerve are clearly visible underneath it.

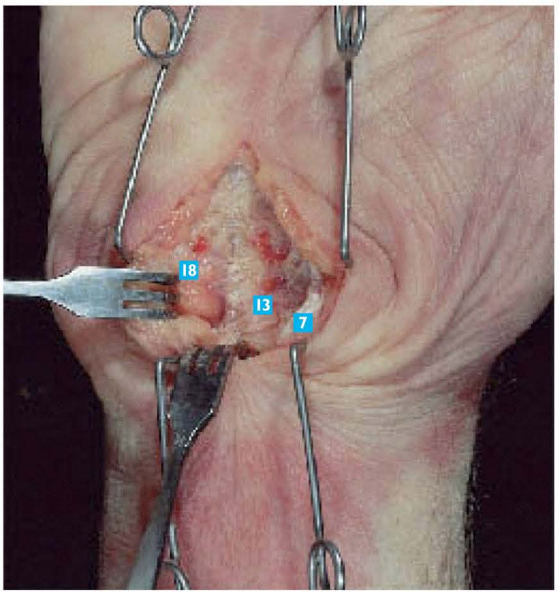

FIGURE 19–7 The view that you would see if you were dissecting to ulnarward. You would still see the palmar fascia in the transverse carpal ligament but you would run into fat before you saw tendons. This indicates you are actually going down Guyon's canal, which puts the ulnar nerve and artery at great risk. Underneath the transverse carpal ligament are the tendons, not fat.

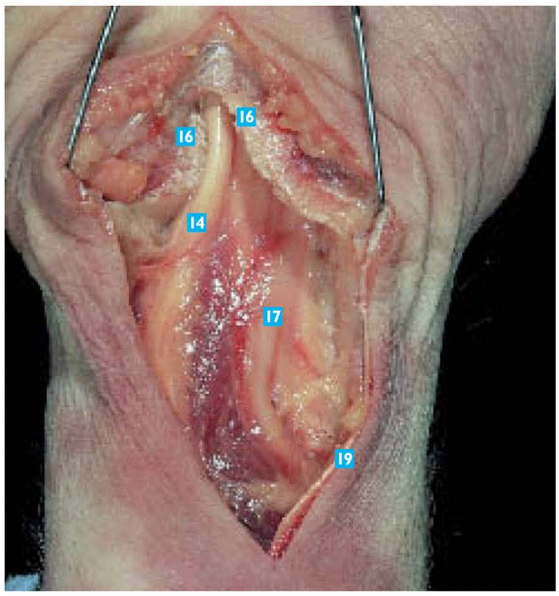

FIGURE 19–8 The proximal expansion of this dissection, showing the median nerve in the forearm, which is distinguished, based just on color and size alone, from the flexor tendons.

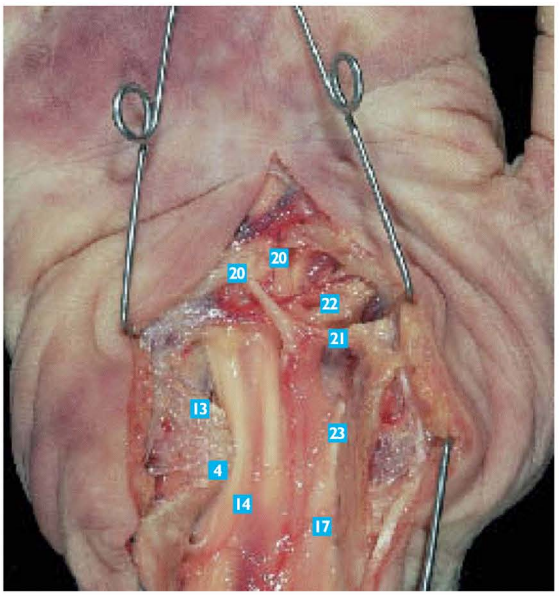

FIGURE 19–9 The distal dissection. The flexor pollicis longus tendon is apparent on the radial side. The hook of the hamate is seen ulnarward. The branching of the median nerve is also noted. Notice that the sensory branch to the thumb comes off proximal and superficial to the motor branch to the thenar muscles.

RUSSE APPROACH

USES

This specialized approach is used for fractures of the scaphoid.

ADVANTAGES

This approach provides the best visualization of the scaphoid with the least risk to the blood supply.

DISADVANTAGES

If there is more pathology requiring repair besides the scaphoid fracture, it is difficult to extend this approach into the palm without disrupting the thenar muscles.

STRUCTURES AT RISK

Proximal to the wrist crease, the radial artery is at risk on the radial side of the incision. The palmar cutaneous branch of the median nerve is at risk on the ulnar side.

TECHNIQUE

The incision starts on the radial side of the wrist and is approximately 3 cm proximal to the wrist flexor crease, just to the ulnar side of the radial pulse, over the flexor carpi radialis tendon. The incision curves across the wrist flexor crease in a slightly dorsal radial fashion. When the flexor carpi radialis tendon is identified, the radial artery is to its radial side. The sheath of the flexor carpi radialis is opened longitudinally. The deep surface of the sheath is longitudinally opened. This artery is retracted radially. The other tendinous structures along with the median nerve are retracted ulnarward, exposing the wrist capsule. The pronator quadratus is seen in the depth of the incision with its muscle fibers running transversely. The incision is carried through the wrist capsule, which exposes the scaphoid.

TRICKS

The main trick to this approach is to identify the flexor carpi radialis tendon and to work around it. Typically, this tendon is retracted in a radial fashion. Everything else goes laterally as you go through the wrist capsule.

HOW TO TELL IF YOU ARE LOST

This approach is based on the key landmark of the flexor carpi radialis (FCR) tendon. If you do not see the tendon, which is an easily identifiable structure, you are lost to one side or the other. If you are deep to the subcutaneous tissue and do not see any tendons, you are typically too far radial. If you go through the flexor retinaculum and see multiple tendons, you are too far ulnarward. This approach should not be carried deep until the FCR tendon is identified.

You can clearly see the fat surrounding the radial artery if you drift too far radially. If you drift too far ulnarward, you will see the multiple tendons in the carpal canal.

If you are in the deep structures and are too far proximal, you will see the transverse red fibers of the pronator quadratus. If you are lost too far distally, you will see the thenar muscle origin coming off the transverse carpal ligament.

FIGURE 20–1 The standard skin incision for the Russe approach to the volar scaphoid.

FIGURE 20–2 The flexor carpi radialis tendon is mobilized from its sheath and retracted radially.

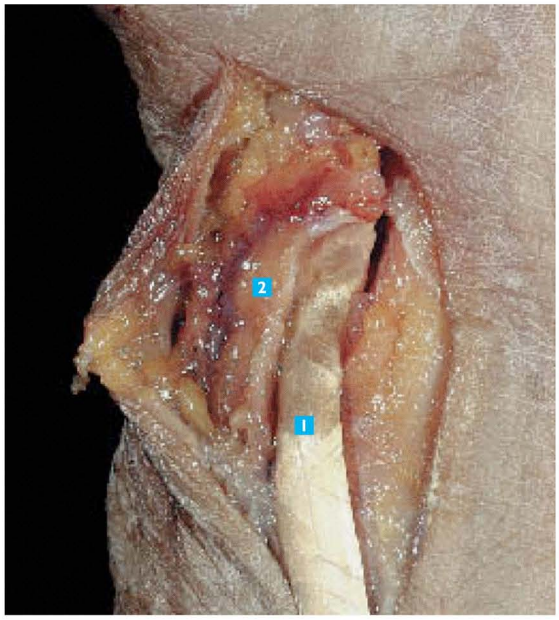

FIGURE 20–3 The radial artery lies immediately lateral to the tendon. It does not require dissection in this approach. However, caution must be exercised in retracting on the radial side.

FIGURE 20–4 The flexor carpi radialis tendon has been mobilized distally and is retracted radially, exposing the volar wrist joint capsule.

1. Flexor Carpi Radialis
2. Radial Artery
3. Wrist Capsule
4. Flexor Retinaculum
5. Finger Flexor Muscle and Tendon Under Retinaculum
6. Capitate
7. Scaphoid
8. Radius
9. Finger Flexor Tendons

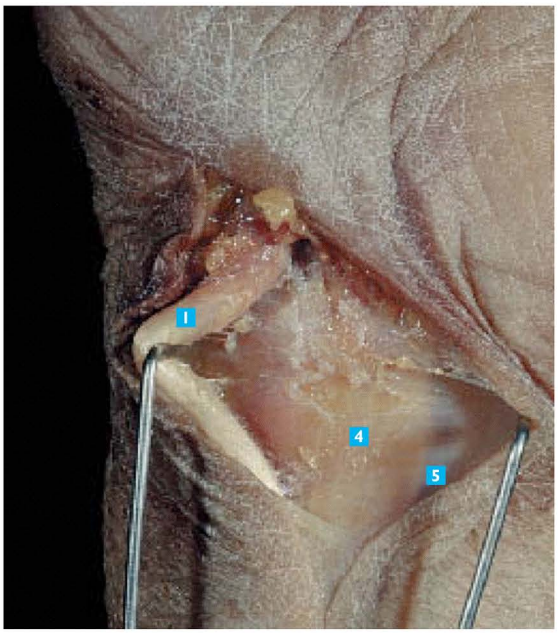

FIGURE 20–5 The flexor carpi radialis is retracted to the ulnar side of the wrist. The flexor retinaculum is seen, below which lie the flexor tendons to the fingers and the median nerve.

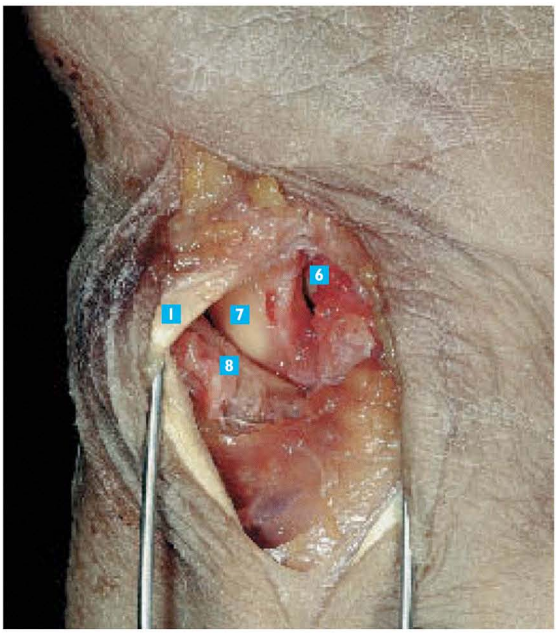

FIGURE 20–6 The wrist joint capsule has been opened, exposing the scaphoid. The radioscaphoid articulation, as well as the scaphocapitate articulation, can be well visualized.

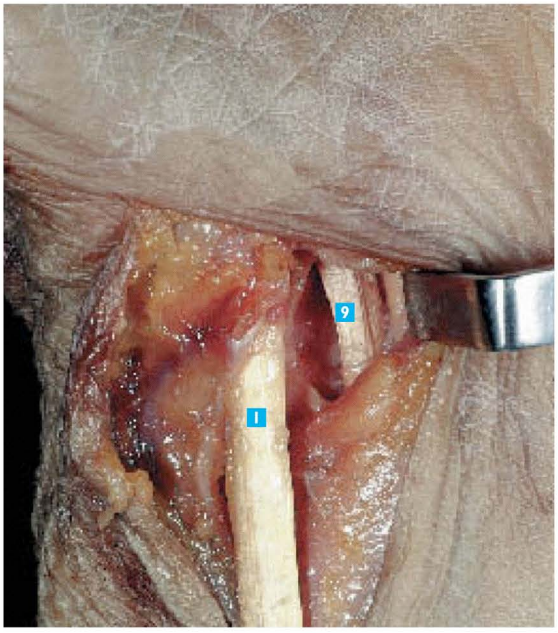

FIGURE 20–7 The flexor retinaculum has been opened to demonstrate the flexor tendons lying immediately adjacent to this incision. You will see these tendons if you are too ulnarward in your dissection.

1. Flexor Carpi Radialis
2. Radial Artery
3. Wrist Capsule
4. Flexor Retinaculum
5. Finger Flexor Muscle and Tendon Under Retinaculum
6. Capitate
7. Scaphoid
8. Radius
9. Finger Flexor Tendons

Approach to the Ulnar Nerve (Guyon's Canal)

USES

This approach provides exposure of the ulnar nerve at the wrist for decompression or repair of the nerve at the wrist and palm, treatment of tumors or masses affecting the ulnar nerve, treatment of ulnar artery injury or thrombosis, treatment of hamate fractures, or for motor neurectomy for spastic contracture of the hand.

ADVANTAGES

The approach provides direct exposure of the nerve at the wrist and is easily extensile along the course of the ulnar nerve in the forearm. The deep dissection can be performed through the same incision as for a carpal tunnel release, and both the median and ulnar nerves can be simultaneously decompressed through the same incision.

DISADVANTAGES

The incision leaves a palmar scar near the hypothenar eminence, which can be very sensitive. Incisions made over the hypothenar eminence are more likely to injure the palmar cutaneous branch of the ulnar nerve. It is sometimes better to use the same skin incision as would be used for a carpal tunnel release, and then mobilize the medial flap to gain access to Guyon's canal.

STRUCTURES AT RISK

There are many structures at risk in this approach, most importantly the ulnar nerve and artery and their branches. The motor branches of the ulnar nerve to the hypothenar muscles are at risk in this approach. They are often thin filamentous branches that can easily be mistaken for fascial bands. The palmar cutaneous branch of the ulnar nerve can also be injured.

TECHNIQUE

The skin incision borders the radial side of the flexor carpi ulnaris (FCU) tendon, diagonally crosses the proximal wrist crease, then follows longitudinally in the palm in line with the ring finger. The fascia on the radial side of the FCU is opened, and the ulnar nerve and artery are identified just below the radial edge of the FCU. The nerve is traced from proximal to distal. The roof of Guyon's canal, the volar carpal ligament, is divided in line with the skin incision. The nerve and artery are carefully mobilized and explored.

TRICKS

Identify the ulnar nerve proximal to Guyon's canal in the distal forearm. Remember that the wrist is "framed by nerves," that is, the ulnar nerve lies medial (ulnar) to the artery. Trace the nerve distally as it enters Guyon's canal. The canal is triangular in shape. The boundaries of the canal are the volar carpal ligament (roof), the pisiform and the fibrous attachments of the pisohamate ligament (medial wall), and the hook of the hamate (lateral wall). The pisiform marks the level of the division of the ulnar nerve into superficial and deep branches.

HOW TO TELL IF YOU ARE LOST

If you are too far radial, you will be directly over the hook of the hamate or over the transverse carpal ligament. Palpate the hook of the hamate to help identify your position. The fibers of the transverse carpal ligament are thicker and more distinct than the fibers of the volar carpal ligament. If you open a ligament and see a lot of tendons, you are in the carpal canal and need to expose the more medial volar carpal ligament. If you are too far ulnar in your dissection, you will be in the muscles of the hypothenar eminence.

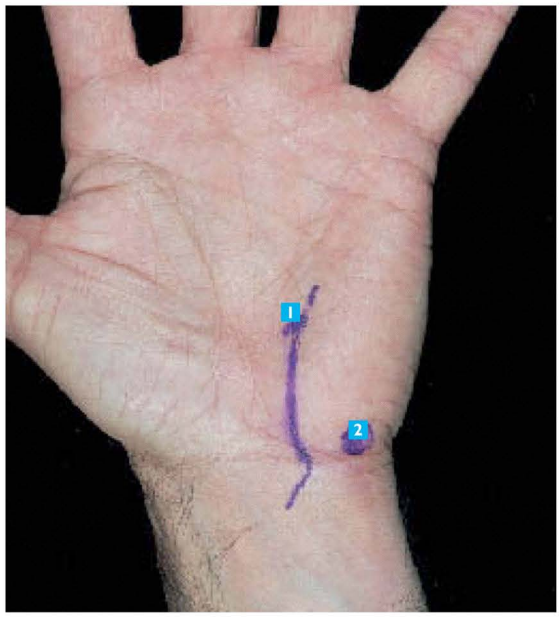

FIGURE 21–1 The outline of skin incision and landmarks.

FIGURE 21–2 The palmar portion of the incision in line with the ring finger.

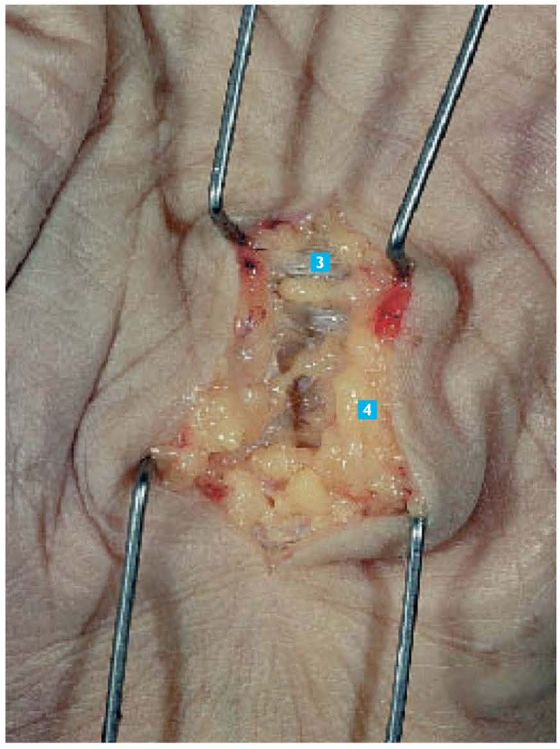

FIGURE 21–3 Fat and subcutaneous tissue overlying the volar carpal ligament.

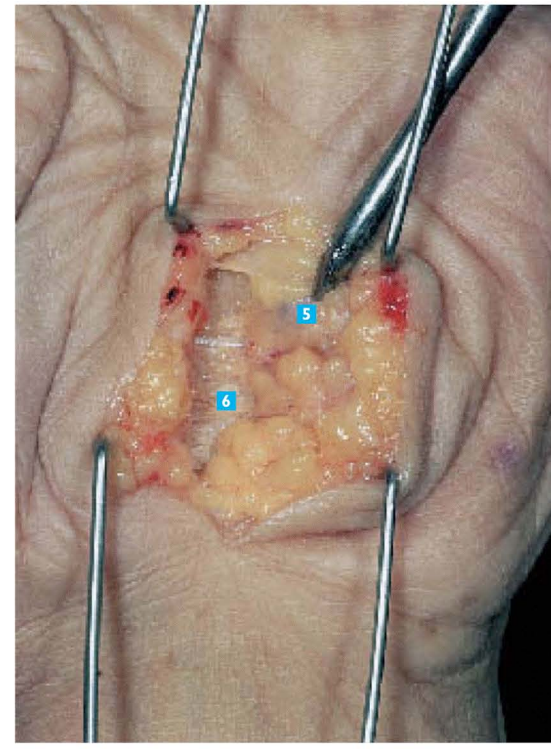

FIGURE 21–4 Fibers of the transverse carpal ligament.

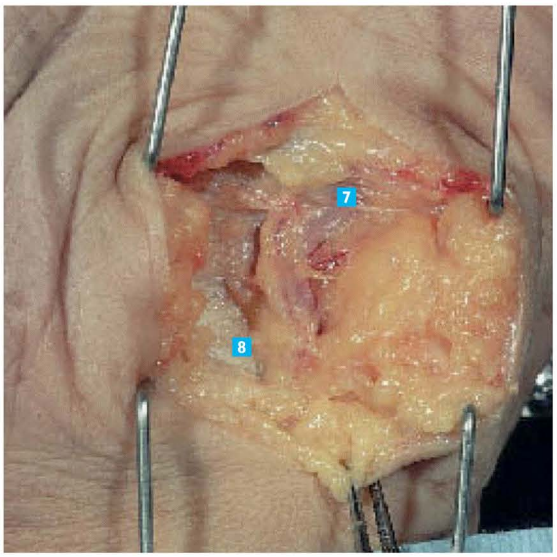

FIGURE 21–5 The volar carpal ligament is opened. The ulnar artery is well visualized. The nerve lies medial to the artery and is covered in fat. Radially, the thicker, more distinct, fibers of the transverse carpal ligament are seen.

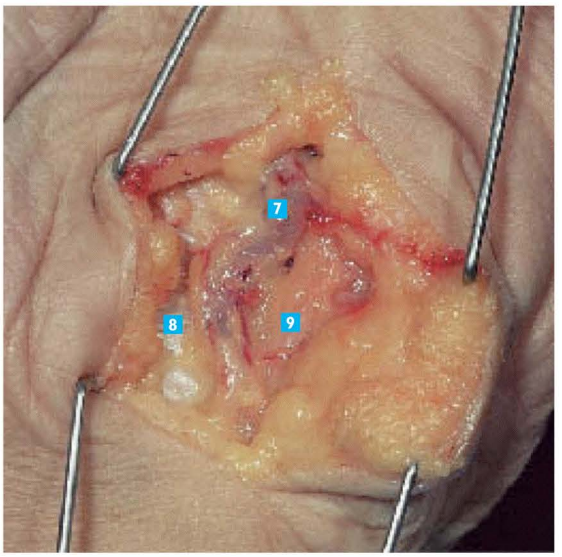

FIGURE 21–6 The ulnar nerve and artery are exposed.

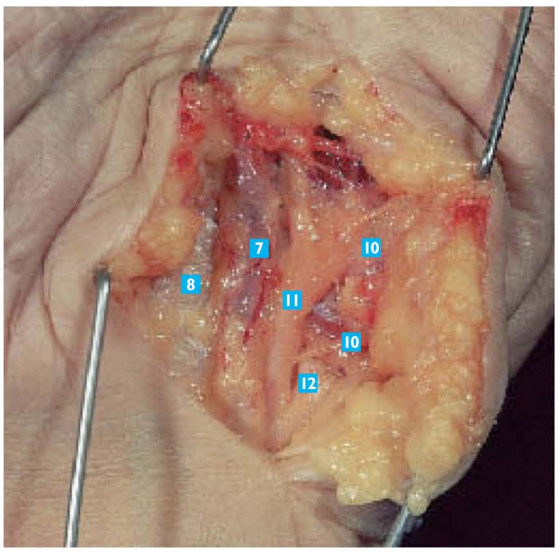

FIGURE 21–7 Thin filamentous branches of the ulnar nerve are seen proceeding to innervate the hypothenar muscles.

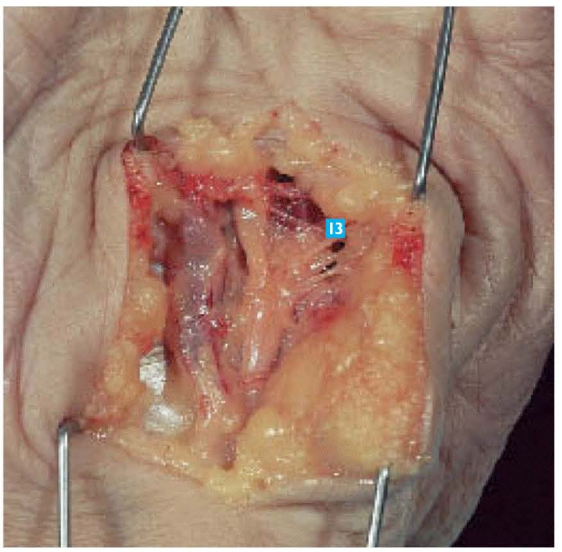

FIGURE 21–8 Division of the ulnar nerve into superficial sensory and deep motor branches at the level of the pisiform.

1. Hook of Hamate
2. Pisiform
3. Fibers of Volar Carpal Ligament
4. Subcutaneous Fat
5. Fascia Overlying Ulnar Artery
6. Fibers of Transverse Carpal Ligament
7. Ulnar Artery
8. Transverse Carpal Ligament
9. Ulnar Nerve
10. Branches of Ulnar Nerve of Hypothenar Muscles
11. Ulnar Nerve (Superficial Division)
12. Deep Motor Branch of Ulnar Nerve
13. Hypothenar Nerve Branches
14. Hypothenar Muscle Branches
15. Ulnar Nerve

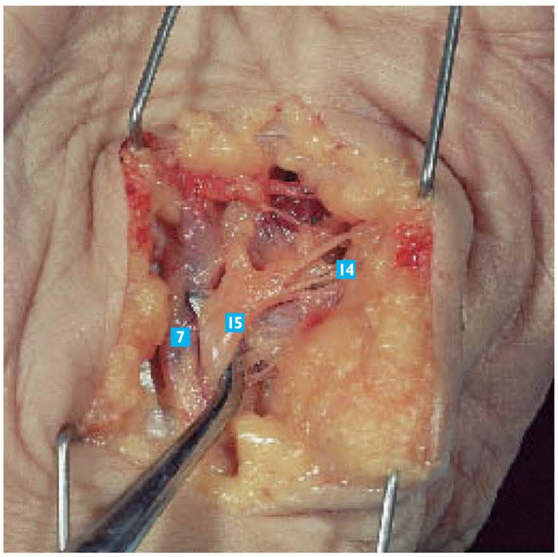

FIGURE 21–9 The probe is under the ulnar nerve, again demonstrating branches to the hypothenar muscles.

1 Hook of Hamate
2 Pisiform
3 Fibers of Volar Carpal Ligament
4 Subcutaneous Fat
5 Fascia Overlying Ulnar Artery
6 Fibers of Transverse Carpal Ligament
7 Ulnar Artery
8 Transverse Carpal Ligament
9 Ulnar Nerve
10 Branches of Ulnar Nerve of Hypothenar Muscles
11 Ulnar Nerve (Superficial Division)
12 Deep Motor Branch of Ulnar Nerve
13 Hypothenar Nerve Branches
14 Hypothenar Muscle Branches
15 Ulnar Nerve

SECTION VI

HAND

Frances Sharpe, M.D.
Milan Stevanovic, M.D.

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Approach to the Lateral (Thenar) Midpalmar Space

USES

This approach is used for decompression of midpalmar abscesses, or to access the index flexor tendons in zone 3 or the origin of the transverse head of the adductor pollicis from the volar shaft of the third metacarpal.

ADVANTAGES

This is the most direct approach to the lateral (thenar or radial) midpalmar space.

DISADVANTAGES

Proximal extension of the incision must be done carefully, as the recurrent motor branch of the median nerve lies near the proximal extent of the incision. This approach only decompresses the lateral (radial) midpalmar space. The medial (ulnar) midpalmar space must be opened through a separate incision.

STRUCTURES AT RISK

The digital nerves to the index and long finger are at risk, as is the recurrent motor branch of the median nerve.

TECHNIQUE

The skin incision lies just ulnar to the thenar crease and parallels the thenar crease. Bluntly dissect through the palmar fascia overlying the flexor tendons to the index finger. Identify the digital nerves and vessels lying alongside the flexor tendons. Open the interval between the flexor tendons and the ulnar neurovascular bundle. The thenar midpalmar space is the potential space below the index and long flexors and above the adductor pollicis muscle. Often, when decompressing a lateral midpalmar space abscess, a separate dorsal incision along the radial border of the index metacarpal should be done to address potential collar button abscesses.

TRICKS

Retract the index flexors and the lumbrical radially to minimize injury to the lumbrical and to provide better access to the origin of the transverse head of the adductor pollicis.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost once you have identified the flexor tendons to the index fingers. If you are in too superficial a position, you will see longitudinal fibers of the palmar fascia. If you are too proximal, you will see the transversely oriented fibers of the transverse carpal ligament (TCL), which means you are in a danger area, as just distal to the TCL is the superficial palmar arch. Also, the distal radial edge of the TCL is the usual location of the recurrent motor branch of the median nerve. If you are too radial or ulnar, but in the correct plane, the digital neurovascular bundles will be in the dissection. The lumbrical muscles lie on the radial side of the flexor digitorum profundus tendon and are a good landmark to your proximal-to-distal position in the palm. They also distinguish the flexor digitorum profundus tendon from the superficialis.

FIGURE 22–1 Skin incision to the thenar midpalmar space.

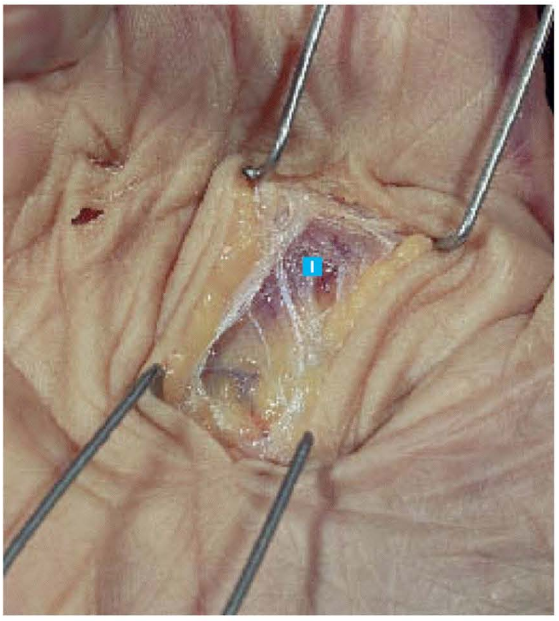


FIGURE 22–2 Palmar fascia overlying the lumbrical muscle to the index finger.

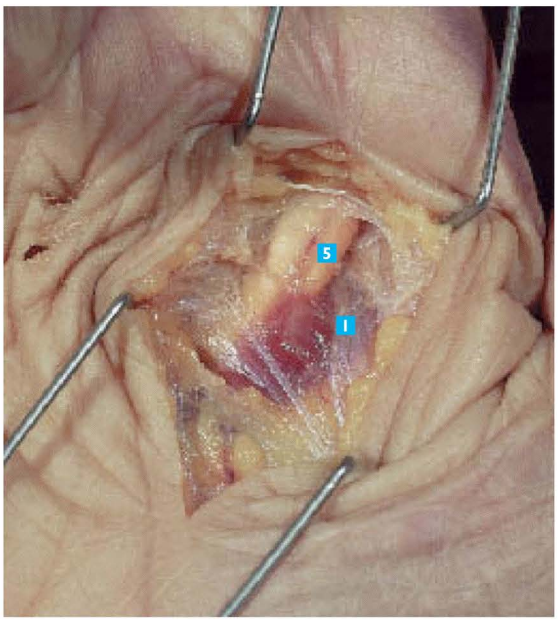


FIGURE 22–3 The flexor tendons to the index finger are exposed. The laterally lying fat encases the radial digital nerve to the index finger.

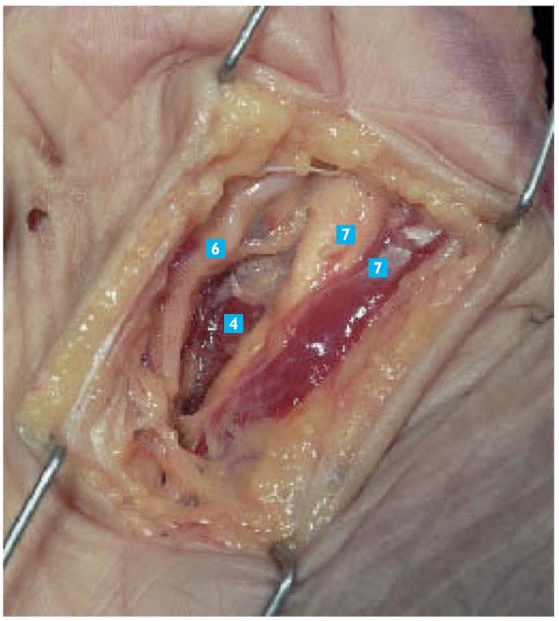


FIGURE 22–4 The midpalmar space is exposed through the interval between the common digital neurovascular bundle and the flexor tendons.

1 Lumbrical to Index
2 Radial Digital Nerve
3 Superficial and Deep Flexor Tendons to Index
4 Adductor Pollicis
5 Flexor Tendons to Index
6 Common Digital Nerve
7 Flexor Tendons and Lumbrical to Index
8 Radial Digital Nerve to Index

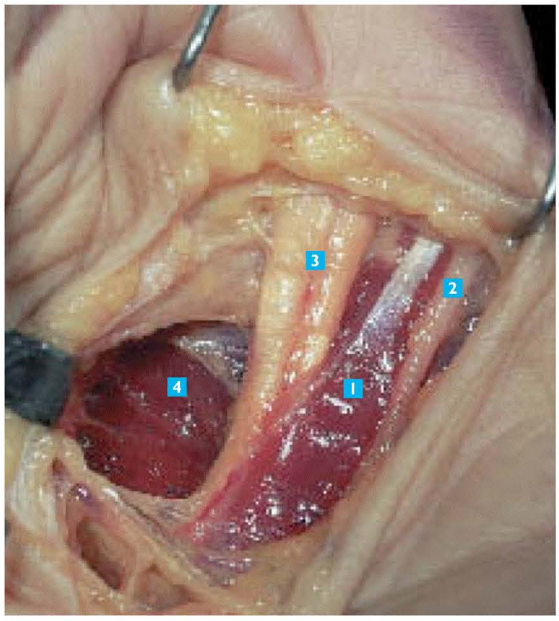


FIGURE 22–5 The interval between the common digital nerve to the index and long fingers and the index flexors is opened longitudinally along the ulnar edge of the flexor tendons. The flexor tendons, lumbrical, and radial digital nerve are retracted laterally exposing the lateral midpalmar space and adductor pollicis muscle belly.

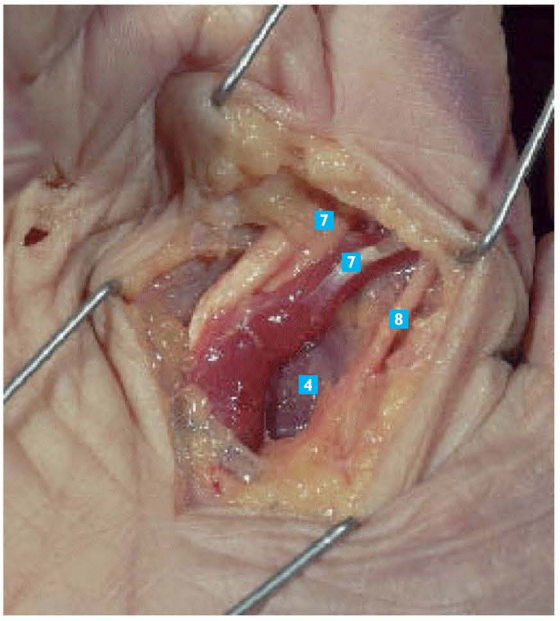


FIGURE 22–6 The interval between the flexors and the radial digital nerve of the index finger is opened to better visualize the adductor pollicis.

Dorsal Approach to the Metacarpophalangeal Joint

USES

This approach is used to gain access to the extensor tendons at the level of the metacarpophalangeal (MCP) joint and to treat pathology of the MCP joint.

ADVANTAGES

The approach lies directly over the area of interest with few intervening structures.

DISADVANTAGES

The surgical incision lies immediately over the extensor tendons, which can cause scarring and adhesions of the tendons. In using this incision for MCP arthroplasty, especially in rheumatoid patients, there is very little tissue covering the implants, placing them at risk of becoming infected.

STRUCTURES AT RISK

Structures at risk include the extensor tendons and sagittal bands. Failure to repair the sagittal bands results in subluxation of the extensor tendon. Also at risk are the dorsal sensory nerve branches.

TECHNIQUE

When approaching all of the MCP joints, which is often the case in reconstructive procedures in the rheumatoid hand, a transverse incision is made across the distal metacarpal, approximately 1 cm proximal to the prominences of the metacarpal heads. Dorsal veins and sensory nerve branches are identified and preserved. The skin and subcutaneous fat layer should be elevated together as a single-layered flap, exposing the extensor tendons and sagittal band. The sagittal band is released on the radial side of the MCP joint and retracted ulnarly. This exposes the dorsal capsule of the MCP joint, which is opened with a longitudinal incision.

TRICKS

Keep the skin and subcutaneous flaps as thick as possible. When using this approach to a rheumatoid hand, the extensor tendon has usually slipped off to the ulnar side of the MCP joint. Also in the rheumatoid hand, the dorsal capsule is often thin and attenuated. Try to maintain the capsular incision as a separate plane from the sagittal band for later closure.

HOW TO TELL IF YOU ARE LOST

If you are too proximal in the dissection, you will not see the extensor expansion and sagittal bands. You may see fascia overlying the interosseous muscle bellies. The joint level can usually be located by flexing and extending the joint.

FIGURE 23–1 A transverse skin incision is used to expose the second through fifth metacarpophalangeal joints. Keep the incision proximal to the prominence of the metacarpal heads. Alternatively, longitudinal incisions can be used to expose each joint separately.

FIGURE 23–2 Extensor tendons are well visualized, centralized over the metacarpophalangeal joints.

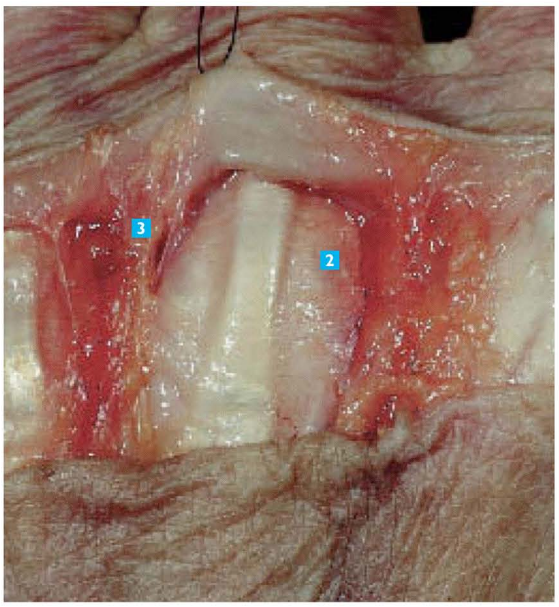


FIGURE 23–3 Sagittal bands are well visualized. The dorsal sensory branches lie in the fat in the sulci between the metacarpal heads.

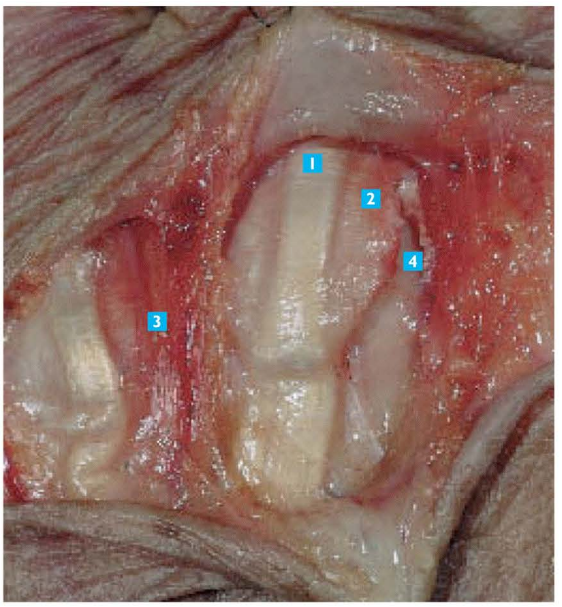
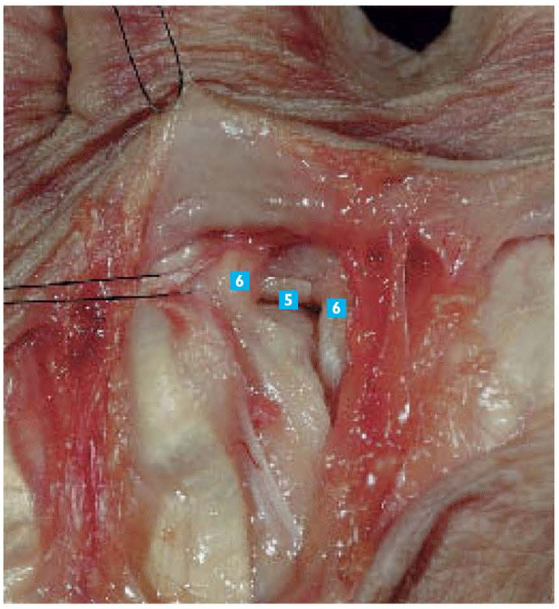


FIGURE 23–4 The sagittal bands are best opened on the radial side of the joint with a longitudinal incision. Leave enough margin for later closure. When the tendon is ulnarly subluxed, it may also be necessary to divide the ulnar sagittal band to allow centralization of the tendon.

1 Extensor Digitorum Communis
2 Sagittal Band
3 Dorsal Sensory Nerve
4 Dorsal Capsule of Metacarpophalangeal Joint
5 Metacarpophalangeal Joint
6 Cut Edge of Metacarpophalangeal Joint Capsule



1 Extensor Digitorum Communis
2 Sagittal Band
3 Dorsal Sensory Nerve
4 Dorsal Capsule of Metacarpophalangeal Joint
5 Metacarpophalangeal Joint
6 Cut Edge of Metacarpophalangeal Joint Capsule

FIGURE 23–5 The capsule is longitudinally opened as a separate layer.

Volar Approach to the Basal Joint of the Thumb (for Bennett's Fracture)

USES

This approach is a limited-use incision, used primarily to address volar pathology at the carpometacarpal (CMC) joint of the thumb, most commonly Bennett's fracture, or for selected Rolando fractures. Some techniques for treatment of basal joint arthritis also use this incision.

ADVANTAGES

There are few structures at risk with this incision. The incision can be extended distally along the flexor carpi radialis tendon, after first diagonally crossing the wrist crease.

DISADVANTAGES

It is more difficult to see the ulnar side of the joint, where the nondisplaced fragment usually lies in a Bennett's fracture.

STRUCTURES AT RISK

Dorsal sensory branches of the superficial radial nerve may cross the incision line.

TECHNIQUE

A longitudinal incision is made along the radial aspect of the first metacarpal. It curves volarward just proximal to the wrist crease. Elevate the thenar muscle above the periosteum from the base of the first metacarpal down to the trapezium. The trapeziometacarpal joint capsule can be opened through a transverse incision.

TRICKS

There are not too many tricks to this dissection. Once you have identified and protected any branch of the superficial radial nerve, you are in a safe plane for dissection. As you proceed in a more volar direction, you will encounter the flexor carpi radialis tendon as it crosses the trapezium.

HOW TO TELL IF YOU ARE LOST

The biggest danger of getting lost is being at the wrong joint. If the approach is for a fracture, and you do not find an intraarticular fracture hematoma or fracture line, you may be at the scaphotrapezial joint. When using this approach to treat something other than trauma, look for the characteristic saddle-shaped contour of the joint. When in doubt, use fluoroscopy for confirmation of position.

FIGURE 24–1 The skin incision, as described by Wagner.

FIGURE 24–2 The abductor pollicis brevis muscle.

FIGURE 24–3 Flaps are raised to identify the metacarpal shaft.

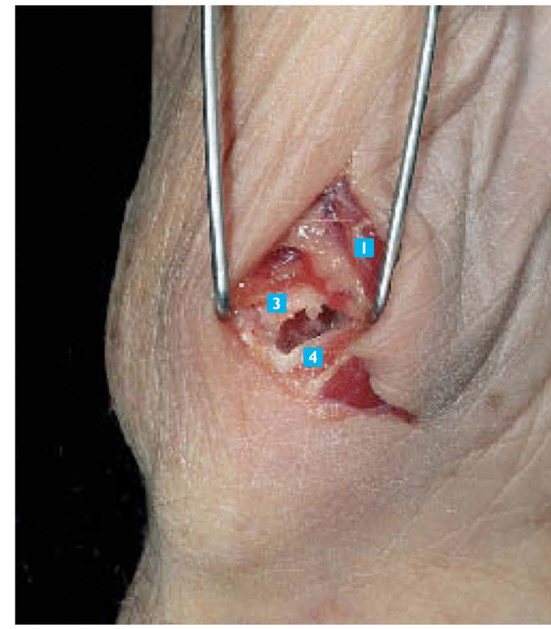


FIGURE 24–4 The thenar muscles are elevated and reflected volarly. The thenar group can be elevated more proximally to gain better access to the trapezium for carpometacarpal arthroplasty or volar oblique ligament reconstruction.

1 Abductor Pollicis Brevis
2 First Metacarpal Shaft
3 Base of First Metacarpal
4 Trapezium

Dorsal Approach to the Basal Joint of the Thumb

USES

This approach is used to address dorsal or dorsoradial pathology of the basal joint of the thumb. It is most commonly used for procedures addressing basal joint arthritis, such as carpometacarpal arthroplasty or ligament reconstruction with interpositional arthroplasty.

ADVANTAGES

The approach provides direct access to the trapeziometacarpal joint. The skin incision can be fashioned to curve proximally and volarly to gain access to the flexor carpi radialis tendon.

DISADVANTAGES

Branches of the superficial radial nerve are retracted in this approach and are susceptible to neuropraxia and/or hypersensitivity.

STRUCTURES AT RISK

Structures at risk include branches of the superficial radial nerve, located in the subcutaneous plane of dissection, and the abductor pollicis longus and extensor pollicis brevis (EPB) tendons, located immediately below the subcutaneous tissue layer. Proximally lies the dorsal branch of the radial artery. Also, when performing a trapeziectomy or a hemitrapeziectomy, the flexor carpi radialis tendon can be injured, where it lies in a volar groove in the trapezium.

TECHNIQUE

Any of several skin incisions can be used. The most common are transverse, T-shaped, or bayonet incisions. Place the incision so that the transverse limb is centered over the trapeziometacarpal joint. Use the knife only to divide skin, then use longitudinal blunt dissection to spread down to the first compartment tendons. Branches of the superficial radial nerve lie in the subcutaneous fat layer and should be carefully protected. The interval between the abductor pollicis longus and extensor pollicis brevis is used to gain access to the dorsal capsule. Flex and extend the thumb and first metacarpal to help identify the carpometacarpal joint. Sharply divide the capsule and elevate the adherent soft tissue envelope from the trapezium and base of the first metacarpal, exposing the trapeziometacarpal joint.

TRICKS

Longitudinal traction along the axis of the thumb both helps to open up the joint space and provides stability to the thumb during the dissection.

HOW TO TELL IF YOU ARE LOST

If the incision is too far dorsal, you will encounter the extensor pollicis longus (EPL) tendon. Pull on the tendon to determine its function. Sometimes the EPB will also cause thumb interphalangeal joint extension, so check where the tendon is located proximally as you pull on it. The EPL is seen just ulnar to Lister's tubercle, and the EPB is seen at the radial border of the anatomic snuff box.

You might also become lost in identifying the carpometacarpal joint. Remember that the basal joint is a saddle-shaped joint. Use longitudinal traction along the thumb to open up the joint space for better visualization of the joint surfaces. When in doubt about your location, use fluoroscopy to confirm your position before resecting any bone. There is an apocryphal story about a prominent hand surgeon who mistakenly excised the scaphoid instead of the trapezium on his patient, who was an orthopaedic surgeon.

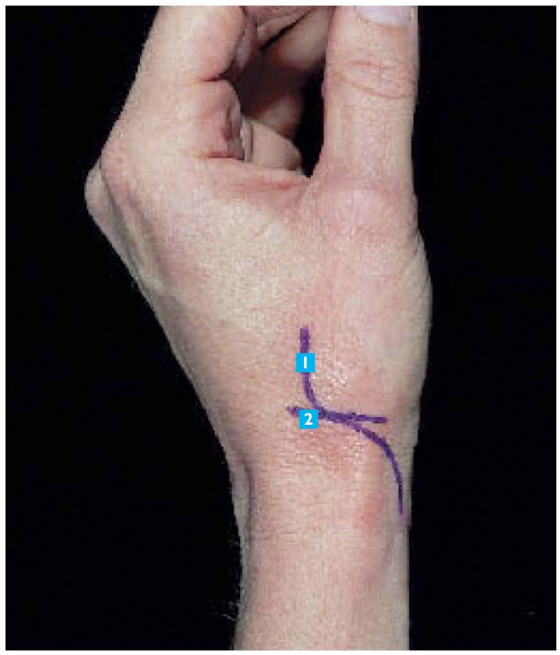


FIGURE 25–1 Two different incisions for this approach are shown. The S-shaped incision is designed with the more transverse incision centered over the basal joint. The proximal portion of the incision is carried volarly over the flexor carpi radialis tendon. The transverse incision does not provide as wide an exposure, but leaves a very cosmetic scar that lies in Langer's lines.

FIGURE 25–2 Several skin incisions have been described. Here is a transverse incision centered over the trapeziometacarpal joint.

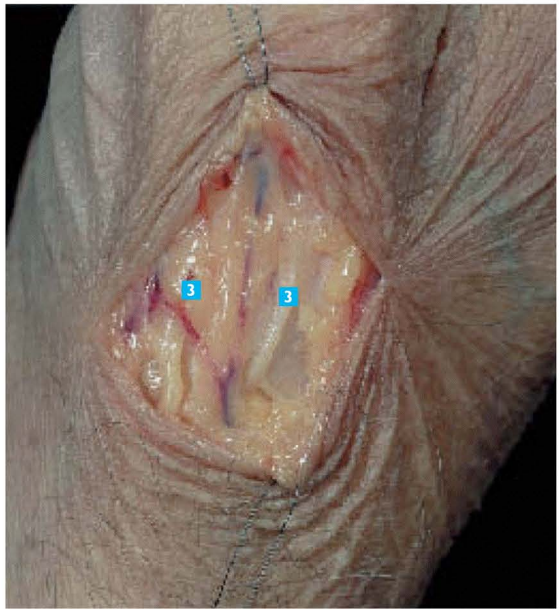


FIGURE 25–3 The subcutaneous fat layer can be very thin. Lying in this plane of dissection are dorsal branches of the superficial radial nerve.

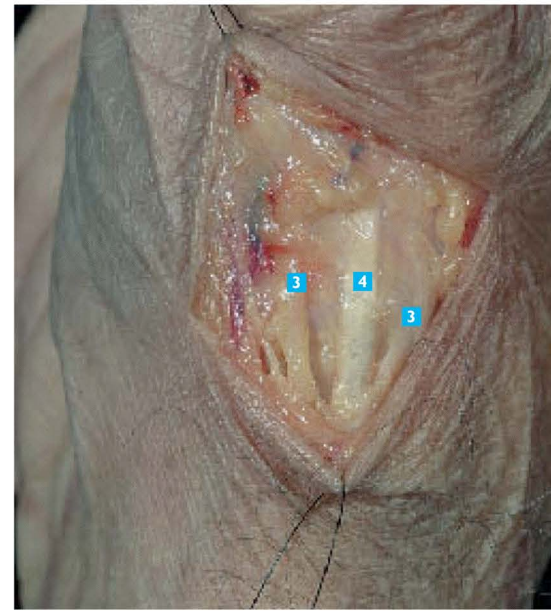


FIGURE 25–4 The first dorsal compartment extensor tendons (abductor pollicis longus [APL] and extensor pollicis brevis [EPB]) lie just below the subcutaneous fat layer.

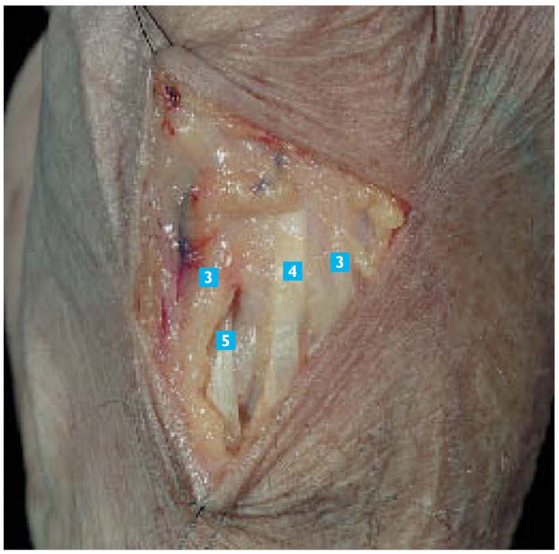


FIGURE 25–5 The interval between the APL and EPB tendons is identified. The tendons are mobilized enough to allow access to the underlying trapezium.

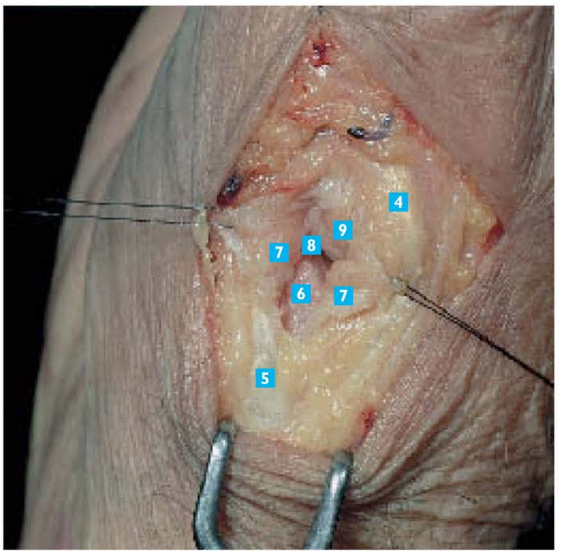


FIGURE 25–6 A longitudinal incision is made over the carpometacarpal joint. This is a safe plane of dissection. The only structure at risk in this plane is the dorsal branch of the radial artery, which lies in the very proximal portion of the incision. The artery is normally not exposed in the dissection, but is often seen incidentally at the time of capsular closure.

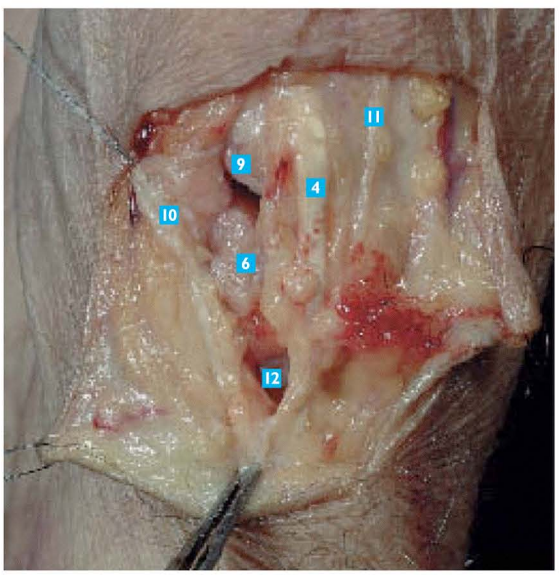


FIGURE 25–7 Sharp dissection along the trapezium continues proximally until the scaphotrapezial joint is reached.

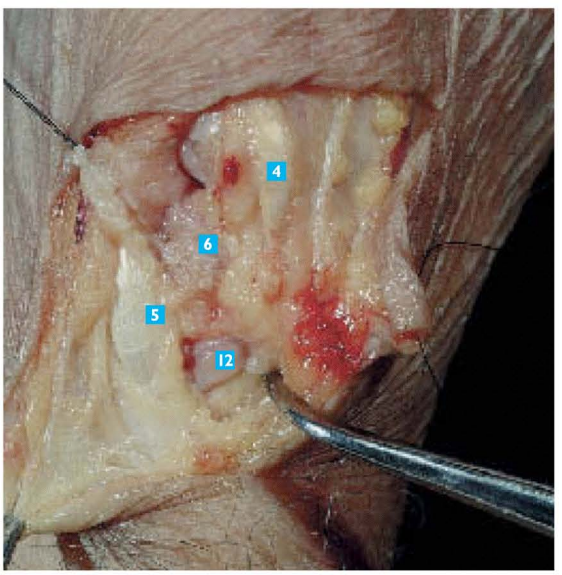


FIGURE 25–8 The dorsal branch of the radial artery is seen crossing the scaphoid.

1. S-Shaped Incision Carried Volarly Over Flexor Carpi Radialis (FCR) Tendon
2. Transverse Incision Centered Over Carpometacarpal (CMC)
3. Branches of Superficial Radial Nerve
4. Extensor Pollicis Brevis Tendon
5. Abductor Pollicis Longus Tendon
6. Trapezium
7. Cut Margins of Opened Joint Capsule
8. Trapeziometacarpal Joint (Carpometacarpal Joint and Thumb)
9. Base of First Metacarpal
10. Reflected Joint Capsule
11. Branch of Superficial Radial Nerve
12. Dorsal Branch of Radial Artery

Gamekeeper's Thumb Approach to the Thumb Metacarpophalangeal Joint

USES

Most commonly used to address tears of the ulnar collateral ligament of the thumb, this approach can be used to address many pathologies at the thumb metacarpophalangeal joint (MPJ). This includes some intraarticular fractures, joint exploration for loose bodies, chondral injuries, or release of intraarticular adhesions. Complex dislocations of the thumb MPJ can be addressed through a dorsal approach as well, although the pathology is volar. It can also be used for reconstructive procedures, including MPJ fusion or arthroplasty.

ADVANTAGES

This approach provides good exposure of the dorso-ulnar MPJ. It can be extended proximally or distally to expose the extensor mechanism of the thumb or to address bone injury or pathology of the proximal phalanx. When addressing complex dislocations of the MPJ, this approach is sometimes preferred to the volar approach, because of the reduced risk of injury to the volar digital nerves.

DISADVANTAGES

It can be difficult to visualize the radial side of the MPJ through this approach, depending on the extent of capsular and ligamentous disruption.

STRUCTURES AT RISK

The main structure at risk in this approach is the dorsal sensory branches of the superficial radial nerve.

TECHNIQUE

A curvilinear incision is made along the dorso-ulnar aspect of the thumb MPJ. Immediately on completing the skin incision, blunt dissection is used through the subcutaneous tissue layer to prevent injury to the superficial dorsal sensory branches. The adductor aponeurosis is identified and divided longitudinally in a line parallel to the extensor tendon. Below this lies the capsule of the MPJ. The ulnar collateral ligament (UCL) is the distinct band of fibers running in a dorsal to volar direction from proximal to distal. An alternate skin incision is the lazy-S incision. The proximal portion of the skin incision is the same as described. At the level of the MPJ, the incision curves volarly, allowing better access to the volar plate.

TRICKS

Once you see the superficial nerves, do not dissect them extensively. Mobilize them only enough for them to be retracted without excessive tension. The less the mobilization, the lower the risk of neuropraxia. When the UCL has been retracted and is lying on top of the aponeurosis, the proximal edge of the aponeurosis may be difficult to identify. The edematous wad of tissue overlying it is probably the distal edge of the UCL and should not be excised. If you are having difficulty identifying the joint line after opening the adductor aponeurosis, the joint can be translated to better visualize the level of the joint. This also sometimes allows better visualization of the ligament.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost in this approach. When in doubt about where the joint is, flex, extend, and translate the joint.

FIGURE 26–1 Skin incision for approach to the thumb metacarpophalangeal joint.

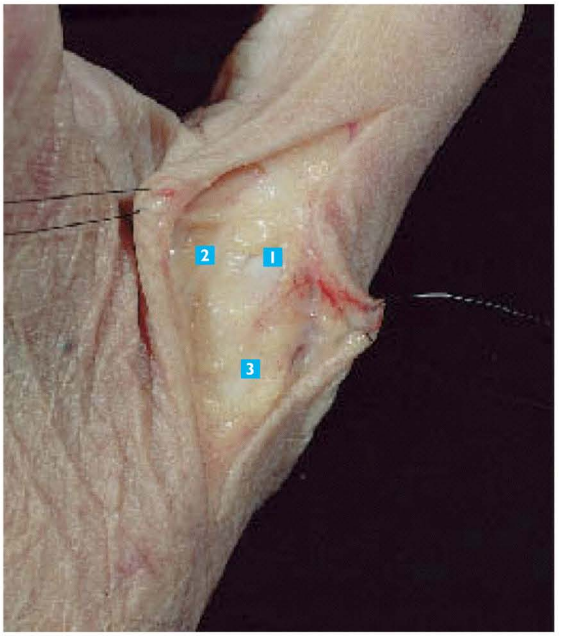


FIGURE 26–2 Blunt dissection is used through the subcutaneous tissue layer. The dorsal sensory branches of the radial nerve lie within this layer.

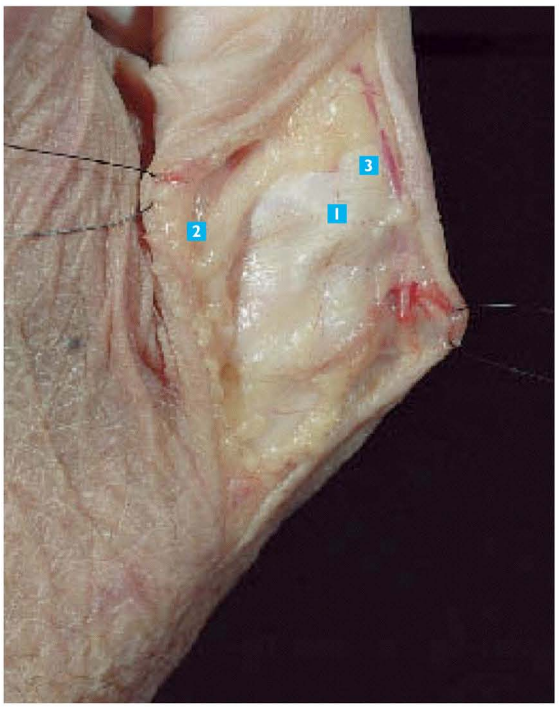


FIGURE 26–3 The proximal and distal margins of the adductor aponeurosis can be clearly identified.

1 Adductor Aponeurosis
2 Dorsal Sensory Branch
3 Extensor Pollicis Longus
4 Cut Edge of Adductor
5 Metacarpophalangeal Joint

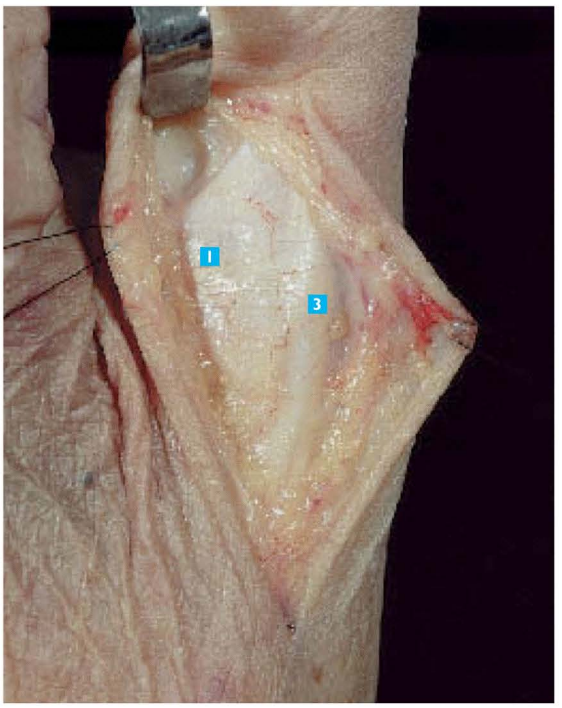


FIGURE 26–4 The adductor aponeurosis.

6 Dorsal Capsule
7 Ulnar Collateral Ligament
8 Proximal Phalanx
9 Metacarpal Head

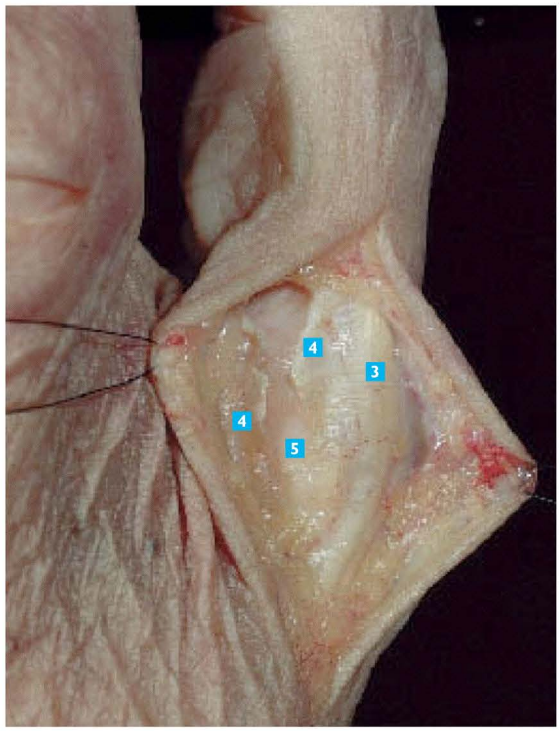


FIGURE 26–5 The adductor aponeurosis is divided in a line parallel to the extensor tendon. The edges are elevated exposing the underlying metacarpophalangeal joint capsule.

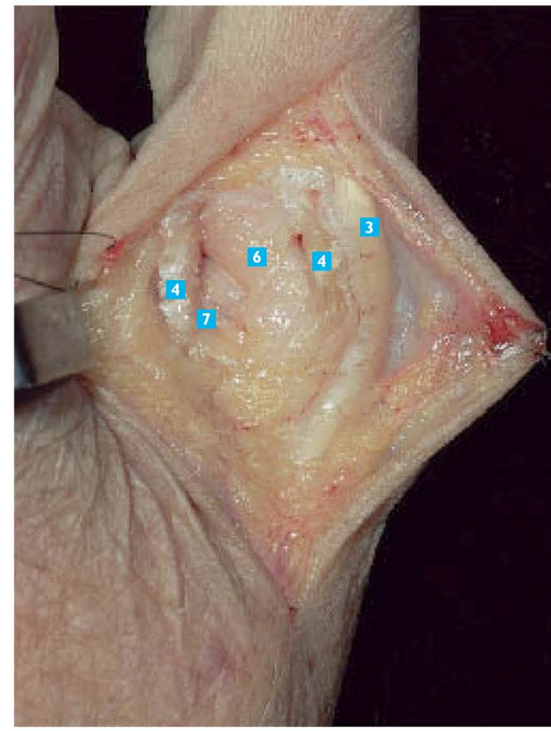


FIGURE 26–6 The ulnar collateral ligament is seen as a distinct structure with its fibers directed from dorsal proximal to volar distal.

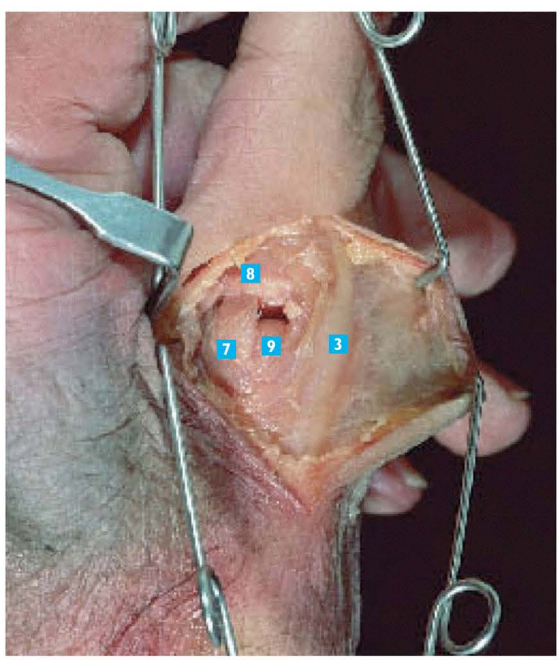


FIGURE 26–7 Dorsal capsule removed, showing the ulnar collateral ligament and metacarpophalangeal joint.

1 Adductor Aponeurosis
2 Dorsal Sensory Branch
3 Extensor Pollicis Longus
4 Cut Edge of Adductor
5 Metacarpophalangeal Joint
6 Dorsal Capsule
7 Ulnar Collateral Ligament
8 Proximal Phalanx
9 Metacarpal Head

Dorsal Approach to the Fingers

USES

This approach is used both to expose the extensor tendons for repair or release and for fracture work.

ADVANTAGES

This extensile approach can be extended as far proximally or distally as necessary. It also goes through a part of the finger that has no major nerves or arteries. It is easy to identify and to retract the extensor tendons out of the way once they are separated from the surrounding tissue.

DISADVANTAGES

This approach is not appropriate for volar pathology in the tendons.

STRUCTURES AT RISK

The only structures at risk are the lumbrical and interosseous tendons and the central slip to the base of the middle phalanx.

TECHNIQUE

Generally, a V-shaped zigzag incision is made through the skin and subcutaneous tissue. Once you are deep to that tissue, the intrinsic muscle tendons are easily identified. There is fascia in between the intrinsic muscle tendons and the central slip tendons, which when split will expose the proximal phalanx. In the middle phalanx, the intrinsic muscles have come together to form a tendon that goes on to the distal phalanx. By staying on either side of this tendon, you can expose the bone. Alternately, the extensor tendon can be divided longitudinally, exposing the dorsal aspect of the proximal phalanx. This must be repaired at the time of closure.

TRICKS

There are no significant tricks for this approach other than cutting through the skin only, so that you do not damage the underlying tendinous structures.

HOW TO TELL IF YOU ARE LOST

It is possible to drift too far to one side or the other on the finger. Because the bone is subcutaneous, it is essentially impossible, however, to get lost. If the incision was placed too far to one side or the other, it can simply be extended to mobilize the skin flaps so that you can easily get to both sides of the finger.

FIGURE 27–1 A zigzag incision is used across the dorsum of the proximal phalanx.

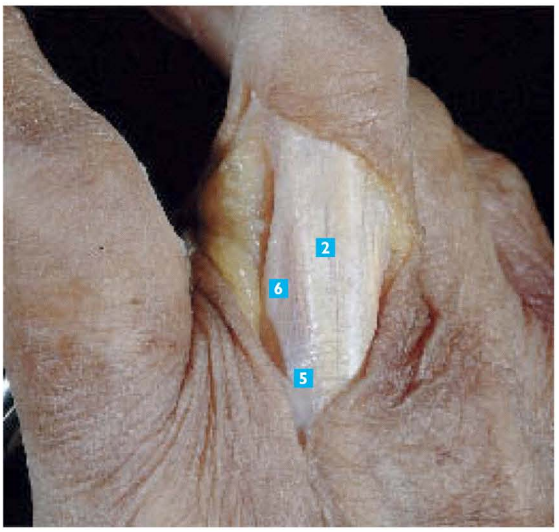


FIGURE 27–2 Full-thickness and subcutaneous tissue flaps are then elevated off of the extensor tendon. The central extensor tendon is seen. The lumbrical tendon is seen more volarly. The fascial tissue in between the lumbrical and the central tendon can be opened to provide access to the proximal phalanx.

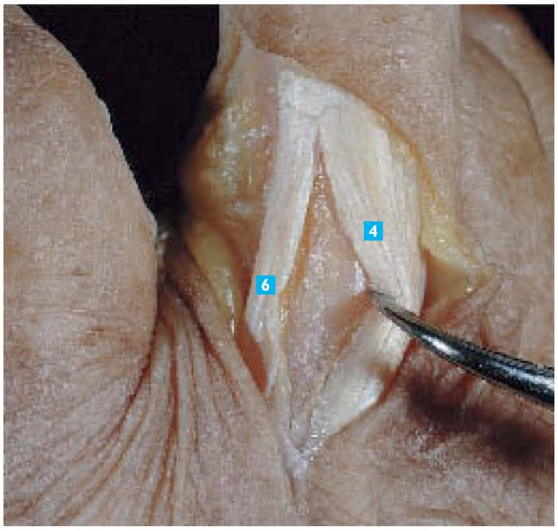


FIGURE 27–3 The interval has been opened, below which lies the periosteum of the proximal phalanx.

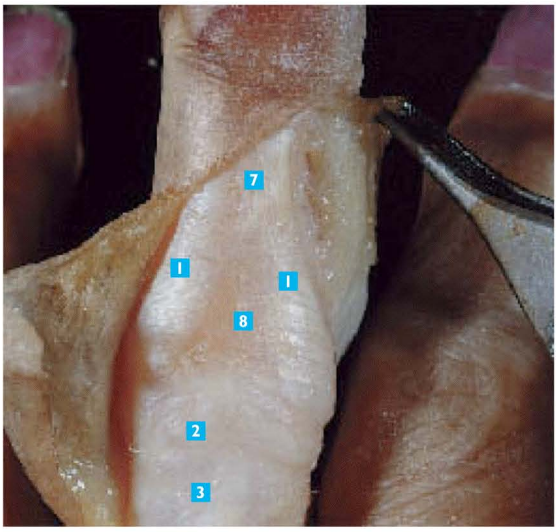


FIGURE 27–4 The skin incision has been extended more distally. At the bottom of the figure is the level of the proximal interphalangeal joint with the central slip insertion at the base of the middle phalanx. More distally, the lateral bands are seen coming from volar to a more dorsal position to reform the terminal extensor tendon. The fascial tissue between the two lateral bands is called the triangular ligament.

1 Lateral Bands
2 Central Slip Insertion
3 Proximal Interphalangeal Joint
4 Extensor Digitorum Communis Central Slip
5 Fascia in Zone Between Tendons
6 Lumbrical Tendon
7 Terminal Extensor Tendon
8 Triangular Ligament

VOLAR APPROACH TO THE FLEXOR TENDONS

USES

The volar approach to the flexor tendons, described by Brunner, is a versatile approach for tendon exploration, repair reconstruction, and tenolysis. It is useful for exploration and repair of the neurovascular bundles to the digits, for treatment of soft tissue infections, and for biopsy of tumors on the volar side of the finger.

ADVANTAGES

This approach provides excellent exposure of the tendon with the flexor tendon sheath and excellent exposure of the neurovascular bundle. It is extremely extensile. It can be extended into the palm and incorporated into a carpal tunnel release, and further extended up the forearm into the antecubital fossa.

DISADVANTAGES

There are very few disadvantages to this approach. It does leave a palmar scar, but this generally heals with good cosmesis. If the flaps are not created well, flap necrosis can result with skin loss and risks of increased scarring about the flexor tendons and resultant stiffness.

STRUCTURES AT RISK

The structures at greatest risk are the neurovascular bundles. Carrying the limbs of the incision too far dorsally puts the digital nerves and arteries at higher risk of injury. Avoid longitudinal incisions across the major flexion creases. As the scar matures and contracts, it can cause a flexion contracture across that flexion crease. Keep skin flaps thick and try to maintain an angle of 60 to 90 degrees between the limbs of the incision to reduce the risk of flap necrosis.

TECHNIQUE

The skin incision is a zigzag pattern designed along the length of the finger. The main goals of the skin incision are to avoid a longitudinal incision across a major skin crease and to create angles of the zigzag incision to approximate 90 degrees.

Create large flaps containing the skin and subcutaneous tissue, using blunt dissection and spreading in a longitudinal direction. The flaps can be retracted with sutures, and the entire flexor tendon sheath can be exposed. The pulleys overlying the tendon should be carefully identified.

The neurovascular bundles lie immediately to the sides of the flexor tendon sheath, below the very thin diaphanous fibers of Grayson's ligament. Graysons's ligament can be longitudinally divided to expose the neurovascular bundle.

Although this is not a good approach to the phalanges, bone can be reached by carefully dissecting between the flexor tendon sheath and the neurovascular bundle. The tendon sheath is retracted, exposing the underlying bone.

TRICKS

When incorporating traumatic wounds into this incision, a more acute angle may be necessary. If you are unable to create a zigzag pattern without creating a skin angle more acute than 60 degrees, then make a longitudinal extension of the traumatic wound to the level of the skin crease, and extend the incision diagonally across the crease.

When raising flaps, use the scissors to bluntly dissect, by spreading in a longitudinal direction. This reduces the chance of injury to the digital nerve and artery. If you are having difficulty finding the nerve, sometimes you can see small white granules in the fatty tissue. These are pacinian corpuscles, and they lie very close to the nerve.

HOW TO TELL IF YOU ARE LOST

If you are in too superficial a position, you will be in fat. There are many transverse crossing veins in this layer, which should not be confused with the digital vessels because of their transverse orientation. Longitudinal spreading directly over the tendon will eventually get you down to the level of the sheath. If you stay in the midline, there is minimal risk of injury to the neurovascular bundle.

If you are too far medial or lateral, you may see the nerve or artery. Try to figure this out before you are seeing a lumen or fascicles in cross section. If you are having difficulty finding the nerves or vessels at the site of an injury, find them out of the zone of injury and trace them proximally or distally.

If you see tendon, without an overlying tendon sheath, then the tendon sheath and/or the pulleys have been violated. Make sure you know where you are entering the flexor tendon sheath, and make every effort to preserve the A_2 and A_4 pulleys, as these pulleys are critical to preventing bowstringing of the tendon.

FIGURE 28–1 The standard zigzag incision as described by Brunner.

FIGURE 28–2 Sutures used at the apices of the incision provide retraction of the skin flaps.

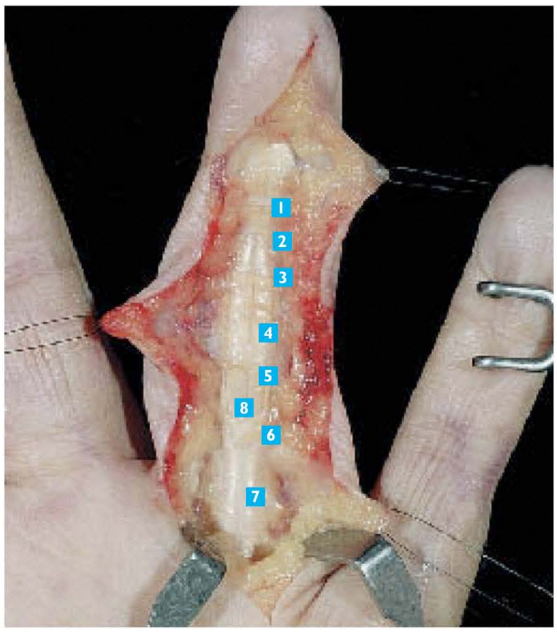


FIGURE 28–3 The flexor tendon sheath exposed from the A_2 to the A_5 pulley.

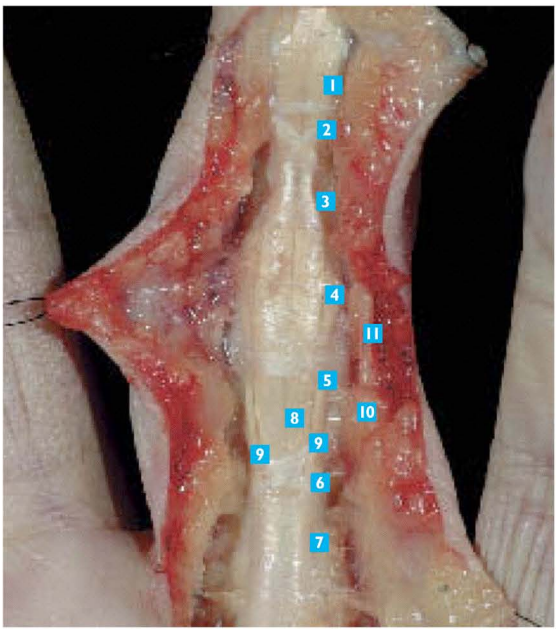


FIGURE 28–4 The pulley mechanism is shown in greater detail. The critical pulleys in preventing bowstringing of the tendons are the A_2 and A_4 pulleys, and every effort should be made to preserve these pulleys.

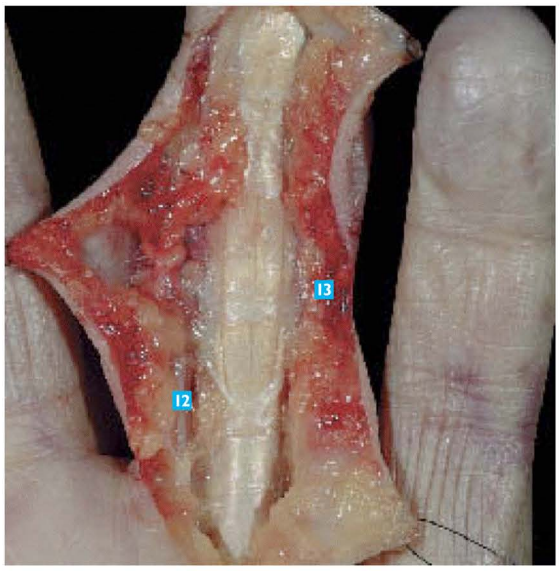


FIGURE 28–5 The neurovascular bundles lie in the fat adjacent to the flexor tendons, and at the same depth as the tendons. They are covered by the diaphanous fibers of Grayson's ligament, which can sometimes be imagined as a distinct structure.

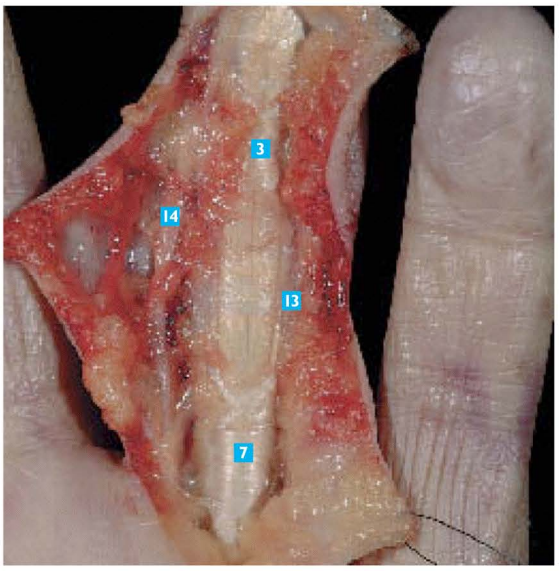


FIGURE 28–6 The ulnar neurovascular bundle has been exposed.

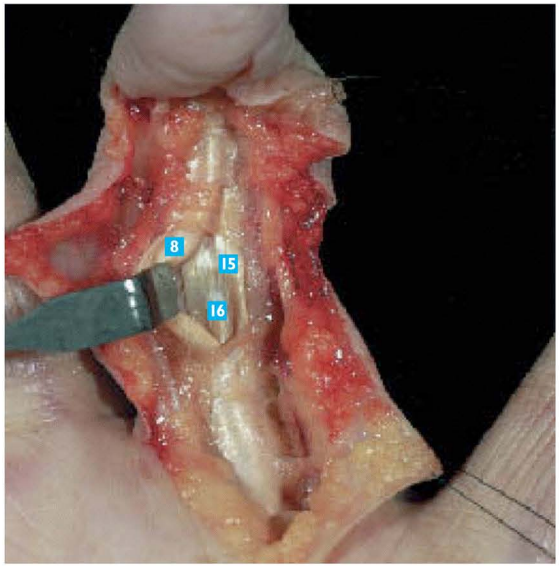


FIGURE 28–7 The A_3 pulley has been opened, and the flexor digitorum profundus tendon is retracted, showing Camper's chiasm, which is the reformation of the flexor digitorum superficialis before it divides again into two slips that insert on the middle phalanx.

1. A_5
2. C_3
3. A_4
4. C_2
5. A_3
6. C_1
7. A_2
8. Flexor Digitorum Profundus
9. Slips of Flexor Digitorum Superficialis
10. Grayson's Ligament
11. Radial Digital Nerve
12. Ulnar Neurovascular Bundle
13. Radial Neurovascular Bundle
14. Ulnar Digital Nerve
15. Flexor Digitorum Superficialis
16. Camper's Chiasm
17. Volar Plate
18. Cut Edge of A_3 Pulley
19. Flexor Digitorum and Superficialis Tendons

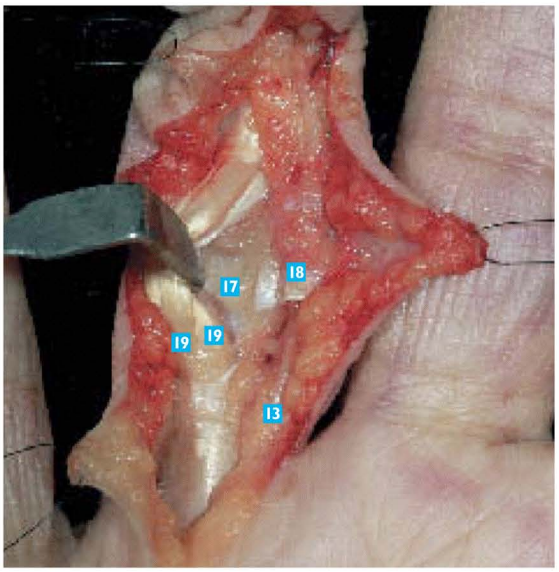


FIGURE 28–8 Both the profundus and the superficialis tendons are retracted at the level of the A_3 pulley, providing access to the volar plate of the proximal interphalangeal joint.

1. A_5
2. C_3
3. A_4
4. C_2
5. A_3
6. C_1
7. A_2
8. Flexor Digitorum Profundus
9. Slips of Flexor Digitorum Superficialis
10. Grayson's Ligament
11. Radial Digital Nerve
12. Ulnar Neurovascular Bundle
13. Radial Neurovascular Bundle
14. Ulnar Digital Nerve
15. Flexor Digitorum Superficialis
16. Camper's Chiasm
17. Volar Plate
18. Cut Edge of A_3 Pulley
19. Flexor Digitorum and Superficialis Tendons

PARONYCHIUM APPROACH

USES

The nail and the paronychium are exposed to treat injuries to the nail bed, to drain infection of the eponychial or paronychial folds (paronychia), or to perform a nail ablation for painful deformities of the nail.

ADVANTAGES

This approach provides excellent exposure of the nail bed.

DISADVANTAGES

Inadvertently cutting into the nail bed may lead to subsequent nail deformity, such as ridging.

STRUCTURES AT RISK

Very little is at risk in this approach, with the exception of the nail bed itself.

TECHNIQUE

The treatment of paronychia uses a longitudinal incision at the corner of the nail, and extending proximally for approximately $\frac{1}{2}$ cm. The nail wall is elevated and the purulence is decompressed. For infections that have migrated across to the opposite side of the nail, a similar longitudinal incision is made in that corner of the nail, and the eponychium and nail wall are elevated. When the infection has extended below the nail, the proximal portion of the nail can be elevated off the underlying nail bed and the proximal one-third to one-half of the nail can be excised.

In treating traumatic injuries to the nail bed, the nail is gently elevated off of the nail bed. The removed nail can be saved to use as a splint following repair of the nail bed.

TRICKS

A freer elevator is very useful in elevating the nail plate off of the nail bed without traumatizing the nail bed.

HOW TO TELL IF YOU ARE LOST

If you get lost in this approach, reconsider radiology. It is easy to get lost in the terminology, so here are a few definitions:

Eponychium: The thin membrane of tissue extending from the nail wall for a short distance onto the nail.
Hyponychium: The mass of keratin beneath the distal nail (just distal to the distal edge of the sterile matrix).
Lunula: The convex opaque portion of the proximal nail, corresponding to the underlying germinal matrix.
Nail bed: All of the soft tissue beneath the nail plate, including the germinal matrix and sterile matrix.
Nail fold: The depression on the dorsum of the finger, where the nail inserts.
Nail wall: The dorsal skin overlying the nail fold.
Parionychium: The nail bed and the paronychium (border tissue around the nail).
Paronychia: An abscess or soft tissue infection of the eponychium or paronychium.
Paronychium: The border tissue around the nail.

FIGURE 29–1 The anatomy of the nail.

FIGURE 29–2 Incision for the treatment of a simple paronychia.

FIGURE 29–3 The eponychium and nail wall are elevated off of the nail plate for decompression of purulence.

FIGURE 29–4 The nail plate can be removed to address injuries to the nail bed or for treatment of more extensive infection.

1 Hyponychium
2 Eponychium
3 Paronychium
4 Nail Wall
5 Lunula
6 Germinal Matrix
7 Nail Bed
8 Sterile Matrix

SECTION VII

HIP

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ANTEROLATERAL (WATSON-JONES) APPROACH

USES

This approach is used for hip arthroplasties and drainage of infections around the hip. Campbell calls this the lateral approach. A true lateral approach described by Harris includes a trochanteric osteotomy. The Hardinge approach uses the same interval but splits the tensor and takes the hip abductors off the greater trochanter and retracts them in a posterosuperior direction, exposing the entire anterior. Opening the capsule widely exposes the femoral head and acetabulum.

ADVANTAGES

This is a relatively straightforward approach that allows anterior dislocation of the hip for hip arthroplasties.

DISADVANTAGES

It is possible to denervate the tensor fascia lata if the split into the muscle is too far proximal.

STRUCTURES AT RISK

The major structure at risk is the superior gluteal nerve to the tensor fascia lata muscle. It is important not to split the muscle too far proximally to avoid damage to the nerve. Some surgeons suggest splitting the muscle far enough proximally to identify the inferior branch of the superior gluteal nerve.

It is possible to damage the femoral nerve and artery if you are too far anterior. The medial femoral circumflex could be damaged in the inferior aspect of the dissection if you are cutting down onto the lesser trochanter to release the iliacus or psoas muscles.

TECHNIQUE

The incision starts 2 cm distal and posterior to the anterosuperior iliac spine and curves in a posterior direction crossing just over the greater trochanter. It is carried through the subcutaneous tissue, and then exposes the tensor fascia lata muscle and posteriorly the gluteal muscles. The interval between these two is developed and split. The tensor fascia lata is retracted anteriorly and the gluteus maximus retracted posteriorly, which then exposes the gluteus medius underneath and the vastus lateralis origin off of the proximal femur. The posterior border of the tensor is in contact with the gluteus medius proximally and with the gluteus maximus distally. The rectus femoris is seen anteriorly distally. In the triangle between these three is the psoas tendon, which crosses the femoral neck. It is sometimes necessary to take the rectus femoris off of its insertion into the anteroinferior iliac spine. Sometimes it is necessary to take off part of the gluteus medius insertion. In the Hardinge approach, the abductors are taken off the trochanter in their entirety and later reattached. This then provides enough exposure. The psoas tendon can be lengthened to get it out of the way or it can be retracted medially. This exposes the femoral neck. The capsule is open and the procedure on the hip can be completed.

TRICKS

The main way to identify the interval between the gluteals and the tensor fascia lata is to do so more proximally. These two entities tend to merge as they proceed distally toward the fascia lata itself. Once that interval is developed, then the only other trick is to place a cobra or similar retractor around the femoral neck anteriorly and posteriorly, retracting the muscles and exposing the capsule.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost posteriorly with this approach, but if your split is entirely through the gluteus maximus, redirect it to the proper interval between the muscles. You will know you are too far posterior because you will have difficulty seeing the greater trochanter and the vastus lateralis origin. If you are too far anterior, you will again have trouble seeing the greater trochanter. Palpation should allow you to identify the location of the trochanter, so you can redirect your dissection. If you come in anterior to the tensor fascia in the interval between the tensor fascia and the sartorius, you will know it because the sartorius fibers are distinctive and the muscle is in a discrete tendon sheath. (This is not a problem as you are just doing an anterior approach.) The sartorius tends to be a round muscle, whereas the tensor fascia tends to be a triangular-shaped, flat muscle.

Once you are deep to the tensor, it is possible to confuse the rectus femoris and iliacus and psoas muscles. The rectus femoris is anterior to the psoas. If you are coming in anterior to the rectus femoris muscle, you will see the branches of the femoral nerve. This should be an immediate warning sign that you are too far anterior and medial.

Once you are deep to the tensor, it is very difficult to be lost posteriorly because you can feel the femoral neck and you will run into it if you try to dissect too far posteriorly.

FIGURE 30–1 The skin incision starting below the anterosuperior iliac spine.

FIGURE 30–2 The tensor fascia anteriorly and the gluteus maximus posteriorly. The fat in the interval between them is apparent.

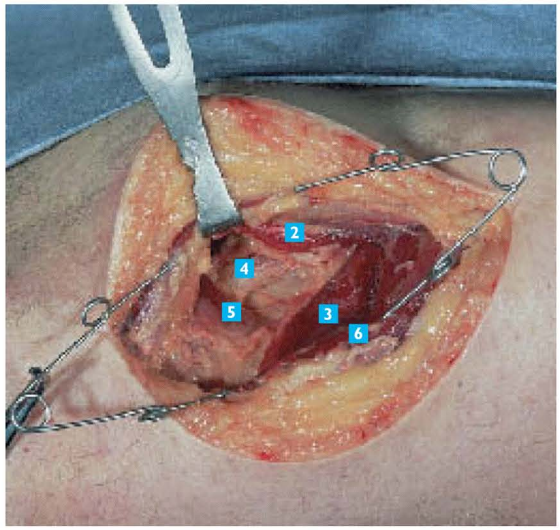

FIGURE 30–3 The gap between those muscles is developed. Deep to the gluteus maximus, you will see the fibers of the gluteus medius. You will also see the longitudinal fibers paralleling the femur of the vastus lateralis. Medial to them you can see the rectus femoris fibers crossing anterior to the hip. The tendon of the psoas muscle is still encased in its sheath and is not readily apparent.

1. Anterosuperior Iliac Spine
2. Tensor Fascia Lata
3. Gluteus Medius
4. Rectus Femoris
5. Vastus Lateralis
6. Gluteus Maximus
7. Hip Capsule
8. Femoral Neck

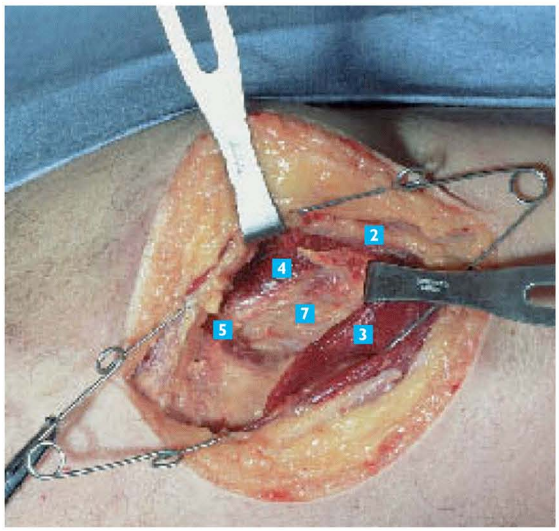

FIGURE 30–4 The rectus femoris muscle visualized more clearly. The vastus lateralis is also clearly seen. The gluteus medius is being retracted posteriorly. The hip capsule is also now visible.

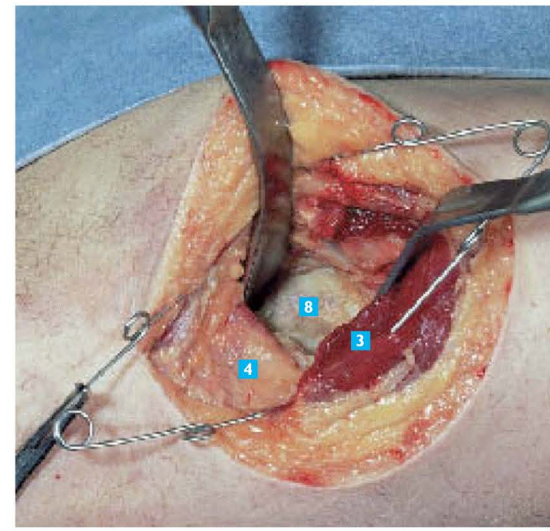

FIGURE 30–5 The retractors in place, retracting all of the muscles out of the way and exposing the femoral neck.

ANTERIOR (SMITH-PETERSON) APPROACH

USES

This approach is used for hip flexor lengthenings or releases, for access to the psoas tendon and the psoas bursa underneath that tendon, and for draining infections of the hip in children. Campbell calls the Smith-Peterson approach an anterolateral approach. Rockwood and Green list it as an anterior approach and call it the iliofemoral approach to the pelvis. The description here is an expanded version of the distal portion of their iliofemoral approach.

ADVANTAGES

This approach comes through the internervous plane between the sartorius and the tensor fascia lata. It also uses the pectineus to protect the femoral neurovascular structures. It does not interfere with blood supply to the hip capsule, which is very important in children.

DISADVANTAGES

This approach provides limited lateral exposure and no posterior exposure to the hip.

STRUCTURES AT RISK

Probably the most commonly injured structure with this approach is the lateral femoral cutaneous nerve, which usually exits the pelvis close to the anterosuperior iliac spine and runs in an oblique course down the thigh. The nerve is typically found in the lateral flap of this approach, but if it crosses more medially than is normal, it may need to be sacrificed and allowed to retract into the pelvis.

The other structures at risk are the femoral nerve and artery. The nerve sits more laterally than the artery and is encountered first. Additionally, it gives off branches to the sartorius, and if there is any dissection along the medial aspect of the sartorius, that muscle can be denervated. This nerve is anterior to the pectineus muscle, which is generally used to protect the nerve. It may branch fairly high, sending off its motor branches to the sartorius and the rectus.

The approach usually requires the release of the rectus femoris to obtain adequate hip exposure. If that is not approximated well, then that muscle function can be compromised.

When you are deep to the rectus femoris muscle and have the iliacus and psoas tendon in view, the medial femoral circumflex artery can be damaged. It generally is approximately 1 cm proximal to the lesser trochanter and is closely approximated to the tendon. The artery is large and will bleed profusely if not protected.

TECHNIQUE

An incision starts generally below the anterosuperior iliac spine, running distally, generally paralleling the sartorius muscle. It is carried through subcutaneous tissue. If the lateral femoral cutaneous nerve is identified, it is usually retracted in a medial direction. The first muscle encountered is the sartorius muscle, which is identified by the direction of its fibers from the anterosuperior iliac spine running in a medial direction. Lateral to it are the tensor fascia lata muscles, whose fibers are originating in the same location and along the iliac crest going posteriorly. As you move distally, the interval between these two muscles is easily developed. Deep to those muscles is the rectus femoris, which is in its own sheath, going up to the anteroinferior iliac spine; it usually needs to be released. When this is done, the anterior capsule is identifiable. Deep to the rectus, again in their own sheaths, are the iliacus and psoas tendons, which generally do not need to be disturbed in the approach to the hip itself.

TRICKS

The key trick is identifying the interval between the sartorius and the tensor fascia. As long as you stay lateral and deep to the sartorius, the femoral nerve and artery will be protected.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost in a lateral direction because you will simply run into the subcutaneous tissue lateral to the tensor fascia. It is quite possible, however, to get lost medially and put the femoral nerve at great risk. The key is the sartorius muscle, whose fibers are long and coming off of the iliac spine. It is a discrete muscle in its own fascial sheath that is easy to identify. If you do not see those fibers running from the anterior spine in a distal medial direction, but are seeing fibers only running longitudinally along the leg, then something is wrong. Once you are deep to the sartorius, you will see the longitudinal fibers of the rectus. The rectus muscle is in a discrete sheath, whose medial border protects the psoas tendon. You should see the longitudinal fibers of the rectus and the discrete sheath. If you are deep to the sartorius and you do not see them you are probably too far lateral. If you see fibers coming directly off of the proximal femur, you are looking at the origin of the vastus intermedius and are too far distal. If you see fibers running from the midline of the body toward the femur, you are looking at the pectineus muscle. Be careful, because the nerve, artery, and vein are just anterior to the pectineus.

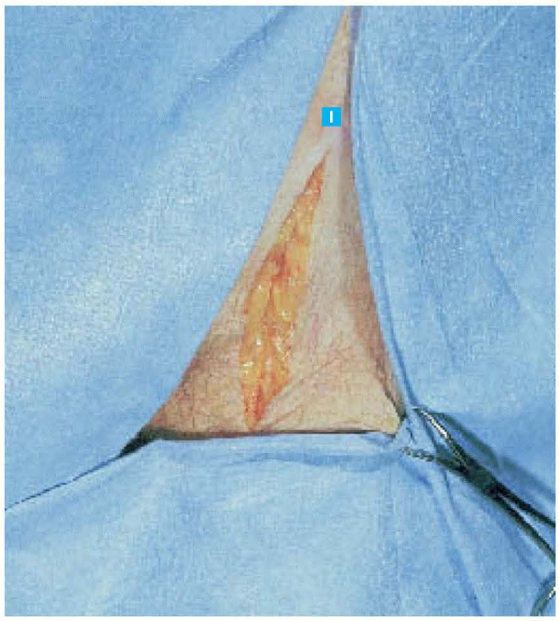

FIGURE 31–1 The incision, with the anterosuperior iliac spine at the top.

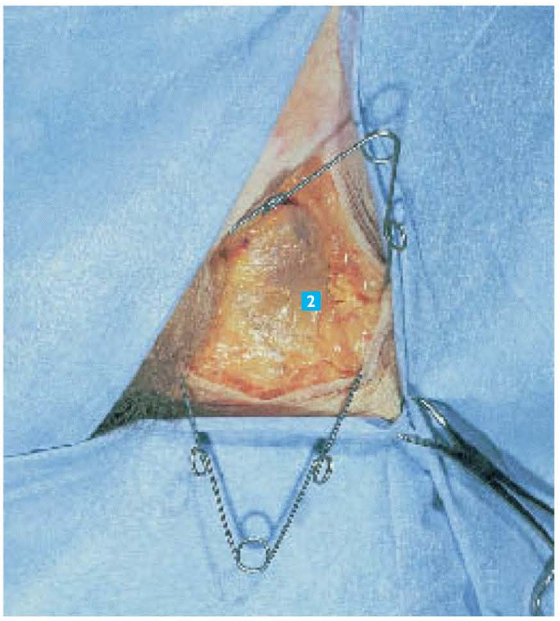

FIGURE 31–2 The subcutaneous fat being retracted laterally; the fascia overlying the muscle is seen. The lateral femoral cutaneous nerve is usually proximal and lateral by the time you are in the subcutaneous tissue, because the incision starts 2 cm distal to the anterosuperior iliac spine. It can, however, come right across the middle of your incision.

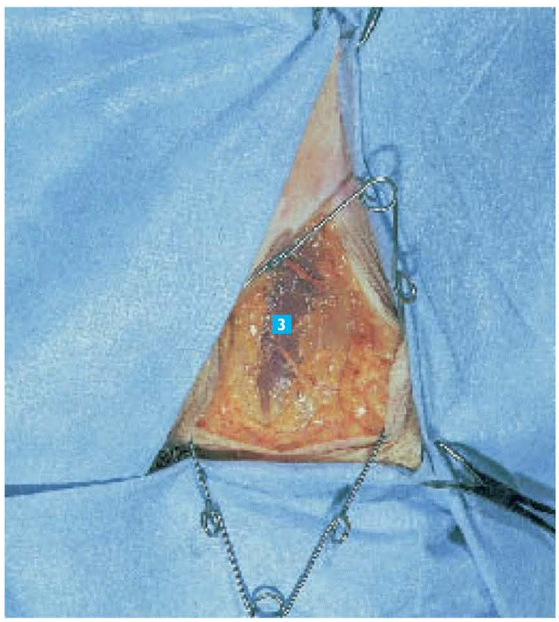

FIGURE 31–3 The sartorius muscle. The tensor fascia lata muscle is lateral and still covered by fat.

1 Anterosuperior Iliac Spine
2 Fascia Over Sartorius
3 Sartorius
4 Interval Between Sartorius and Tensor
5 Lateral Femoral Cutaneous Nerve
6 Femoral Nerve Under the Fat
7 Psoas
8 Rectus
9 Rectus Sheath
10 Tensor Fascia Lata
11 Hip Capsule
12 Femoral Head
13 Femoral Neck
14 Femoral Nerve
15 Pectineus
16 Femoral Artery

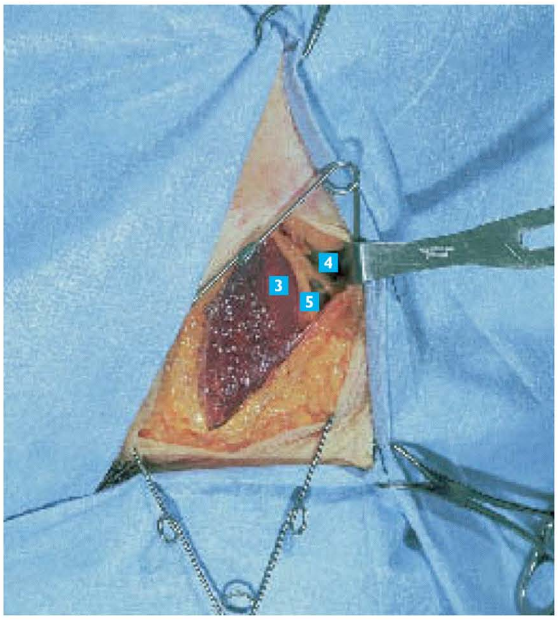

FIGURE 31–4 The nerve and the interval between the sartorius and tensor are now readily apparent.

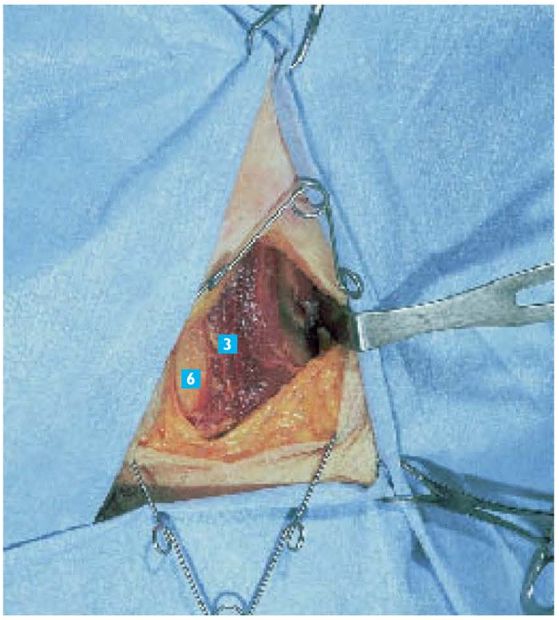

FIGURE 31–5 The sartorius muscle's medial border is as far medial as this approach should go. The femoral neurovascular structures are close to this border.

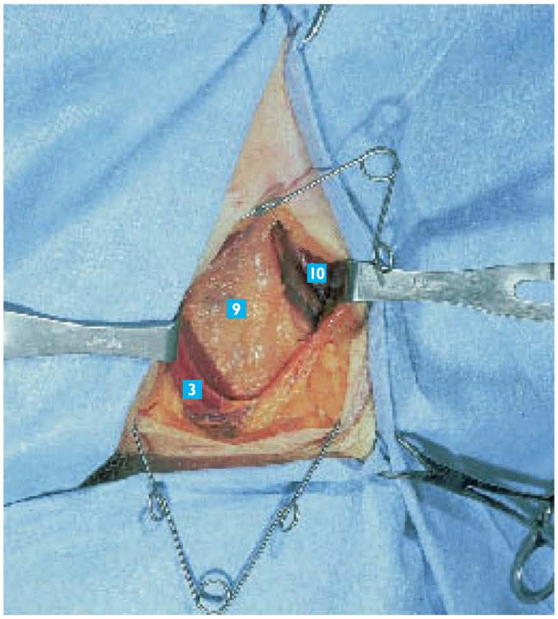

FIGURE 31–6 The fat and fascia overlying the rectus muscle. The sartorius is retracted medially and the tensor fascia laterally.

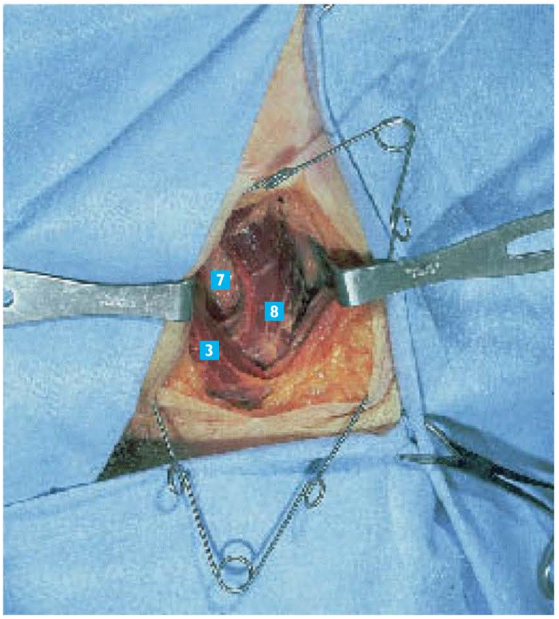

FIGURE 31–7 The rectus femoris tendon being opened and with the sartorius and tensor retracted. The psoas sheath is seen in the depth of the wound.

1 Anterosuperior Iliac Spine
2 Fascia Over Sartorius
3 Sartorius
4 Interval Between Sartorius and Tensor
5 Lateral Femoral Cutaneous Nerve
6 Femoral Nerve Under the Fat
7 Psoas
8 Rectus

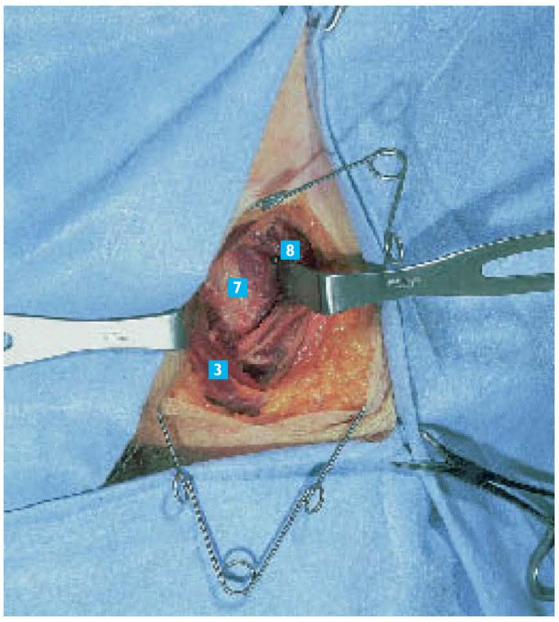

FIGURE 31–8 The reflected head of the rectus femoris coming onto the hip capsule. The main body of the rectus is retracted laterally and the sartorius medially. The psoas is now readily apparent.

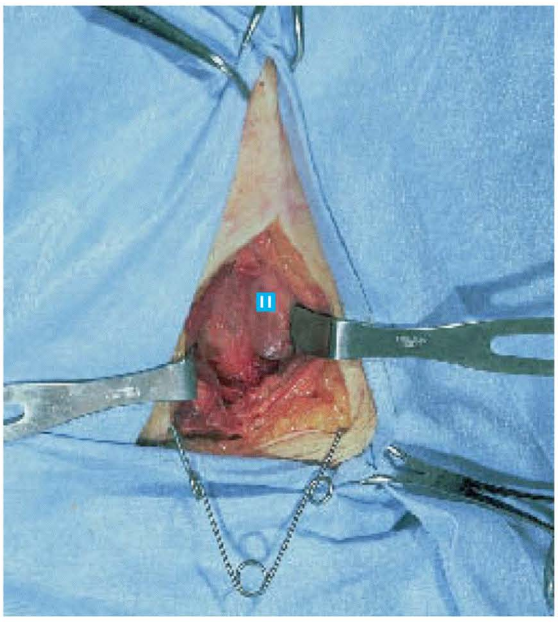

FIGURE 31–9 The rectus being retracted medially. The reflected head has been removed from the capsule and the capsule of the hip joint is seen in the depth of the wound.

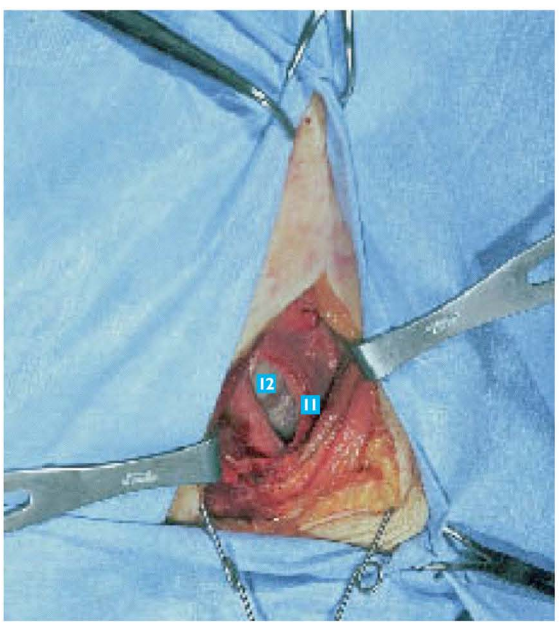

FIGURE 31–10 The hip has been opened, exposing the femoral neck.

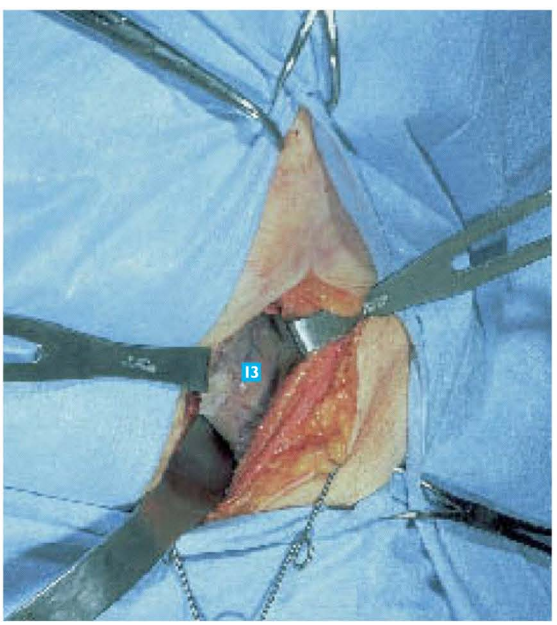

FIGURE 31–11 The femoral neck exposed and the femoral head visible at the top of the figure. The only muscle origin that was moved was the reflected head of the rectus femoris.

9 Rectus Sheath
10 Tensor Fascia Lata
11 Hip Capsule
12 Femoral Head
13 Femoral Neck
14 Femoral Nerve
15 Pectineus
16 Femoral Artery

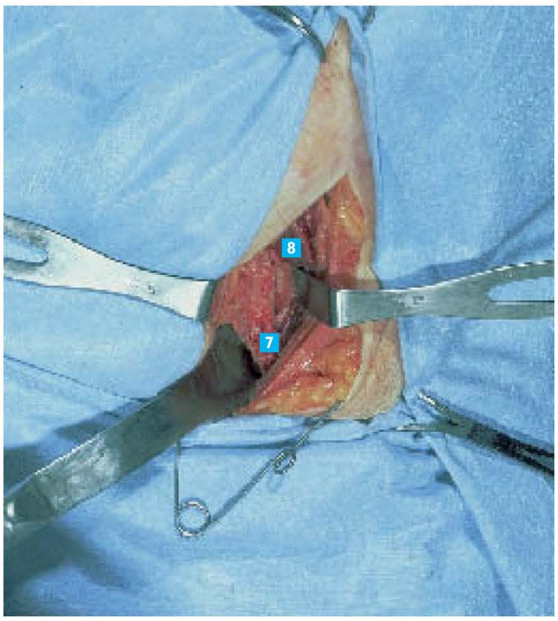

FIGURE 31–12 The psoas tendon is seen with the rectus retracted now laterally. The sartorius, pectineus, and femoral neurovascular structures are retracted medially. Going medial to the psoas is dangerous.

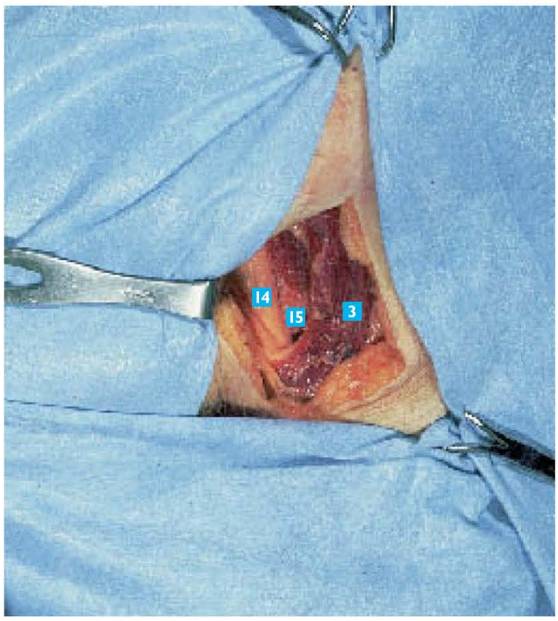

FIGURE 31–13 The femoral nerve. If you are medial to the sartorius tendon sheath, you are going to run into the femoral nerve.

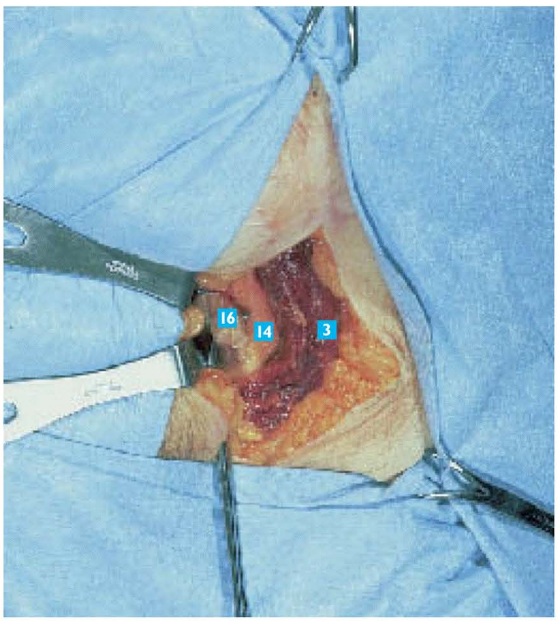

FIGURE 31–14 The femoral artery medial to the nerve. The muscle that is seen is the sartorius.

1 Anterosuperior Iliac Spine
2 Fascia Over Sartorius
3 Sartorius
4 Interval Between Sartorius and Tensor
5 Lateral Femoral Cutaneous Nerve
6 Femoral Nerve Under the Fat
7 Psoas
8 Rectus
9 Rectus Sheath
10 Tensor Fascia Lata
11 Hip Capsule
12 Femoral Head
13 Femoral Neck
14 Femoral Nerve
15 Pectineus
16 Femoral Artery

Medial Approach to the Hip and the Proximal Thigh

USES

In adults, this approach is used primarily for release of the adductor muscle. In children, it is used for adductor lengthening, for a partial obturator nerve neurectomy, or as an approach to the hip in congenital dislocation (in which case it is called the Ludloff approach).

ADVANTAGES

This approach provides direct access to the adductors. It also allows you to access the anterior and posterior branch of the obturator nerve, if you want to transect just a portion of the nerve.

DISADVANTAGES

This approach is of limited use in that it is difficult to see any structures deeper than the adductor muscles in an adult. Using it as an approach to the hip in an adult is very difficult, but in infants, because of the small size of their thigh and the looseness of the tissue, it is an approach that makes some sense.

STRUCTURES AT RISK

The most commonly injured structure with this approach is the obturator nerve or the artery. They run together and split into the anterior and posterior portions on either side of the adductor brevis muscle. As you proceed medially and approach the iliopsoas tendon, the medial femoral circumflex artery is at risk. It typically runs 1 cm proximal to the lesser trochanter.

Anteriorly, the pectineus muscle protects the femoral artery and nerve. If you are releasing the pectineus because it is also contracted, then those structures need to be protected.

TECHNIQUE

An incision is made starting as far proximally as possible and directly over the adductor longus tendon. The incision is carried through the subcutaneous tissue. The adductor longus tendon is easily palpated. In adults, these tendons are much, much bigger than what you would expect based on any experience you may have in pediatric orthopaedics. The adductor longus fascia is split. Just posterior to it is the long, flat origin of the gracilis muscle, which is very thin but very wide, from 6 to 7 cm in an anterior to posterior direction. Just lateral to the adductor longus is the adductor brevis. Again, this muscle is much bigger than generally appreciated and it is usually difficult to pass a large hemostat entirely around the muscle. When the muscle is released, it is usually released in stages. If the approach is being carried over to the iliacus and psoas tendons, then the pectineus with the femoral neurovascular bundle is retracted anteriorly and the femur is palpated. In children, this retraction allows the hip capsule to be exposed.

TRICKS

The adductor longus is the key to this approach. The incision should be centered over that tendon. The adductor longus needs to be retracted in the medial direction and posteriorly to expose the adductor brevis.

HOW TO TELL IF YOU ARE LOST

It is easy to get confused as to which muscle is which with this approach because of the muscles' very large size and because they all tend to run together, especially proximally. If you are not seeing the adductor longus and brevis discretely with the anterior branch of the obturator nerve, then you are probably lost. Usually you would be lost anteriorly, which is a very dangerous situation, because if you are anterior to the pectineus the femoral neurovascular structures are very much at risk.

If you are lost posteriorly, you will see the fibers of the gracilis, which are running longitudinally down the leg. The key clue here is the thinness of this muscle in a medial and lateral direction; the width of the muscle runs from anterior to posterior rather than medial to lateral, like the other adductors.

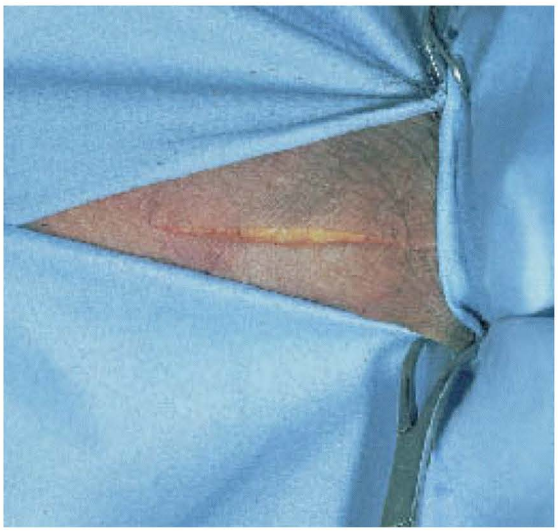

FIGURE 32–1 The skin incision, which starts right at the most proximal portion of the leg directly over the adductor longus tendon.

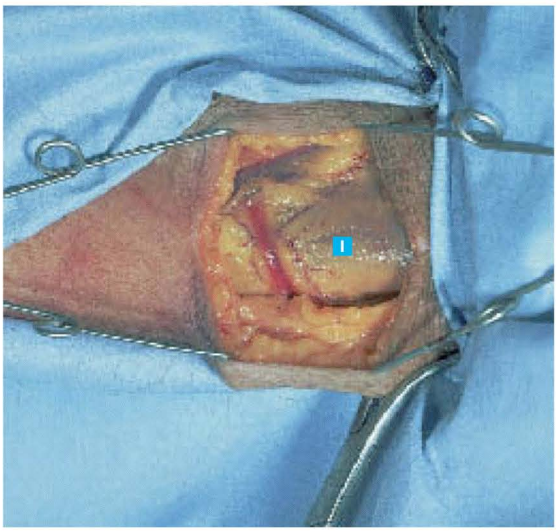

FIGURE 32–2 The adductor longus tendon. The gracilis, which is in an inferior position, is still covered by fat and is not visible. Note the large size of the adductor longus.

FIGURE 32–3 The fascia over the adductor longus tendon split, exposing the tendon more completely.

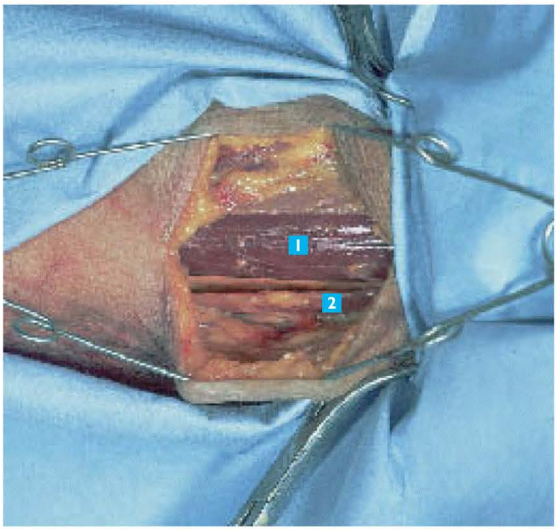

FIGURE 32–4 The gracilis muscle with the fat removed. The gracilis is a very wide muscle running in an anterior and posterior direction, but is very thin, medial to lateral.

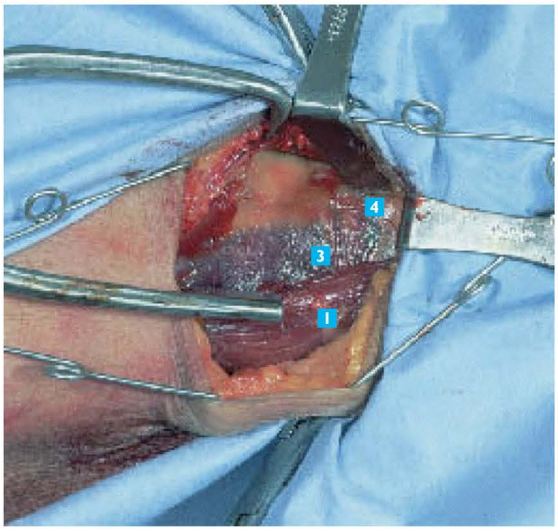

FIGURE 32–5 The adductor longus and gracilis pulled in a posterior direction exposing the adductor brevis tendon. Note the neurovascular bundle of the anterior branch of the obturator nerve and artery on the anterior aspect of the muscle.

1 Adductor Longus
2 Gracilis
3 Adductor Brevis
4 Obturator Nerve

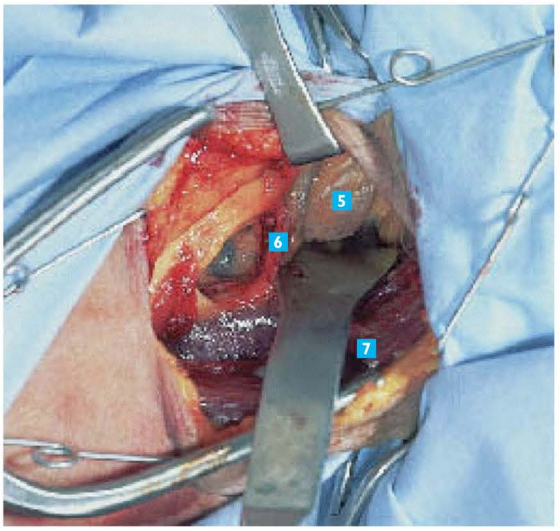

FIGURE 32–6 All of the adductors retracted in a posterior direction. The Bennett retractor is sitting underneath the lesser trochanter. You can see the iliacus muscle and psoas tendon, and notice the very large medial femoral circumflex artery, which usually crosses within 1 cm of the lesser trochanter.

5 Iliacus Muscle and Psoas Tendon
6 Medial Femoral Circumflex Artery
7 Adductor Muscles

POSTEROLATERAL (GIBSON) APPROACH

USES

This approach is used for hip prostheses, for piriformis releases in cases where the sciatic nerve is being compressed by that muscle, and for resection of the greater trochanteric bursa.

ADVANTAGES

This approach provides excellent access to the hip joint itself, and probably gives the best access to that joint without requiring the release of significant muscles. It is also an internervous approach because the gluteal muscles innervated by the gluteal nerves are retracted superiorly. The sciatic innervated muscles are located posteriorly and medially, and the femoral innervated muscles anteriorly.

DISADVANTAGES

This approach has a slightly higher dislocation rate following prosthetic implant in the hip joint than does an anterior approach. There is also some risk of damage to the sciatic nerve, which is not the case with the anterior approach. Also, in children, there is risk to the blood supply to the femoral epiphysis, which largely comes through the capsule. The most critical blood vessels come in at the posterosuperior corner of the capsule. For this reason, the posterior approaches to the hip are generally avoided in children with an open growth plate at the hip.

STRUCTURES AT RISK

The major structure at risk with this approach is the sciatic nerve. It is imperative that this nerve not be damaged. The nerve is fairly far medial. If the approach to the hip joint is through the external rotators along their insertion into the greater trochanter, then the nerve will be protected by those muscles as they are retracted. The nerve is easy to identify because of the loose tissue around it and because it is large and runs longitudinally, whereas all the other structures in the area run transversely.

If the split between the gluteus maximus and medius is carried too far proximally, then the superior gluteal nerve can be damaged. This is the nerve supply to the gluteus medius and minimus, and tensor fascia lata. Damage to the nerve causes significant hip abductor weakness with resultant gait abnormalities.

TECHNIQUE

The incision starts 3 cm distal to the tip of the greater trochanter and just behind it, proceeds proximally in a curved posterosuperior fashion, and is carried through the subcutaneous tissue. The fascia lata and the gluteus maximus insertion are seen, and typically the fascia lata is split longitudinally distally for 4 or 5 cm in the region of the gluteus maximus insertion into it. The interval between the gluteus maximus and medius is developed and split proximally, so that the maximus can be retracted posteriorly and the medius and minimus retracted anteriorly.

After the gluteus maximus is retracted in a posterior direction, the greater trochanteric bursa is identified. This bursa needs to be resected off of the back of the greater trochanter and femoral neck area, to expose the external rotators. The piriformis is the easiest to identify because it has a discrete tendon. These rotators are then transected off of their insertion. There is typically a blood vessel in the inferior portion of the external rotators that needs to be cauterized. At that point, the hip capsule can be opened and the rest of the procedure completed.

TRICKS

The major trick to this exposure is getting the gluteus maximus released so that it can be moved posteriorly and then to hold the medius and minimus anteriorly. It is sometimes necessary to release part of the minimus to get to the superior aspect of the femoral neck. Typically, a periosteal elevator can be used to strip the soft tissues overlying the external rotators down. This wiping motion exposes them without risking damage to the sciatic nerve.

One of the other problems is identifying the proper place to split the muscles in the interval between the gluteus maximus and medius. Once the fascial portion of the gluteus maximus has been split, you can place your finger underneath the more muscular portion and feel for the thin part. That would be the correct location to make your split.

HOW TO TELL IF YOU ARE LOST

It is possible to get lost in this approach if the split through the gluteus maximus is too far anterior or posterior, which will make retraction of the bigger flap difficult and limits exposure to the femoral head and neck. If you are going to err, it is probably better to err by being slightly posterior. This will take you back almost into what has been called the southern approach, which goes through the posterior portion of the gluteus maximus.

If you are lost too far anteriorly, you will have trouble retracting your posterior muscular flap. In either case, if you are lost too far anteriorly or posteriorly, it is relatively easy to resolve this problem by putting a transverse cut into the fascia lata anteriorly or maximus tendon posteriorly, which will relax the tissues, allowing them to be adequately retracted. This cut then can be closed without difficulty.

FIGURE 33–1 The usual incision. The patient is in a lateral decubitus position, with the affected hip positioned so that the greater trochanter is facing upward and the pelvis is locked in position to keep it perfectly positioned. Proximal is to the left, lateral is at the top.

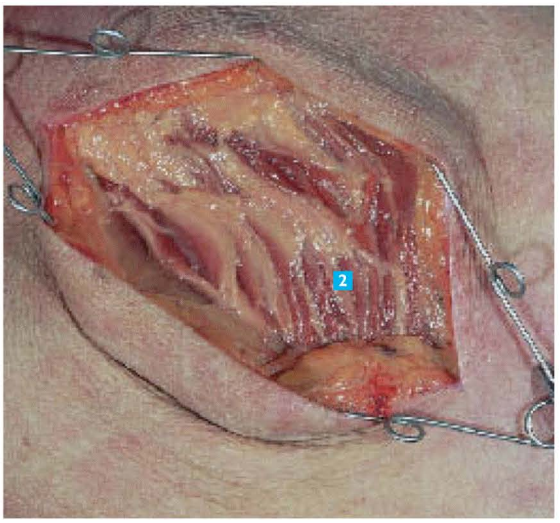

FIGURE 33–2 The skin incision open and the fibers of the gluteus maximus merged with those of the gluteus medius.

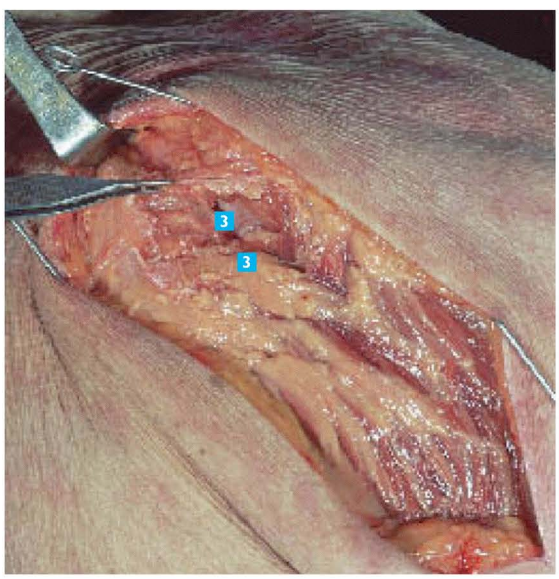

FIGURE 33–3 The split in the fascia lata attachment to the gluteus maximus. This then allows the maximus to fall posteriorly.

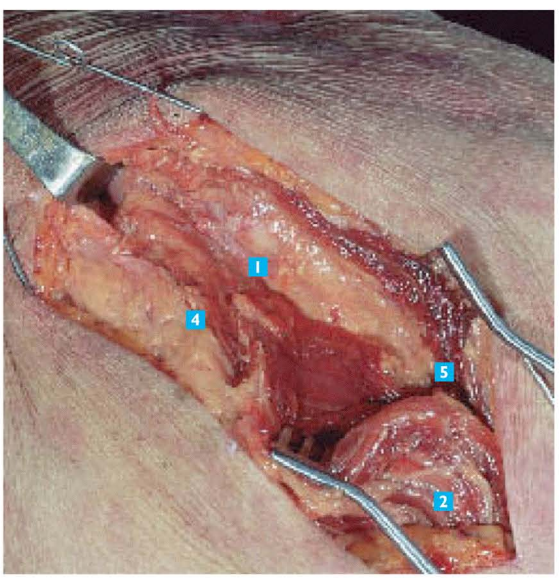

FIGURE 33–4 The split completed with the fascial edges widely separated and the muscle splitting into its anterior and posterior portions.

1 Greater Trochanter
2 Gluteus Maximus
3 Gluteus Maximus Insertion into the Fascia Lata
4 Cut Edge of Fascia
5 Gluteus Medius
6 Greater Trochanter Bursa
7 External Rotators
8 Bursa
9 Cut Edge of Rotators
10 Capsule
11 Femoral Head
12 Acetabular Labrum
13 Acetabular Edge (Labrum Removed)
14 Piriformis
15 Sciatic Nerve
16 Piriformus Released

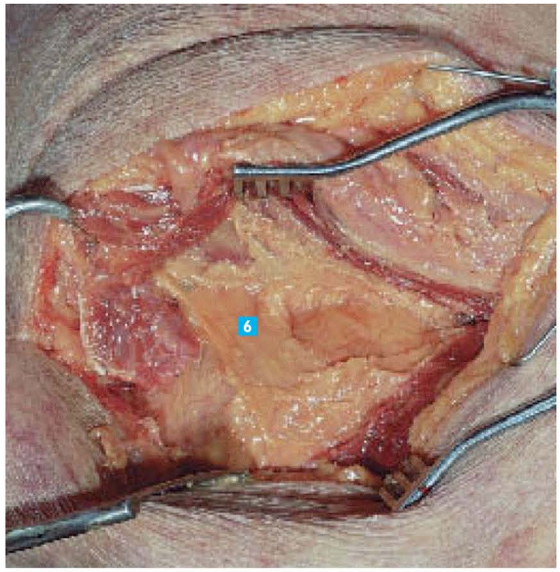

FIGURE 33–5 The greater trochanteric bursal area, which is a vague structure and very thin.

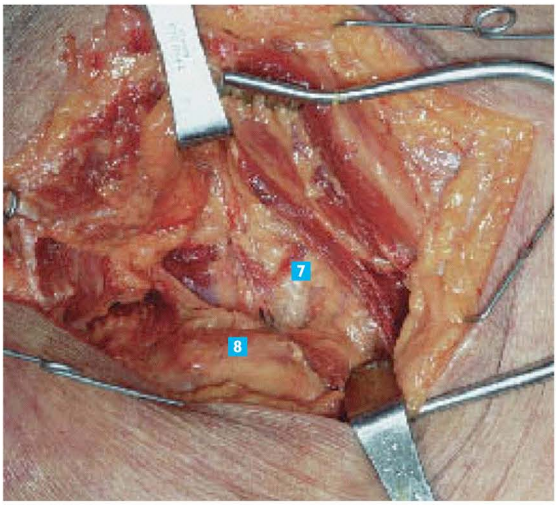

FIGURE 33–6 The bursa pushed in a posterior direction and the external rotators coming into view. The piriformis can frequently be identified as a discrete tendon, but these rotators are covered by the bursa and frequently some fat.

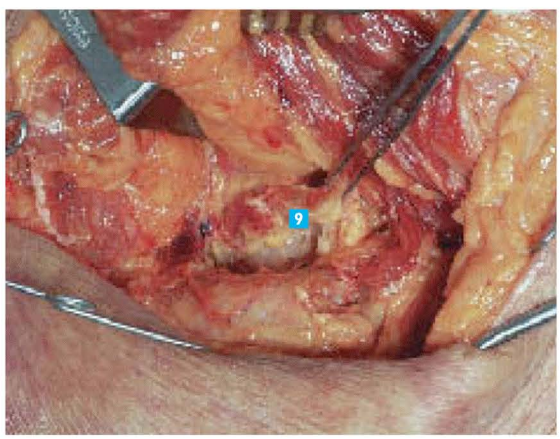

FIGURE 33–7 The external rotators as they are being resected from their insertion into the trochanteric notch area. Note that the sciatic nerve is not apparent at this point in the approach; it is posteromedial and would be at the bottom of the figure.

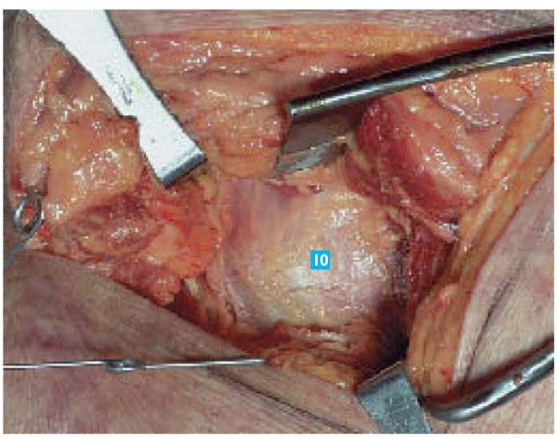

FIGURE 33–8 The external rotators being completely transected and being retracted posteriorly, exposing the hip capsule.

1 Greater Trochanter
2 Gluteus Maximus
3 Gluteus Maximus Insertion into the Fascia Lata
4 Cut Edge of Fascia
5 Gluteus Medius
6 Greater Trochanter Bursa
7 External Rotators
8 Bursa
9 Cut Edge of Rotators
10 Capsule
11 Femoral Head
12 Acetabular Labrum
13 Acetabular Edge (Labrum Removed)
14 Piriformis
15 Sciatic Nerve
16 Piriformus Released

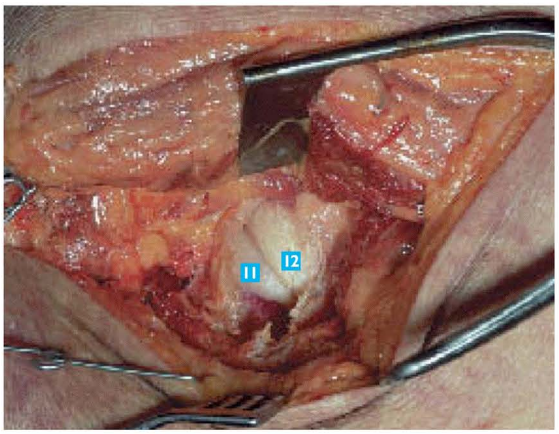

FIGURE 33–9 The capsule opened with the femoral head visible. The acetabulum and its attached labrum are also apparent.

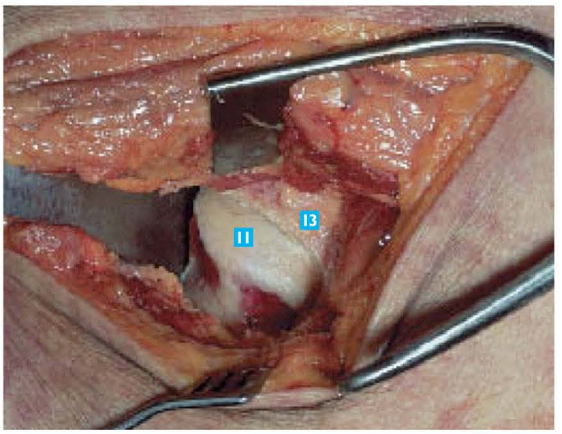

FIGURE 33–10 The femoral head and neck, now well exposed. The labrum has been resected off of the acetabulum showing the true bony edge of the acetabulum.

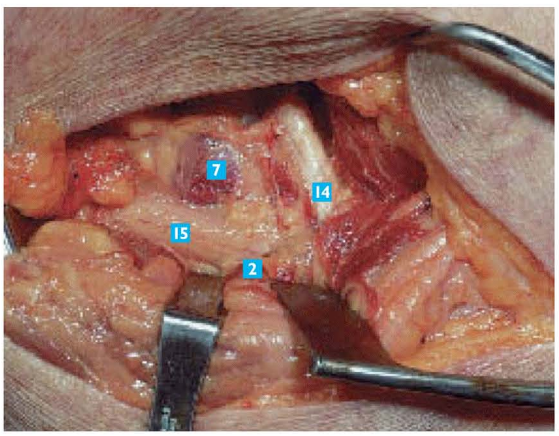

FIGURE 33–11 The sciatic nerve prior to release of the external rotators. The gluteus maximus is being retracted in a posterior direction. The piriformis crosses over the top of the nerve and is easily identified. The nerve itself enters the leg between the piriformis muscle and the other external rotators of the hip.

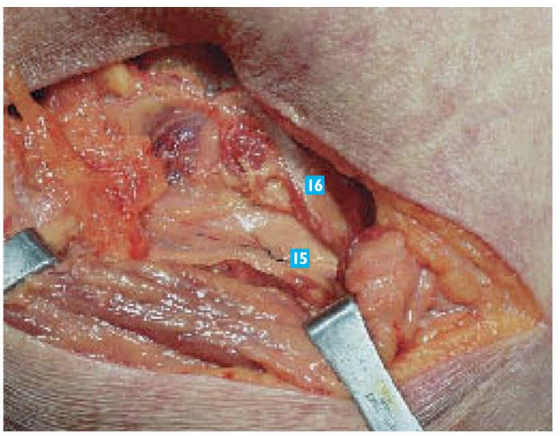

FIGURE 33–12 The piriformis muscle released, exposing the sciatic nerve more proximally, as would be done for a piriformis syndrome pinching the nerve, causing sciatica.

Lateral Approach to the Hip and Proximal Femur

USES

This approach is used for screw fixation of hip fractures. The proximal extension of this approach is used for the starter hole for intramedullary rodding of the femur.

ADVANTAGES

This approach provides direct access down to the femur. If the vastus lateralis is retracted anteriorly, this approach becomes an internervous one.

DISADVANTAGES

This approach allows very limited exposure to the femoral neck.

STRUCTURES AT RISK

There are no nerves and no significant arteries at risk. The arteries that are at risk are primarily the perforators coming from the posterior direction along the lateral aspect of the femur. If they are not cauterized prior to being transected, they can retract in a medial direction behind the femur and create problems with bleeding.

TECHNIQUE

For hip fractures, the incision usually starts 1 or 2 cm distal to the tip of the greater trochanter and proceeds distally for a distance of 5 cm, plus the length of the plate that is going to be used. The incision is carried through the subcutaneous tissue down through the fascia lata, which is split in line with the fibers in the midline. Proximal division of this fascia will usually go into the muscular portion of the tensor fascia. This division exposes the vastus lateralis, which is in its own fascia. The fascia is split in the midlateral line. At this point, the vastus lateralis needs to be separated from the posterior portion of the fascia, which is usually best accomplished with a periosteal elevator, moving from distal to proximal, lifting the fibers away. This separation allows the entirety of the vastus lateralis to be retracted anteriorly toward its nerve supply. As you approach the femur, you must be on the alert for the perforating arteries and veins, which can be cauterized. If the muscle is split in the middle of its fibers, then the area of the muscle posterior to the split will be denervated.

Once the vastus lateralis is retracted in an anterior direction, the lateral femur is exposed and the rest of the procedure can be completed.

TRICKS

The major trick is to be aware of the perforating blood vessels. They can be problematic if they are cut, and then they retract medially and continue bleeding. The other helpful trick is to peel the posterior portion of the vastus lateralis off of its fascia and retract the muscle as a whole anteriorly. During closure, the muscle will fall back in place and can be covered by closing the fascia.

Once you have split the fascia lata and are looking at the vastus lateralis origin, you will see fibers coming in from the posterior direction approaching the femur. These fibers are the direct attachment to the gluteus maximus, typically at the level of the lesser trochanter, and they will help as a guide to placement of guidewires for hip stabilization.

HOW TO TELL IF YOU ARE LOST

In cases where it is difficult to feel the greater trochanter, it is possible to be too far anterior or posterior. It is usually possible to feel the patella and the lateral femoral condyle, which will give you some idea of where the femur is located. If you are too far anterior, the fascia lata will appear very thin, and you will see the rectus femoris muscle in its sheath. This muscle is much smaller than the vastus lateralis, generally being approximately 3 cm in diameter. Also, its fibers do not originate off of the femur.

If you are too far posterior, the fascia will again appear thin, and this time you will see hamstring tendons.

Generally speaking, in excessively obese patients, once you are deep to the subcutaneous tissue, you can palpate the femur, which will guide you to the midline.

FIGURE 34–1 The incision site of the lateral approach to the hip.

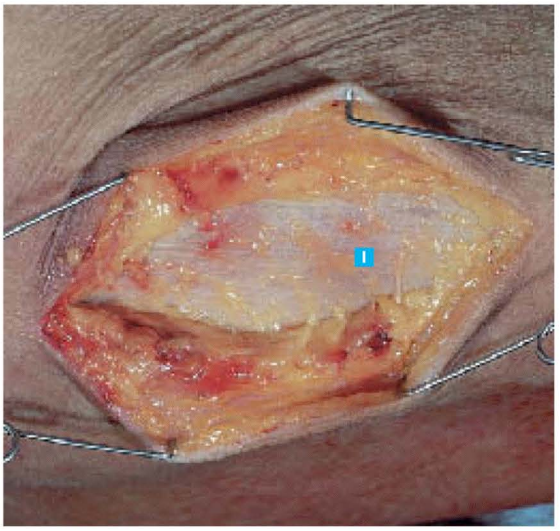

FIGURE 34–2 The subcutaneous tissue spread and the fascia lata underlying it.

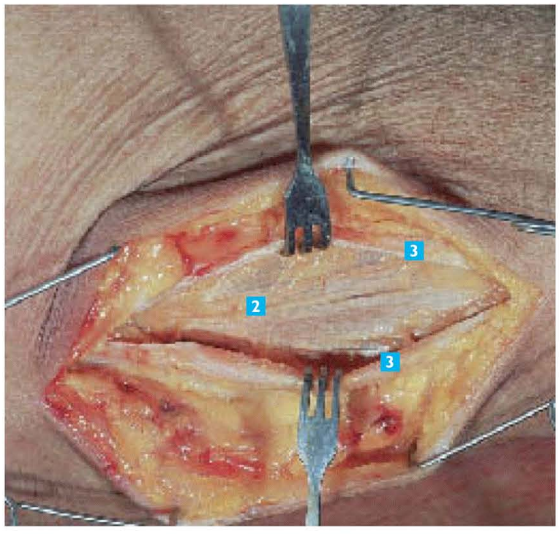

FIGURE 34–3 The fascia lata split from the fascia overlying the vastus lateralis, which is visualized.

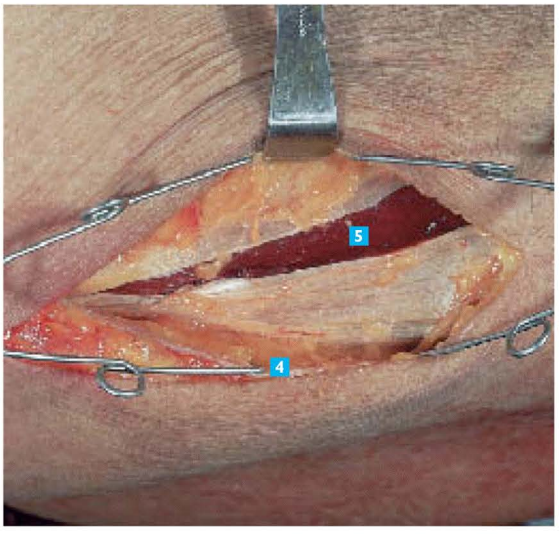

FIGURE 34–4 The fascia split with the muscle underneath it. There are thus two layers of fascia to go through before seeing the vastus lateralis muscle.

1. Fascia Lata
2. Vastus Lateralis Fascia
3. Fascia Lata Split
4. Fascia Lata Retracted
5. Vastus Lateralis
6. Lateralis Fascia
7. Perforating Vessel
8. Vastus Lateralis Fascia (Posterior Half)
9. Femur
10. Gluteus Maximus Insertion

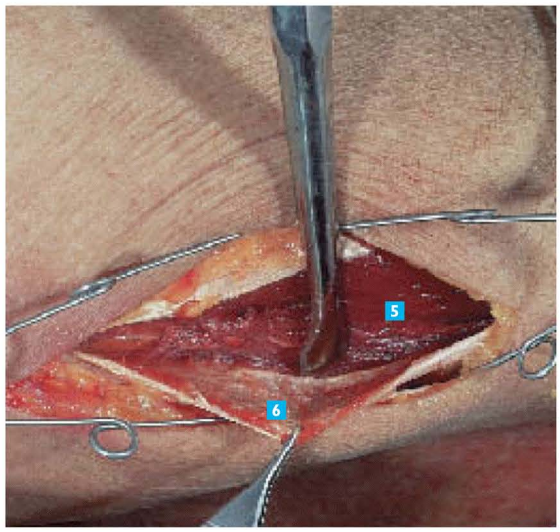

FIGURE 34–5 The periosteal elevator, used to strip the muscle off of the posterior portion of the vastus lateralis fascia.

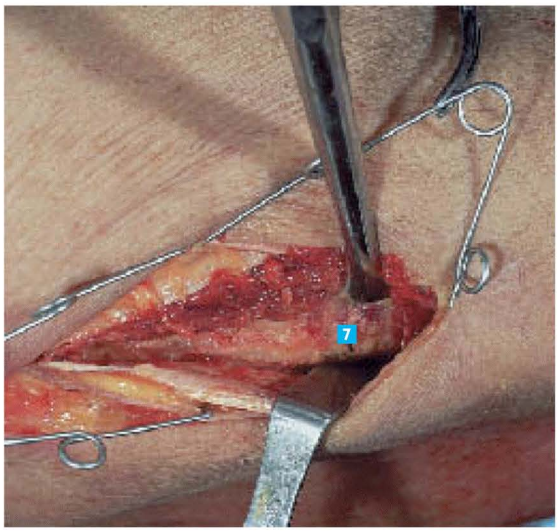

FIGURE 34–6 One of the perforating vessels, which is wrapping directly around the femur. These vessels need to be identified and cauterized.

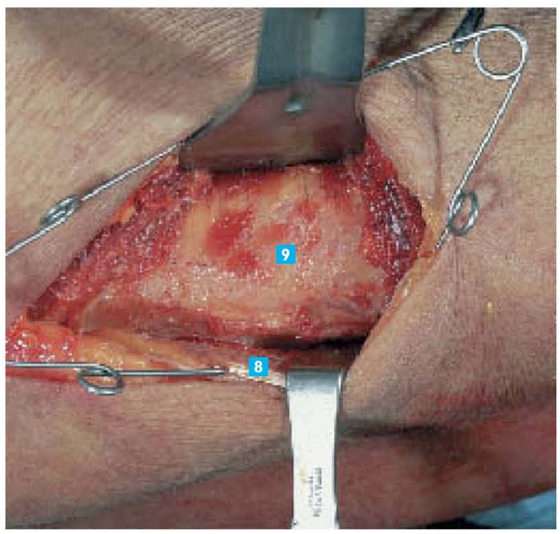

FIGURE 34–7 The entirety of the vastus lateralis retracted anteriorly. The posterior portion of the vastus lateralis fascia is retracted posteriorly, exposing the lateral femoral shaft. By retracting the entirety of the vastus lateralis anteriorly and not splitting it in the middle, you do not denervate any of the muscle.

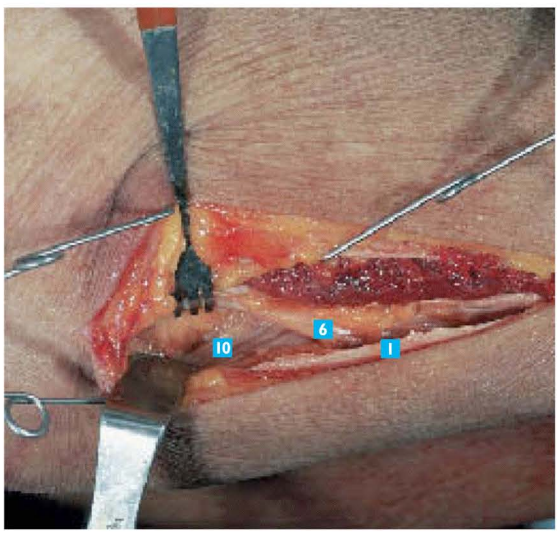

FIGURE 34–8 The vastus lateralis anteriorly and the fascia lata retracted posteriorly. The fibers of the gluteus maximus are seen approaching the femur from the posterior direction.

1 Fascia Lata
2 Vastus Lateralis Fascia
3 Fascia Lata Split
4 Fascia Lata Retracted
5 Vastus Lateralis
6 Lateralis Fascia
7 Perforating Vessel
8 Vastus Lateralis Fascia (Posterior Half)
9 Femur
10 Gluteus Maximus Insertion

SECTION VIII

THIGH

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Anterior Approach to the Distal Thigh and Femur

USES

This approach is used for release of the rectus femoris, for quadricepsplasties in the face of contracture, and for harvesting of quadriceps tendon and bone in cases where they are being used as an anterior cruciate ligament graft.

ADVANTAGES

This approach is straightforward, as there are no significant neurovascular structures in the area. This approach can be extended proximally and distally, as needed, for greater exposure.

DISADVANTAGES

This approach has no disadvantages if used for the purposes for which it was designed.

STRUCTURES AT RISK

There are no significant structures at risk.

TECHNIQUE

A straight incision is made over the area of interest. If the plan is to harvest part of the patella and the quadriceps tendon, then the incision starts over the patella. If it is for a rectus femoris release or a quadricepsplasty, it starts approximately 4 cm proximal to the patella and proceeds proximally from there. The incision is carried through subcutaneous tissue down to the fascia. The rectus femoris fascia is identified and split. This muscle is in its own fascial layer proximal to the coalescence of the quadriceps tendon and is easy to identify. The vastus medialis and lateralis typically join underneath the rectus femoris, with the intermedius coming in from below.

TRICKS

Because this approach is very straightforward, there are no special tricks for its successful execution.

HOW TO TELL IF YOU ARE LOST

The patella is subcutaneous and is easy to identify, thus making it hard to get lost. If you are trying to do a quadricepsplasty or a rectus release, and you are too far proximal or distal, you simply extend the incision in whatever direction is needed.

FIGURE 35–1 The skin incision starting 4 cm proximal to the patella and proceeding proximally from there. This incision is carried distally if the goal is to harvest the quadriceps tendon and a portion of the patella for ligament reconstruction.

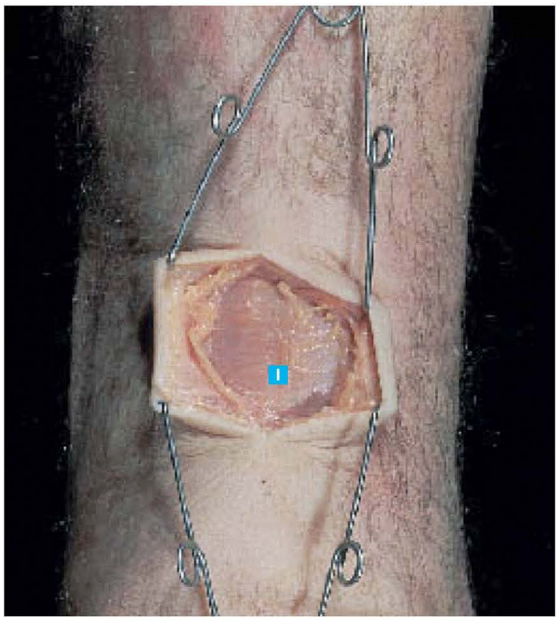

FIGURE 35–2 The fascia overlying the quadriceps tendon.

FIGURE 35–3 The quadriceps tendon starting to be exposed. The vastus medialis is coming in from the right side.

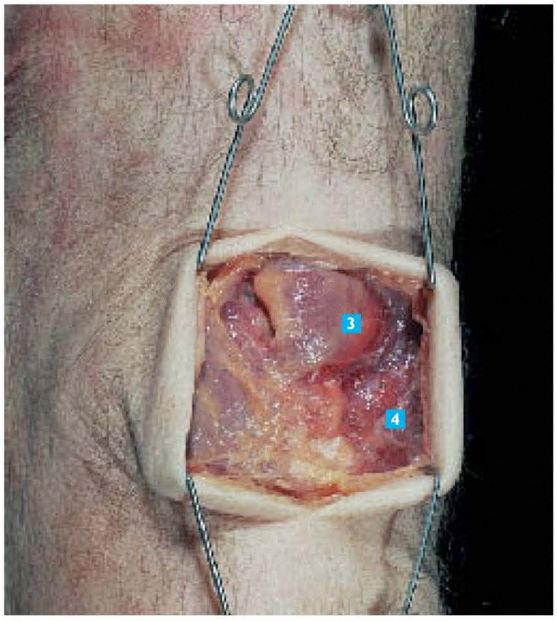

FIGURE 35–4 The rectus femoris with its sheath being opened. Its fibers are running longitudinally parallel to the femur, whereas those of the medialis and lateralis are running at an oblique angle.

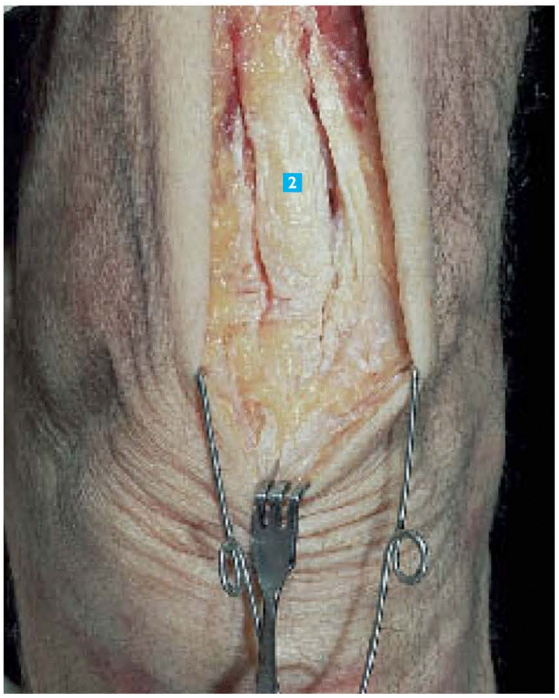

FIGURE 35–5 The extension of the incision distally onto the patella. The quadriceps tendon is visible. The center portion can be harvested for transplant.

1 Fascia Over Quadriceps
2 Quadriceps Tendon
3 Rectus Femoris

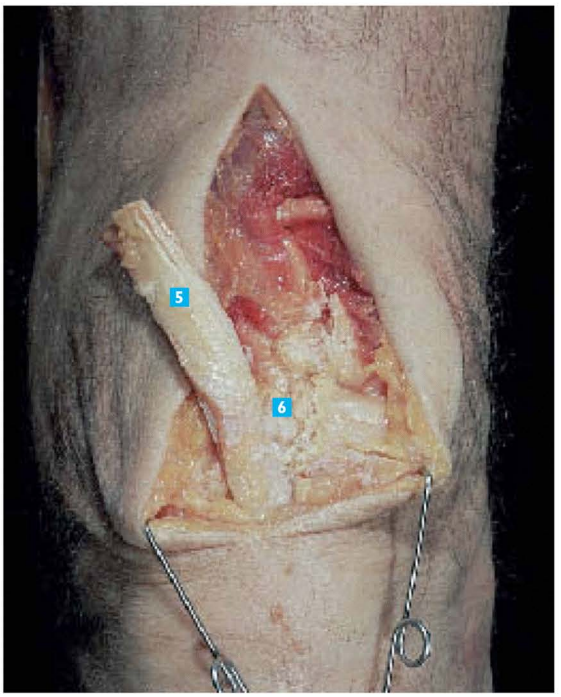

FIGURE 35–6 The quadriceps tendon ready for resection, with the remaining quadriceps tendon underneath.

4 Vastus Medialis
5 Quadriceps Tendon for Transfer
6 Remaining Tendon

MEDIAL APPROACH TO THE DISTAL THIGH AND FEMUR

USES

This approach is used for fracture work on the distal femur, for resection of medial-based osteochondromas on the femur, and for hamstring release (by keeping the incision slightly posterior). Also, this approach is used to place the starter hole for flexible rod intramedullary fixation done in a retrograde fashion.

ADVANTAGES

For the appropriate pathology, this approach is direct. As long as you stay distal on the femur, you are in an area that is safe from a neurovascular standpoint.

DISADVANTAGES

There is a limit to how far proximally this approach can be extended because of the femoral artery.

STRUCTURES AT RISK

The two significant structures at risk are the saphenous nerve and the femoral artery. Both cross from anterior to posterior in the area of the incision. Usually, the artery crosses 13 cm or more proximal to the knee joint. The nerve can be further distal than that.

TECHNIQUE

The incision starts at the level of the adductor tubercle and proceeds proximally as far as necessary. It is carried through the subcutaneous tissue. The first structure that should be identified is the adductor longus tendon, which is a thick tendinous structure going down toward the adductor tubercle. Once that tendon is identified, a search should be made for the saphenous nerve to be sure that it is protected. The posterior border of the quadriceps muscle is then identified and the muscle is stripped off of the femur and adductor longus tendon in the area of interest, exposing the medial distal femur.

TRICKS

The major trick is to start at the adductor tubercle and to come down and identify the adductor tendon. This tendon then guides you to the quadriceps and keeps you in the safe area.

The second trick is to realize that the artery and saphenous nerve cross from anterior to posterior. The saphenous nerve enters and then exits through the sartorius muscle, but in this approach it is usually seen before it enters the sartorius muscle. The key to identifying it is to be aware of where it is located; look for the thin white structure moving obliquely from anterior to posterior.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost anteriorly because you will see the vastus medialis, which is quite apparent. This approach should be made along the posterior border of the quadriceps muscle. It is not possible to be lost laterally because you will run into the femur. It is possible to be too far posterior and to come in below the adductor longus tendon. If you are looking at some tendinous structure that does not hook into the distal femur, you are looking at a hamstring tendon and are lost too far posteriorly. Another clue to being too far posterior is seeing the sartorius muscle. Its fibers run parallel to the femur, and not up toward the patella.

FIGURE 36–1 The skin incision. Distal is to the right.

FIGURE 36–2 The vastus medialis fascia. The hamstrings are at the bottom of the figure.

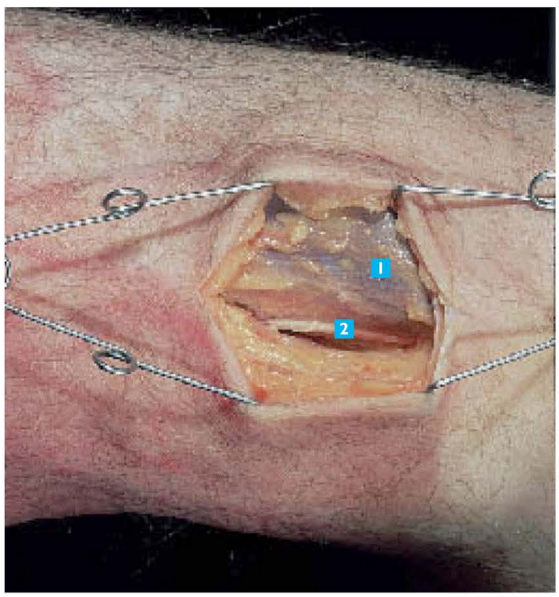

FIGURE 36–3 The adductor longus tendon approaching the abductor tubercle. This is an important landmark, as everything anterior to this is quadriceps innervated by the femoral nerve and everything posterior is the hamstrings. The artery is posterior at this level.

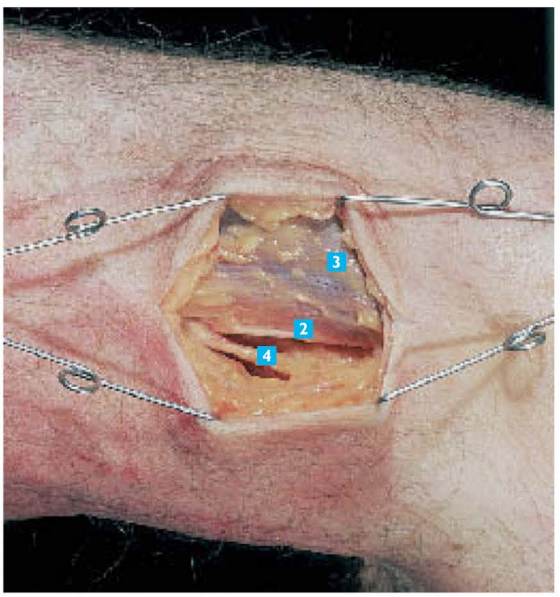

FIGURE 36–4 The saphenous nerve crossing. Distally, it exits through the sartorius in its course down the leg.

1 Quadriceps
2 Adductor Longus Tendon
3 Vastus Medialis
4 Saphenous Nerve
5 Fascia Over Femur
6 Femur
7 Femoral Artery
8 Sartorius

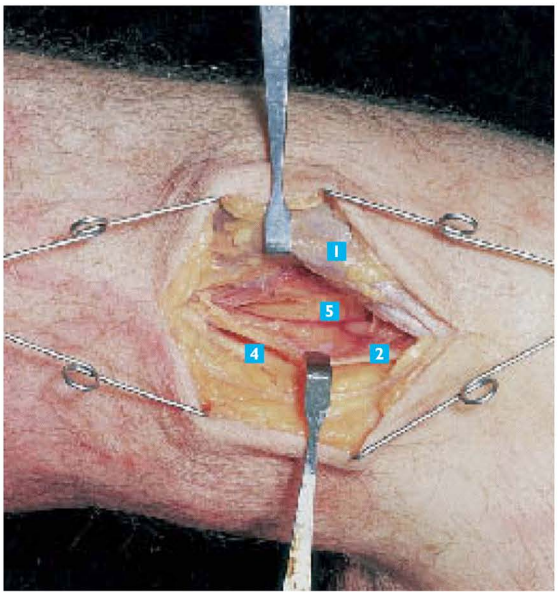

FIGURE 36–5 The quadriceps retracted in an anterior direction and the adductor longus retracted posteriorly.

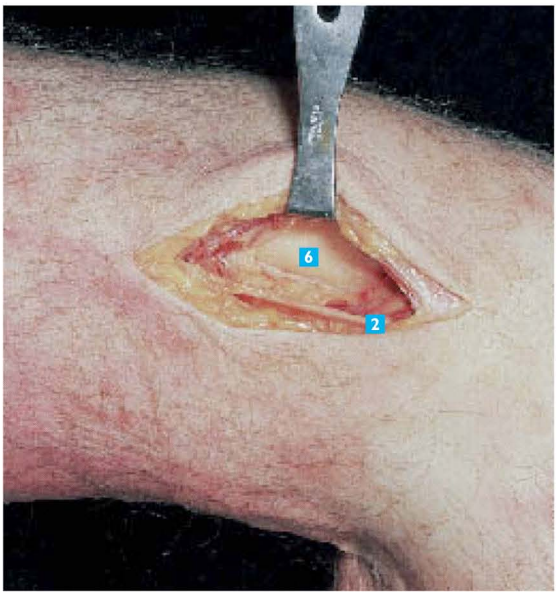

FIGURE 36–6 The medial aspect of the femur and the periosteum stripped off of it.

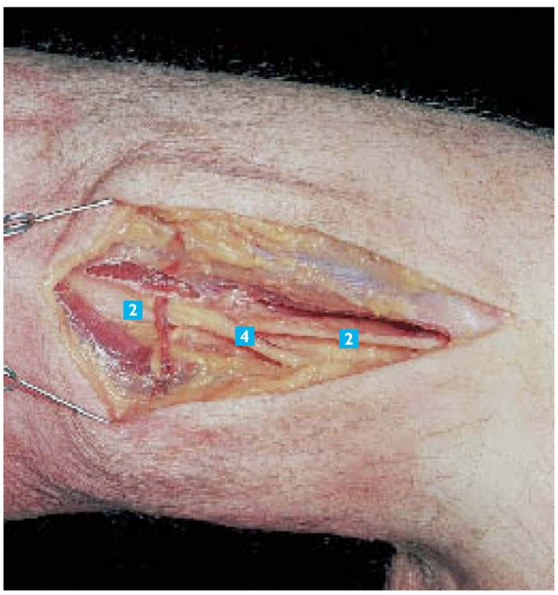

FIGURE 36–7 The extended approach proximally. Portions of the vastus medialis are originating off of the adductor tendon. The sartorius is in the posterior aspect of the wound. The saphenous nerve can be seen coming out, crossing the adductor, and proceeding distally.

FIGURE 36–8 The adductor longus tendon in the region of the adductor canal. The femoral artery is seen deep; it will pass through the hiatus in the adductor tendon as it proceeds from anterior to posterior.

1 Quadriceps
2 Adductor Longus Tendon
3 Vastus Medialis
4 Saphenous Nerve
5 Fascia Over Femur
6 Femur
7 Femoral Artery
8 Sartorius

LATERAL APPROACH TO THE DISTAL THIGH

USES

This approach is used for supracondylar fractures and for releasing the iliotibial band in iliotibial-band friction syndrome. The fascia lata can be easily harvested or the iliotibial band lengthened through this incision. Additionally, by moving the incision slightly posterior, it is possible to do a biceps femoris release, lengthening, or transfer.

ADVANTAGES

This approach does not put any nerve or artery at risk.

DISADVANTAGES

There are no disadvantages if this approach is used for the purposes for which it is intended.

STRUCTURES AT RISK

There are no significant structures at risk. The fascia lata and iliotibial band are split longitudinally, but that usually is the point of the approach.

It is potentially possible to damage the peroneal nerve, but only if you are seriously lost medially and posteriorly. As long as you stay anterior to the biceps femoris, there is no risk.

TECHNIQUE

A straight incision is made from the femoral condyle area proximally. It is carried through subcutaneous tissue. The iliotibial band is identified and split, and the vastus lateralis is apparent underneath it. The lateralis should be stripped off the intermuscular septum and retracted in a medial direction, exposing the lateral femoral shaft and the lateral femoral condyle. It is important to stay out of the knee joint by coming from underneath and lifting the joint capsule and synovium anteriorly.

If the goal is to release the hamstrings, then the posterior border of the iliotibial band is identified and the biceps fascia is split just behind it, exposing the muscle of the biceps. The short head of the biceps originates off of the femur in this area and will need to be stripped off of the femur to expose the medial border of the biceps. This will allow the peroneal nerve to be identified and protected prior to doing any harvesting or lengthening of the biceps femoris.

TRICKS

The major trick here is to identify the intermuscular septum and the posterior border of the quadriceps, and thus keep away from the peroneal nerve. The muscle can be held in a medial direction with a Bennett retractor, exposing the lateral femur. The dissection can be carried as far proximally in this manner as necessary.

HOW TO TELL IF YOU ARE LOST

It is almost impossible to get lost with this approach. As soon as you are deep to the subcutaneous tissue, you will see the longitudinal white fibers of the iliotibial band. Once these fibers are split, the fibers of the vastus lateralis are apparent underneath the iliotibial band. The iliotibial band merges with the fascia overlying the biceps femoris. The intermuscular septum proceeds from the band down to the femur at the posterior border of the quadriceps.

It is potentially possible to be lost too far posteriorly, which you will know if you see muscle fibers running in a posterior oblique direction toward the head of the fibula instead of in an anterior oblique direction toward the patella.

FIGURE 37–1 The skin incision with the iliotibial band deep to the subcutaneous.

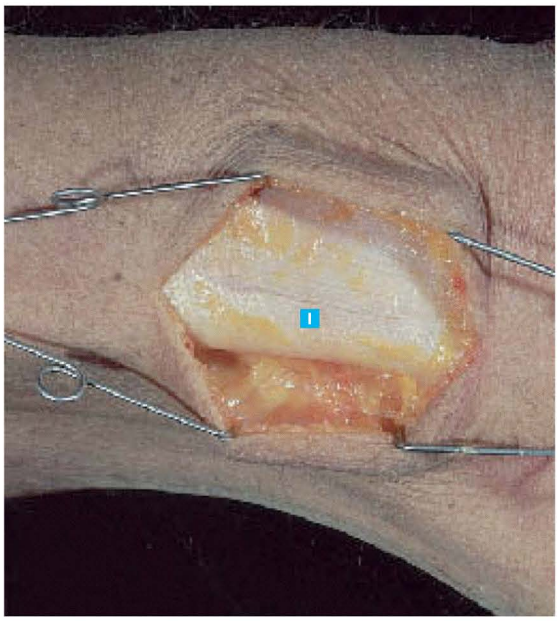

FIGURE 37–2 The iliotibial band in its posterior border. Notice the fat just below that, which is overlying the biceps femoris.

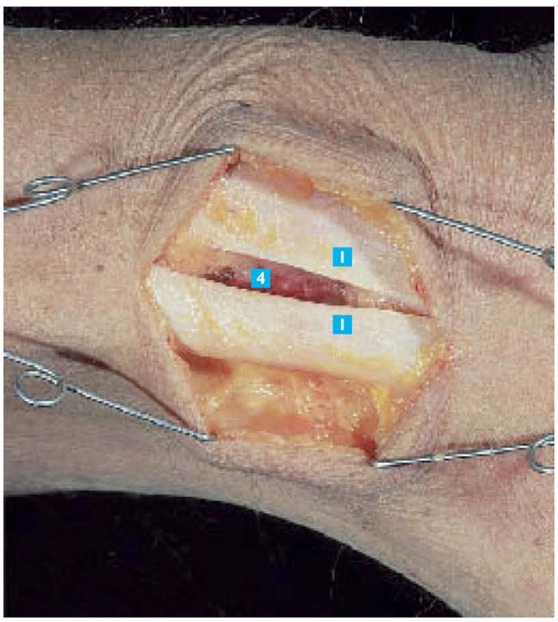

FIGURE 37–3 The split in the iliotibial band, with the muscles of the vastus lateralis apparent in the depth of the wound.

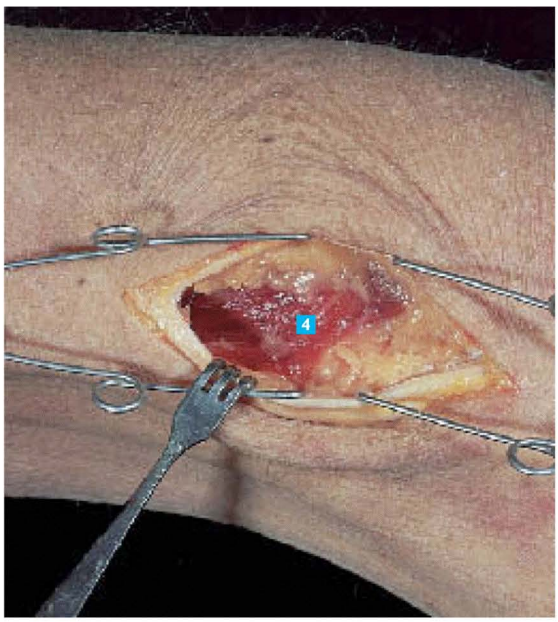

FIGURE 37–4 The lateralis more clearly visible. Notice that the direction of the fibers is toward the patella.

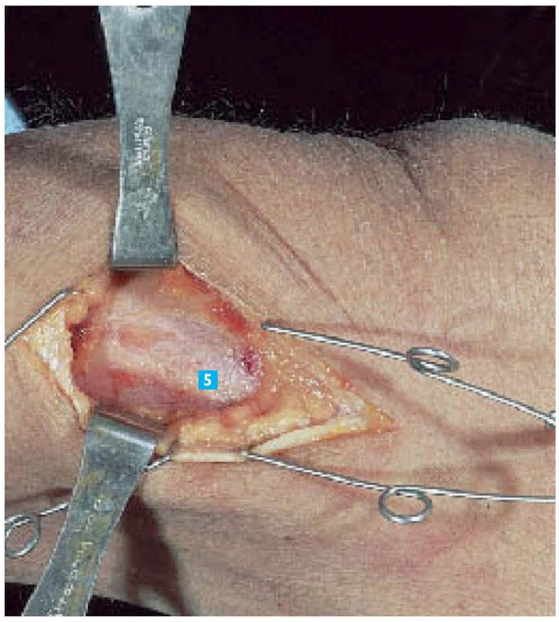

FIGURE 37–5 The vastus lateralis retracted in an anterior direction, exposing the lateral femoral shaft in the region of the condyles.

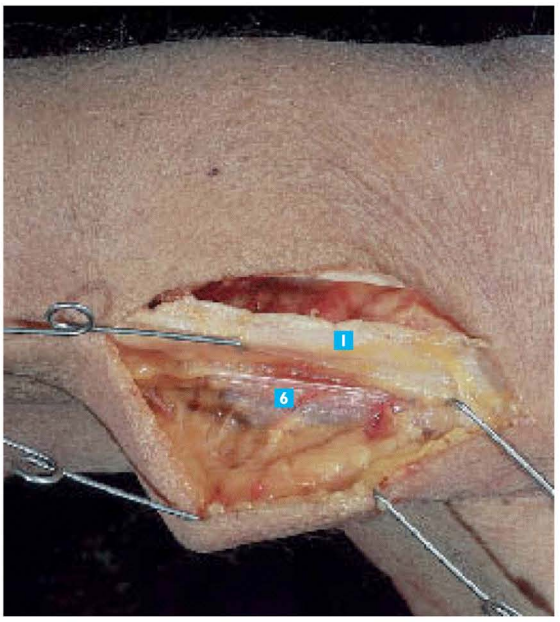

FIGURE 37–6 The posterior border of the iliotibial band, with the fascia overlying the biceps femoris. Notice how far posterior the position is to the initial split in the iliotibial band.

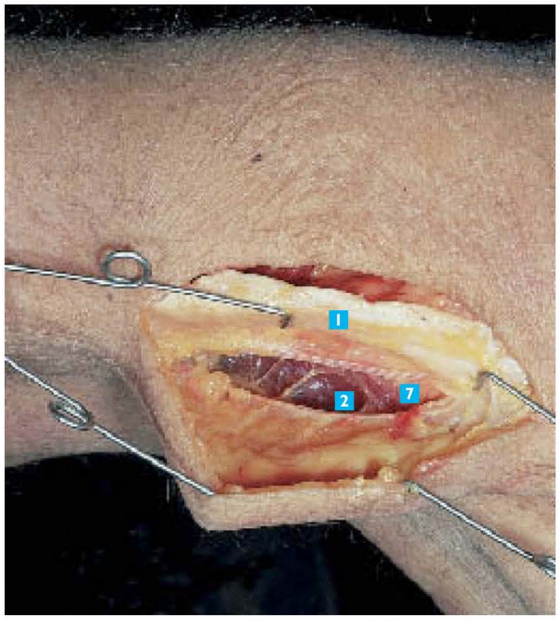

FIGURE 37–7 The fibers of the short head of the biceps coming off of the femur and heading in a posterior oblique direction toward the fibular head. The peroneal nerve is medial to the short head of the biceps, and to identify it at this level you would need to strip the short head off of the femur and look on its medial side.

1 Iliotibial Band
2 Biceps Femoris
3 Medial Hamstrings
4 Vastus Lateralis
5 Femur
6 Biceps Fascia
7 Fat in Area of Peroneal Nerve

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SECTION IX

KNEE

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ANTERIOR APPROACH

USES

This approach is the universal approach to the knee. It is used for total knee arthroplasties, supracondylar fractures of the distal femur, open cruciate ligament reconstruction, and patellar surgery.

ADVANTAGES

This extensile approach can be extended proximally or distally as far as necessary. Also, there are no neurovascular structures at risk. This approach allows easy access to either side of the patella. If it is necessary to access the posteromedial and posterolateral corners, this approach facilitates creating equal skin flaps. The approach has the lowest risk of wound healing complications in revision knee surgery.

DISADVANTAGES

The approach allows only limited exposure to the posteromedial and posterolateral corners.

STRUCTURES AT RISK

If the incision is carried far enough distally, the infrapatellar branch of the saphenous nerve would be transected, causing some numbness on the lateral aspect of the knee. Except for this nerve transection, there are no structures at risk.

TECHNIQUE

An incision is made generally over the midline. Some surgeons use a median parapatellar approach. In general, however, the straight-down-the-middle incision allows you to create equal medial and lateral flaps with less undermining of the skin. Once you are through the subcutaneous tissue, you have to proceed along the patella edge, usually using a median parapatellar approach leaving 1 cm of soft tissue attached to the patella. The incision is made through the quadriceps in its tendinous portion in the midline, leaving a rim of tendon attached to the vastus medialis, around the medial border of the patella and then down along the patellar tendon. Once you have reached the tibial tubercle, no further dissection is necessary. At that point, the synovium is opened. If there is enough release done proximally, you can invert the patella. If it is not possible to do that, it is sometimes required that you partially resect the patellar tendon off of its insertion, but great care must be taken not to resect excessive amounts. When the patella is loose enough to be inverted, no further dissection is necessary.

It is possible to do a subvastus medialis approach in patients who are thin and have fairly loose tissues. (This is the approach that is demonstrated in this chapter's figures because it is less well known.) To do so, you make the same inferior incision along the patellar tendon, but when you reach the inferior border of the vastus medialis you move medially and superiorly parallel to the border of those fibers. This incision is then carried as far medial as necessary to provide the looseness that is required. It is possible to resect part of the vastus medialis off of the adductor tendon area and intermuscular septum to provide the laxity needed to invert the patella.

TRICKS

This approach is straightforward, with no real tricks. There is no reason to separate the subcutaneous tissue from the skin generally, and it is better from a healing standpoint if they are incised as one layer. Once you are deep to the subcutaneous tissue, further dissection curves around the medial or lateral borders of the patella. As the incision approaches the tibial tubercle, it should veer either to the medial or lateral sides so it is not directly over the prominence of the tubercle.

HOW TO TELL IF YOU ARE LOST

It is almost impossible to get lost with this approach because the patella is directly subcutaneous. You can be slightly further medial in your median parapatellar incision than is ideal, but you should not be lost.

FIGURE 38–1 The usual incision.

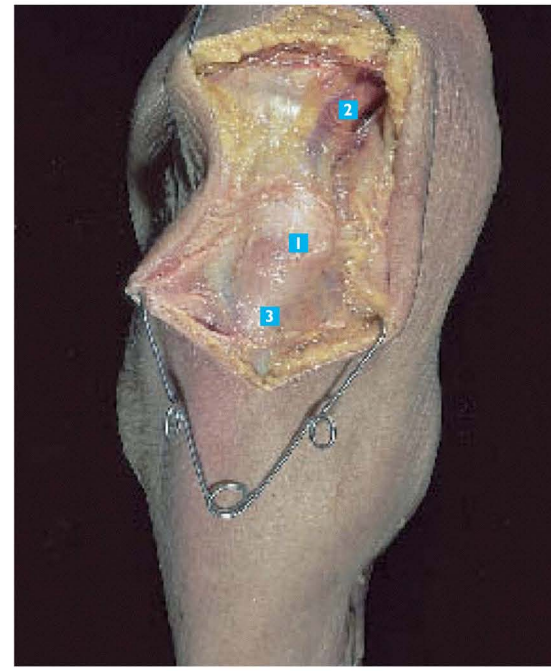


FIGURE 38–2 The incision deepened through the subcutaneous tissue. The vastus medialis has more oblique fibers than does the lateralis. The main portion of the quadriceps tendon is in the midline.

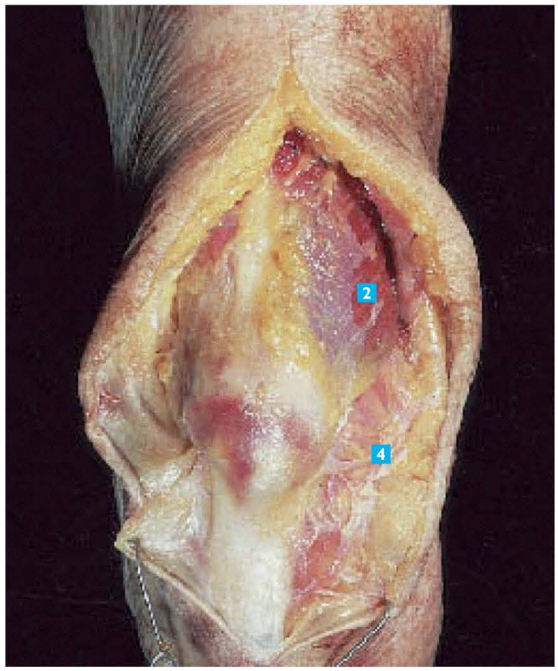
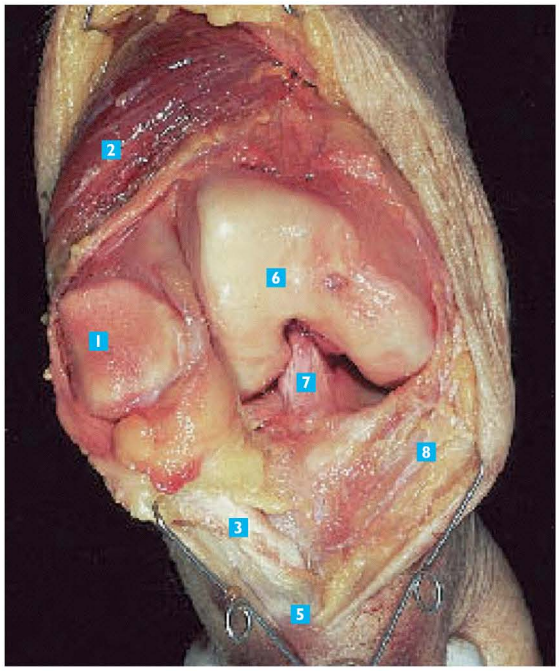


FIGURE 38–3 The vastus medialis along with the patella and the capsule. This approach is the subvastus type, which is useful for total knee arthroscopy. In relatively thin patients, it is usually possible to immobilize the vastus medialis in its entirety. This not only helps preserve some blood supply but also makes the closure and rehabilitation easier.



1 Patella
2 Vastus Medialis
3 Patellar Tendon
4 Fascial Edge
5 Tibial Tubercle
6 Femoral Condyle
7 Anterior Cruciate Ligament
8 Edge of Capsule

FIGURE 38–4 The completed approach. The exposure to the distal femur is limited, so the subvastus approach is inappropriate for fracture work on the distal femur. It is usually adequate, however, for total knee arthroplasty.

Posterior Approach

USES

This approach is used to access any of the posterior structures of the knee, for neurolysis, neurectomies, phenol injections into the motor branches in spastic patients, capsulodesis for recurvatum deformities, Baker's cyst excisions, and open posterior cruciate ligament reconstructions.

ADVANTAGES

This approach exposes all of the structures in the posterior aspect of the knee, including the neurovascular structures.

DISADVANTAGES

This large approach passes directly past the neurovascular structures. The most difficult to work around are the geniculate arteries.

STRUCTURES AT RISK

Because this approach comes directly onto the neurovascular structures, the whole point of the approach is to identify them. They need to be clearly identified and protected.

TECHNIQUE

A curved incision crosses the joint parallel to the flexor crease. Whether the proximal arm is medial or lateral depends on what the goal of surgery is. The incision is carried through the subcutaneous tissue, exposing the superficial fascia. The sural nerve is identified just below this fascia. It can then be retracted out of the way and the fascia can be spread. In the fat that is deep to the fascia is the posterior tibial nerve, in between the two heads of the gastrocnemius. The only branch of the posterior tibial nerve coming off and going laterally is the branch to the lateral head of the gastrocnemius. Typically, the nerve is retracted medially to protect all of the other branches, and care must be taken not to put too much tension on the branch to the lateral head of the gastrocnemius. Deep to those branches you will find the vein and artery, which are also midline structures at this level. As they are retracted, care must be taken not to damage the geniculate branches. Commonly one of the geniculates has to be clamped and sacrificed to retract the artery far enough away to access the posterior capsule of the knee.

TRICKS

The horizontal component of the incision is placed into the knee flexor crease, which is slightly proximal to the knee joint. Typically, the proximal portion is medial and the distal portion is lateral. The sciatic nerve splits into its posterior tibia and peroneal nerve branches at the proximal end of this incision. Finding the larger nerve proximally and dissecting its branches facilitate identifying the branches. It is important also to realize that the nerve is superficial to the vascular structures. The vein is the structure closest to the femur. The artery and vein are tethered to the posterior tibia just distal to the posterior cruciate ligament insertion.

HOW TO TELL IF YOU ARE LOST

It is relatively easy to get lost medially or laterally in this approach, but as long as you are careful with your dissection, it is easy to recover. The main way to tell that you are lost proximally or distally is if you do not feel the posterior aspect of the joint. Once you are deep to the subcutaneous tissue, that is usually palpable. It is not a big deal if you are lost proximally or distally; you must simply adjust yourself as needed.

The major problems come when you are lost medially or laterally. It is possible to confuse hamstring tendons with the posterior tibial or peroneal nerve, and that can create significant problems. If you see muscle attaching to a structure, it is a tendon. The semitendinosus, however, usually does not have muscle on its tendon through the course of this approach, and it does lie just medial to the posterior tibial nerve. The major way to tell what you are looking at is to look for the branching of the nerve. The motor branches to the gastrocnemius muscle medially and laterally are high and, in fact, may actually come off the nerve proximal to the joint. All longitudinal structures that are identified with this approach should be traced far enough distally or proximally so that they can be clearly identified as muscle, nerve, or artery.

FIGURE 39–1 The usual curvilinear incision. Whether the proximal or distal arm is medial or lateral does not matter. The principle is not to cross the joint at a right angle to the flexor crease.

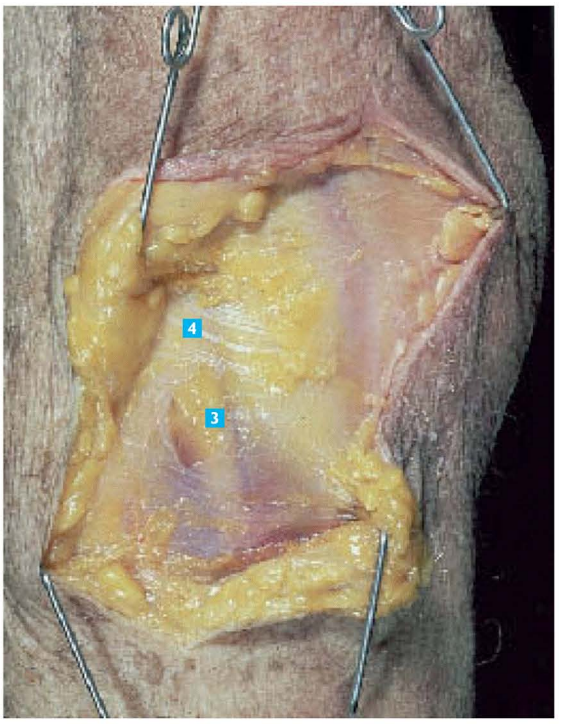
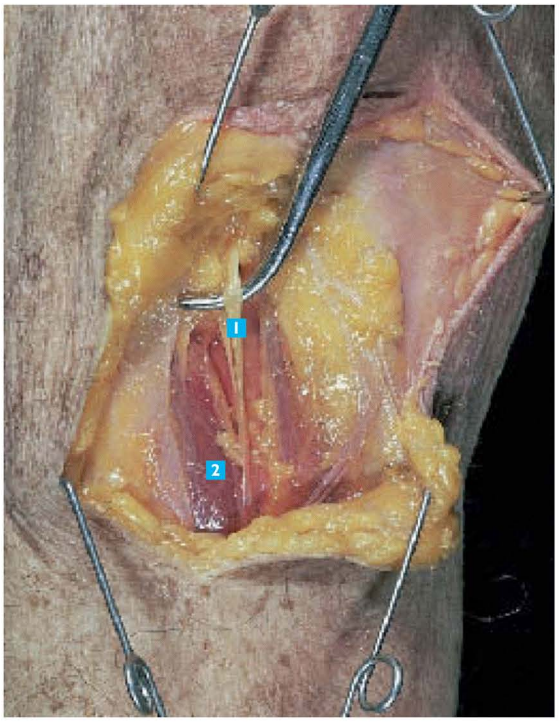


FIGURE 39–2 The superficial fascia with the neurovascular bundle encased in fat just deep to it. You can see the reddish muscle of the gastrocnemius through the fascia and laterally.



1 Sural Nerve
2 Gastrocnemius
3 Neurovascular Bundle
4 Fascia
5 Gastrocnemius Muscle
6 Gracilis
7 Biceps
8 Peroneal Nerve
9 Fat Around Neurovascular Bundle
10 Posterior Tibial Nerve
11 Biceps Tendon
12 Popliteal Artery
13 Motor Branch to Gastrocnemius
14 Posterior Cruciate Ligament

FIGURE 39–3 The sural nerve, which is a proximal branch off the posterior tibial nerve that runs down the leg. It is a fairly superficial structure, which can be damaged if you do not specifically look for it.

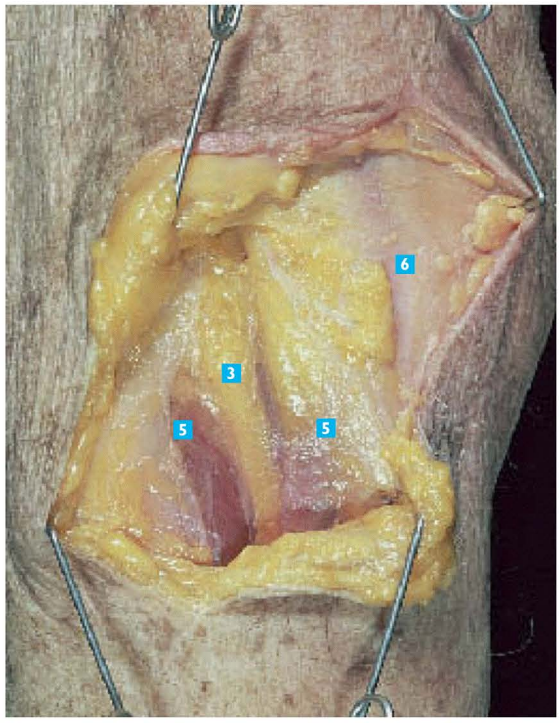


FIGURE 39–4 The neurovascular bundle again, is still, at this point, encased in fat. Any fat deep to the subcutaneous tissue is a warning sign. All fat within the muscle planes is usually surrounding an artery or a nerve.

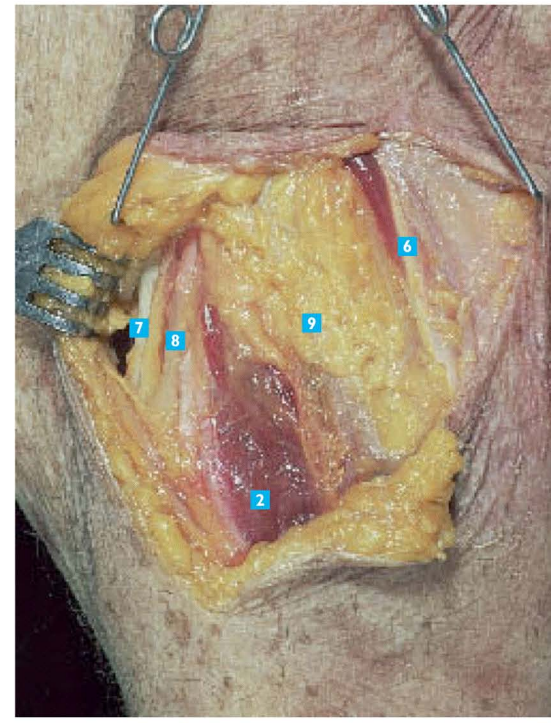
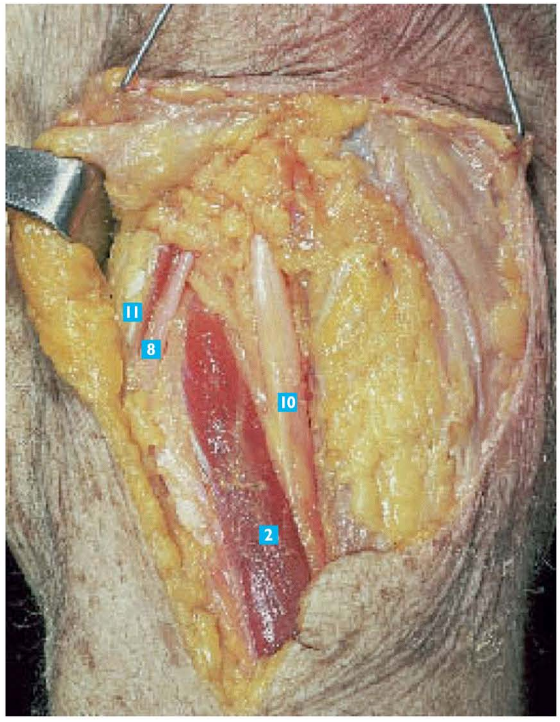


FIGURE 39–5 The peroneal nerve and the biceps tendon lying next to each other. Again, you can still see the fat around the main neurovascular bundle and you can see the medial hamstrings.



1 Sural Nerve
2 Gastrocnemius
3 Neurovascular Bundle
4 Fascia
5 Gastrocnemius Muscle
6 Gracilis
7 Biceps
8 Peroneal Nerve
9 Fat Around Neurovascular Bundle
10 Posterior Tibial Nerve
11 Biceps Tendon
12 Popliteal Artery
13 Motor Branch to Gastrocnemius
14 Posterior Cruciate Ligament

FIGURE 39–6 The posterior tibial nerve and the peroneal nerve. The artery is deep to the nerve and so is not yet seen until the posterior tibial nerve is retracted out of the way.

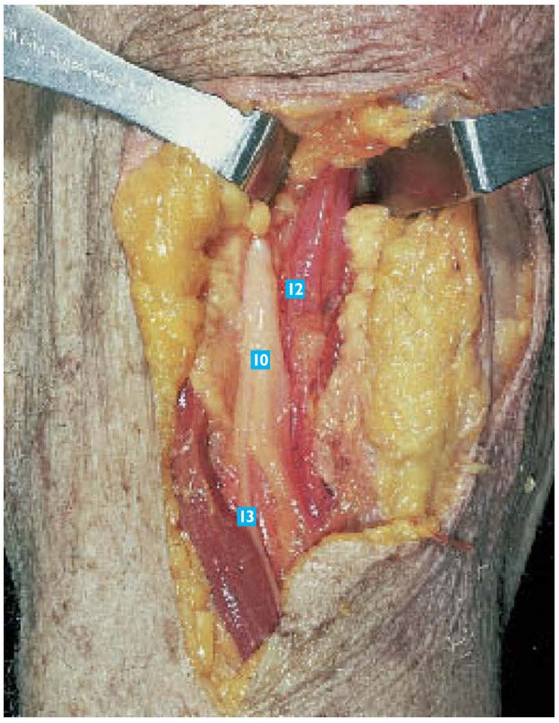


FIGURE 39–7 The posterior tibial nerve being retracted. You can see the artery underneath it and slightly to the medial side of it. You can also see the motor branch going to the gastrocnemius coming off the posterior tibial nerve. This is the first motor branch off of the nerve.

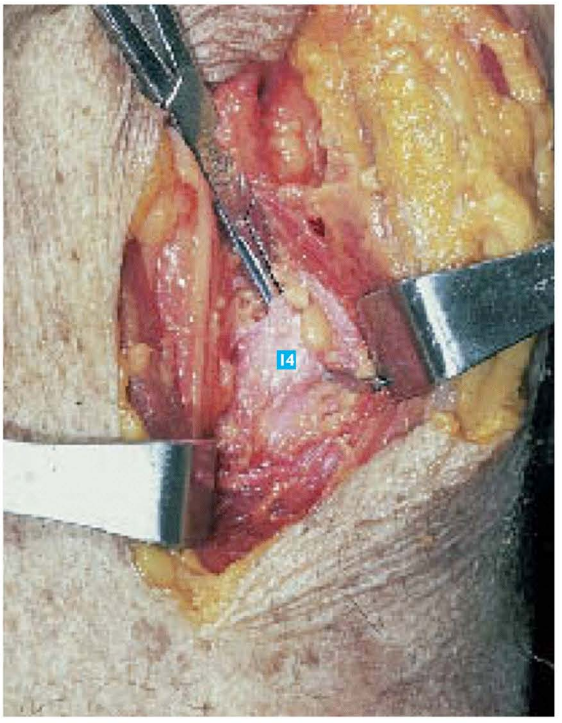


FIGURE 39–8 The artery being retracted in one direction and the nerve being retracted in the other, exposing the posterior capsule. The right-angle clamp has been passed underneath the posterior cruciate ligament. This approach is needed for posterior capsular reconstruction, which was done in the old polio patients. The middle geniculate artery usually needs to be ligated to provide this sort of exposure to the posterior capsule and posterior cruciate ligament. The superior and inferior geniculates are usually far enough out of the way that they are not a problem.

MEDIAL APPROACH

USES

This approach is used for medial collateral ligament reconstruction and open medial meniscus repair. The upper portion can be used for retrograde insertion of flexible (Ender) nails. The upper portion medially is also used for medial hamstring lengthenings or releases and can be used to reach the neurovascular structures.

ADVANTAGES

The incision can be easily shifted either anteriorly or posteriorly depending on the structure of interest, and extended distally as far as necessary.

DISADVANTAGES

This approach provides limited anterior exposure. There are problems that require both an anterior and a medial exposure and are better served by an anterior midline or median parapatellar type incision.

STRUCTURES AT RISK

The infrapatellar branch of the saphenous nerve is the most commonly damaged structure. In cases where the branch takes off from the saphenous nerve more proximally, it is definitely at risk and if right in the middle of the incision, may need to be sacrificed. There are no other significant structures at risk, as long as the normal anatomy is identified. The artery is well lateral to the medial knee structures. It is also anterior to the tendons and lies next to the femur. The medial hamstring tendons could be cut if any dissection was done perpendicular to the femur.

TECHNIQUE

The incision is made anteriorly or posteriorly over the structure of interest. It is typically centered on the medial femoral condyle. The incision is carried through the subcutaneous tissue, exposing the fascia. Unlike what is usually seen in the textbooks, the medial collateral ligament and the pes anserine tendons are all merged together without any clear distinction. It is necessary to know where the structures are located so that the fascia can be separated off of them. The medial collateral ligament runs off of the medial femoral condyle down to the proximal tibia, angling slightly anteriorly as it proceeds distally. The pes tendons are more posterior. The saphenous nerve usually runs at approximately the same depth as the pes anserine tendons. It gives off the infrapatellar branch at varying levels so that the nerve may be seen with this approach.

The fascia overlying the medial collateral ligament is split in line with its fibers. Usually, the ligament can be perceived as a thickening of the capsule. Once the ligament is identified, it serves as the guide to entering the knee joint. A capsular incision anteriorly and posteriorly can be created, allowing excellent exposure to do an open repair of the medial meniscus. It also allows the ligament to be reconstructed.

By carrying this dissection posteriorly, you can identify the semimembranosus coming in parallel to the femur and deep. You can identify the medial head of the gastrocnemius, whose fibers are perpendicular to those of the semimembranosus and lateral to it. These two tendons can be used for ligament reconstruction.

TRICKS

The key to identifying the medial collateral ligament is knowing its course from the abductor tubercle down to the proximal tibia and looking for the thickening of the capsule. This thickening is in fact the ligament.

The key to identifying the medial hamstring tendons is flexing the knee, which drops the tendons away from the femur, making their identification easier. This flexion also makes it possible to identify the medial head of the gastrocnemius, which is just lateral to the semimembranosus.

The sartorius is the key to finding the saphenous nerve. The nerve becomes superficial either through or just posterior to the muscle.

HOW TO TELL IF YOU ARE LOST

The medial knee approach, as seen in Figures 40–2 and 40–3, does not provide much in the way of visual cues as to where the various structures are. The major way to identify the location of the medial collateral ligament is by palpation. It is easy to feel the medial femoral condyle and the ligament as the thickening in the capsule. If you are too far proximal or distal and not centered over the joint line itself, you simply need to extend the incision. If you are too far anterior, you will see the anterior aspect of the femoral condyle when you enter the knee and you will simply have to extend the capsulotomy enough to return posteriorly to where you want to go. If you go too far posteriorly, you will see the curve of the posterior portion of the femoral condyle, as it comes back up to join the femoral shaft. Again, you will just need to extend the capsulotomy to give you the room to return anteriorly.

FIGURE 40–1 The skin incision centered over the adductor tubercle.

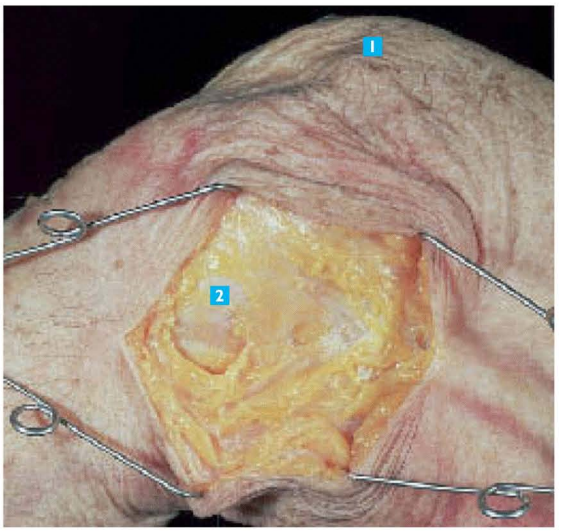


FIGURE 40–2 The usual appearance of the fat. The fascia is deep to the fat. In this patient, the saphenous nerve is in the posterior flap.

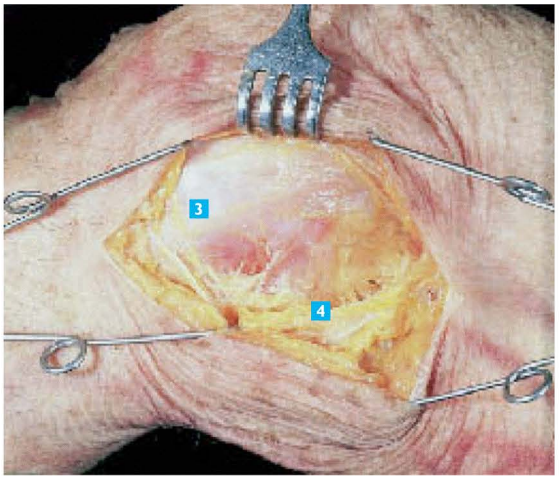


FIGURE 40–3 The superficial layer of fascia split. You are now looking at the thickening of the medial collateral ligament and the knee capsule.

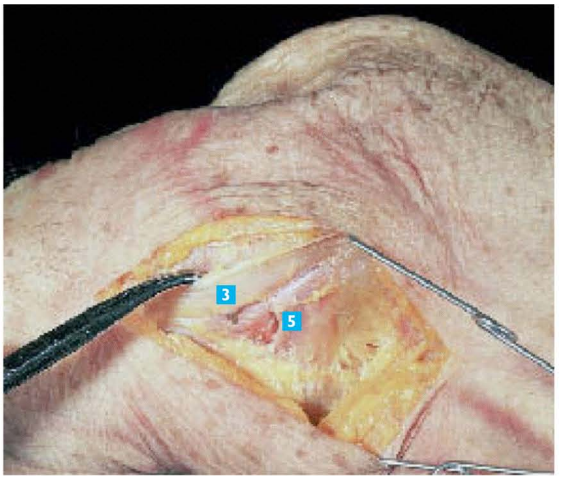


FIGURE 40–4 The medial collateral ligament separated from the capsule anteriorly and posteriorly and lifted up by the right-angle clamp.

1 Patella
2 Fascia
3 Medial Collateral Ligament
4 Fascial Edge
5 Posterior Capsule
6 Anterior Capsule
7 Medial Femoral Condyle
8 Meniscus Rim
9 Femoral Condyle

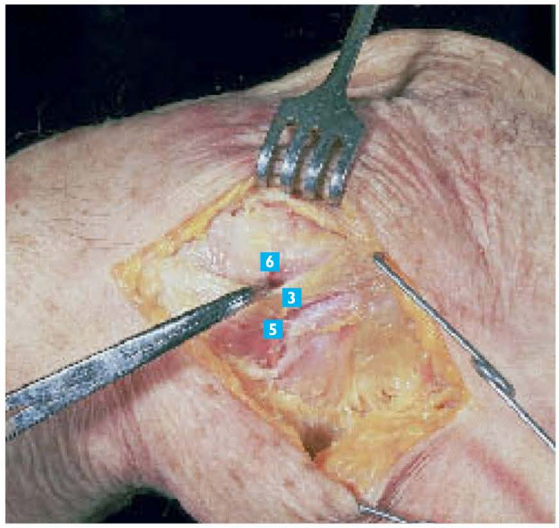


FIGURE 40–5 The capsule ready to be opened. This layer can be separated from the medial collateral ligament, but when first seen it is merged with the ligament.

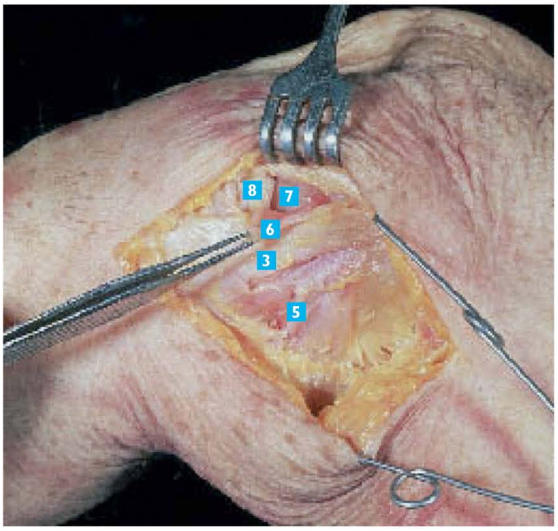


FIGURE 40–6 The anterior capsulotomy with the meniscus rim in view and the medial femoral condyle. The medial collateral ligament is just posterior.

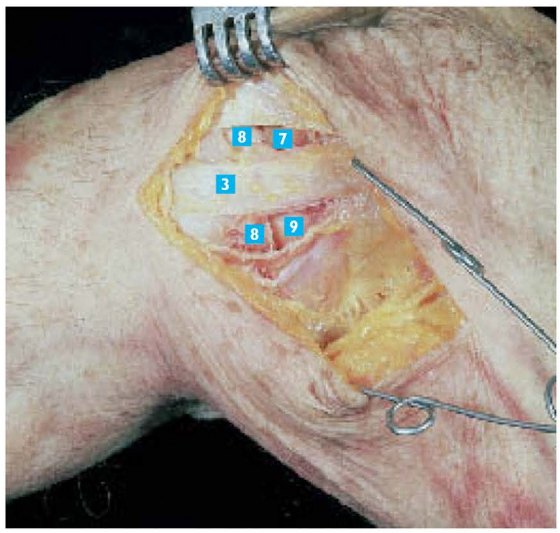


FIGURE 40–7 A capsulotomy posterior to the medial collateral ligament. This is the view that you would need for doing an open meniscus repair.

1 Patella
2 Fascia
3 Medial Collateral Ligament
4 Fascial Edge
5 Posterior Capsule
6 Anterior Capsule
7 Medial Femoral Condyle
8 Meniscus Rim
9 Femoral Condyle

LATERAL APPROACH

USES

This approach is used for lateral ligament reconstructions, open lateral patellar releases, iliotibial band surgery, and peroneal explorations. The approach varies in its anterior and posterior locations depending on the indication for surgery. It is the distal extension of the lateral approach to the femur discussed in Section 8.

ADVANTAGES

The approach can be shifted anteriorly or posteriorly, and extended proximally or distally, with ease.

DISADVANTAGES

This approach has no significant disadvantages for surgery on the lateral structures of the knee. A straight incision generally works well. It can be curved if necessary for open lateral meniscus repairs, as a longitudinal incision's exposure is not as good unless it is quite extensive. For that procedure, an incision paralleling the joint line would be more suitable.

STRUCTURES AT RISK

The important structures that can be damaged with this approach include the fibular collateral ligament, the popliteus tendon, and the peroneal nerve. All of the other structures in the area are running parallel to the incision and will be split longitudinally if a cut is made inadvertently too deep. The key to identifying the lateral collateral ligament is its orientation, running from anterior to posterior with the knee flexed. With the knee extended, it runs on an oblique angle that is clearly heading posteriorly and is not parallel to the fibers of the iliotibial band.

The peroneal nerve is definitely at risk. It is always posterior to the biceps femoris tendon and crosses below the head of the fibula going around the neck of the fibula. However, as it crosses the posterolateral corner, it is in direct contact with the biceps tendon and is frequently very difficult to distinguish from the tendon on the basis of color or tightness. Therefore, it should always be approached from the tendon side, that is, anteriorly, and identified proximal to the knee, where it is separate from the biceps.

TECHNIQUE

Typically, the incision is straight, starting as far proximally as necessary and going as far distally as necessary for the structure in question. Once you are through the skin and subcutaneous tissue and you are looking at the fascia, it is necessary to palpate the various structures. The head of the fibula is easily palpated, as is Gerdy's tubercle. The lateral collateral ligament can be felt running in a more direct anteroposterior direction. If the goal is to open the lateral knee capsule, then the patellar tendon should be palpated and the capsulotomy should be done 1 cm lateral to that. If the goal is to repair lateral ligaments, the dissection should stay anterior to the head of the fibula to protect the peroneal nerve. The iliotibial band is easily identified in the tissues because of the direction of its fibers. It can be split along its anterior or posterior borders or in the middle without risk to any significant structure. The vastus lateralis is directly beneath it anteriorly. Below the posterior edge of the iliotibial band, the short head of the biceps femoris will be seen. If the fascia connecting to the iliotibial band along its lower surface is cut in line with the fibers and the iliotibial band is lifted anteriorly, the lateral collateral ligament can be seen. The posterior capsule of the knee can be opened just anterior to that by cutting in line with the fibers of the ligament. If necessary, you can go behind the ligaments with equal facility.

If the goal is to expose the peroneal nerve, then the incision should be placed more posteriorly and carried more distally. Here, the key landmark is the head of the fibula. The nerve should be identified with a nerve stimulator. In this location, the biceps tendon is almost indistinguishable from the peroneal nerve but anterior to it. When approaching the biceps tendon, it is critical that the nerve be identified so that you can tell one from the other and protect the nerve.

TRICKS

A trick to identifying the fibular collateral ligament is flexing the knee and finding the tight structure running from anterior to posterior.

The main trick for finding the peroneal nerve is to dissect proximally until there is more separation between the nerve and the biceps tendon. Flexing the knee again helps to relax the structures so that there is more separation between the nerve and the biceps tendon. The safe direction to approach this nerve is always from anteriorly, identifying first the biceps tendon with its attached muscle.

HOW TO TELL IF YOU ARE LOST

Because the fascia lata merges almost indistinguishably with the fascia overlying the biceps, it is difficult to tell if you are lost visually. The primary clue comes from palpation. It is quite easy to palpate the head of the fibula, Gerdy's tubercle, the lateral femoral condyle, and the posterior curve of the femoral condyle, indicating the back of the knee. Depending on what structure you are looking for, it is possible to be too far anterior or posterior. If you are too far anterior or posterior, you simply split the iliotibial band transversely to its fibers and then repair them and close the defect, if necessary. If you are too far proximal or distal, you simply extend the incision through the fascia lata to get to where you want to be. The main direction you are going to be lost is posteriorly, and if you see the reddish fibers of the biceps femoris running almost parallel to the femur, then you know you are too far posterior. If you are deep to the fascia lata and too far anterior, you will see the vastus lateralis, but it should be quite obvious that its fibers are going distally and anteriorly toward the patella.

FIGURE 41–1 The skin incision is placed just posterior to Gerdy's tubercle with the joint line at the middle of the incision.

FIGURE 41–2 The fascia overlying all of these structures once you are deep to the subcutaneous tissue. The fascia lata merges as a continuous sheet with the more posterior biceps fascia.

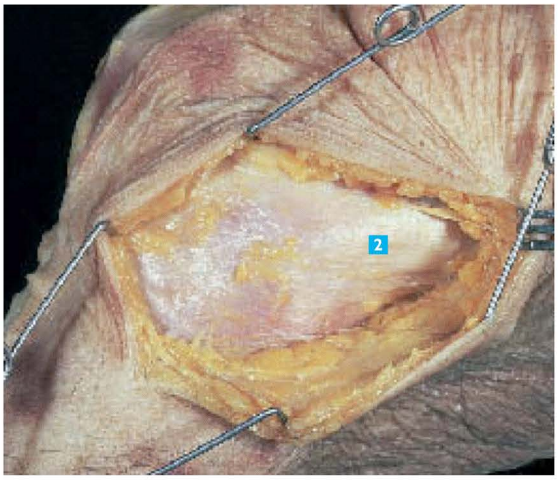


FIGURE 41–3 The superficial fascia is opened. You will see the iliotibial band, but it is difficult to distinguish where the band ends and the biceps fascia begins.

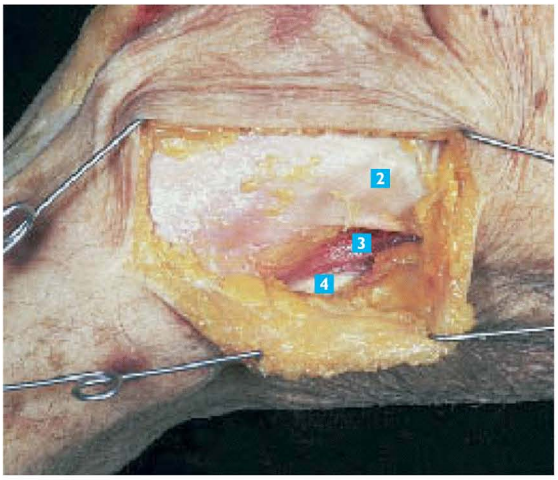


FIGURE 41–4 The posterior border of the iliotibial band. The fascia overlying the biceps femoris has been opened and the fibers of the muscle can be clearly seen. The muscle fibers of the short head of the biceps are anterior to the tendon and the whitish biceps tendon is seen in the more posterior portion of the exposure.

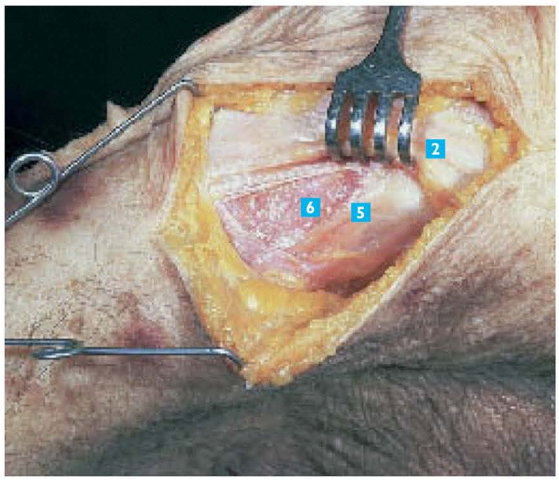


FIGURE 41–5 The iliotibial band being retracted anteriorly. The biceps is now out of the picture. The capsule of the knee and the lateral collateral ligament are clearly visible. The lateral collateral ligament is identifiable as a thickening in the capsule, and its fibers run almost perpendicularly to those of the iliotibial band and biceps tendon, which helps to distinguish the ligament from the more superficial fibrous structures.

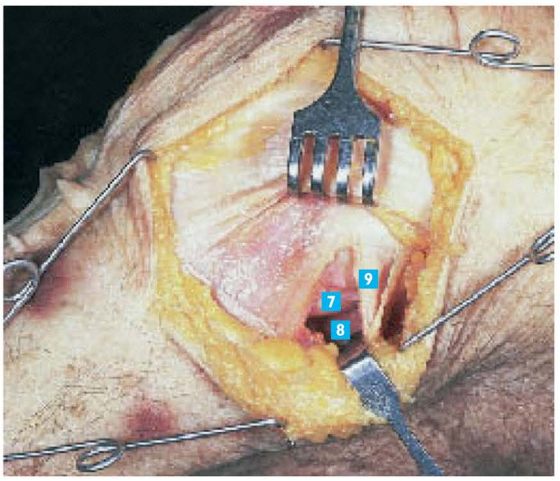


FIGURE 41–6 The knee joint open. You can go either anteriorly to the lateral collateral ligament and popliteus tendon, as is seen in this exposure, or posterior to it. The capsulotomy is generally done in line with the fibers of the ligament.

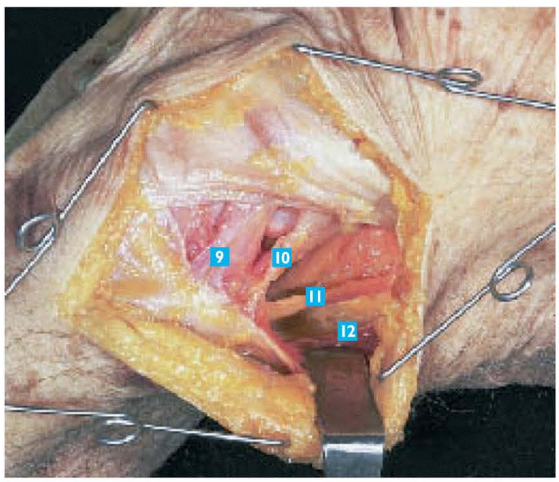


FIGURE 41–7 The location of the peroneal nerve in relation to the posterior capsule of the knee and the biceps femoris. In this figure the nerve looks anterior, but in fact it is really medial. The biceps has been retracted in a posterior direction to show the nerve. Without that retraction, the nerve would be sitting just medial to the biceps.

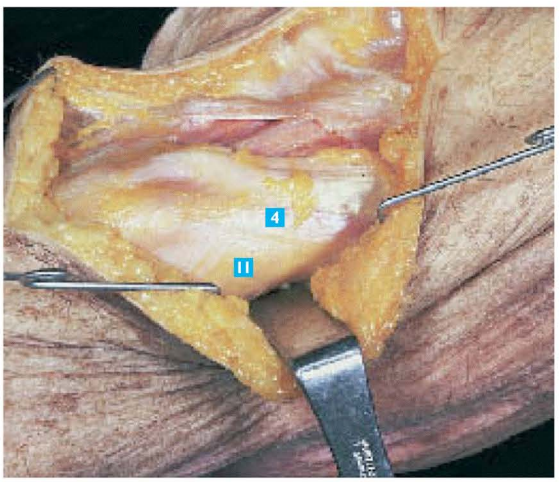


FIGURE 41–8 A more distal extension of this approach. If the goal is to explore the peroneal nerve as it crosses around the fibula, then this distal portion of the approach would be all that was necessary. The major point to realize here is that it is absolutely impossible to visualize where the biceps tendon ends and the nerve begins when you first approach this layer of the dissection.

1 Patella
2 Iliotibial Band
3 Biceps Short Head
4 Biceps Tendon
5 Lateral Collateral Ligament
6 Knee Capsule
7 Femoral Condyle
8 Posterior Knee Capsule
9 Ligament
10 Capsule
11 Peroneal Nerve
12 Biceps
13 Fibular Head
14 Nerve
15 Anterior Tibialis
16 Head of Fibula

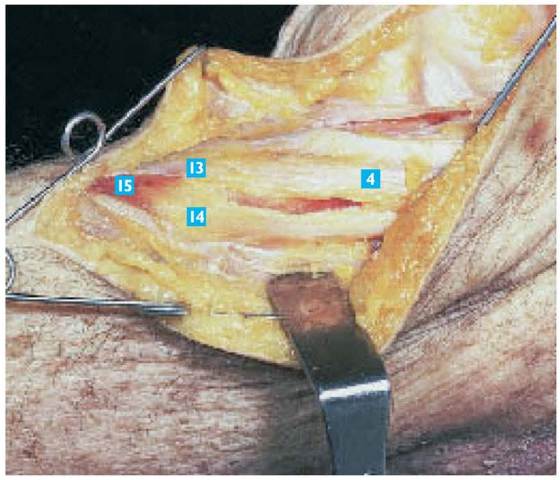


FIGURE 41–9 The space being developed between the biceps tendon and the peroneal nerve. The nerve is directly posterior to the biceps at the level of the head of the fibula. If this area needs to be explored, the nerve should definitely be identified more proximally, where it sits medial to the biceps tendon, and then traced along its course as it goes behind the tendon and around the fibular neck. It should not be identified simply by splitting the fibers that are seen in Figure 41–8 and hoping that you hit the right interval.

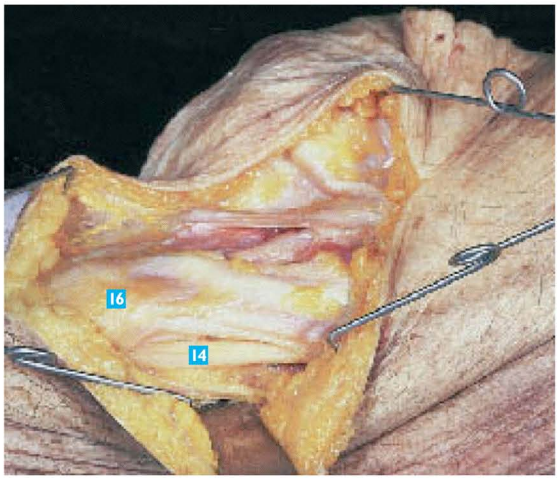


FIGURE 41–10 A slightly distal dissection, where you have the biceps tendon anteriorly along with the head of the fibula, and the peroneal nerve crossing around the fibular neck and going underneath the anterior tibialis.

1 Patella
2 Iliotibial Band
3 Biceps Short Head
4 Biceps Tendon
5 Lateral Collateral Ligament
6 Knee Capsule
7 Femoral Condyle
8 Posterior Knee Capsule
9 Ligament
10 Capsule
11 Peroneal Nerve
12 Biceps
13 Fibular Head
14 Nerve
15 Anterior Tibialis
16 Head of Fibula

SECTION
X

LOWER LEG

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ANTEROLATERAL APPROACH TO THE TIBIA

USES

This approach is used for fracture reduction and fixation and for posterior to anterior tendon transfers.

ADVANTAGES

This extensile exposure is in a safe area and can be carried as far proximally or distally as necessary.

DISADVANTAGES

This approach does not provide any access to the posterior lower leg. Also, to access the medial aspect of the tibia, it requires a longer incision. Exposing the tibia for fracture fixation with this approach also strips its periosteal blood supply coming from the lateral side.

STRUCTURES AT RISK

The only structures at risk are the dorsalis pedis artery and the deep peroneal nerve. In the proximal half of the tibia, the structures are well protected by the muscles. They come close to the tibia in the distal half of the tibia (see Fig. 45–4) and can be damaged with indiscriminate stripping of the muscle off of the tibia.

If you are doing this procedure for a posterior to anterior tendon transfer, then you need to realize that the communicating peroneal artery runs along the posterior aspect of the interosseous membrane and can be damaged when the membrane is opened. You must be aware of that possibility and be sure to cauterize the ends of the blood vessels if they are seen.

TECHNIQUE

A straight incision is made generally 1 to 2 cm lateral to the tibial crest. This then leaves a muscular bed under the incision in case there are any wound healing problems. The fascia overlying the musculature is split as far as necessary proximally or distally to provide good exposure or to release the compartment.

Once the fascia is split, the musculature can be mobilized laterally, exposing the tibia. Distally, the artery and nerve will exit the muscle and may actually lie on the tibia, rather than within the muscle belly. They need to be separated from the tibia before doing any probing or instrumentation along the lateral aspect of the tibia.

After the neurovascular structure has been identified and mobilized laterally, the interosseous membrane is exposed. This then can be opened if you are going to do any posterior to anterior transfers.

TRICKS

The key trick to the safe use of this exposure is wide splitting of the fascia overlying the muscles so it can be easily mobilized. Also, be aware of the fact that the artery and nerve can be attached to the tibia.

HOW TO TELL IF YOU ARE LOST

It is practically impossible to get lost with this approach because of the tibia, which is going to be on the medial side throughout the entire approach. It is possible to confuse the muscle belly of the anterior tibialis with the toe extensors and the peroneus tertius if you are drifting too far laterally.

FIGURE 42–1 The fascia is seen directly below the subcutaneous tissue.

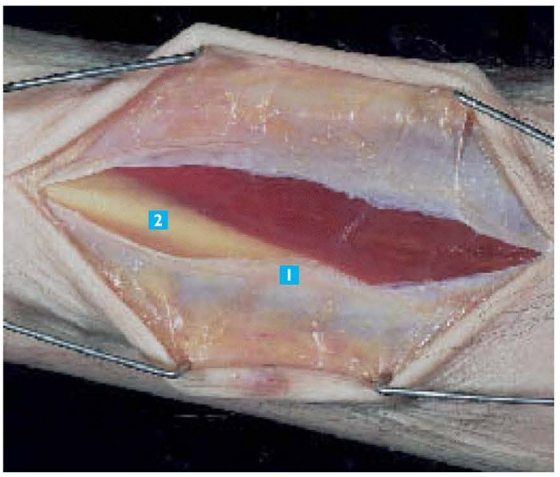

FIGURE 42–2 The anterior tibialis tendon. The tibia is not yet seen.

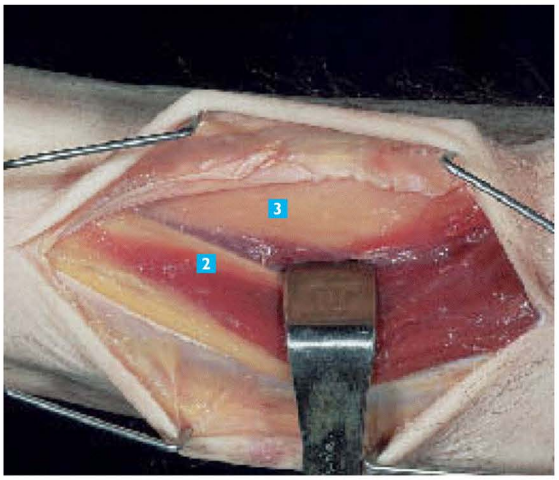

FIGURE 42–3 The fascia split more widely, exposing the tibia, which is on the medial side. The tendon of the anterior tibialis is visible laterally, being held by the retractor.

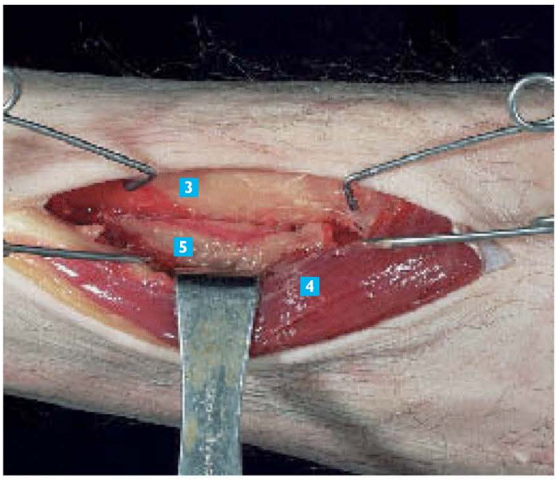

FIGURE 42–4 The dorsalis pedis artery and deep peroneal nerve. In this person they are running with the muscle, which had to be split to identify them. It is important to remember that, in some patients, the neurovascular structures are actually running with the tibia and not with the muscles. This is especially true as you move further distal. If your goal is to expose the interosseous membrane, the neurovascular structures must be retracted laterally along with the muscle.

1. Fascia
2. Anterior Tibialis Tendon
3. Tibia
4. Anterior Tibialis Muscle
5. Neurovascular Bundle
6. Interosseus Membrane
7. Extensor Hallus Longus

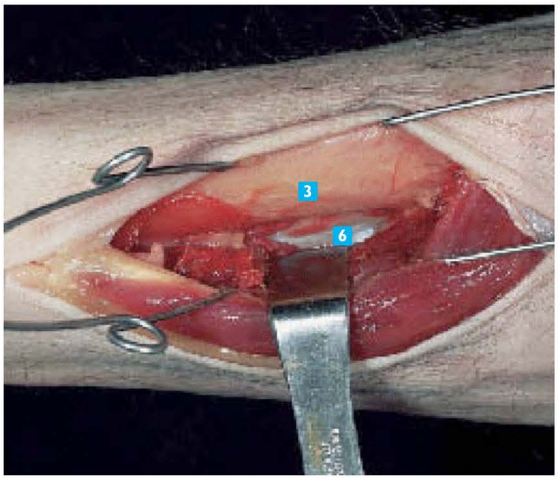

FIGURE 42–5 The tibia medially and the musculature and neurovascular bundle retracted laterally, with the interosseous membrane seen in the depth of the incision. This then could be split to allow an anterior transfer. It is very important to remember that the peroneal artery runs along the posterior side of the interosseous membrane and can be cut if the membrane is split. This sometimes is an unavoidable situation, and it is important that you be aware of the possibility and cauterize the end of the artery if it occurs. Otherwise, you can get significant bleeding and swelling in the lower leg following any surgery in this area.

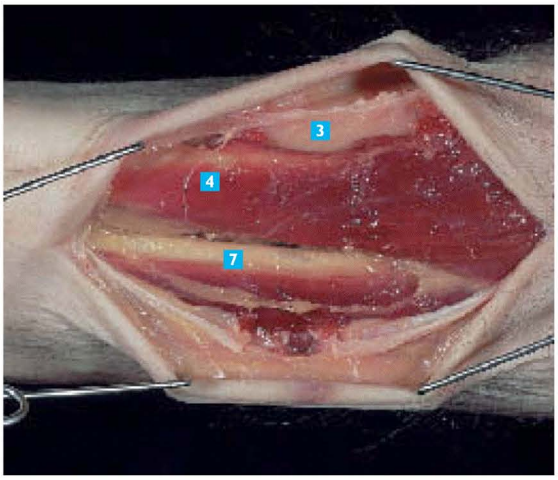

FIGURE 42–6 The interval between the anterior tibialis muscle and the extensor hallus longus muscle. It is possible to access the interosseous membrane through this interval also, although it is sometimes difficult to identify and protect the artery and nerve by doing so.

Posteromedial Approach to the Calf

USES

This approach is used primarily for release of the posterior compartments in compartment syndromes. It is also used for release of the posterior tibial muscle off of the tibia in cases of periostitis causing posteromedial pain.

ADVANTAGES

This is a direct approach for the purpose of releasing the posterior compartments.

DISADVANTAGES

This approach provides no exposure laterally and requires a second lateral incision for complete release of all compartments.

STRUCTURES AT RISK

There are no structures at risk with this approach until you are in the deep posterior compartment. The saphenous nerve and vein are subcutaneous and usually easily retracted. The posterior tibial nerve and artery run along the anterior, that is, the deep border of the soleus, and need to be identified. There are descending branches to the posterior tibial and toe flexor muscles and these branches should be preserved.

TECHNIQUE

An incision is made 1 cm posterior to the posteromedial corner of the tibia, cutting as far proximally and distally as necessary to achieve the desired exposure. The incision is carried through the subcutaneous tissue, exposing the muscle belly. The overlying fascia is split. The interval between the posterior tibialis and gastrocnemius soleus complex is identified and developed. All compartments are opened by splitting the fascia.

TRICKS

The major trick is to identify all of the compartments. The interval between the gastrocnemius and soleus is easily developed and seen in Figure 43–3. The soleus comes off the back of the tibia, actually overlying the origin of the flexor digitorum longus, which is seen in Figure 43–4 overlying the posterior tibialis (this is the deepest of the muscles). The flexor digitorum longus is the first muscle encountered when dissecting directly behind the tibia. The flexor hallucis longus is a more lateral structure coming off of the interosseous membrane and fibula proximally.

HOW TO TELL IF YOU ARE LOST

The usual purpose for making this incision is to release the compartment. Getting lost is usually not an issue. If you are in too superficial a position, you will simply be in the gastrocnemius and soleus area, which is one of the places where you want to go anyway. If the goal is to release the posterior tibial muscle, you should feel the tibia and stay along its posteromedial corner. If you do not feel the tibia, you are lost. Once you have identified the superficial muscles of the gastrocnemius and soleus, you will create the plane between those and the posterior tibialis. It is possible to split the muscle. If you do not see a distinct plane, again, you are in the wrong place.

FIGURE 43–1 The skin incision.

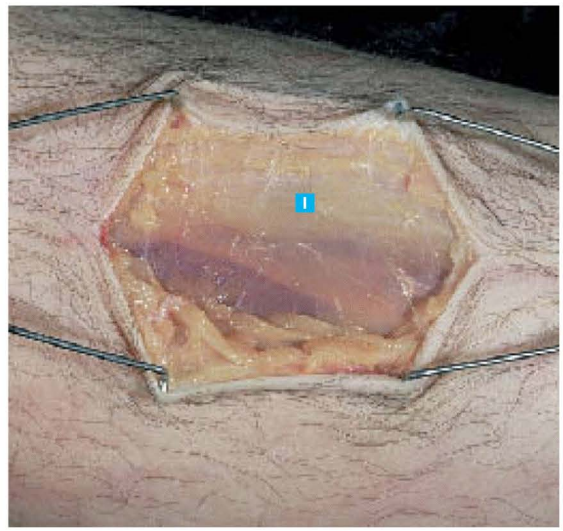

FIGURE 43–2 The skin incision with the overlying fascia. The area of the tibia anteriorly is noted, as is the area of the muscle more posteriorly.

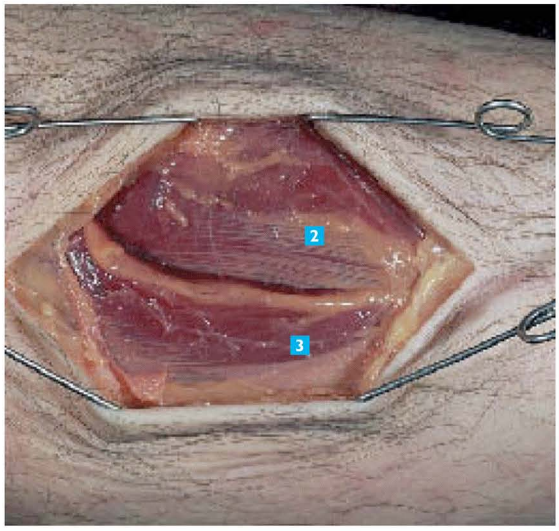

FIGURE 43–3 The fascia open in the superficial posterior compartment, exposing the soleus and gastrocnemius interval. It is frequently possible to get into this interval and think you are getting into the deep posterior compartment, which needs to be approached directly behind the tibia.

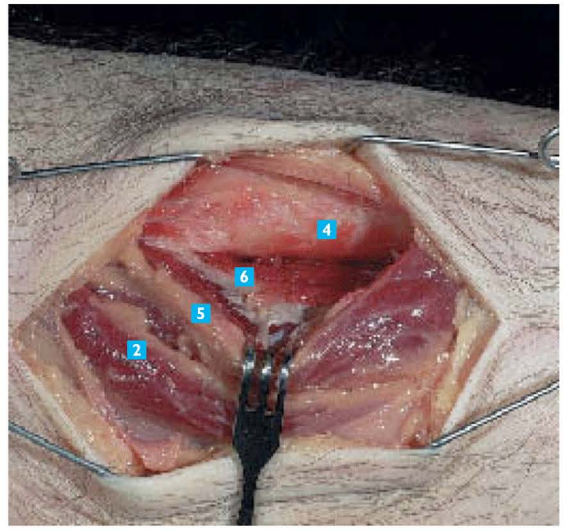

FIGURE 43–4 The soleus retracted posteriorly. The posterior tibialis is coming off the tibia and part of the origin of the toe flexors is visible.

1. Fascia Over Tibia and Muscles
2. Soleus
3. Gastrocnemius
4. Tibia
5. Toe Flexor
6. Posterior Tibialis
7. Deep Posterior Compartment
8. Neurovascular Bundle

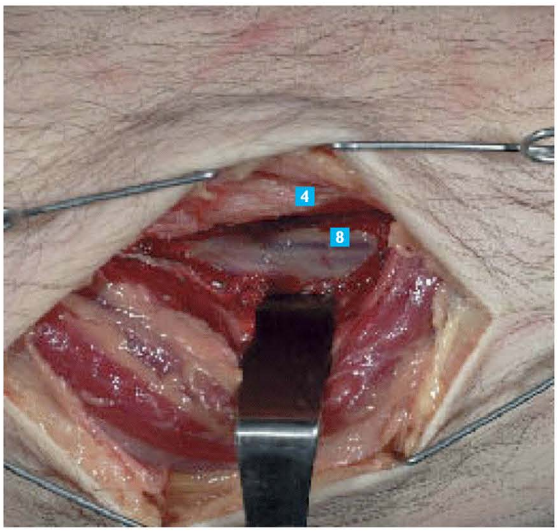

FIGURE 43–5 The posterior tibialis and other musculature retracted posteriorly. The tibia can be seen anteriorly and the neurovascular structures can be seen in the depth of the wound. When doing a fasciotomy for a compartment syndrome, it is important to remember that the neurovascular structures are on the lateral side of the flexor digitorum longus origin and are between it and the tibia.

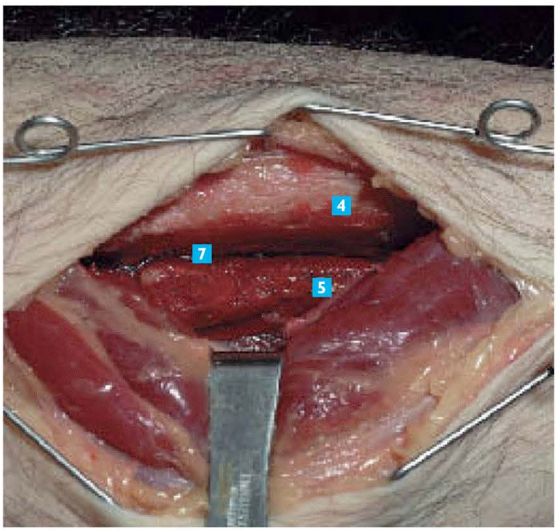

FIGURE 43–6 This is the picture you should see if you were doing a posterior compartment release.

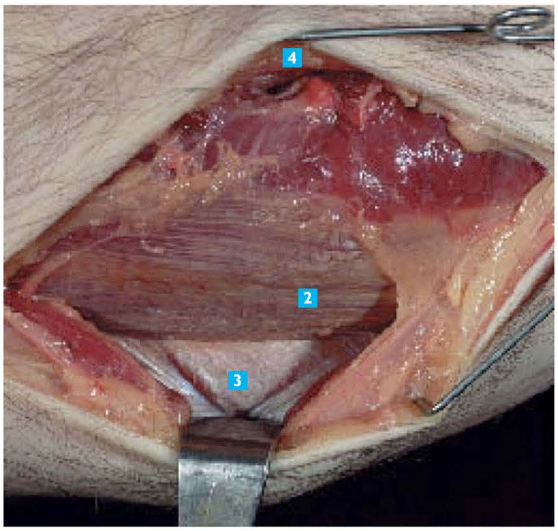

FIGURE 43–7 The interval between the soleus and the gastrocnemius developed. If you are going to get lost posteriorly, this is usually the interval that you will be in. If you see this picture of the tendinous portion of the gastrocnemius, you are too far posterior.

1 Fascia Over Tibia and Muscles
2 Soleus
3 Gastrocnemius
4 Tibia
5 Toe Flexor
6 Posterior Tibialis
7 Deep Posterior Compartment
8 Neurovascular Bundle

LATERAL APPROACH TO THE FIBULA

USES

This approach is used for harvesting the fibula for a bone graft. It can also be used if extended far enough proximally and distally to release the anterior, lateral, and posterior compartments, although this approach is not the best way to release the deep posterior compartment.

ADVANTAGES

This approach, which is largely subcutaneous, is straightforward and easy. It can be extended as far proximally and distally as necessary for adequate exposure.

DISADVANTAGES

The major disadvantage is that the fibula is actually posterior to the tibia, and the fibula gets in the way of accessing the deep muscles posteriorly.

STRUCTURES AT RISK

There are perforating blood vessels that run from posterior to anterior around the fibula. They need to be identified and cauterized or ligated before transection.

If you drift too far anteriorly and are dissecting into the muscle belly, the peroneal nerve to the musculature is at risk. If you are too far posterior, you will either be going through the peroneal musculature or into the gastrocnemius.

TECHNIQUE

A straight incision is made over the fibula laterally. It is carried as far proximally and distally as necessary for exposure. Once you are deep to the subcutaneous tissue, the fibula is palpated, and the muscles are separated anteriorly and posteriorly.

If this approach is being used for a compartment syndrome, then the anterior and lateral compartments are easily identified and decompressed. They are just anterior and posterior to the fibula. The most secure way to release the posterior compartments is to resect the fibula. If you choose not to do that, then the peroneal musculature is separated from the fibula and retracted posteriorly. This will then allow you to enter the deep posterior compartment. The posterior tibial nerve and artery will be running along the back of the tibia, and indiscriminate dissection should not be done once you are medial to the peroneal muscles.

To release the superficial posterior compartment, it is necessary to dissect superficial to the peroneals, at which point you will identify the lateral border of the gastrocnemius and soleus, and then the underlying fascia can be opened. By pulling the gastrocnemius and soleus in a posterior direction, the flexor hallucis longus is identified, providing a potential way into the deep compartment.

TRICKS

There are no major tricks to this approach. Because this is an approach to a bone, the main thing to remember is that old adage, "Get to the bone and stay there." Once you are on the bone, generally speaking, unless there is an artery crossing your plane of dissection, you are safe from the risk of damaging other structures.

HOW TO TELL IF YOU ARE LOST

In general, if you do not feel the fibula, you are lost and you need to redirect your dissection back to the fibula. If you are anterior to the fibula, you will be in the anterior compartment. There is usually some fat between the muscle bellies of the anterior tibialis and the extensor hallucis longus. An easy way to tell if you are lost, however, is simply to pull on the tendon that you are looking at and see what moves.

FIGURE 44–1 Anterior is on the top.

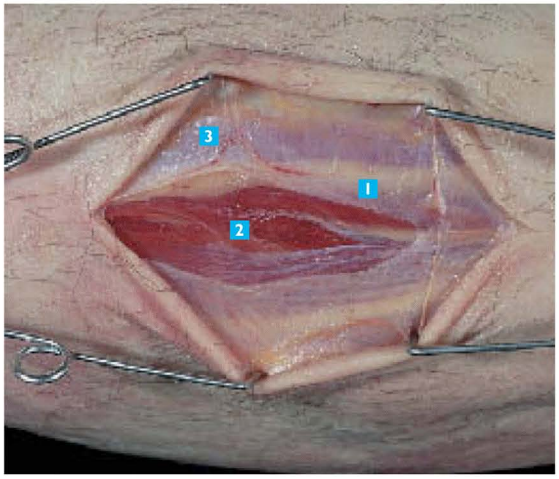

FIGURE 44–2 The fascia overlying the peroneal musculature open. The fascia overlying the anterior compartment is still closed. The area of fat between the musculature, which is the region of the fibula, is apparent.

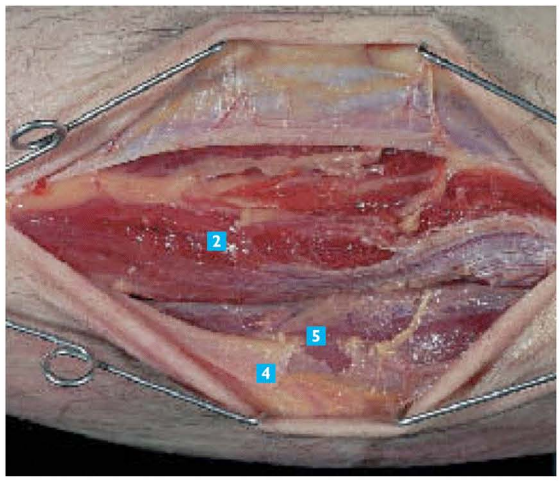

FIGURE 44–3 The dissection carried posteriorly splitting the fascia overlying the gastrocnemius and soleus in the superficial posterior compartment. This is the approach for a compartment release in this area.

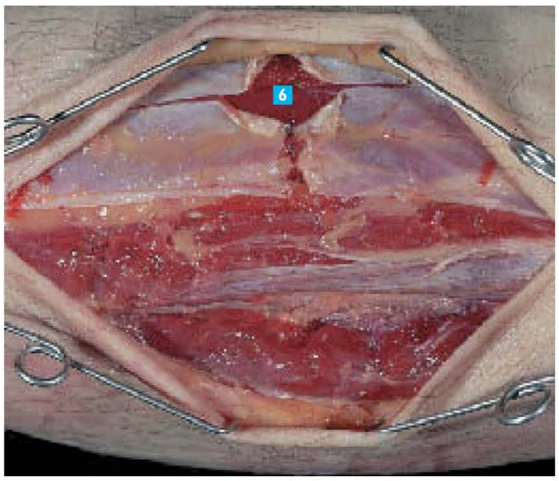

FIGURE 44–4 The anterior compartment similarly opened. Through this approach, the three compartments can be easily released.

1. Fibula
2. Peroneal Muscles
3. Dorsiflexor Muscles
4. Fascia Over Gastrocnemius
5. Gastrocnemius
6. Anterior Tibialis
7. Blood Vessels
8. Anterior Compartment
9. Flexor Hallicus Longus and Deep Posterior Compartment

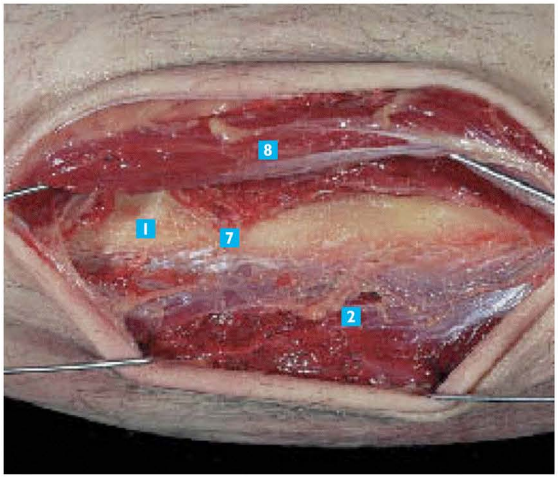

FIGURE 44–5 The fibula, exposed by taking the musculature anteriorly and posteriorly. Note the artery crossing the bone. This neurovascular structure needs to be cauterized prior to exposing the bone completely. Otherwise, it will have a tendency to retract into the muscle and continue bleeding.

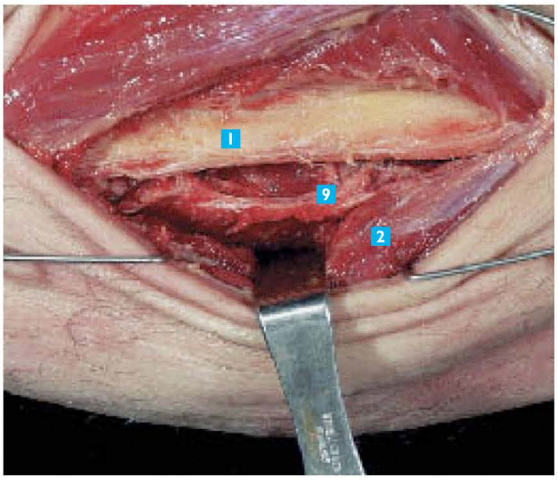

FIGURE 44–6 The fibula exposed. By pulling the peroneal muscles in a posterior direction, the deep posterior compartment can be seen in the depth of the wound. This approach does not provide excellent exposure to these muscles, but it is usually adequate.

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SECTION XI

ANKLE

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TARSAL TUNNEL APPROACH

USES

This approach is used for neurolysis of the posterior tibial nerve and tarsal tunnel syndrome.

ADVANTAGES

This approach comes directly down over the pathology.

DISADVANTAGES

This is a single-use approach. For fracture work you need to be more anterior, and for Achilles tendon work you need to be more posterior. Except for freeing the nerves, it does not make sense to come down directly over them.

STRUCTURES AT RISK

The neurovascular structures are generally centered in the incision and are definitely at risk. Because the whole point of the surgery is generally to free up the nerve, it would be in harm's way no matter where you put the incision.

TECHNIQUE

An incision is made generally midway between the posterior border of the distal tibia and the Achilles tendon anterior border. Instead of coming around the medial malleolus paralleling the posterior tibialis muscle, as in the posteromedial approach used for fractures, this incision angles more directly toward the arch of the foot and is carried through the subcutaneous tissue to the superficial fascia. This fascia is split. Usually the neurovascular bundle is visible through the fascia, and the splitting should be done along the anterior edge of where that bundle seems to be located. It is better to err by being anterior rather than posterior. The fascia is split down to the abductor hallucis origin. The nerve passes underneath and can be impinged by the sharp fibers of its tendon of origin off of the calcaneus. Because the nerve generally needs to be traced down into the arch of the foot where it splits into the medial and lateral plantar branches, it is usually necessary to release the tendinous portion of the abductor hallucis.

TRICKS

There are several useful tricks to this approach. One is to realize that the branches of the nerve come off posteriorly, and so the dissection is more safely done along its anterior border. The second is to realize that the nerve is generally deep to the vascular structures, usually slightly anterior and deep and therefore not as apparent as the more purplish artery and vein. The third trick is to make sure the nerve is freed into the arch of the foot, which means that the fibers of the abductor hallucis usually need to be released. Finally, the calcaneal branch of the posterior tibial nerve should also be freed if there is any numbness or heel pain.

HOW TO TELL IF YOU ARE LOST

It is easy to tell if you are lost too far anteriorly—you will simply see the tendons and the tibia. It is also easy to tell if you are lost too far posteriorly because you will see the Achilles tendon. The neurovascular bundle is between those tendons.

FIGURE 45–1 The skin incision with the small veins and the subcutaneous tissue.

FIGURE 45–2 The fascia underlying the subcutaneous tissue. At this point, the neurovascular bundle is indicated by the slightly purplish color with yellowish fat underneath the fascia.

FIGURE 45–3 The fascia being opened. The neurovascular bundle is now visible. The bottom of the incision shows the origin of the abductor hallucis muscle, which is an important landmark.

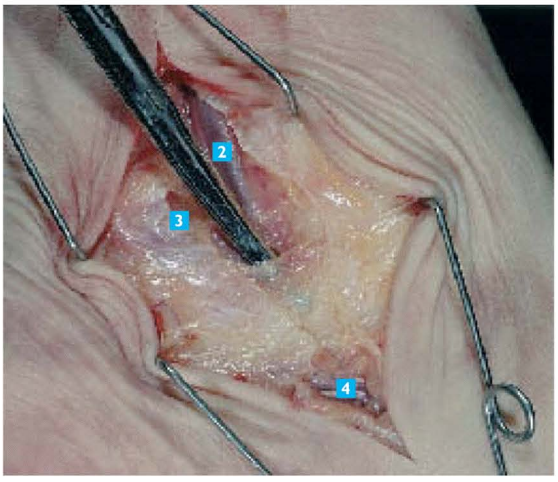


FIGURE 45–4 The fascia being split, exposing the neurovascular bundle.

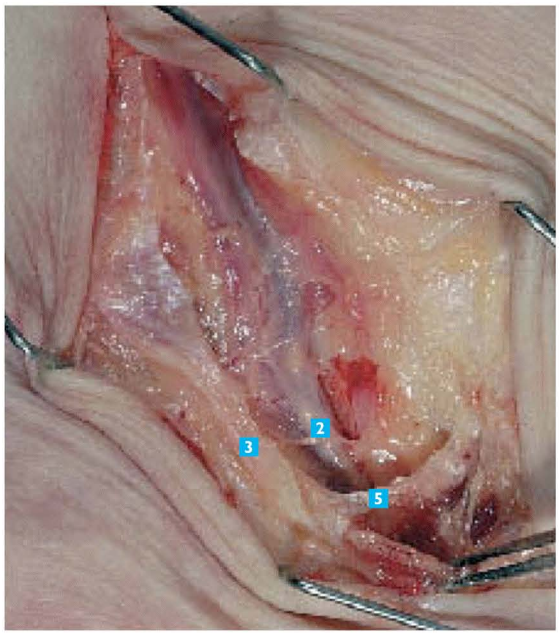


FIGURE 45–5 The neurovascular bundle exposed; the fascial edges are visible. The sharp edge of the abductor hallucis origin is also visible, and it is important to split it to completely free up the posterior tibial nerve.

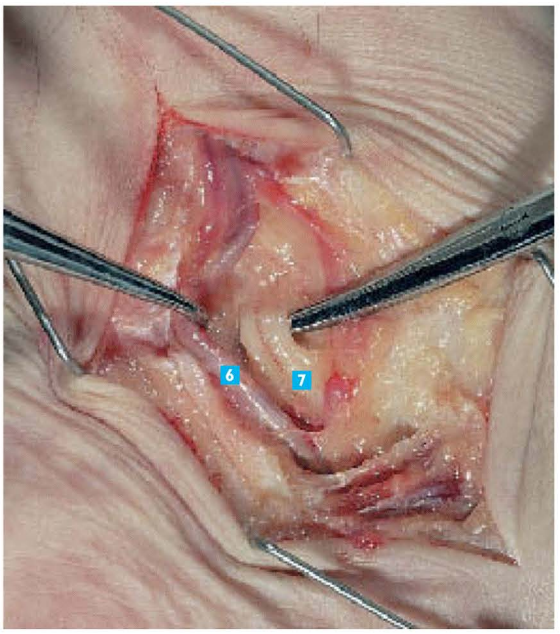


FIGURE 45–6 The nerve, which lies deep to the artery.

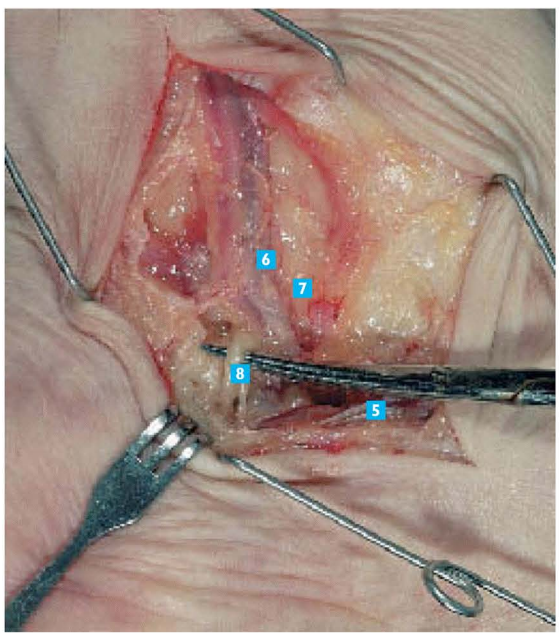


FIGURE 45–7 The neurovascular bundle well exposed. The calcaneal branch of the posterior tibial nerve is being lifted up by the scissors. All of the branches of the posterior tibial nerve come off of its posterior side, so that dissection along the nerve should be done on its anterior edge.

1. Fascia
2. Neurovascular Bundle
3. Fascial Edge
4. Abductor Hallucis Origin
5. Sharp Edge of Abductor
6. Artery
7. Nerve
8. Calcaneal Branch of Posterior Tibial Nerve

POSTEROMEDIAL APPROACH

USES

This approach is used for all medial and posterior malleolar fractures. Release of the posterior tibial tendon sheath is done through this approach. Long toe flexor releases can be done easily through the upper portion of this approach.

ADVANTAGES

This approach can easily be extended proximally or distally. The skin flap can be extended anteriorly far enough that the anterior medial aspect of the ankle can also be visualized, which is important when fixing malleolar fractures. In spite of creating a large flap, wound healing is generally not a problem. By extending the incision slightly posteriorly on its distal half, the approach is useful for tarsal tunnel releases.

DISADVANTAGES

This approach provides limited anterior exposure and no exposure laterally. If you need an approach to the ankle that shows the entirety of both the medial and the lateral portions of the distal tibia, an anterior approach would be more appropriate.

STRUCTURES AT RISK

The major structure at risk is the posterior tibial neurovascular bundle, which is behind the toe flexor tendon. The flexor digitorum longus and posterior tibialis tendons are in the center of this approach and can be damaged. Anteriorly, at risk is the saphenous nerve, which branches down into the medial malleolus area and, if transected, can cause neuromas trapped in the incision.

TECHNIQUE

The incision is generally 10 cm in length and centered over the posterior corner of the medial malleolus. For fracture work, the incision generally follows the course of the posterior tibialis tendon curving around to the anterior aspect of the medial malleolus. For a tarsal tunnel release, the distal half is continued in line with the flexor digitorum longus tendon and is more posterior. Once you are deep to the subcutaneous tissue, it is important to identify the toe flexor tendon. If you come down directly over this tendon, you will not damage the neurovascular bundle. Once the superficial fascia is released, you can then carry your dissection anteriorly for fracture work or posteriorly for nerve release.

TRICKS

The major landmark for this approach is the flexor digitorum longus tendon. The neurovascular structures are posterior to this tendon, and so staying along the tendon's anterior edge is the safest way to do this approach. When doing fracture reductions, carry the distal portion of the incision anteriorly until you are almost to the anterior tibialis tendon, which allows you to create a skin flap that is able to be retracted far enough laterally to see the anterior aspect of the medial malleolus without difficulty and to inspect the ankle joint.

HOW TO TELL IF YOU ARE LOST

The incision should come directly down on the flexor digitorum longus, which is usually very apparent. The posterior tibialis is frequently so close to the tibia that it is difficult to identify it, but the toe flexor is apparent. If you see the tibia in the center of your dissection, you are too far anterior. If the toe flexor is not centered in your dissection, you are too far posterior and are coming in right over the neurovascular bundle, which will then be at significant risk. If you see the Achilles tendon, you are well posterior.

FIGURE 46–1 The skin incision, usually 1 cm behind the medial malleolus and centered on the malleolus proceeding proximally and distally for approximately 4 to 5 cm.

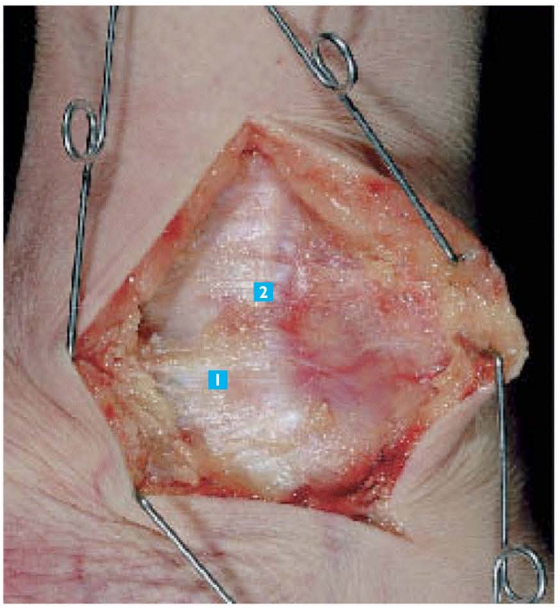


FIGURE 46–2 The fascia. At this point, the tendons are not visible, but the outline underneath the fascia can be seen and palpated.

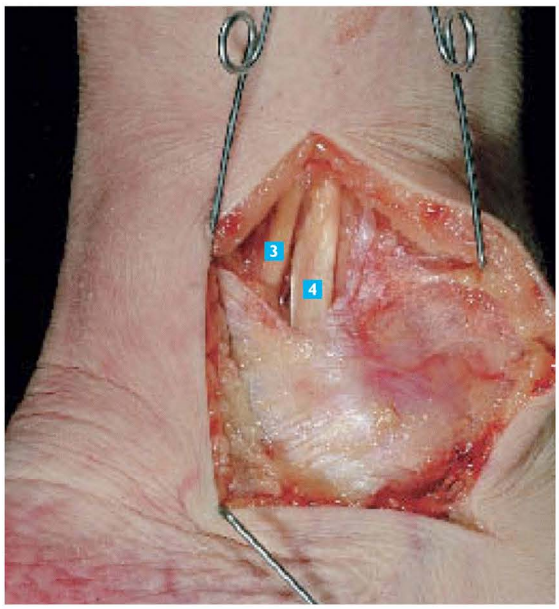


FIGURE 46–3 The tendon sheath open, showing the posterior tibialis tendon next to the bone and the flexor digitorum longus tendon just behind it.

FIGURE 46–4 The soft tissues retracted, showing the fat and fascia overlying the neurovascular bundle, which is posterior to the posterior tibialis and flexor digitorum longus tendons.

1 Fascia
2 Tendons Under Fascia
3 Flexor Digitorum Longus Tendon
4 Posterior Tibialis Tendon
5 Tendons
6 Neurovascular Bundle Under Fat and Fascia
7 Medial Malleolus
8 Tendon Sheath Merged with Superficial Deltoid
9 Deltoid Ligament
10 Talus

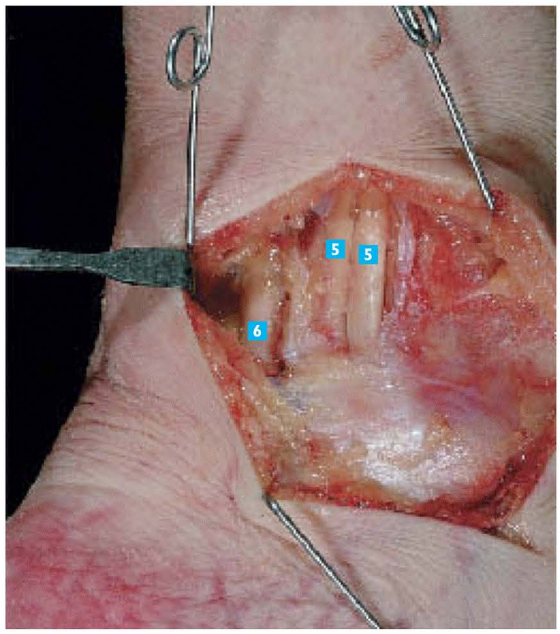


FIGURE 46–5 The neurovascular bundle now exposed. During most surgery in this area, there is no reason to expose the neurovascular bundle.

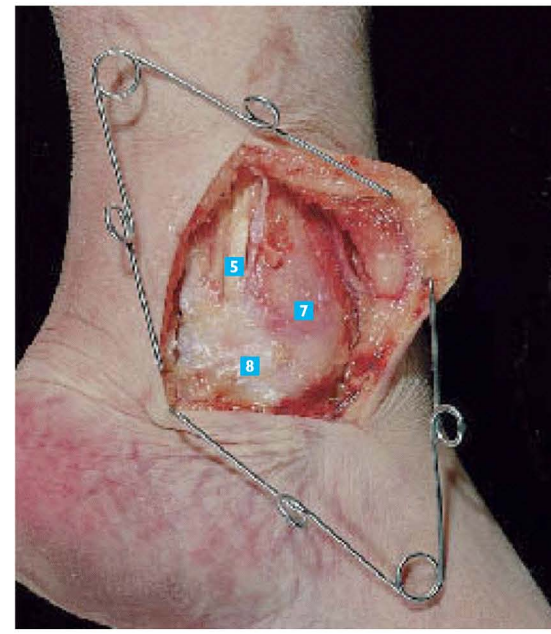


FIGURE 46–6 The medial malleolus, with the tendon sheath and the superficial deltoid ligament merged.

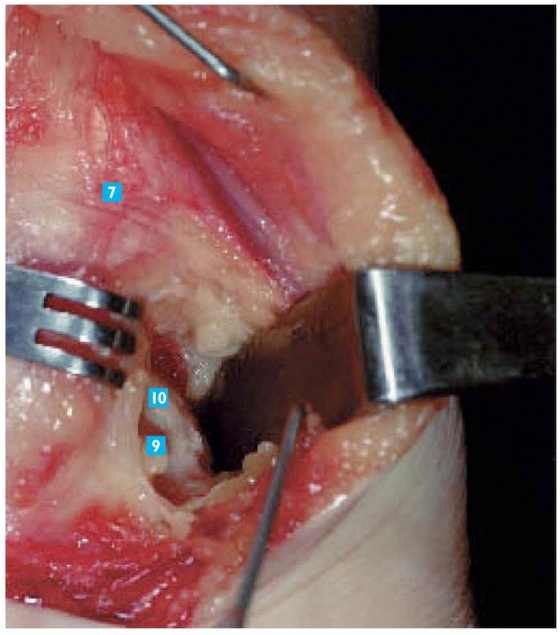


FIGURE 46–7 The ankle joint open and the deltoid ligament visible in the depths of the figure.

1. Fascia
2. Tendons Under Fascia
3. Flexor Digitorum Longus Tendon
4. Posterior Tibialis Tendon
5. Tendons
6. Neurovascular Bundle Under Fat and Fascia
7. Medial Malleolus
8. Tendon Sheath Merged with Superficial Deltoid
9. Deltoid Ligament
10. Talus

ANTERIOR APPROACH

USES

This approach is used for fracture of the distal tibia in some cases, for ankle fusions, and for treatment of osteochondritis dissecans of the ankle.

ADVANTAGES

With this midline approach, it is possible to go as far medially or laterally as necessary, and the entire anterior aspect of the ankle can be exposed. It is the only approach that provides that view of the ankle.

DISADVANTAGES

The approach shows only the anterior aspect of the ankle, so if there is a need to get around the medial or lateral corners, then incisions medially or laterally would be more appropriate with dissection to allow for anterior exposure. This approach also puts the dorsalis pedis artery and deep peroneal nerve at risk.

STRUCTURES AT RISK

The major structures at risk are the dorsalis pedis artery and the peroneal nerve, which typically cross into the foot just lateral to the tibia and go down into the foot between the base of the first and second metatarsal. They need to be retracted either medially or laterally, whichever can be accomplished with minimal tension on those structures.

TECHNIQUE

A straight incision is made anterior to the ankle joint in the midline. It is carried through subcutaneous tissue down to the superficial fascia, which is split, exposing the tendon of the anterior tibialis and the toe extensors. Usually the artery and the nerve are identified under the extensor hallucis longus and are then protected. The neurovascular structures and tendons are retracted, exposing the ankle capsule, which is opened to expose the ankle joint.

TRICKS

The major trick is in getting a sense of which way the artery and nerve can be retracted with the least amount of tension. Usually that would be medially because they are going medially.

HOW TO TELL IF YOU ARE LOST

It is difficult to get significantly lost with this approach. It is not a major disadvantage to be too far medial or lateral as long as the artery and nerve are protected. If you see the tendon of the anterior tibialis, which can be identified by putting tension on the tendon, you are too far medial. If your most medial tendon in view is one of the common extensors, you are too far lateral.

FIGURE 47–1 Medial is to the right.

FIGURE 47–2 The extensor hallucis longus tendon in the midline. The anterior tibialis tendon is seen on the edge. The transverse fibers of the retinaculum overlying the tendons are also visible. These tendons are usually identified initially by palpation.

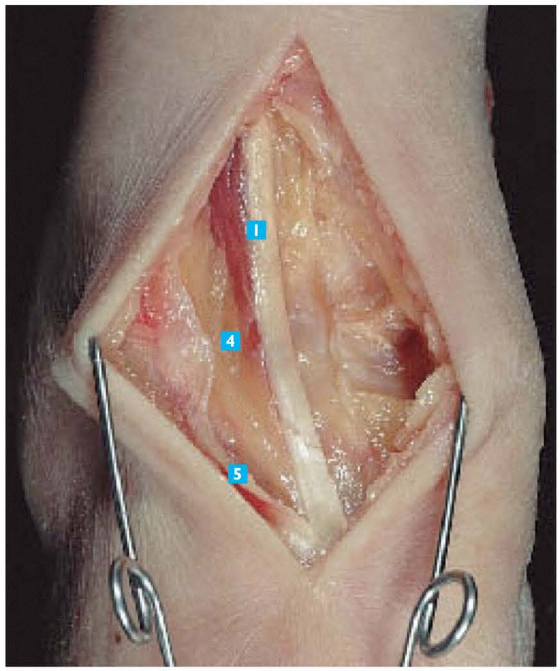
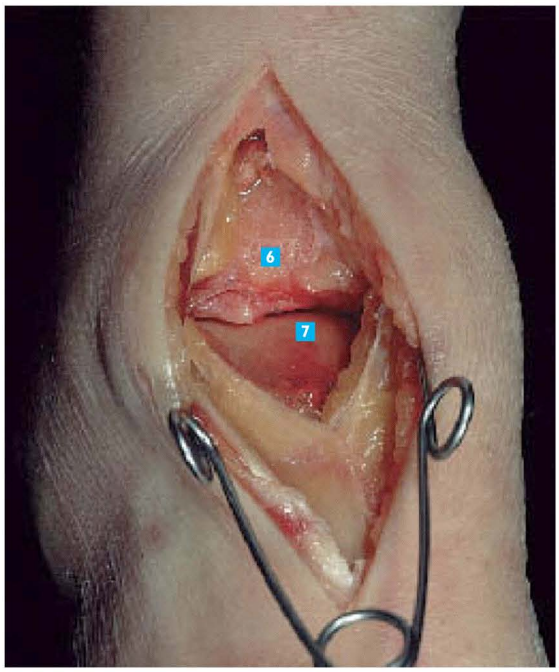


FIGURE 47–3 The extensor hallucis longus tendon separated from its overlying tendon sheath. The neurovascular bundle is just to the medial side and deep to this tendon. Note that the neurovascular bundle is covered by tissue and not readily apparent.

FIGURE 47–4 The neurovascular bundle now more thoroughly exposed underneath the tendon.



1 Extensor Hallucis Longus
2 Anterior Tibialis
3 Retinaculum
4 Neurovascular Bundle
5 Edge of Retinaculum
6 Tibia
7 Talus

FIGURE 47–5 The neurovascular structure and tendons retracted with the ankle capsule opened. This incision could be carried more proximally or distally as necessary for greater bone exposure.

Anterolateral Approach to the Ankle Ligaments

USES

This approach is used for reconstruction of the lateral ligaments of the ankle.

ADVANTAGES

This approach provides excellent exposure to the ligaments. It also runs parallel to the superficial sensory branches of the peroneal nerves so that they are less at risk with this approach.

DISADVANTAGES

This approach provides limited exposure to any other structures around the ankle or midfoot.

STRUCTURES AT RISK

The major structures at risk are the sensory branches of the peroneal nerve. The peroneus tertius tendon runs parallel to the incision and should not be damaged. Inferiorly, the peroneal tendons could be transected if the dissection is carried to far plantarward.

TECHNIQUE

An incision is made starting just 1 cm anterior to the fibula and 1 cm above the joint line and carried in an inferior direction toward the anterior process of the calcaneus. Deep to the subcutaneous tissue, the extensor retinaculum is identified, and the portion that attaches to the calcaneus should be carefully preserved if a ligament reconstruction is being done, as this portion can be used in ligament reconstruction. Once it is moved distally or is released, the anterior talofibular ligament is identified.

The posterior dissection is carried out to the calcaneal fibular ligament.

TRICKS

The major trick is not to release the extensor retinaculum off the calcaneus.

HOW TO TELL IF YOU ARE LOST

It is hard to get lost posteriorly or superiorly because you will run into the fibula or ankle joint. It is possible, however, to be too far distal with the incision and actually be over the midfoot area. If you see the anterior process of the calcaneus, you are too far distal. If you see the peroneus tertius tendon running into the fifth metatarsal from the dorsal side, you are also too far distal. If you are too far in the plantar direction, you will run into the peroneal tendons.

FIGURE 48–1 The skin incision.

FIGURE 48–2 The extensor retinaculum just deep to the subcutaneous tissue.

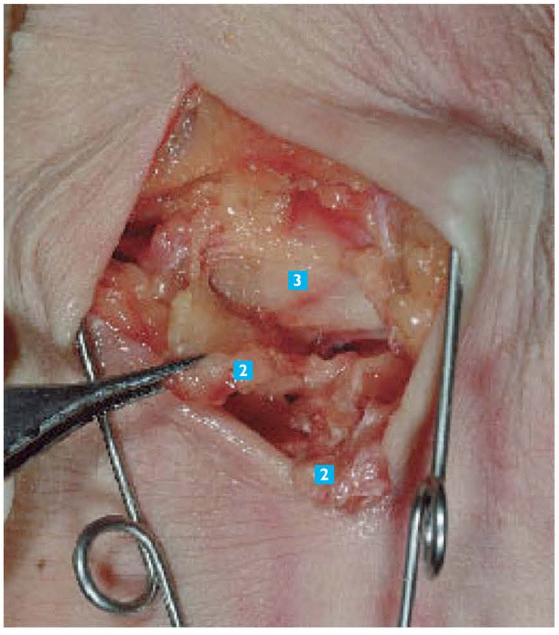


FIGURE 48–3 The anterior talofibular ligament in its initial exposure.

FIGURE 48–4 The area where the extensor retinaculum would be sutured if it was going to be used as part of a ligament reconstruction procedure.

1 Fibula
2 Retinaculum
3 Anterior Talofibular Ligament

APPROACH TO THE SUBTALAR JOINT (OLLIER APPROACH)

USES

This approach is used for a subtalar fusion or for a triple arthrodesis.

ADVANTAGES

This approach provides good access to the sinus tarsi and to the posterior facet of the subtalar joint.

DISADVANTAGES

Except for the above-mentioned uses, this is not a very utilitarian approach.

STRUCTURES AT RISK

Because this approach crosses the midfoot transversely, the sensory branches of the peroneal nerve coming onto the anterolateral aspect of the foot are at risk and can be damaged. They should be identified and protected as much as possible. The sural nerve crosses posteriorly and can be damaged at the more proximal plantar end of the incision. These branches must be looked for and avoided.

TECHNIQUE

The incision starts 1 to 2 cm distal to the end of the fibula, runs at a 60-degree angle to the line of the fibula, aiming toward the lateral aspect of the talonavicular joint. Deep to the subcutaneous tissue, it is usually easy to palpate the sinus tarsi. The origin of the extensor digitorum brevis is covering part of this area and can feed from the bone and be retracted out of the way. This exposes the fat in the sinus tarsi, which is removed, in turn exposing the posterior facet of the subtalar joint. By dissecting inferiorly and distally, the anterior process of the calcaneus is seen and the calcaneal cuboid joint is exposed.

TRICKS

The major trick is to place the incision far enough distally that you can get to the calcaneal cuboid joint. The incision should be just proximal to the anterior process of the calcaneus, which is almost always palpable. This then allows easy access to both the subtalar and the calcaneal cuboid joints.

A small Homan or other type of similar retractor placed under the calcaneal fibular ligament and over the superior end of the posterior facet exposes that portion of the subtalar joint in its entirety.

HOW TO TELL IF YOU ARE LOST

The distal fibula limits your ability to get lost by being too far superior or anterior. It is possible, however, to be too far posterior or distal. You are too far distal if you do not feel the empty space of the sinus tarsi centered in your wound. Instead you will feel the prominence of the anterior process of the calcaneus.

FIGURE49–1 The calcaneus is to the left.

FIGURE 49–2 The skin edge retracted, with the soft tissues overlying the sinus tarsi visible. The sinus tarsi is identified by palpatations once you have this view.

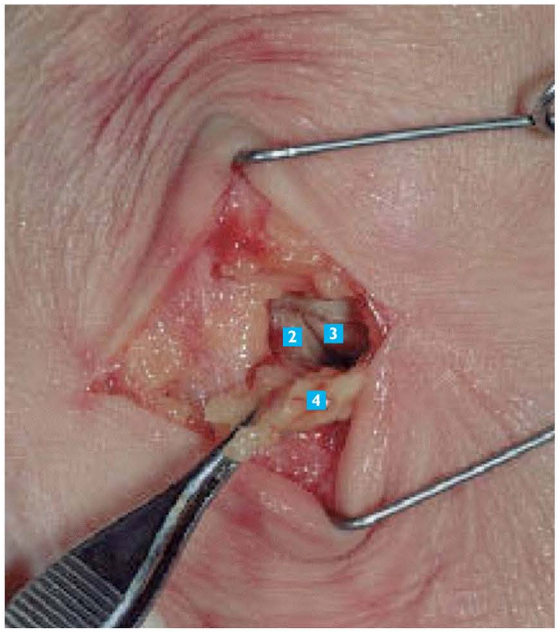


FIGURE 49–3 The fat in the sinus tarsi being retracted, exposing the anterior portion of the posterior facet.

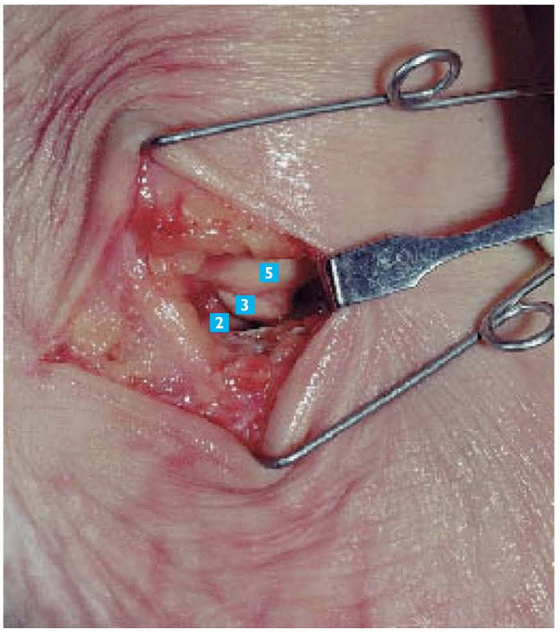


FIGURE 49–4 Close-up view of the calcaneal fibular ligament, which passes from the fibula over the top of the talus going down to the fibula. The foot is plantar flexed, which makes the ligament run in a more transverse direction.

1 Distal Fibula
2 Calcaneus
3 Talus
4 Fat from Sinus Tarsi
5 Calcaneal Fibular Ligament

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SECTION XII

FOOT

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Medial Approach to the Midfoot

USES

This approach is used for anterior tibial tendon transfers and harvesting toe flexor tendons for transfer. The proximal end of the incision is used for midfoot osteotomies and to release the plantar compartments of the foot for compartment syndromes.

ADVANTAGES

This approach goes deep to the neurovascular structures and uses the muscle of the abductor hallucis and the tendons of the toe flexors to protect the nerves and arteries.

DISADVANTAGES

There is essentially no exposure to the dorsum of the foot.

STRUCTURES AT RISK

The only significant structures at risk are the nerves and arteries. These are superficial, that is, plantar to the long flexor tendons. The anterior tibialis tendon attaches to the medial aspect of the cuneiform and base of the first metatarsal and can be transected if you are cutting down to those bones.

TECHNIQUE

The incision typically runs from the navicular tubercle distally just posterior of the midline. By putting the incision slightly posterior, it is in the arch of the foot where it will not be under pressure when wearing shoes or walking. You do not want to put it so far posterior that it will be in the weight-bearing area of the arch; 5 to 10 mm below the midline is all you should ever be.

After going through the subcutaneous tissue, taking care to protect any sensory nerves that are identified, the anterior edge of the abductor hallucis is identified and separated from the underlying bone. When it is retracted plantarward, you will see the white tendon of the flexor hallucis brevis origin, which should be released from the overlying bone in line with the bone, that is, longitudinally. When that is done, you will have more access laterally into the compartment where the flexor tendons are located. If you are too far distal, the flexor hallucis longus tendon will already be in the muscle belly of the flexor hallucis brevis and will be difficult to identify. Once identified, these tendons can be grasped and pulled into the wound for release or preparation for transfer.

The incision can also be used to dissect anteriorly and identify the insertion of the anterior tibialis tendon. These fibers run generally parallel to the metatarsal at this point, inserting into the medial cuneiform and base of the first metatarsal.

The proximal portion of this incision can also be used to approach the navicular tubercle and the posterior tibialis tendon insertion.

TRICKS

The major trick is finding the anterior edge of the abductor hallucis, freeing it from the bone, and retracting it plantarward. The second important trick is to transect the origin of the flexor hallucis brevis completely so that you can get lateral to that thick tendinous structure and find the long flexor tendons.

When identifying the anterior tibialis, the tendon sheath should be split; look for the longitudinal fibers of the tendon.

HOW TO TELL IF YOU ARE LOST

The abductor hallucis muscle belly is the key landmark. It is just to the posterior midline on the medial aspect of the foot. If you do not see it, you are too far anterior or posterior, usually anterior. If you err posteriorly, you will be into the bottom of the arch. This muscle is in the midline medially. Once its anterior edge is identified, it is then freed up from the underlying bone and retracted in a plantar direction.

Erring too far distally or proximally can be determined by identifying the bony structures.

FIGURE 50–1 The skin incision, usually 4 cm in length. Just deep to the fat is seen the purplish color of the abductor hallucis.

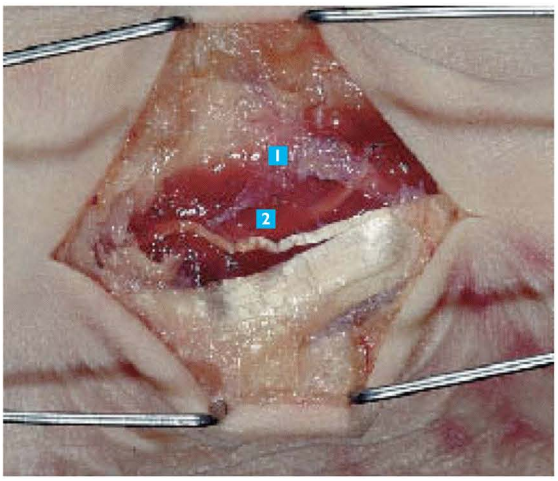


FIGURE 50–2 The fascia overlying the muscle split and the tendon and muscle, now visible. The first metatarsal is not well seen. It is still covered by fascia.

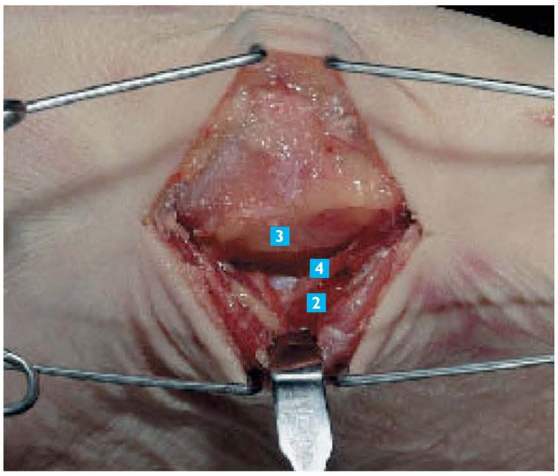


FIGURE 50–3 The abductor hallucis being pulled in a plantar direction. In the depth of the wound, you will see the white origin of the flexor hallucis brevis. Taking it off of the undersurface of the metatarsals is the key step in identifying the more laterally and superficially based flexor tendons. The abductor needs to be retracted with some vigor to expose this structure.

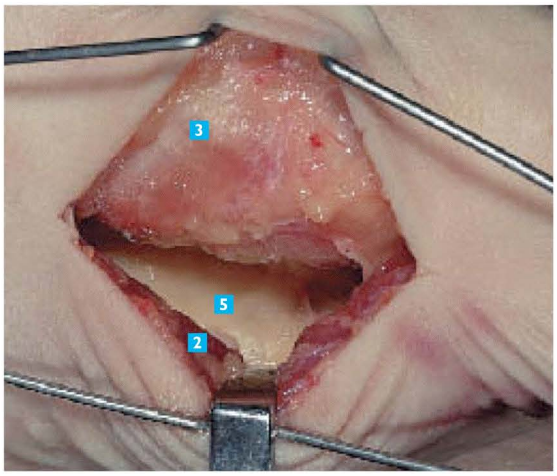


FIGURE 50–4 The flexor hallucis brevis now released and retracted plantarward. The fat overlying the flexor tendons is now visible. This is also the approach you would use to get into the deep compartment of the foot in compartment releases of the foot.

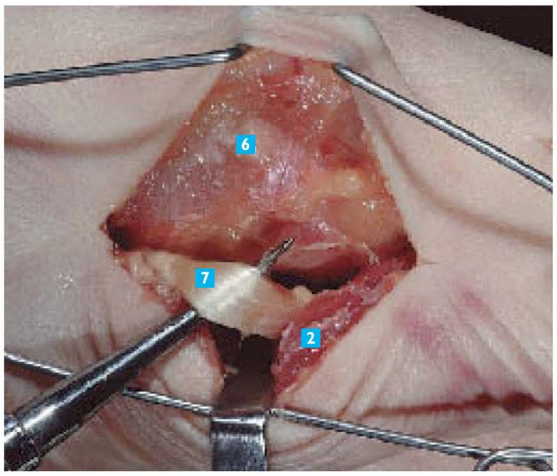


FIGURE 50–5 The flexor hallucis longus pulled out into the wound. The first metatarsal area is just superior. The whitish anterior tibialis tendon is visible underneath the fascia.

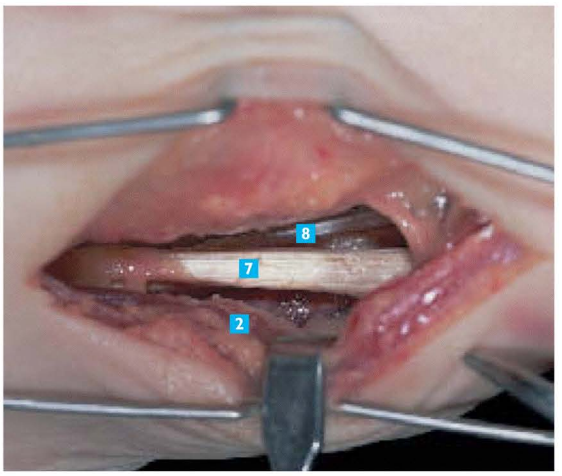


FIGURE 50–6 The flexor hallucis longus tendon in the foreground and the flexor digitorum longus tendon in the background, now visible.

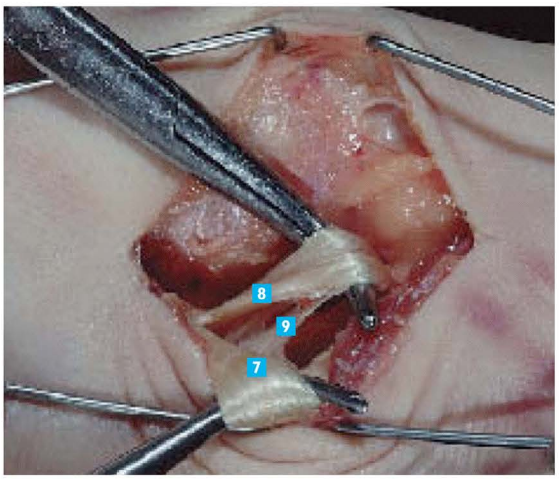


FIGURE 50–7 The above structures retracted, demonstrating the cross-connection between the flexor hallucis longus and the flexor digitorum longus. When either or both of these tendons are being harvested, this cross-connection must be identified and cut. Otherwise, it will not be possible to pull the tendons into the more proximal incisions because they come through different tendon sheaths, and the cross-connection will hang up on that tendon sheath.

1. First Metatarsal Area
2. Abductor Hallucis
3. First Metatarsal
4. Flexor Hallucis Brevis Origin
5. Fat Over Long Flexor Tendons
6. Anterior Tibialis Tendon Under Fascia
7. Flexor Hallucis Longus
8. Flexor Digitorum Longus
9. Cross Connection Between Flexor Hallucis Longus and Flexor Digitorum Longus

PLANTAR FASCIAL APPROACH

USES

This approach is used for release of the plantar fascia.

ADVANTAGES

This approach comes directly down on the plantar fascia. It comes from a direction that does not put the neurovascular structures at risk.

DISADVANTAGES

This is a single-use approach.

STRUCTURES AT RISK

When doing the transection of the plantar fascia, if you cut too far medially, you risk cutting the plantar nerves and arteries. The transection should be limited to the plantar fascia only.

TECHNIQUE

The key to this technique is placement of the skin incision just distal to the weight-bearing area of the heel fat pad. This puts it in the proximal end of the arch, which is safe from a walking standpoint.

A 1.5- to 2.0-cm incision is centered over the plantar fascia just distal to the weight-bearing area, and carried through subcutaneous tissue. The next structure encountered is the plantar fascia. Using a periosteal elevator, the subcutaneous fat can be pushed off of the plantar fascia as far medially and laterally as necessary. A retractor is then placed along the medial and lateral edge of the fascia so that your cut through the fascia does not extend too far. The fascia is then transected. You will see the muscle origin of the flexor digitorum brevis in the depth of the incision. This does not need to be cut to manage the pathology of plantar fasciitis.

TRICKS

The key trick to this procedure is to place the incision off of the weight-bearing area. Once the fascia is encountered, you strip the fat far enough medially and laterally so that you can place a retractor on either side of the plantar fascia and can directly visualize what you are going to cut. It is important not to cut too far medially or you risk damaging the plantar nerves and arteries.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost with this approach. You simply go through the skin and the subcutaneous tissue. Next you see the white plantar fascia, so getting lost is hard to do. It is possible to be too far medial or lateral with your incision, and if you are, just undermine the skin back to where you need to be.

FIGURE 51–1 A 2.0-cm-long incision is made in the midline on the plantar aspect of the foot, just at the distal edge of the heel, off of the weight-bearing area of the heel. The dissection is carried proximally as you go deep, coming back toward the heel.

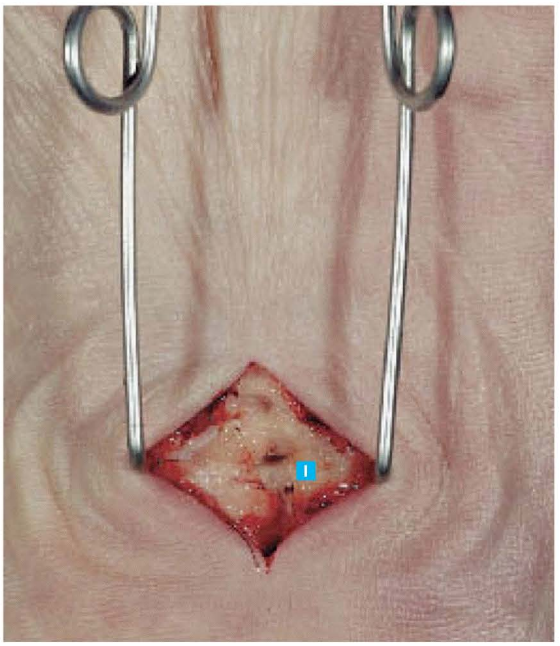


FIGURE 51–2 The subcutaneous fat.

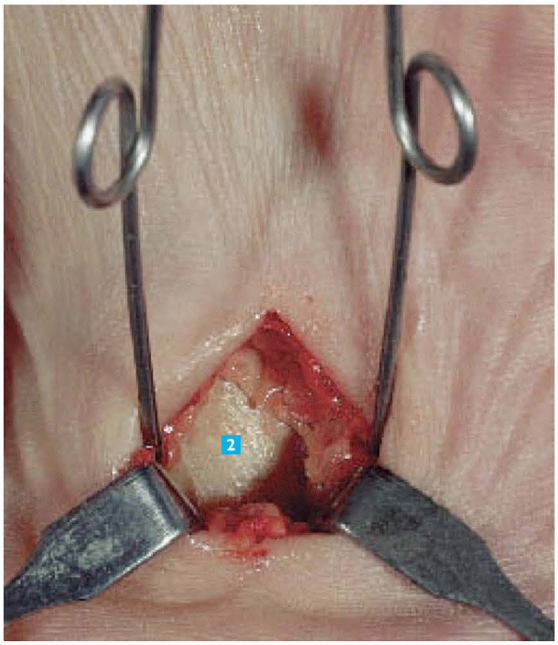


FIGURE 51–3 The fat, which has been pushed away with a periosteal elevator and is being retracted. The underlying plantar fascia is visible. This is the structure to be transected.

1 Fat
2 Fascia

PLANTAR METATARSAL HEAD APPROACH

USES

This approach is used primarily to resect amputation neuromas that occur after a prior Morton's neuroma resection.

ADVANTAGES

This approach comes directly down on the pathology through an easy approach that is not in the weight-bearing area of the foot.

DISADVANTAGES

This approach does not provide good exposure to any other structures, such as the tendons or the metatarsals themselves.

STRUCTURES AT RISK

The only structures at risk are the plantar nerve and artery. The point of the surgery is usually to identify the nerve and resect it more proximally. It is not technically a structure at risk. The plantar arteries, however, can be damaged and, if possible, should be protected.

TECHNIQUE

A 2 cm incision is made proximal to the metatarsal heads on the plantar aspect of the foot. It should be centered such that the area of the Tinel's sign is in the distal half of the incision. Thus, the nerve can be identified and resected far enough proximally to prevent a second symptomatic amputation neuroma. Once you are in the subcutaneous tissue, you start spreading the tissues and you can usually find the nerve. The nerve and artery are more superficial than the tendons and the metatarsals.

TRICKS

The major trick is placing the incision appropriately so that you can identify the nerve and resect it proximally or bury it in some tissue where it will not cause symptoms. By putting the area of the Tinel's sign in the distal portion of the incision, you will usually have enough proximal incision to do an adequate resection.

The second trick is to start looking for the nerve once you are in the subcutaneous tissue. The fat is fairly minimal in the arch area and is not thick like it is around the heel or metatarsal heads.

HOW TO TELL IF YOU ARE LOST

If you do not find the nerve, you are obviously lost. The nerve itself comes from the medial portion of the foot and courses laterally. You have to keep looking medially and laterally until you find the nerve. It angles toward the area between the metatarsal heads.

FIGURE 52–1 The skin incision. Notice that it is proximal to the thickened skin underneath the metatarsal heads.

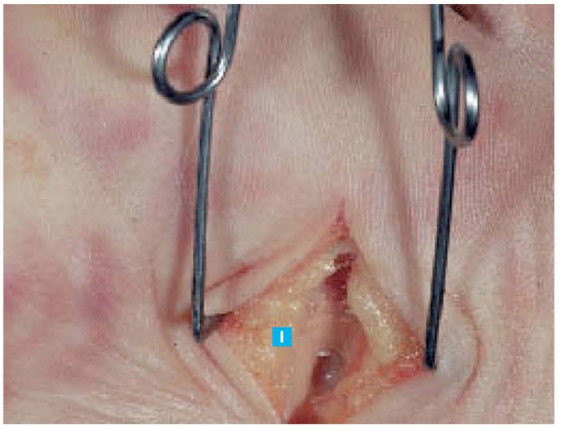


FIGURE 52–2 The subcutaneous tissue and the nerve identified in the tissue and just deep to it.

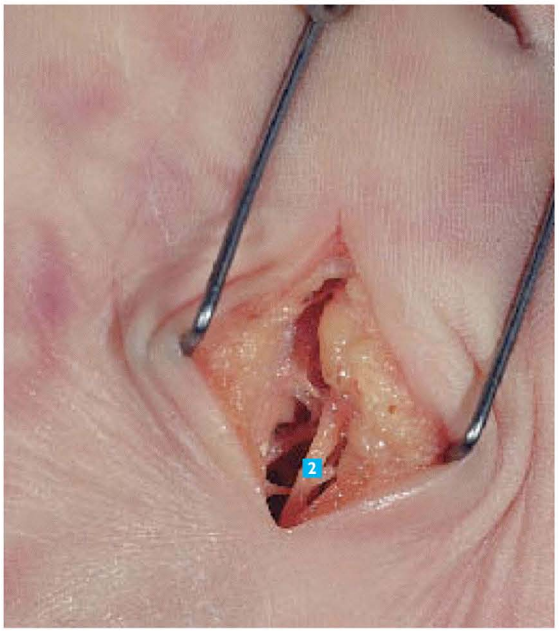


FIGURE 52–3 The nerve separated from the fat.

1 Fascia Over Nerve
2 Nerve

INTERMETATARSAL (DORSAL WEB) APPROACH

USES

This approach is used for interdigital neuroma resections and for dorsal approaches to the metatarsophalangeal joints.

ADVANTAGES

By staying on the dorsum, the scar is kept off of the plantar aspect of the foot, which can be painful with walking.

DISADVANTAGES

This approach provides poor exposure for any of the plantar structures, and accessing the plantar aspect of the metatarsophalangeal joints is difficult.

STRUCTURES AT RISK

The digital artery and nerves are the main structures at risk. This far distal they are small and sometimes difficult to identify. They come from the plantar side toward the dorsal side, which helps somewhat with identification.

TECHNIQUE

A straight incision is made for 3 cm starting in the web space and proceeding proximally, through the subcutaneous tissue, exposing the intermetatarsal area. The tendons are retracted out of the way. The lumbrical tendon is usually retracted laterally. The intermetatarsal ligament crosses the bottom of the joint and is the key structure in identifying the neuroma. This ligament is transected. A lamina spreader is placed between the metatarsals to open the gap. At that point, the neurovascular structures can be identified and the nerve resected.

TRICKS

The major trick is transecting the intermetatarsal ligament and then using the lamina spreader to widen the gap.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost with this approach because the interval between the metatarsals is easy to palpate.

FIGURE 53–1 The skin incision starting at the web space and proceeding proximally.

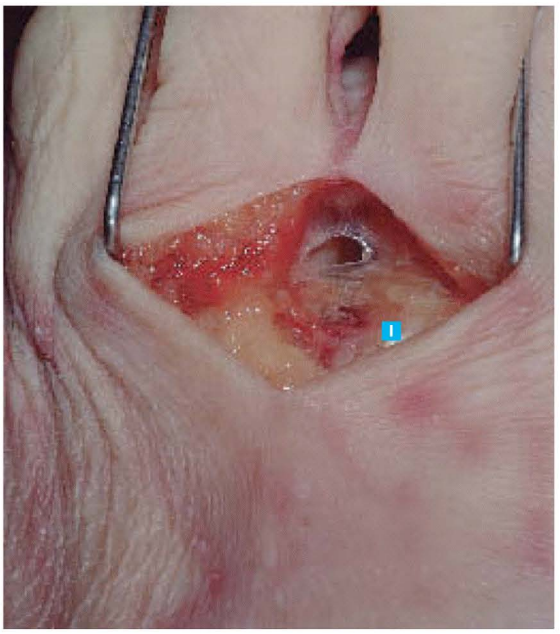


FIGURE 53–2 The subcutaneous tissue with the loose tissue in between the metatarsals. The white glistening extensor tendon is apparent.

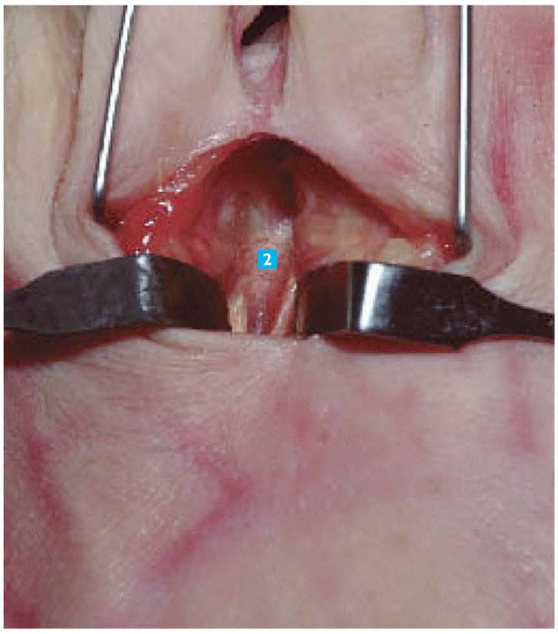


FIGURE 53–3 The interosseous tendons approaching the toes and the inter metatarsal ligament in the depth of the incision.

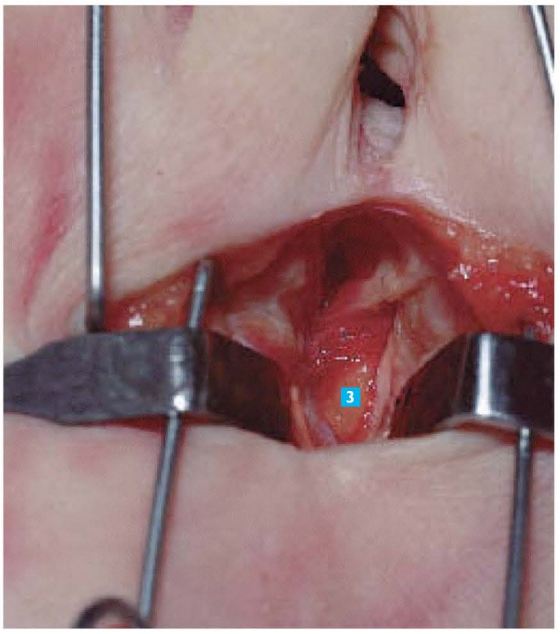
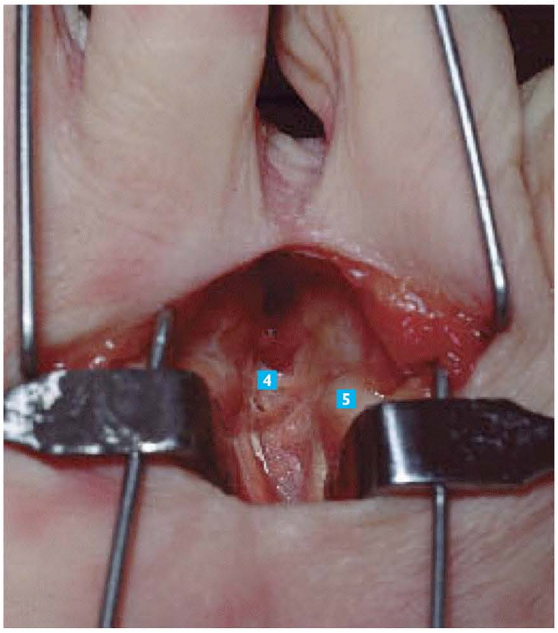


FIGURE 53–4 The inter metatarsal ligament transected with the fat in the plantar aspect apparent. This is the fat in which the neurovascular bundle is found.

1 Toe Extensor Tendon
2 Ligament
3 Fat Over Neurovascular Bundle
4 Neurovascular Bundle
5 Metatarsal Head



1 Toe Extensor Tendon
2 Ligament
3 Fat Over Neurovascular Bundle
4 Neurovascular Bundle
5 Metatarsal Head

FIGURE 53–5 The neurovascular bundle as it is starting to become more apparent.

Dorsomedial Approach to the First Toe and Metatarsophalangeal Joint

USES

This approach is used for bunion procedures, osteotomies of the proximal phalanx of the first toe, and treatment of hallux rigidus.

ADVANTAGES

This is a direct approach onto the bones, which are subcutaneous. The approach is in the gap between the dorsum of the toe and the medial aspect of the toe, where shoes would put pressure on the area of the incision.

DISADVANTAGES

There are no major disadvantages to this approach.

STRUCTURES AT RISK

The only significant structures at risk are the sensory nerves, which typically are in the area of the incision. The toe extensor tendons are at risk if you drift too far in a lateral direction. The sensory nerves need to be identified and protected; otherwise, the patient may develop a painful neuroma when wearing shoes or sandals.

TECHNIQUE

The incision is made in the interval between the medial prominence of the first metatarsal head and the toe extensor tendon. It is usually centered over the metatarsophalangeal joint and carried to the subcutaneous tissue sharply. At that point, blunt dissection should be done until the sensory nerves are identified and protected. From there, it is possible to cut directly down on the metatarsal and first toe, opening the metatarsophalangeal joint. At that point, whatever bone procedure was planned can be completed.

TRICKS

The major trick is putting the incision in the slightly depressed area between the medial prominence of the metatarsal head and the toe extensor tendon.

HOW TO TELL IF YOU ARE LOST

It is difficult to get lost because the bones are subcutaneous. If you see the extensor tendon of the first toe, you are too far lateral. If you see the toe flexor tendons, you are too far plantar. It is possible to be too proximal or too distal if your goal is to get to the metatarsophalangeal joint; it is easily remedied by extending the incision.

FIGURE 54–1 The skin incision, generally centered over the joint surface.

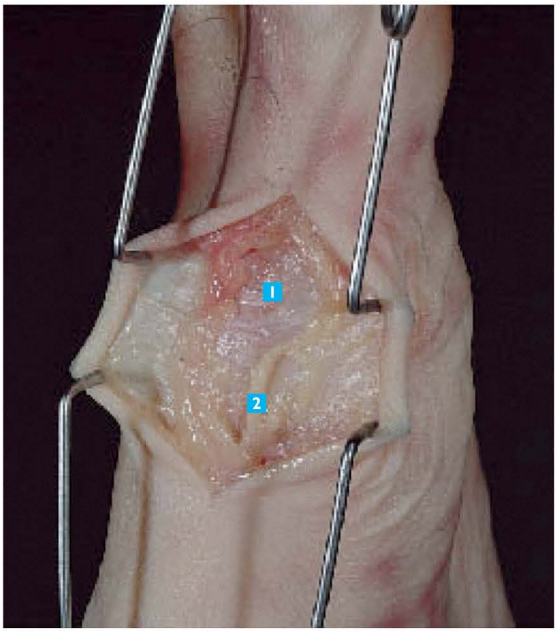


FIGURE 54–2 The subcutaneous tissue. The sensory nerves, which are common in this area, are clearly seen, as is the fascia.

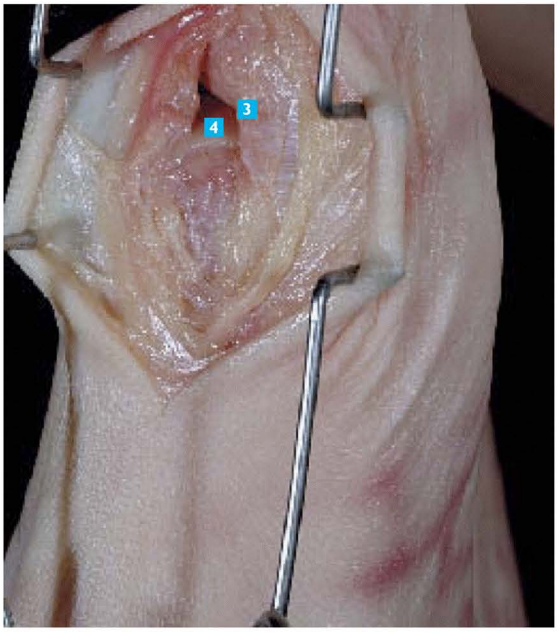


FIGURE 54–3 The capsule opened longitudinally, exposing the joint surface.

1 Fascia
2 Sensory Nerve
3 Capsule
4 Joint Surfaces

PLANTAR APPROACH TO THE TOE FLEXORS

USES

This approach is used primarily for the release of the toe flexor tendons. This is also a useful approach to harvest the toe flexors for dorsal transfer.

ADVANTAGES

This approach comes directly down on the pathology and provides good visualization so that the neurovascular structures can be protected.

DISADVANTAGES

There are no disadvantages if this approach is used for a toe flexor release. It provides no exposure dorsally.

STRUCTURES AT RISK

The neurovascular structure on either side is at risk. They do not need to be specifically identified, but they do need to be protected.

TECHNIQUE

A 1-cm incision is generally made in the midline over the proximal phalanx of the toe just distal to the metatarsal fat pad. It is carried through subcutaneous tissue to the tendon sheath, which is usually easy to identify directly below the subcutaneous tissue. The retractor is placed on the medial and lateral sides to hold the neurovascular structures out of the way, and the tendon sheath is opened, exposing the flexor tendons, which can be transected or released and transferred. If the purpose of the surgery is to do a toe flexor release at this level, it is important to find both the medial and the lateral slips of the flexor digitorum brevis tendon. The flexor digitorum longus tendon passes through a split in the brevis tendon identical to the way the profundis tendon goes through the split in the sublimis tendon in the hand. If all three portions are not released, a persisting deformity will result.

TRICKS

The only tricks are to stay in the midline and to retract the nerve and artery to the side. Do not cut anything deep to the subcutaneous tissue if you do not see the tendon sheath clearly.

HOW TO TELL IF YOU ARE LOST

It is impossible to get lost if you come down the midline. If you are too proximal or distal, you will still run into the tendon. If you go proximally too far, you will be in the fat of the metatarsal fat pad. If you are distal to the proximal interphalangeal joint, you will not see the short flexor tendon (which is identical to the sublimis of the hand).

FIGURE 55–1 The skin incision over the proximal phalanx.

FIGURE 55–2 The retractor in place, which holds the neurovascular bundle away from the tendon sheath in the midline.

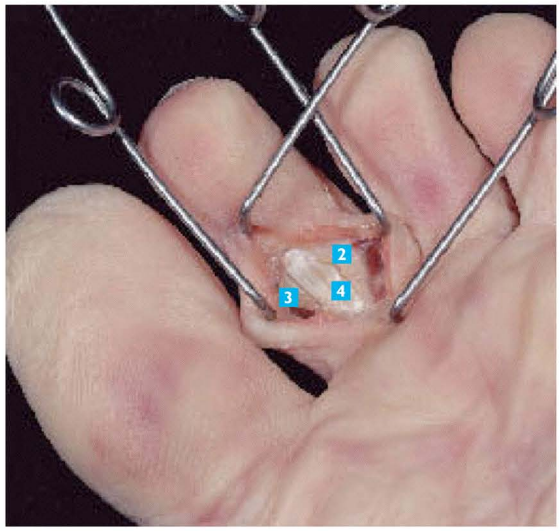


FIGURE 55–3 The tendon sheath open. On the side is seen the medial slip of the flexor digitorum brevis. The flexor digitorum longus is more superficial. Notice it has a split in its midportion, which is frequently seen. This split should not confuse you into thinking that you have identified the lateral tendon of the flexor digitorum brevis. At this level, these two tendons are identical to the arrangement in the hand between the sublimis and profundis. If you are doing a toe flexor release and you leave the branch of the flexor digitorum brevis tendon uncut, the patient will have a persisting deformity.

1 Flexor Tendon Sheath
2 Tendon Sheath Overlying Lateral Slip of Flexor Digitorum Brevis
3 Flexor Digitorum Brevis Medial Slip
4 Flexor Digitorum Longus

SECTION XIII

SPINE

Michael L. Reyes, M.D.
Larry Khoo, M.D.

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Anterior Approach to the Cervical Spine

USES

This approach is used to access the anterior vertebral bodies of C3 through T1, including the disk spaces in between. Its main utility is for anterior cervical decompression and fusion (ACDF), which ranges from a single-level diskectomy to a multilevel corpectomy with bone grafting and plating. This approach may be used for resection of tumors and debridement of infection located in the anterior and middle columns of the cervical spine.

ADVANTAGES

This approach is relatively easy to perform. The supine positioning is less time consuming and, in theory, safer for the patient compared to the prone position. Furthermore, as the skin incision follows skin creases, a more cosmetic scar usually results.

DISADVANTAGES

Numerous vital structures are placed at risk in this approach (see below). Hence, a clear understanding of the anatomy is important to minimize complications. Also, significant postoperative soft tissue swelling around the trachea may occur, causing transient airway compromise.

STRUCTURES AT RISK

Many important structures are at risk with this approach. The right and left recurrent laryngeal nerves, which supply the larynx, are branches of the vagus nerve. The left recurrent laryngeal nerve, after circumventing the aortic arch, ascends in the tracheoesophageal groove. The right recurrent laryngeal nerve, on the other hand, takes off from the parent vagus nerve and curves around the right subclavian artery at a more cephalad level, crossing from lateral to medial in the lower part of the cervical spine, then ascending the neck directly adjacent to the trachea. Also, anatomic variability in the takeoff level of the right recurrent laryngeal nerve has been described. This renders the nerve more vulnerable in the right-sided approach, as the level where it crosses the operative field is less predictable.

The carotid sheath and its contents (common carotid artery, internal jugular vein, and vagus nerve) are also at risk in the lateral margin of the dissection. The sheath should be carefully identified and protected after the deep cervical fascia on the medial aspect of the sternocleidomastoid muscle is divided. Midline structures, such as the trachea and esophagus, must be identified and protected. Overzealous, continuous, or sharp retraction of these structures should be avoided, as this may cause damage. Blunt handheld retractors are preferred.

Deeper in the dissection, the vertebral artery is at risk. It ascends the spine within the lateral aspect of the transverse processes, within the costotransverse foramen. It is not normally visualized in this approach. Dissection lateral to the uncinate process of the vertebral body increases the likelihood of arterial injury. Also in the deep dissection, the cervical sympathetic trunk may be at risk as it lies directly anterior to the prevertebral fascia, which envelopes the prevertebral muscles. After incising the fascia in the midline, careful subperiosteal dissection of the vertebral body protects this structure.

Finally, as with any approach to the spine, the dura must be meticulously dissected to prevent cerebrospinal fluid leak.

TECHNIQUE

The patient is placed in the supine position with a roll placed transversely between the scapulae in order to extend the neck. The head is turned away from the side of the approach. Following palpation of landmarks, a 5-cm skin incision is made along a skin crease at the level of interest. Alternatively, a longer oblique or longitudinal incision can be made if an extensive decompression is planned (i.e., >3-level corpectomy). Injection of lidocaine with epinephrine into the skin prior to incising may help diminish superficial bleeding.

Incise the superficial fascia overlying the platysma along the skin incision. The fibers of the platysma muscle are then either incised longitudinally along the directions of its fibers or split transversely. The deep cervical fascia underneath is then identified. Next, palpate the medial border of the sternocleidomastoid (SCM) muscle and carefully split the fascia longitudinally, which facilitates retracting the SCM laterally. The laryngeal strap muscles (sternohyoid, sternothyroid) as well as the midline structures immediately deep to them (trachea and esophagus) are then retracted medially. Deep to the SCM muscle, identify the carotid sheath as well as the pretracheal fascia overlying it. Carefully incise the fascia medial to the sheath while protecting the midline structures. The carotid sheath can now also be retracted laterally.

Using blunt dissection, develop a plane toward the midline until the prevertebral fascia directly anterior to the vertebral bodies can be visualized. Identify the midline of the vertebral bodies (corresponding to the white stripe of the anterior longitudinal ligament) as well as the longus colli on each side. Using electrocautery, incise the prevertebral fascia longitudinally to the desired length. Use a periosteal elevator to then subperiosteally uncover the vertebral bodies and intervening disk spaces. Place retractors under each longus colli muscle to protect surrounding structures. Place a spinal needle in a disk space and obtain a cross-table lateral radiograph of the cervical spine to confirm the level. An assistant pulling axially on wrist straps depresses the shoulders and allows for a better radiograph. After confirming the level, a diskectomy and/or corpectomy can be performed as indicated.

TRICKS

Several tricks make this approach safer. First is meticulous hemostasis. Use of bipolar cautery is recommended. Second, the use of magnification with an operating microscope or loupes greatly enhances visualization in a small operative window, and allows easier identification and protection of structures at risk. Finally, ensuring the correct level of the skin incision also prevents difficulty in dissection. Palpable landmarks in the neck aid in identifying the approximate level. The inferior angle of the mandible corresponds to C2-3, the hyoid bone to C3, thyroid cartilage to C4-5, the cricoid cartilage to C6, and the carotid tubercle to C7.

HOW TO TELL IF YOU ARE LOST

To stay in the correct plane of dissection, one must know which structures to retract medially and which to retract laterally. Superficially, the SCM muscle should be lateral. The carotid sheath directly underlying this muscle, which should be easily identified by palpating the carotid pulse, should also be retracted laterally without directly visualizing its contents. Deeper in the dissection, one must be able to palpate the midline vertebral bodies under the prevertebral fascia. Dissection lateral to the midline will split the fibers of one of the longus colli muscles.

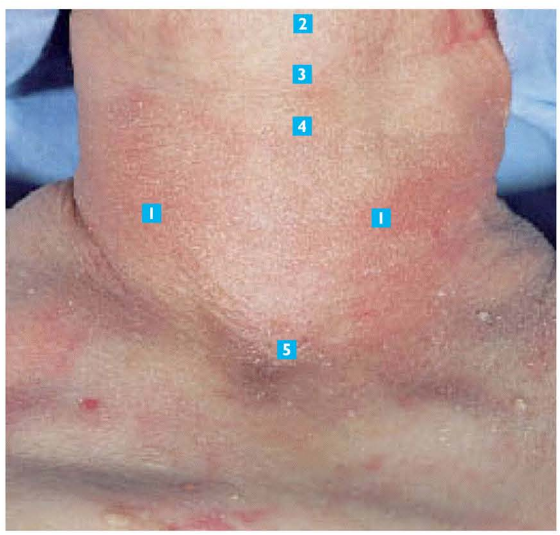

FIGURE 56–1 Landmarks of the anterior neck.

1. Sternocleidomastoid (SCM) Muscles
2. Hyoid (C3)
3. Thyroid Cartilage (C4-5)
4. Cricoid Cartilage (C6)
5. Stemal Notch
6. Platysma Muscle
7. Laryngeal Strap Muscles
8. Left SCM Muscle
9. Medial Border of SCM Muscle
10. Right and Left Longus Colli Muscles
11. Anterior Longitudinal Ligament

FIGURE 56–2 Transverse skin incision extending from midline along a skin crease at the C5 level. Note that the neck is slightly extended and rotated away from the operative side.

12. C5 Vertebral Body
13. C5-C6 disk
14. C6 Vertebral Body
15. Right and Left Longus Colli Muscles (Elevated and Retracted)
16. C5-C6 Diskectomy
17. C6 Partial Corpectomy
18. C6-C7 Diskectomy
19. Inferior End Plate of C5
20. Dura
21. Superior End Plate of C7

FIGURE 56–3 Platysma and part of deep cervical fascia split revealing the sternocleidomastoid (SCM) muscle.

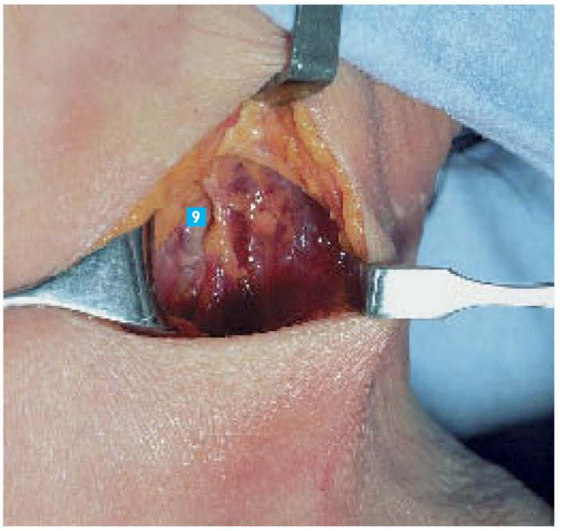

FIGURE 56–4 Medial border of SCM seen after strap muscles are retracted medially.

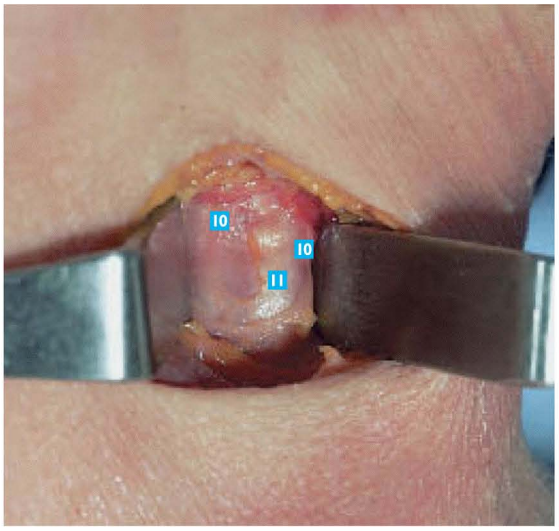

FIGURE 56–5 Sternocleidomastoid muscle retracted laterally with carotid sheath to expose prevertebral fascia.

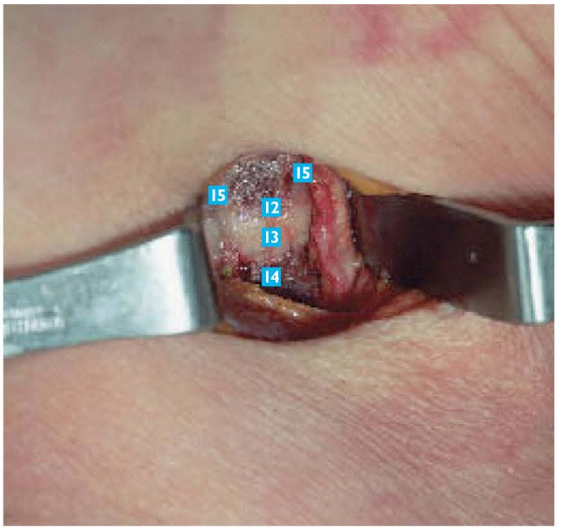

FIGURE 56–6 Prevertebral fascia split subperiosteal dissection of vertebral bodies.

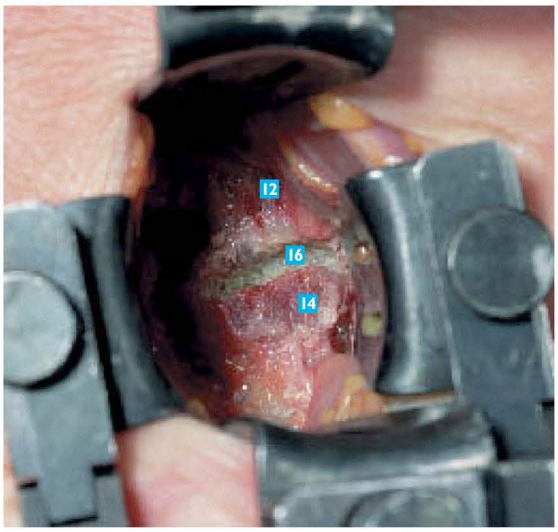

FIGURE 56–7 C5-C6 diskectomy.

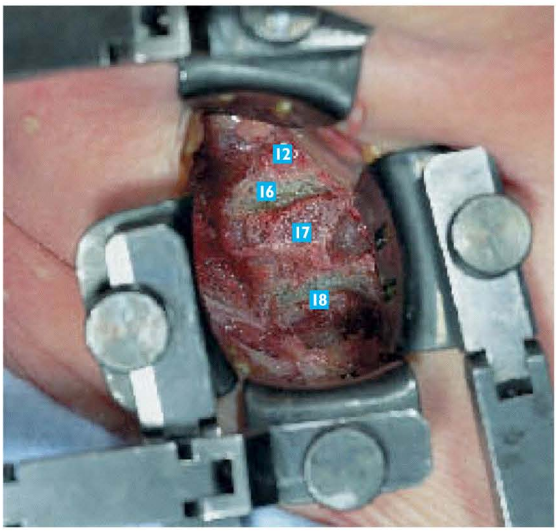

FIGURE 56–8 C5 corpectomy.

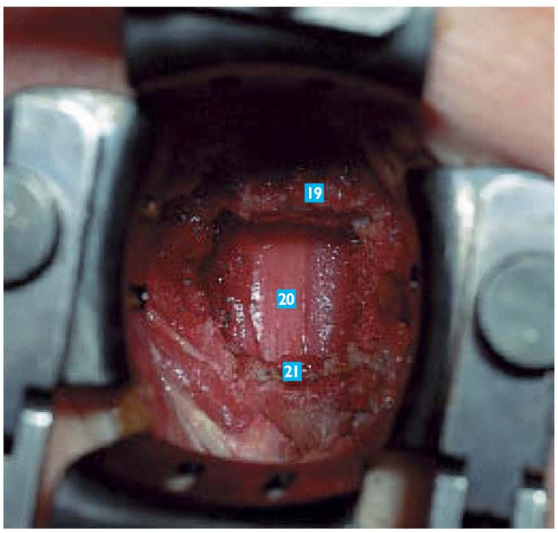

FIGURE 56–9 Complete C5 corpectomy revealing underlying dura.

1. Sternocleidomastoid (SCM) Muscles
2. Hyoid (C3)
3. Thyroid Cartilage (C4-5)
4. Cricoid Cartilage (C6)
5. Stemal Notch
6. Platysma Muscle
7. Laryngeal Strap Muscles
8. Left SCM Muscle
9. Medial Border of SCM Muscle
10. Right and Left Longus Colli Muscles
11. Anterior Longitudinal Ligament
12. C5 Vertebral Body
13. C5-C6 disk
14. C6 Vertebral Body
15. Right and Left Longus Colli Muscles (Elevated and Retracted)
16. C5-C6 Diskectomy
17. C6 Partial Corpectomy
18. C6-C7 Diskectomy
19. Inferior End Plate of C5
20. Dura
21. Superior End Plate of C7

Posterior Approach to the Occipitocervical Junction and Cervical Spine

USES

The posterior approach to the midline cervical spine is used for a wide variety of indications. Simple decompressive procedures such as laminectomy, foraminotomy, and laminoplasty are commonly employed to treat a host of pathologies, including foraminal compression, facet arthropathy, cervical spondylytic disease, cervical myelopathy, cervical stenosis, ossified posterior longitudinal ligaments, intra- and extradural spinal cord tumors, nerve root tumors, and infections. For cases of instability due to tumor, fracture, or infection, a host of arthrodesis and stabilization techniques can be used from a posterior midline approach, including posterior laminar wiring, Brooks or Gallie fusions, lateral mass plating, translaminar wiring or screw placement, transarticular screw placement, Luque rectangle placement, pedicular screw placement, and in-situ bony fusion. For cases of occipitocervical or atlantoaxial instability (e.g., trauma or rheumatoid arthritis), exposure of the foramen magnum and the occipital bony squama also allows for extension of the stabilization construct. Decompression for cases of Chiari malformation or basilar invagination can also be achieved.

ADVANTAGES

As detailed above, the midline posterior cervical approach is highly versatile. It can be performed over a few segments for focal pathology or instability, or it can be extended for extensive instrumentation of the occipitocervical or cervicothoracic junction. If the exposure is kept to the midline of the subaxial cervical spine, few neurovascular structures are at risk. This is in contrast to anterior cervical exposures, which place a far greater number of vital structures in harm's way. Additionally, posterior cervical approaches allow for many levels to be simultaneously exposed, whereas anterior approaches are more limited. Numerous fixation sites are available for fusion and instrumentation, such as the lateral masses, facets, lamina, and spinous processes.

DISADVANTAGES

Anterior pathology is poorly visualized through a posterior approach and places the cervical spinal cord at untoward risk. Severe anterior canal or cord compression typically requires an anterior surgical corridor for resection. Extensive resection of posterior bony elements to decompress a straightened, kyphotic, or flexible neck carries with it an increased risk of progressive deformity. In cases of severe deformity with loss of anterior column support, a posterior approach does not allow for grafting and restoration of intervertebral height.

STRUCTURES AT RISK

Unlike other spine approaches, the posterior cervical approach places several structures at risk prior to incision. As the cervical spine is highly mobile, it is at risk for subluxation and spinal cord injury during the intubation procedure itself. After the patient is paralyzed, the cervical spine is at further risk during the turn to the prone position. This is especially true for cases of unstable fractures and anterior spinal cord compression. The head must typically be immobilized in a Mayfield head rest, Gardner-Wells tongs, or a HALO device. All these items require the use of head pins and place the cranial venous sinuses and intracerebral contents at risk. Traction should also be placed gradually to avoid additional spinal deformity. Thus, great caution must be used for all phases of the early perioperative preparation. The use of awake neurological testing, fiberoptic intubation, and somatosensory evoked potentials are all helpful in preventing iatrogenic neurological injury. After positioning, radiographic confirmation of the spinal alignment should be sought immediately.

Immediately in the midline, few neurovascular structures are at immediate risk. The C1 ring and lamina are often very thin and can be cracked under excessive pressure. Subperiosteal dissection in the high cervical spine should be performed gently with electrocautery. Far lateral dissection during the exposure places the vertebral arteries, nerve roots, and brachial plexus at risk. A venous plexus typically overlies the artery at the level of the foramen transverserium and can be cauterized with bipolar or gently tamponaded with Gelfoam and a cotton patty.

The course of the vertebral arteries should be completely familiar to the operative surgeon. Anomalous courses and ectatic variants are not uncommon. Preoperative computed tomography (CT), CT-angio, and magnetic resonance imaging/arthography (MRI/MRA) are helpful to exclude such anomalies. For cases of occipitocervical exposure, the foramen magnum dura and vertebral arteries during their transverse turn are also easily injured. There is frequently a notch along the superior aspect of the C1 ring approximately 1.5 cm from the

midline posterior tubercle, where the vertebral artery lies superficial and posterior. A lateral triangle of fascia typically surrounds the vertebral artery at this point and should be opened cautiously with scissors.

For cases of occipitocervical fusion, injury to the posterior fossa dura, large cerebral venous sinuses, and bony sinuses may occur. Additionally, decompression of the foramen magnum also places the inferior fourth ventricle, cerebellar tonsils, and medulla oblongata at risk of injury. Accidental violation of the dura may also lead to persistent cerebrospinal fluid leak, which can retard fusion and increase the risk of infection.

TECHNIQUE

After proper fixation of the head in pins and/or traction as noted above, radiographic assessment of the spinal alignment and confirmation of the neurological exam should be obtained prior to incision. A midline incision is then made over the pathology in question. For occipitocervical fusions, this incision should typically extend from the inion on the skull to slightly above the C7 prominence. A more limited incision can be made for subaxial cases. Due to the narrowed interspaces and inferior inclination of the spinous processes, overdissection and stripping of the facets may lead to unwarranted fusion of uninvolved levels, leading to an excessive decrease of mobility.

The dissection is carried down sharply in the midline to the level of the posterior cervical musculature fascia. A midline raphe is formed from the union of the deep cervical fascia, prevertebral fascia, ligamentum nuchae, and the supraspinous ligaments. By maintaining the exposure in this relatively avascular midline plane, blood loss can be minimized. Frequent palpation of the bony processes demarcating the midline is essential. Self-retaining retractors are placed to maintain the exposure, but excessive retraction can obscure the midline and lead to scything to either side.

After the ligamentum nuchae is encountered over the cervical spinous processes, a subperiosteal dissection is performed to mobilize the muscles off the spinous processes. As the processes are often bifid, care should be taken to avoid accidental spinal canal entry. The exposure is then carried down to the laminae, which are palpated and identified. Using gentle lateral retraction with a small Cobb elevator, electrocautery is used to dissect the muscles off the lamina. Excessive downward pressure with the elevator must be avoided as the cervical spine is highly mobile even in its normal state under anesthesia. The laminae of the cervical spine are angulated 45 degrees from medial to lateral and in a cephalad direction. The interlaminar areas are also wide and should be exposed cautiously. The ligamentum flavum is often thin and attenuated between C1 and C2. Depending on the nature of the procedure, the dissection can be carried out as far laterally as the lateral edge of the facet joints and lateral masses. It is here that the venous plexus overlying the –vertebral artery is often encountered as the facet capsule is exposed. Bipolar cautery and gentle tamponade with Gelfoam are usually effective in obtaining hemostasis. For uninvolved levels, care should be taken to preserve the facet capsule (zygapophyseal joint). Self-retaining retractors to maintain exposure should be placed at or above the anteroposterior plane of the facets to avoid injury to the nerve roots and vertebral artery.

For cases requiring exposure of the occiput and foramen, the dissection should be begun at the inion. After the skin incision, the dissection is carried down to the skull squama with the electrocautery in the midline along the inferior nuchal line. The semispinalis and splenius capitis muscles are retracted laterally with a Cobb and elevated with the electrocautery off the occipital bone. Emissary veins and bony venous lacunae are common in this area and can be controlled with a combination of electrocautery and bone wax. As the dissection is carried caudad, frequent palpation of the foramen magnum should be done. As the musculature is elevated and swept off the lip of the foramen, the posterior atlanto-occipital membrane overlying the dura between the C1 arch and the skull comes into view. Exposure laterally along C1 more than 1.5 cm past the midline places the vertebral artery at risk and is rarely needed.

HOW TO TELL IF YOU ARE LOST/TRICKS

The incision should be marked directly over the spinous processes. Frequent palpation of the bony landmarks is typically all that is needed to ensure a midline approach. A midline raphe between the cervical musculature provides an excellent avascular plane for dissection. If the exposure seems excessively bloody with extensive muscle bleeding, stopping and identifying this midline plane will reduce further blood loss. The C2 spinous process is typically large and bifid. The C3 process is often immediately under and apposed to the C2 process. The C7 process is also typically the most prominent landmark at the cervicothoracic junction. Frequent palpation and confirmation of the location of the foramen magnum is crucial to prevent accidental dural and spinal cord injury. Confirmation of the level of pathology, however, is essential and is best achieved by either intraoperative radiographs or fluoroscopy. The surgeon must often count the bodies from a definitive landmark to confirm that the appropriate level is being exposed.

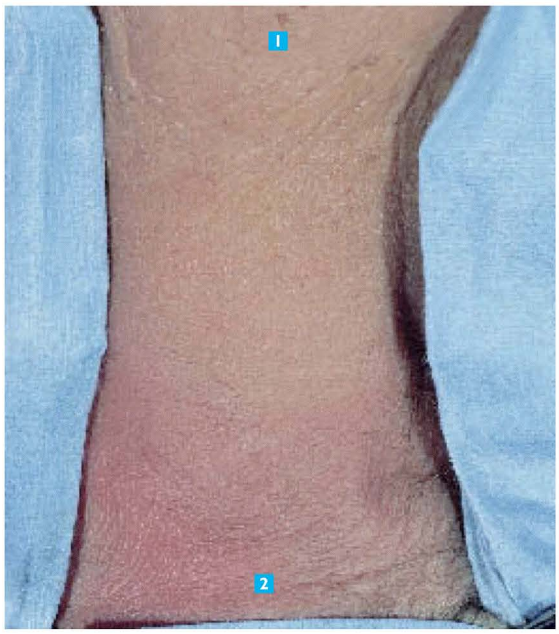

FIGURE 57–1 The typical extent of the draped field is demonstrated extending from the inion to the level of the C7 spinous process prominence.

FIGURE 57–2 A midline incision has been carried down to the subcutaneous layer from the inion to the tip of the C4 spinous process for a planned occipitocervical fusion-type procedure.

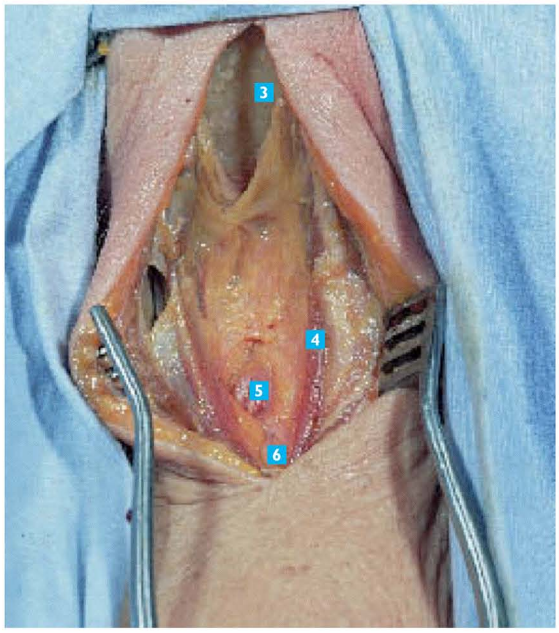

FIGURE 57–3 The superior aspect of the incision has been opened sharply down to the level of the occipital squama. The incision is begun through the midline raphe. The semispinalis muscles have been retracted laterally with the interspinous ligaments starting to be visible over the C3 spinous process.

1 Inion
2 C7 Spinous Process
3 Occipital Squama
4 Semispinalis
5 Interspinous Ligaments
6 Midline Raphe (Split)
7 Inferior Nuchal Line
8 Occipital Bone
9 Vertebral Artery
10 C1 Arch
11 C2 Spinous Process
12 C2 Lamina
13 C3 Spinous Process
14 C2/3 Lateral Facet/Mass (Zygapophyseal Joint)
15 C3 Lamina
16 Atlanto-occipital Membrane
17 Posterior Tubercle C1
18 Ligamentum Flavum
19 C2 Lateral Mass
20 C3 Lateral Mass

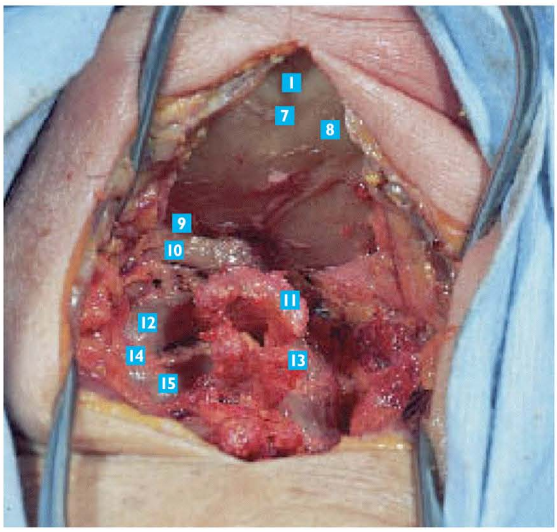

FIGURE 57–4 A subperiosteal exposure of the occiput to C4 lamina has been performed. The vertebral artery has been dissected at the left C1 arch to demonstrate its position. The C2 and C3 laminae have been exposed to the level of their left lateral joint with the C2 and C3 lateral masses seen. The intimate relationship of C2 to C3 is demonstrated. Additionally, the C1 arch is seen immediately adjacent to the edge of the foramen magnum.

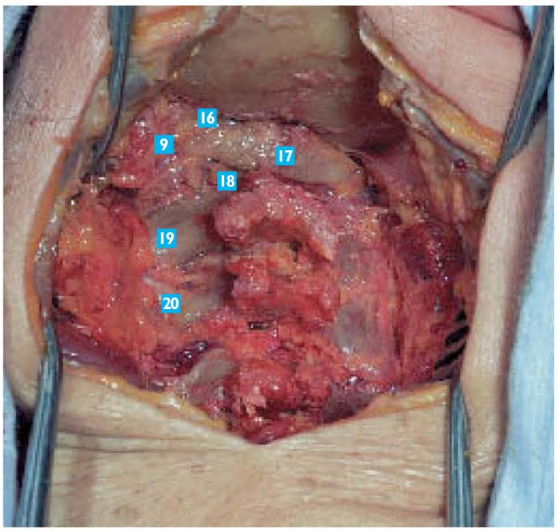

FIGURE 57–5 The atlanto-occipital membrane has been further exposed and magnified. The dissection has been carried down to the level of the ligamentum flavum between C1 and C2 as well. The lateral masses of C2 and C3 are clearly seen.

1 Inion
2 C7 Spinous Process
3 Occipital Squama
4 Semispinalis
5 Interspinous Ligaments
6 Midline Raphe (Split)
7 Inferior Nuchal Line
8 Occipital Bone
9 Vertebral Artery
10 C1 Arch
11 C2 Spinous Process
12 C2 Lamina
13 C3 Spinous Process
14 C2/3 Lateral Facet/Mass (Zygapophyseal Joint)
15 C3 Lamina
16 Atlanto-occipital Membrane
17 Posterior Tubercle C1
18 Ligamentum Flavum
19 C2 Lateral Mass
20 C3 Lateral Mass

Lateral Extracavitary/Lateral Parascapular Approach to the Thoracic Spine

USES

The lateral extracavitary approach allows for simultaneous exposure of the posterior bony elements and the anterior vertebral column. In the upper thoracic spine, this approach is modified to include mobilization of the scapula to provide adequate visualization of the anterior column of the spine (lateral parascapular approach). Both approaches can be used for a variety of indications including metastatic vertebral body tumors, thoracic disk disease (especially centrally located ones), vertebral osteomyelitis with instability or canal compression, anterior neural tumors, pathological or anterior compression fractures, and primary tumors of bone. It is particularly attractive for cases where both an anterior decompression or release must be combined with a posterior fusion and arthrodesis. This approach allows for both of these goals to be accomplished during one operation and precludes the need for staged procedures and prolonged hospital stays. Like a standard midline posterior approach, the lateral extracavitary and parascapular techniques allow for long-level posterior instrumentation. These approaches can be used from C7 down to the thoracolumbar junction. Below L1, the lumbar roots, lumbar plexus, and the iliopsoas musculature tend to limit the degree of anterior exposure.

ADVANTAGES

The lateral extrapleural and extrascapular approaches are advantageous in that they allow for simultaneous anterior decompression and posterior instrumentation at one sitting. They provide far more anterior access and visualization than the transpedicular or costotransverse approaches. Whereas these traditional approaches do not allow for anterior column restoration, the lateral approaches typically afford more than enough exposure for decompression, grafting, and restoration of normal anterior column height and alignment. Although a standard thoracotomy does provide superior anterior visualization for cases requiring complex reconstruction, the morbidity of the diaphragmatic dissection, pleural dissection, chest tube drainage, and severe associated pain can be preclusive for older or more unstable patients. The single lung ventilation typically required for a thoracotomy is also not tolerated by many patients. Additionally, the need for a second surgical procedure for posterior stabilization adds even further surgical risks. For such cases, the single-stage lateral extracavitary/parascapular procedure may be the procedure of choice.

DISADVANTAGES

This approach is associated with higher immediate blood loss than is a standard thoracotomy. Additionally, the surgical time for anterior exposure during a lateral extracavitary approach is longer. Thus, in cases where only anterior reconstruction is needed, the thoracotomy may be a better choice. Although one- or two-level anterior exposures can be readily achieved via this approach, extensive or diffuse vertebral body disease is often best treated through a more direct anterior corridor. This is especially true for lesions of the high thoracic spine where even a well-mobilized scapula can limit the surgical access to the anterior column. Other relative contraindications to the procedure include severe cardiac or pulmonary disease, a life expectancy of less than 3 to 6 months, and the inability to tolerate or accept a blood transfusion.

STRUCTURES AT RISK

As in the standard posterior approach to the thoracic spine, the paraspinous musculature is at risk during the dissection and exposure. Partial denervation of the erector spinae at the level of the exposure is unavoidable, but long-level injury should be avoided to prevent delayed neurogenic deformity of the spine. The lateral parascapular approach also places the trapezius, latissimus dorsi, and subscapular musculature at risk if the loose areolar plane separating these muscles from the erector spinae is violated. This dissection when carried too far anterior or lateral also places the long thoracic nerve, brachial plexus, and subclavian vessels at risk. The risk of skin flap necrosis is also increased as more intercostal vessels are sacrificed. As the anterolateral aspect of the vertebral body is dissected, the intercostal neurovascular bundle can easily be injured, which often occurs during removal of the rib head and transverse process. Pleural injury with associated pneumo- or hemothorax is not uncommon and a chest tube should always be available. Horner's syndrome, nerve root injury, sympathectomy, and intercostal neuralgia may occur.

TECHNIQUE

The patient is positioned prone with the arms tucked to the side. Adequate chest roll support is needed, but should be placed to allow the arm and scapula to fall free for the lateral parascapular approach. This can be accomplished by placing the chest roll more medially on the side of the scapula to be mobilized. As blood loss can be high, adequate monitoring and large-bore intravenous access is essential. Typically, single-lumen ventilation is adequate. For cases involving the high thoracic and cervicothoracic spine, "high-frequency" ventilation is useful to decrease lung and pleural excursion into the field during the anterior decompression.

The posterior neck, back, and parascapular region are prepped and draped. A wide variety of incisions can be

FIGURE 58–1 A hockey-stick incision is marked two to three levels above and two to three levels below the level of interest. It is extended laterally and obliquely to follow the edge of the scapula.

FIGURE 58–2 The subcutaneous flap is raised to reveal the rhomboid/trapezius/latissimus dorsi fibers with their oblique orientation. The thoracodorsal fascia is shown with its aponeurotic attachment to the interspinous ligaments.

1 Medial Border Scapula
2 Midline
3 Inferior Scapula Angle (T6/T7)
4 Elevated Subcutaneous Flap
5 Rhomboids
6 Interspinous Ligaments
7 Aponeurotic Thoracodorsal Fascia
8 Inferior Trapezius Fibers
9 Scapula (Medial Border)
10 Elevated Scapular Edge
11 Rhomboid/Trapezius (Musculocutaneous Flap)
12 Ventral Rib Angulation
13 Erector Spinae
14 Medial Border (Facet)
15 Spinous Processes
16 Erector Spinae Muscle Mass Reflected Contralaterally Over Spinous Processes
17 Laminae (T5)
18 Spinous Processes
19 Facet Capsule
20 Rib Head
21 Exposed Rib
22 Pleura
23 Intercostal Neurovascular Bundle
24 Sympathetic Chain
25 Resected Rib Head (T5)
26 Intervertebral Foramen
27 Intervertebral Disk
28 Nerve Root and Ganglion
29 Epidural Fat/Venous Plexus
30 Spinal Cord Dura
31 Resected Pedicle Head
32 Partially Resected Lamina

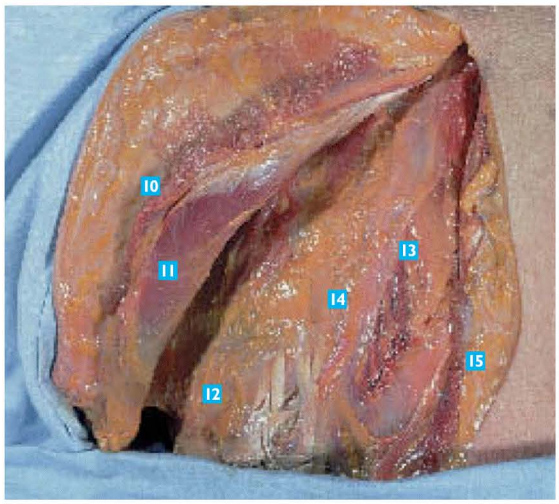

FIGURE 58–3 The dissection along the ventral border of the scapula is carried along the loose areolar layer below the musculocutaneous flap. The erector spinae musculature is now visualized. The underlying facet column is also appreciated.

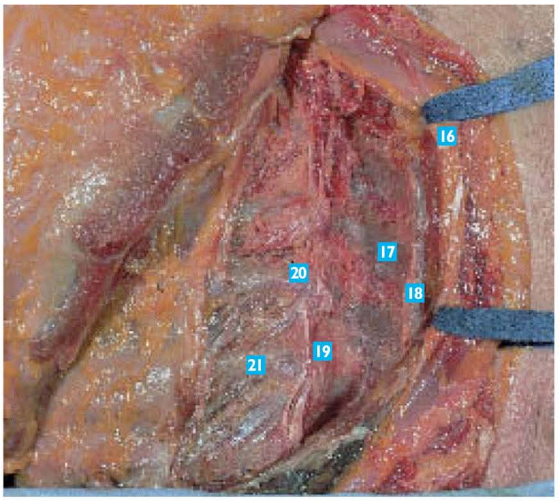

FIGURE 58–4 The column of erector muscles has been freed subperiosteally and retracted to the contralateral side of the spinous processes. The thoracodorsal fascia has been stripped to reveal the rib and rib heads. The facet capsules are now fully visualized along with the laminae.

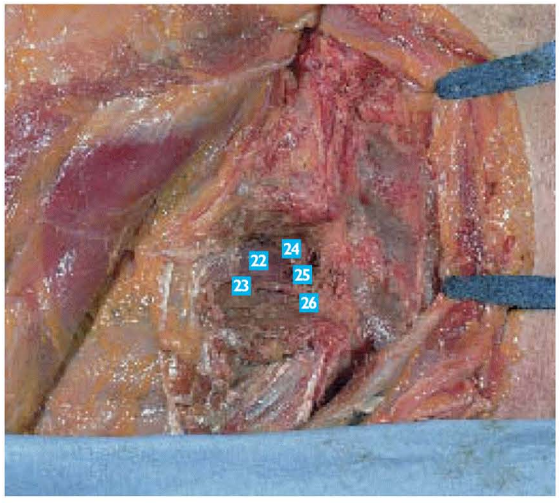

FIGURE 58–5 After subperiosteal stripping, the rib head and adjacent rib segment have been resected to the ventral rib angle. The intercostal nerve and vessel are identified as they course to the intervertebral foramen along the parietal pleura. The sympathetic chain is also seen along the lateral aspect of the vertebral body.

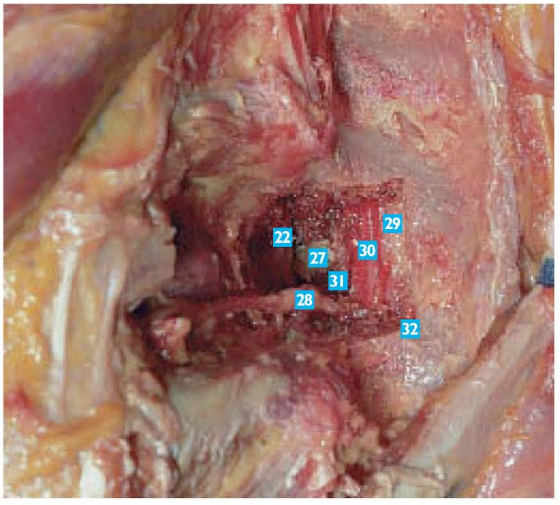

FIGURE 58–6 The parietal pleura and chain (sympathetic) have been dissected and mobilized anteriorly to reveal the T4/T5 bodies with the intervening disk annulus. The pedicle has been resected along with a limited portion of lamina to reveal the spinal cord and canal contents. The entry of the nerve root to the spinal cord is seen.

used in the middle to lower thoracic spine. For the parascapular approach, a hockey-stick or semilunar incision is made to shadow the outline of the scapular border. It is important not to limit the length of the incision, as extensile exposure is needed to mobilize the erector spinae. Typically, an incision two to three spinous processes above and below the level of pathology is required. The dissection is carried sharply down to the thoracodorsal fascia. This fascia is then incised along the lateral border of the spinous processes. The fibers of the trapezius and rhomboid muscles are identified by their oblique orientation and freed from the spinous processes as well. The interspinous ligaments should be preserved to maximize posterior stability. The loose areolar plane is found between these shoulder muscles and the erector spinae, and blunt dissection along it allows for the trapezius and rhomboid to be raised toward and under the scapula as a single musculocutaneous flap. The inferior border of the trapezius muscle must be sharply transected, but should also be tagged for reapproximation during closure. As the inferior trapezius musculature is mobilized, the latissimus dorsi fibers are encountered. An aponeurotic layer of the thoracodorsal fascia extends from the spinous processes to the lateral insertion of the trapezius. As this layer is excised, the scapula then falls laterally and anteriorly out of the surgical field.

The erector spinae are then mobilized off the spinous processes and lamina in a subperiosteal fashion. This stripping is carried out laterally beyond the facet joints and transverse processes. This dissection should be carried rostrally and caudally to the extent of the skin exposure. The erector spinae muscle mass is then mobilized with either retractors or loops over the spinous processes to the contralateral side. The dorsal rib cage and posterior vertebral elements are thus exposed.

The facet joints and rib heads are then resected sharply with a large rongeur. The number of ribs removed ultimately depends on the extent of anterior exposure required. For complete exposure of a single body, the corresponding cephalad and caudad ribs must be removed. Exposure of a single disk space typically requires only the resection of the immediately adjacent rib. Intraoperative fluoroscopy should be used to confirm the level of the approach. The intercostal muscles, neurovascular bundle, and underlying pleura should be cautiously stripped off the rib. The rib head and neck are mobilized by incising the costotransverse and costovertebral ligaments. The ribs are then resected at the point where they angle and begin to turn ventrally. After bony transection, a periosteal elevator and large Mayo scissors are used to cut free the remaining ligamentous attachment of the rib to the body. The rib may then be kept for future graft. Preservation of the intercostal bundle may be done for cases where a vascularized rib graft is desired.

The intercostal nerves and vessels are then identified as they pass along the pleural surface. By tracing them back to the intervertebral foramen, the superior and inferior pedicles can be identified. The rami communicantes and radicular vessels are seen here as well. By bipolar coagulation of the radicular vessels, the sympathetic chain can be mobilized anterolaterally with the pleura. Cautious blunt dissection in this direction of the pleura exposes the anterolateral aspect of the vertebral body. By identifying the pedicles and neural foramen, the lateral and posterior boundary of the spinal canal can be noted. Pedicular removal reveals the spinal cord dura mater and associated epidural venous plexus. Early visualization of these structures serves as a safe guide for the remainder of the anterior decompression and reconstruction. Self-retaining retractor systems (e.g., Bookwalter) are helpful in maintaining the exposure once this dissection has been completed.

Posterior Approach to the Thoracic Spine

USES

This approach is used for a diverse number of indications including scoliotic or kyphotic deformity, fractures, vertebral body tumors, vertebral or paravertebral infections, and osteomyelitis. When this approach is combined with a laminectomy, tumors and other lesions of the posterolateral spinal cord, canal, and nerve roots can also be treated. Additional visualization of far lateral bony or canal lesions is achieved through modifications of the midline posterior approach. These modifications include the costotransverse, transpedicular, and lateral extracavitary approaches. True ventral pathology of the spine, however, may require anterior or transthoracic approaches to minimize risks of neurological deterioration.

ADVANTAGES

The posterior midline approach is readily achieved with easily palpable landmarks. There are few neurovascular structures at risk during a routine approach to the bony lamina and posterior elements. An extensive extensile exposure can be achieved from the cervical to lumbar spine if necessary for complex scoliotic deformities.

DISADVANTAGES

Visualization of anterolateral pathology is often limited through a midline approach. Furthermore, treatment of some anterior lesions (e.g., herniated disks) through a simple posterior approach and laminectomy has been associated with an unacceptably high incidence of neurological sequelae or deterioration. Correction of severe deformities via a posterior approach is often precluded without a concurrent or antecedent anterior release procedure.

STRUCTURES AT RISK

Certain aspects of the thoracic spinal cord place it at increased risk during a routine midline posterior approach. The thoracic spinal canal is tighter around the cord than in either the cervical or lumbar regions. Thus, laminectomy of the thoracic canal must be achieved cautiously under direct visualization to prevent accidental cord compression and injury. Additionally, the upper and midthoracic regions of the spinal cord are crucial to the vascular supply. The artery of Adamkiewicz typically is found on the left side between T9 and T12 in 80% of patients. As it is often the major segmental arterial supply to the anterior spinal artery, injury to this structure should be avoided to prevent spinal cord ischemia. At the level of the neural foramen and further laterally, the surgeon must also identify the intercostal nerves and vessels. The parietal pleura is also immediately adjacent and anterior to the ribs. Unintentional pleural injury with pneumothorax can result. The deep layer of the paraspinous musculature (e.g., sacrospinalis, semispinalis, multifidi, and rotators) are supplied by posterior rami. Lateral dissection beyond the transverse processes may lead to their denervation.

TECHNIQUE

The patient is positioned prone on the operative table. A multitude of cushion arrangements and special frames are available for use. Allowances for intraoperative X-rays should also be anticipated. The abdomen should be allowed to hang loosely to decrease venous back pressure. All pressure points and the groin should be free of compression.

A straight incision is made over the midline as defined by the tips of the spinous processes. For cases of complex deformity, a plumb line should be drawn from the C7 spinous process to the intergluteal cleft. This dissection is then carried down to the level of the paraspinous musculature fascia via electrocautery. Extensive lateral dissection above this layer should be avoided to prevent unnecessary dead space. A cartilaginous apophyses is often encountered over the spinous processes in children and should be split sharply in the midline. The dissection is then continued sharply over the edges on both sides of the spinous processes. The exposure is continued in the subperiosteal plane via either sharp Cobb elevators or electrocautery. The paraspinous muscles are thereby mobilized off the spinous processes and then over the lamina. Blunt dissection with an elevator and gauze is then used to strip the muscles out laterally to the level of the facets. The facet capsules should be preserved at uninvolved levels to prevent unnecessary destabilization and "creeping" fusion. A self-retaining retractor is then placed to maintain the exposure.

The spinous processes at the involved levels should be removed when a laminectomy is to be performed. Using a large rongeur, the processes are resected down to the junction of the lamina. Cautiously, smaller rongeurs or a drill is used to thin the remaining bone and expose the ligamentum flavum over the spinal cord. Bone wax is helpful to provide hemostasis of raw bleeding bone edges. The flavum is then removed in a cephalad and caudal direction with either Kerrison punches or curettes and sharp transection. Attention should be paid to avoid inserting large

instruments under the lamina into an already tight canal space. Epidural veins encountered during this decompression can be cauterized with bipolar forceps or tamponaded gently with thrombin-soaked Gelfoam and cotton patties.

TRICKS

Good hemostasis is essential to provide a clear exposure. The patient should be positioned with the abdomen hung loosely to minimize venous pressure and thus decrease intraoperative blood loss. Exposure of the thoracic spinal musculature is also best achieved from a medio-caudal to latero-rostral fashion as that is the direction of the fibers.

HOW TO TELL IF YOU ARE LOST

The incision should be marked directly over the spinous processes. Frequent palpation of the bony landmarks is typically all that is needed to ensure a midline approach. Confirmation of the level of pathology is essential and is best achieved by either intraoperative radiographs or fluoroscopy. The surgeon must often count the bodies from a definitive landmark to confirm that the appropriate level is being exposed.

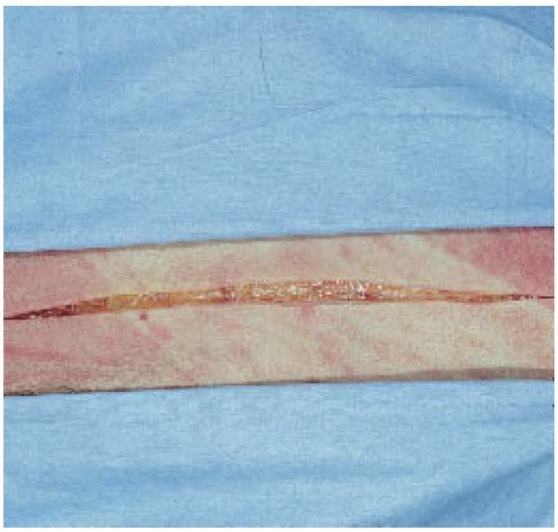

FIGURE 59–1 A skin incision is made sharply over the palpated spinous processes with a knife down to the level of the subcutaneous fat.

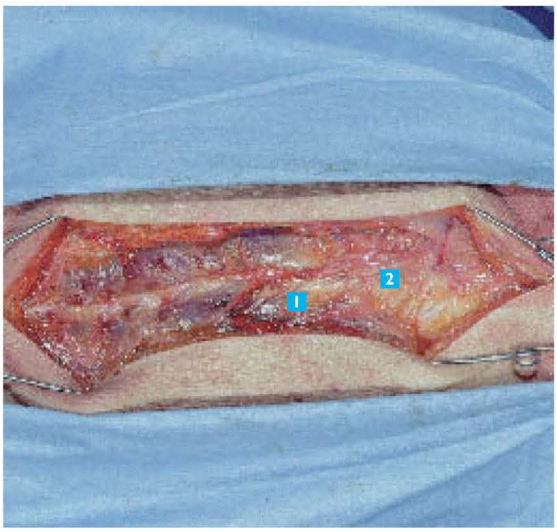

FIGURE 59–2 Using sharp dissection, the fascia over the paraspinous musculature is exposed. A midline cartilaginous apophysis is frequently encountered over the spinous processes. Note the orientation of the muscle fibers.

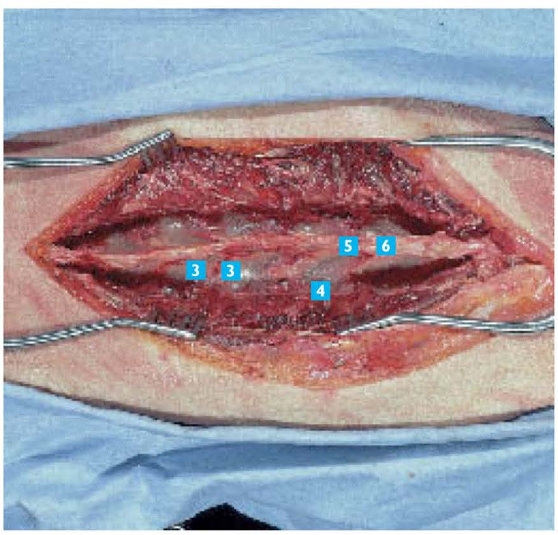

FIGURE 59–3 The spinous processes and lamina are clearly seen after subperiosteal dissection and lateral retraction of the paraspinous musculature. The raised ridges on either side of the lamina represent the facets with their encasing capsules and attached musculature. Caution to avoid unneeded facet stripping will avoid destabilization of the joints.

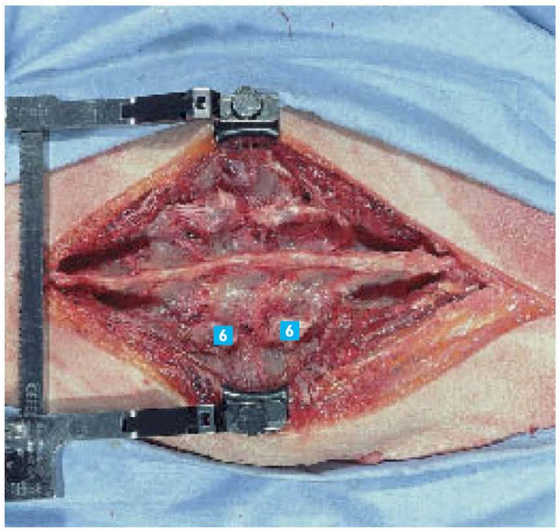

FIGURE 59–4 The ligamentous capsules and attached muscle insertions have been stripped over the involved levels to reveal the coronal orientation of the thoracic facets. A self-retaining retractor has been placed to maintain the exposure.

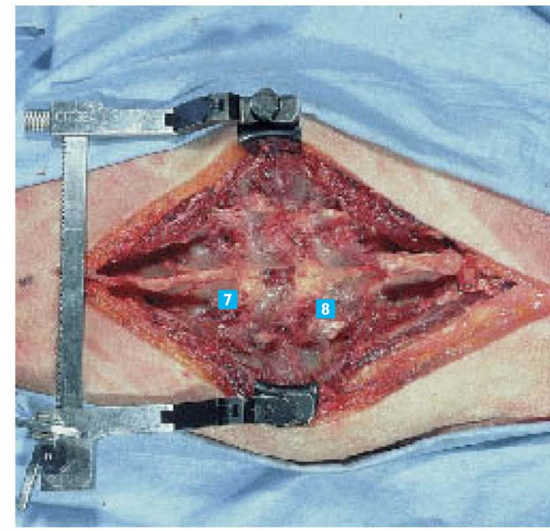

FIGURE 59–5 A laminectomy is performed over the involved thoracic level. The ligamentum flavum has been exposed and a window has been opened with the use of Kerrison punches over the spinal cord. The anastomotic epidural venous plexus is visualized overlying the dura mater of the spinal cord. The lateral aspects of the flavum on either side of the bony canal can be seen around the cord as well.

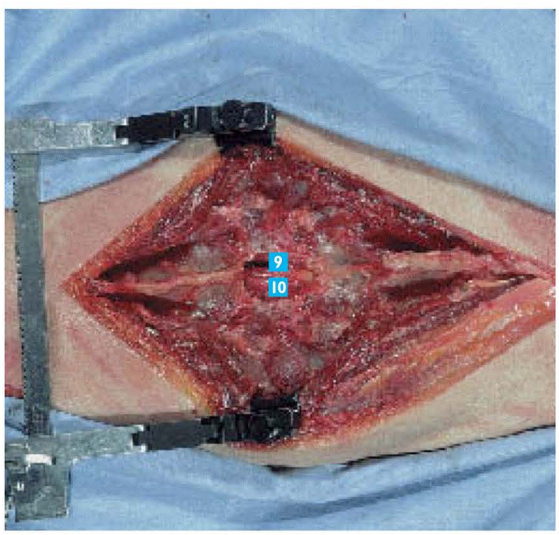

FIGURE 59–6 The ligamentum flavum has been fully removed rostrally and caudally. Furthermore, the lateral aspects of the flavum have also been removed. Kerrison punches were then used to widen the canal exposure. The spinal cord is seen with a right-sided nerve root seen exiting the canal.

1 Paraspinous Muscle Fascia
2 Spinous Process
3 Lamina
4 Facet Capsule
5 Interspinous Ligament
6 Facets and Joint
7 Spinal Cord with Epidural Veins
8 Ligamentum Flavum with Cut Edge
9 Nerve Root
10 Dura Mater

Posterior Approach to the Lumbar Spine

USES

This approach is commonly used to access the posterior elements of the lumbar spine, most frequently for excision of lumbar disk herniations. Posterior lumbar decompression with or without fusion and instrumentation, foraminotomy, and tumor resection are other applications.

ADVANTAGES

Compared to the anterior approach to the lumbar spine, the posterior approach is easier in that accessibility is less of a problem. Dissection is relatively superficial, and major structures that are encountered (e.g., peritoneum, great vessels, genitofemoral nerves) are rarely at risk here. Furthermore, a smaller, midline, and hence more cosmetic incision is usually used in this approach.

DISADVANTAGES

The disadvantage of this approach is that access to the middle or anterior columns is limited. Decompression of burst fracture fragments from the neural canal may not be adequately and safely performed from the back. Clearly, an anterior approach is superior in this situation. Also, the prone position is associated with increased anesthetic risks and potential for soft tissue pressure problems.

STRUCTURES AT RISK

If dissection is carried further lateral to the facet joints, the dorsal branch of the segmental artery as well as the posterior primary rami of the spinal nerve (which both lie within the substance of the paraspinal muscles) are at risk. Careful subperiosteal dissection prevents damage to these structures. In cases where fusion or instrumentation are not planned, the facet joint capsules must be preserved as well to prevent spinal instability. Within the spinal canal, the dura as well as the exiting and traversing nerve roots are encountered, and should be protected with nerve root retractors. If a diskectomy is performed, care must be taken to prevent perforation of the anterior annulus and anterior longitudinal ligament by the instrument, as this may also injure the aorta on the other side of the spine.

TECHNIQUE

After confirming the spinal level, a midline longitudinal incision is centered over the lamina of interest. Incise the subcutaneous tissues in line with the skin incision until the lumbodorsal fascia is visualized. The fascia is then split longitudinally in the midline or slightly paramidline if a unilateral approach is planned. Using a Cobb elevator and cautery, the paraspinal muscles are subperiosteally elevated off the spinous processes and the laminae. Take the dissection laterally just beyond the facet joints, preserving the joint capsules. A retractor may be placed under the mamillary process. If a diskectomy is planned, the ligamentum flavum is resected with a curette starting from its origin on the cephalad edge of the caudal lamina and elevating in a superior direction. An inferior laminotomy of the cephalad lamina can then be performed. A burr is usually used to remove bone until the deep (anterior) cortex of the lamina is reached. At this point a blunt elevator is used to dissect the ligamentum flavum attachments off of the undersurface of the lamina. Then a Kerrison rongeur can be used to complete the partial laminotomy safely. Identify the dura underneath as well as the exiting nerve roots. A blunt instrument can be used to carefully palpate the pedicles laterally, which are a key landmark as the exiting nerve root passes immediately caudal to the pedicles. A nerve root retractor can be used to retract the dura and nerve root medially. The disk space should be visible underneath.

TRICKS

Rolls placed longitudinally under the patient's sides while prone keep the abdomen supple. This in turn decreases intraabdominal pressures, prevents venous plexus pooling, and allows blood around the cord to drain freely with gravity away from the surgical site, leading to a less bloody field. Also, regardless of the table used, keeping the lumbar spine in neutral or relative kyphosis "opens up" the disk space posteriorly, thereby allowing better visualization. Finally, use of an operating microscope has made this approach safer and easier. The study of microscopic dissecting technique is therefore recommended.

HOW TO TELL IF YOU ARE LOST

Positive identification of the involved spinal level is key in this approach. As the spinous processes do not lie in the same axial plane as their corresponding lamina and disk spaces, confirmation of the correct level with cross-table lateral radiographs using spinal needles is mandatory, particularly when small incisions are used (e.g., microscopic lumbar diskectomy or endoscopic diskectomy).

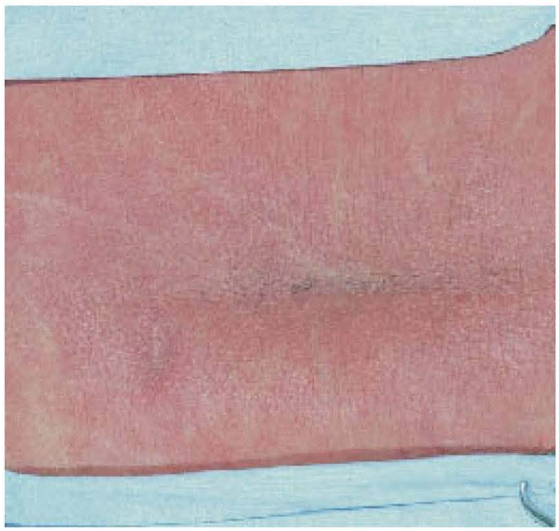

FIGURE 60–1 Midline posterior lumbar region.

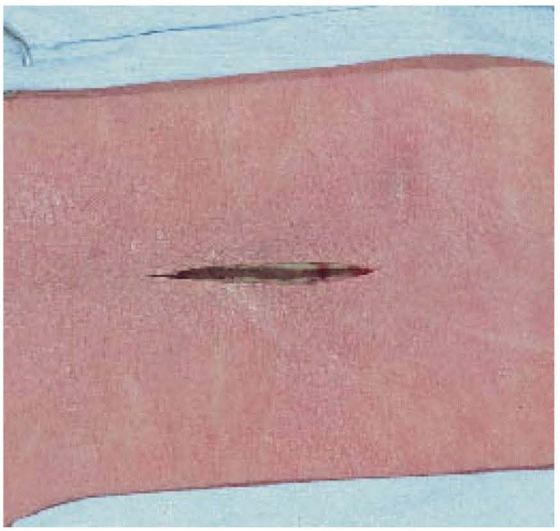

FIGURE 60–2 Midline skin incision between L2 and L3 spinous processes.

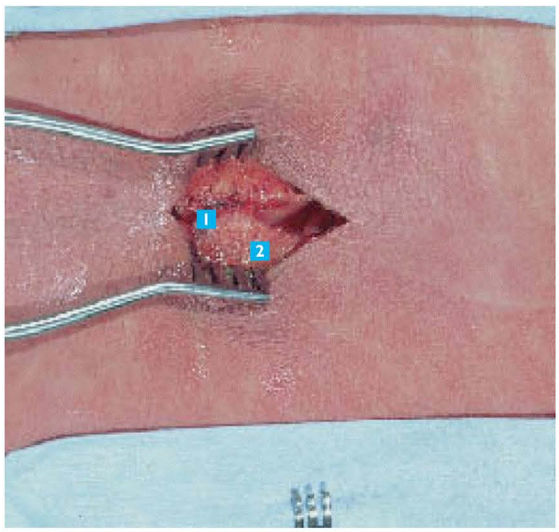

FIGURE 60–3 Superficial dissection revealing lumbodorsal fascia (skin and subcutaneous tissue retracted laterally).

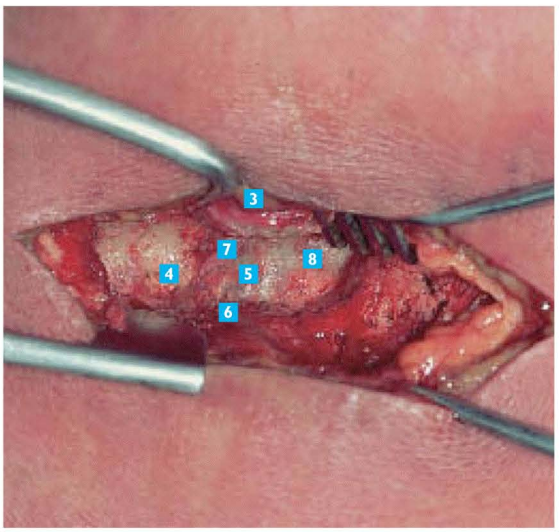

FIGURE 60–4 Subperiosteal dissection of right paraspinal muscles off spinous processes and laminae.

1 L3 Spinous Process
2 Lumbodorsal Fascia
3 L2 Spinous Process
4 L3 Lamina
5 L2-L3 Interlaminar Space
6 Right L2-L3 Facet Joint
7 Ligamentum Flavum
8 L2 Lamina
9 Partial (Cephalad) Laminotomy L3
10 Partial (Caudal) Laminotomy L2
11 Pedicle L3 (Palpable)
12 L2-L3 Disk (Posterior Annulus Seen)
13 Exiting L2 Nerve Root
14 Pedicle L2 (Palpable)

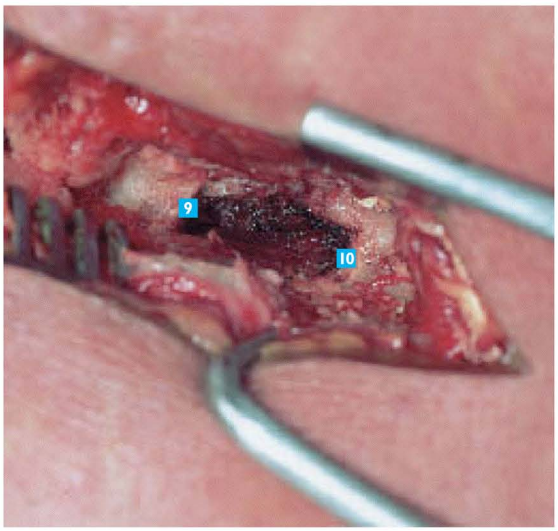

FIGURE 60–5 Partial laminotomies of L2 and L3.

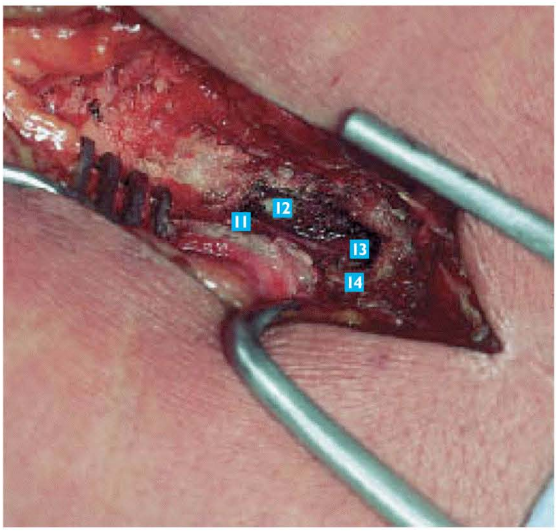

FIGURE 60–6 Extensive laminotomies revealing disk and adjacent nerve root.

1. L3 Spinous Process
2. Lumbodorsal Fascia
3. L2 Spinous Process
4. L3 Lamina
5. L2-L3 Interlaminar Space
6. Right L2-L3 Facet Joint
7. Ligamentum Flavum
8. L2 Lamina
9. Partial (Cephalad) Laminotomy L3
10. Partial (Caudal) Laminotomy L2
11. Pedicle L3 (Palpable)
12. L2-L3 Disk (Posterior Annulus Seen)
13. Exiting L2 Nerve Root
14. Pedicle L2 (Palpable)

Posterior Approach to the Iliac Crest

USES

This approach is most commonly used to obtain bone graft, usually for posterior spinal fusions.

ADVANTAGES

Because patients are already in the prone position for posterior spinal fusion, the posterior iliac crest is conveniently accessible. If a long lumbar incision is planned, the approach can be done through the same incision by subcutaneously elevating the soft tissues laterally to the iliac crest. Also, compared to the anterior iliac crest, a greater volume of bone graft is available posteriorly.

DISADVANTAGES

One possible disadvantage is patient discomfort to the surgical site, particularly when lying supine.

STRUCTURES AT RISK

The sciatic nerve and superior gluteal artery are at risk if the dissection is taken close to or beyond the sciatic notch. To avoid these structures, the dissection is kept subperiosteal and cephalad to the sciatic notch. The clunial nerves also cross the posterior iliac crest and are at risk for causing painful neuromas if injured. If the incision is kept less than 8 cm lateral to the posterior superior iliac spine, the nerves are protected.

TECHNIQUE

If a separate approach is required, an oblique incision is made in line with the palpable iliac crest and centered over the posterosuperior iliac spine (PSIS). If a midline posterior lumbar incision has already been done, the incision can be extended to the sacrum, and the subcutaneous tissue and fat elevated off the lumbodorsal fascia laterally to the iliac crest. The fascia can then be incised starting over the PSIS and extending laterally directly over the bony crest. The posterior gluteal line, which separates the gluteus maximus and medius attachments to the ilium, is identified. Subperiosteal dissection is performed in the outer cortex caudally. Dissection should not extend to the greater sciatic notch. An imaginary line is created from the PSIS out laterally and perpendicularly to the longitudinal axis. Keeping the dissection cephalad to this level protects the notch and its contents. Osteotomes can then be used to take corticocancellous bone strips in a manner similar to the anterior approach.

TRICKS

The thickest portion of the posterior iliac crest is directly lateral to the PSIS along the posterior gluteal line. This area would be ideal for harvesting cancellous bone graft.

HOW TO TELL IF YOU ARE LOST

The key to safety in this approach is keeping the dissection subperiosteal. If the dissection strays into the gluteal musculature, excessive bleeding and injury to the neurovascular structures are more likely. If the sacroiliac joint is visualized, the dissection has been brought in too medial a position. If the sciatic notch is visualized, the dissection has been brought in too distal a position.

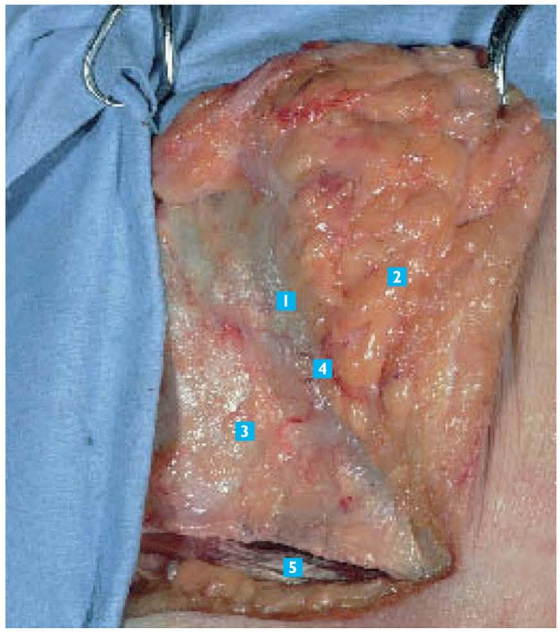

FIGURE 61–1 The same midline posterior incision can be used to approach the posterior iliac crest. The subcutaneous tissue is dissected off the lumbodorsal fascia from the posterosuperior iliac spine (PSIS) to the iliac crest.

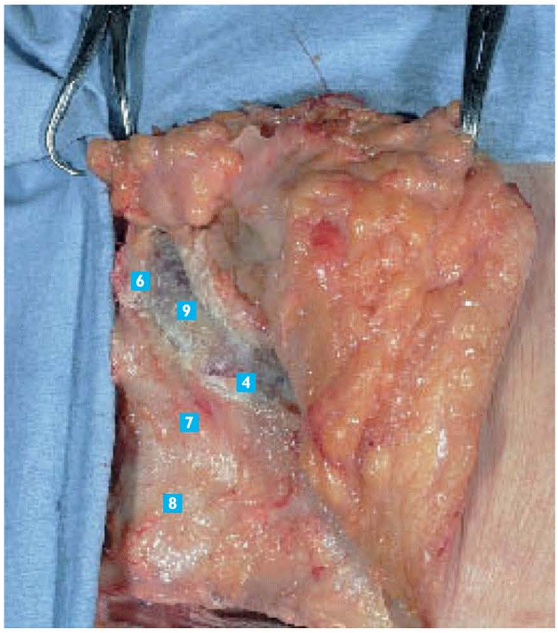

FIGURE 61–2 Fascial incision over posterior iliac crest and subperiosteal elevation of gluteal muscles to expose outer table.

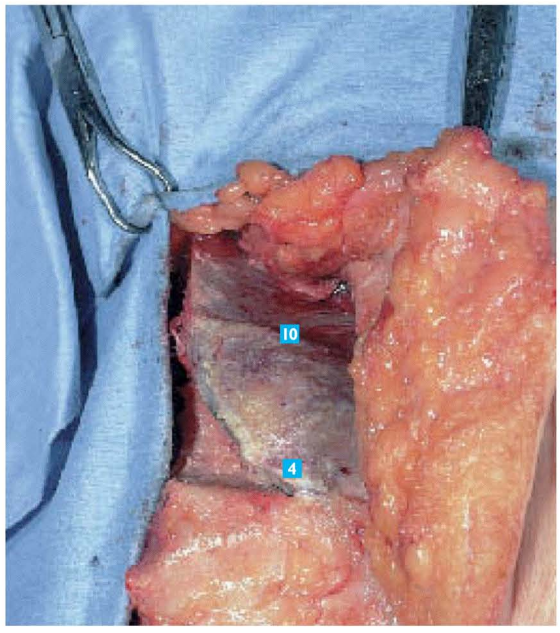

FIGURE 61–3 Extensive exposure of the outer table of the posterior iliac crest.

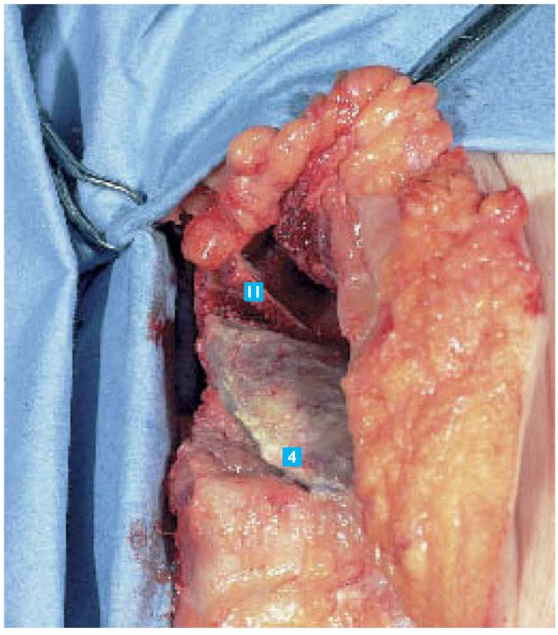

FIGURE 61–4 Corticocancellous bone strips elevated off the outer table.

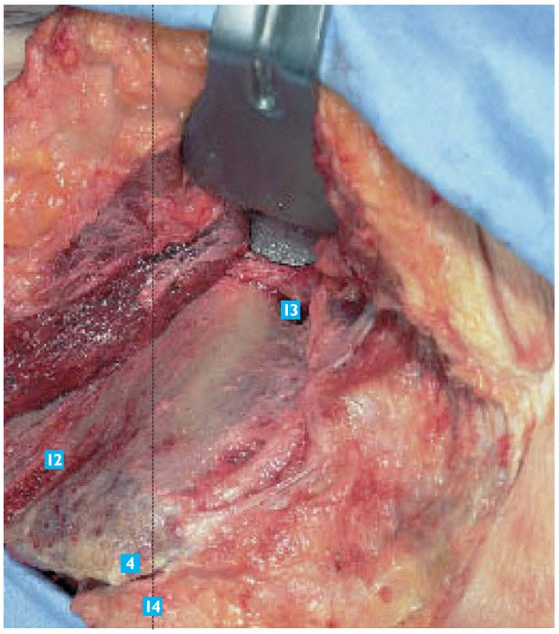

FIGURE 61–5 Subperiosteal dissection of the outer table continued caudally to demonstrate proximity of sciatic notch. Keeping dissections cephalad to imaginary line protects the notch and its contents.

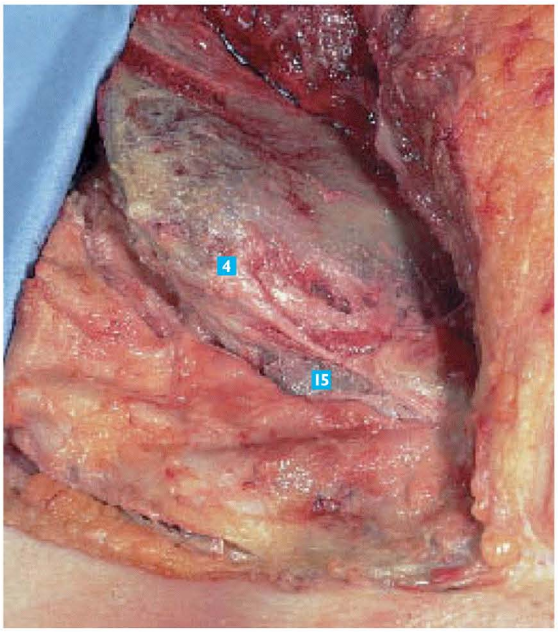

FIGURE 61–6 Posterior sacroiliac joint capsule elevated.

1 Fascia Overlying Right Iliac Crest
2 Subcutaneous Tissue Retracted
3 Lumbodorsal Fascia
4 Posterosuperior Iliac Spine (PSIS)
5 Midline Incision Lumbosacral Spine
6 Fascia Overlying Right Iliac Crest Incised
7 Sacroiliac Joint
8 Lumbodorsal Fascia Overlying Sacrum
9 Outer Table Posterior Iliac Crest
10 Posterior Gluteal Line
11 Corticocancellous Bone Strip
12 Corticocancellous Bone Strip Removed
13 Sciatic Notch
14 Imaginary Line Drawn from PSIS Perpendicular to Axial Midline
15 Sacroiliac Joint Exposed