

15

Resection of the Posterior Compartment of the Thigh

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OVERVIEW

This chapter discusses the anatomic considerations, staging studies, techniques of biopsy and indications and contraindications to the treatment of posterior thigh sarcomas.

In general, the posterior thigh (hamstring musculature) is the least common of the three compartments of the thigh for sarcomas to arise within. There is great variation in the size of tumors that occur in the posterior thigh, and variation in the location from a proximal location near the ischium to a distal location involving the popliteal space.

The posterior thigh is a quiet surgical area. The most significant structure is the sciatic nerve. Almost all low-grade sarcomas can be resected safely. Most high-grade sarcomas can be resected by either a complete or partial muscle group resection. The sciatic nerve is rarely involved; even if resection is required, an amputation is not necessary.

Preoperative examination must evaluate the ischium, ischiorectal space, the retrogluteal area, and the popliteal space for tumor extension. The most useful imaging studies are CAT and MRI scans. Angiography is required only if the tumor extends distally into the popliteal space. Function following posterior thigh resection is almost normal. Knee flexion is maintained by the remaining sartorius, gracilis, and gastrocnemius muscles.

INTRODUCTION

The posterior compartment of the thigh is the least common of all of the thigh compartments for soft-tissue sarcomas to originate within. Approximately 15–20% of the soft-tissue sarcomas of the thigh arise within the posterior hamstring musculature. The posterior compartment consists of the semimembranosus, semitendinosus, and the long and the short heads of the biceps muscles. All of these muscles originate at the ischium and the linea aspera. The lateral hamstrings insert onto the fibular head whereas the medial hamstrings insert onto the medial and posteromedial aspect of the tibia and joint capsule. The most significant anatomic structure of the posterior compartment is the sciatic nerve that runs from the sciatic notch and passes just lateral to the ischium, then down the midposterior thigh, where it enters the popliteal space.

Classically, large tumors of the posterior thigh were treated by a hemipelvectomy. Today, most sarcomas of the posterior thigh can be resected by either a partial or total muscle group resection. The most crucial structures for evaluation are the sciatic nerve, popliteal space, and retrogluteal area. On rare occasions a compartmental resection may be performed with removal of the sciatic nerve. This allows for a functional extremity requiring only an ankle-foot orthosis (AFO).

ANATOMIC CONSIDERATIONS

The posterior thigh compartment consists of the semimembranosus and semitendinosus muscles and the long and short heads of the biceps. These originate from the ischium and along the linea aspera. There is no major artery that is involved with this compartment. The sciatic nerve is the most significant structure and passes into the compartment from lateral to the ischium and divides the medial and lateral hamstrings. The nerve is surrounded by a large layer of fibro-fatty tissue. A thick sheath surrounds the nerve, acting as a barrier to direct tumor extension. Often tumors arise within one of the individual muscles of the posterior thigh or between the muscles. In most cases the sciatic nerve is displaced around an adjacent muscle.

UNIQUE ANATOMIC CONSIDERATIONS

The specific anatomic sites to be evaluated prior to a limb-sparing resection are the following:

1. *Retrogluteal area* (beneath the gluteus maximus muscle). Tumors of the hamstring muscles may involve proximal extension into the retrogluteal area and adjacent to the ischium. Extension into this compartment must be taken into consideration at the time of resection.

2. *Ischium*. The ischium is the site of proximal origin of all of the hamstring muscles. Tumors that extend close to the ischium may extend into the ischiorectal space or to the inferior pubic ramus as well as the ischium.
3. *Sciatic nerve*. The sciatic nerve runs from the sciatic notch through the midline of the thigh posteriorly to the popliteal space where it divides into the peroneal and posterior tibial nerves. The relationship of the sciatic nerve to a sarcoma arising in the posterior compartment is extremely important to determine. True sciatic nerve involvement is rare. Most often the sciatic nerve is displaced but not directly invaded by tumor. Rarely are there primary sarcomas arising from the nerve itself (neurofibrosarcoma).
4. *Popliteal space*. The popliteal space is the distal end of the posterior compartment. It is made up of the short head and long head of the biceps on the lateral aspect, and the semimembranosus on the medial aspect. The popliteal artery and vein enter through the adductor hiatus on the medial side; therefore, tumors that arise in the posterior thigh that extend into the popliteal space may easily involve the popliteal artery and vein. It is essential to evaluate these structures prior to surgery.

STAGING STUDIES

CAT Scan and MRI

CAT scan and MRI evaluation are excellent in determining the muscle involved by a sarcoma and the relationship of the adjacent sciatic nerve to the tumor (Figure 15.1).

Bone Scan

Bone scan may determine involvement of the underlying femur, linea aspera, or ischium. Tumors that involve the linea aspera may become extracompartmental by passing into the anterior or medial compartments of the thigh.

Biplane Angiograms

Angiography is required to determine the relationship of the popliteal artery and vein to tumors extending from the distal portion of the posterior thigh. Most often these vessels are displaced. Tumor extension into the popliteal space makes resection more difficult but not impossible.

Biopsy

Multiple core needle biopsies of the tumor mass are preferred. The puncture site should be near the midline

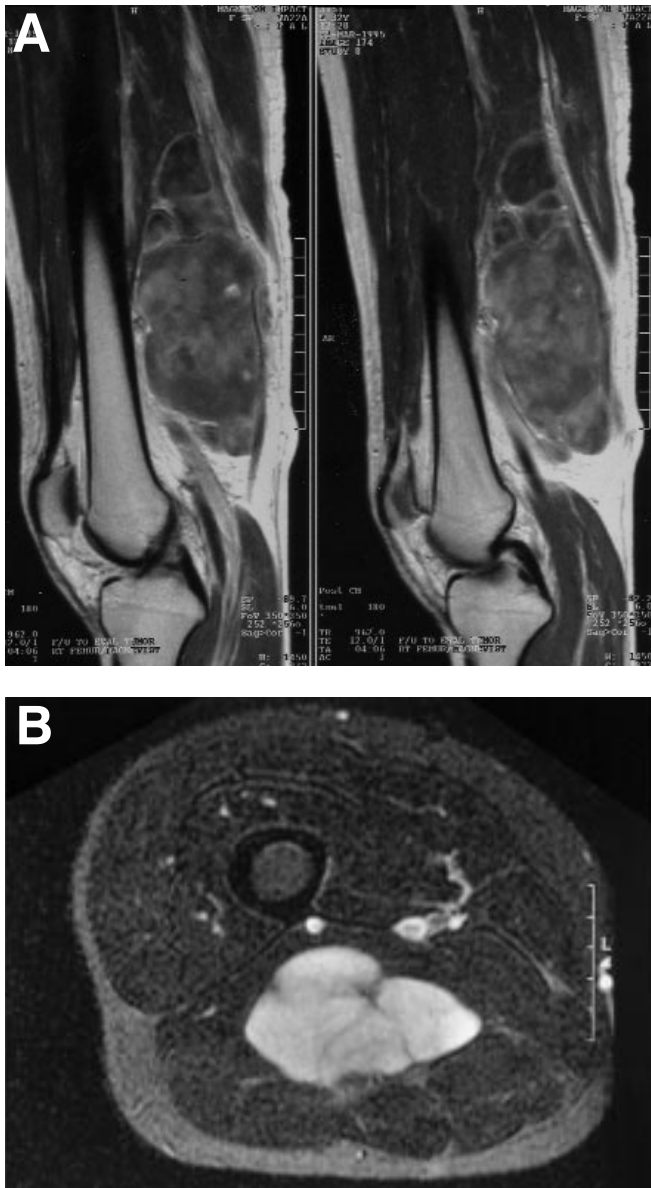


Figure 15.1 MRI scans for evaluation of posterior thigh compartment. (A) Sagittal T1 weighted image of a moderately sized posterior thigh sarcoma. Tumors of the posterior thigh often displace but rarely involve the adjacent sciatic nerve. The sciatic nerve can rarely be visualized well on an MRI scan. It is important to note that this tumor does not extend into the popliteal space as it approaches it. Angiography is utilized if tumor extends into the popliteal space. (B) Axial T2 weighted MRI scan of the same tumor that shows it arises between the medial and lateral hamstring muscles, not within the muscle itself. This is termed an extracompartmental versus extramuscular origin. The sciatic nerve cannot be well visualized and it is our policy to explore these lesions with the aim of resection and preservation of the nerve. Only if the nerve is encased by tumor is an amputation recommended. However, sciatic nerve resections with good postoperative extremity function have recently been reported.

of the posterior thigh with the needle directed toward the underlying muscle and tumor. This site is in the line of anticipated resection. The definitive incision extends from the ischium along the midline of the posterior thigh and then to the popliteal space.

INDICATIONS AND CONTRAINDICATIONS

Almost all low-grade sarcomas of the posterior thigh can be treated by partial or total resection of the involved muscle. Intramuscular or extramuscular tumors are treated by wide excision. If the tumor is extramuscular, but still remaining within the compartment, a partial muscle group resection is performed. High-grade sarcomas are treated by complete myomectomy of the muscle involved. Multiple muscles or the entire compartment can be resected in lieu of an amputation (Figure 15.3).

Contraindications for posterior compartment soft-tissue tumor resections include:

1. *Extension into ischiorectal space.* This makes the resection more difficult and may indicate the need for an amputation.
2. *Popliteal space involvement.* Tumors of the posterior thigh that extend distally may involve the popliteal space and thus the popliteal artery and vein are often in close opposition to the peroneal nerve and posterior tibial nerve. This space must be explored prior to resection.
3. *Sciatic nerve involvement.* Direct involvement of the sciatic nerve usually indicates the need for amputation but rarely occurs. If adequate margins cannot be obtained with preservation of the sciatic nerve, then the nerve must be resected. The functional result with the sciatic nerve resected is far superior to that of a hemipelvectomy. These patients require only an ankle-foot orthosis (AFO) (Figure 15.4).
4. *Femoral involvement.* If the underlying femur is involved by tumor as shown by CT scan or bone scan, partial resection of the linea aspera is required; otherwise, an amputation is recommended. A high-speed Midas Rex burr is utilized for resection of the outer 2 or 3 mm of the linea aspera.
5. *Ischial involvement.* Large posterior tumors may involve the ischium and extend into the ischiorectal space or proximally into the retrogluteal area. Proximal tumor extension may indicate the need for an amputation.

GUIDELINES OF SURGICAL TECHNIQUE

The surgical technique is summarized:

1. The incision extends from the ischium curving toward the midline, down the posterior thigh to the

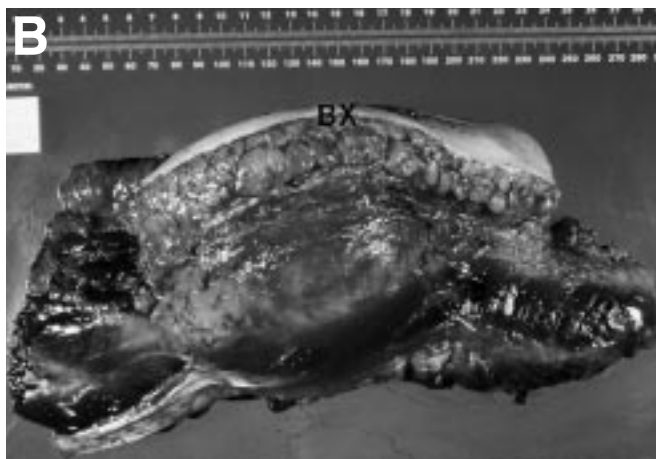
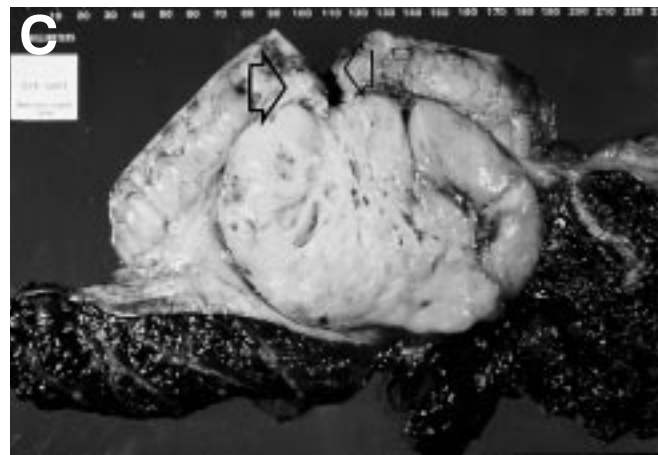
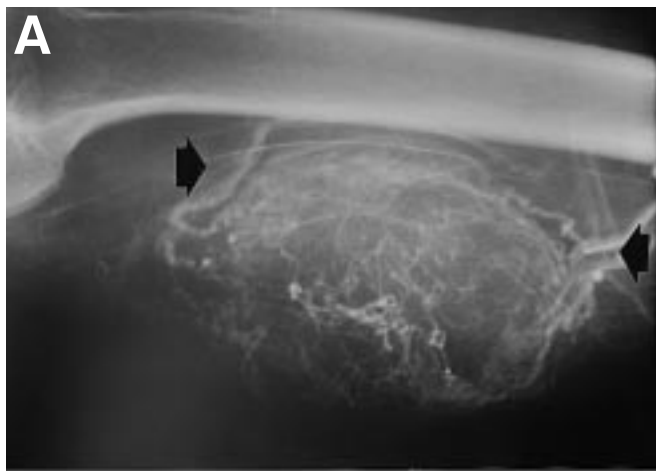


Figure 15.2 A high-grade soft-tissue sarcoma arising in the posterior compartment. (A) Lateral angiogram showing a large tumor blush (arrows) with large draining veins. (B) The gross specimen following resection. Notice that the mass is well encapsulated by the adjacent muscles. The biopsy site (BX) was removed en-bloc with the mass. (C) Pathological specimen after sectioning showing the tumor being encased within the deep muscle and subcutaneous tissue. The arrows indicate the biopsy site that has been removed.

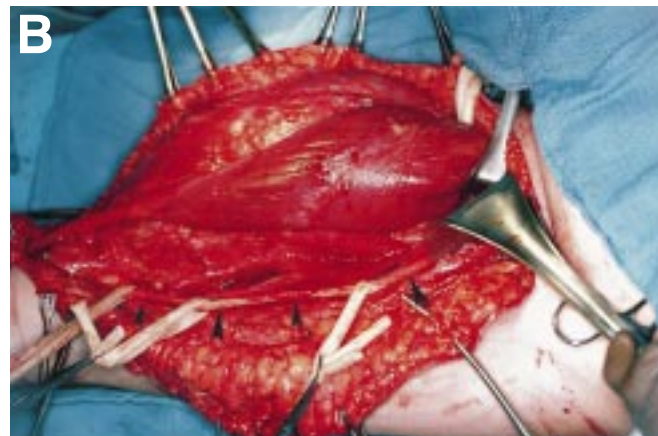


Figure 15.3 Clinical and intraoperative photographs of a large hamstring tumor arising in the lateral hamstrings (biceps). (A) Clinical photograph prior to incision showing the large size of the tumor involving the hamstrings with displacement of the adductor muscles. T1 and T2 represent two large palpable masses. The cross-hatched area indicates the palpable pulse and the sartorial canal. Similar to adductor group resections, large posterior hamstring muscle tumors may invade adjacent structures and should involve exploration of the superficial femoral artery and popliteal space prior to resection. This can often be determined by the preoperative MRI (see above) and an angiogram. (B) Intraoperative photograph demonstrating that the entire posterior compartment is being elevated, showing the tumor is located in the medial and lateral hamstrings. Note the sciatic nerve has been dissected completely free and appears not to be involved (arrows). The sciatic nerve must be exposed from the sciatic notch to the popliteal space. Functional results after posterior compartmental resection are excellent with minimal gait disturbance.

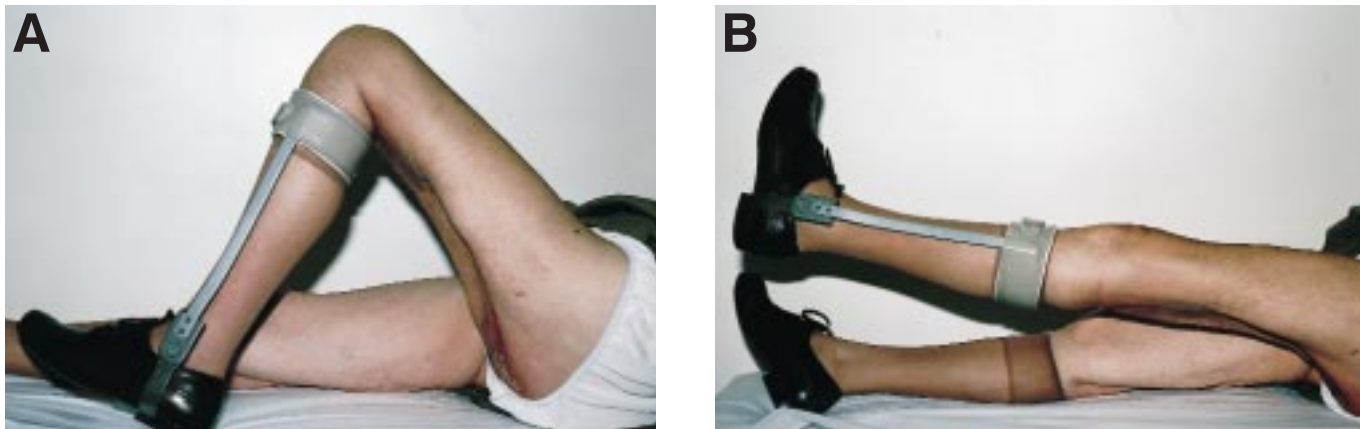


Figure 15.4 Clinical photographs of a patient who has undergone resection of the posterior thigh compartment along with the length of the sciatic nerve. The main functional need is an AFO (ankle-foot orthosis) to stabilize the foot in gait. Knee extension is normal and knee flexion is adequate due to the gastrocnemius heads, sartorius muscle, and gracilis muscle. In addition, if the nerve is resected distal to a portion of the biceps, and if the biceps can be preserved, then the extremity function is good.

level of the popliteal space, and then across the popliteal space in an S shape (from medial to lateral). It then passes to the fibular head. This incision permits exposure of the popliteal space, the sciatic nerve and both medial and lateral hamstrings, as well as the origin from the ischium.

2. Resection consists of releasing the origin of the hamstring muscles from the ischium and exploring the retrogluteal area at the time of resection for proximal tumors, as well as the ischiorectal space, to make sure that there is no tumor extension.
3. Popliteal space exploration is required if the tumor is distal in the posterior thigh. The popliteal artery and vein are explored and retracted, as well as the sciatic nerve.
4. The involved muscles are released from either the medial aspect of the knee or the fibula and the entire muscle group can then be resected from the linea aspera.

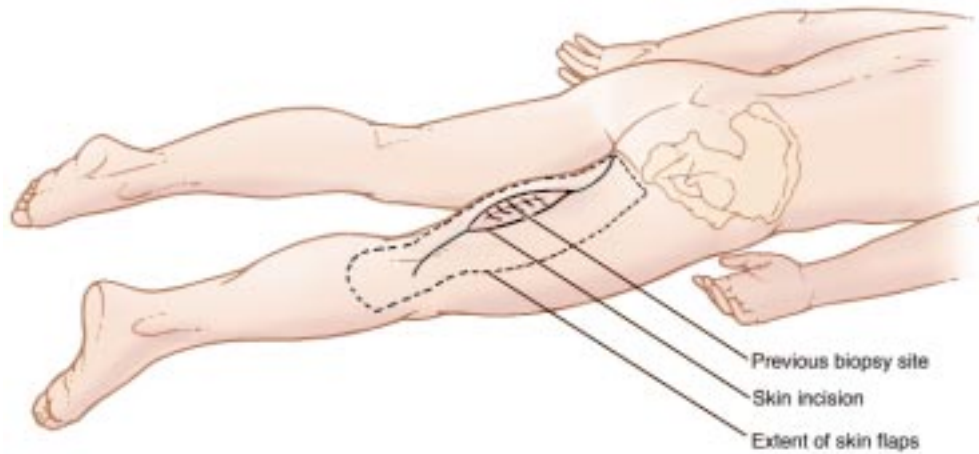


Figure 15.5 Incision and skin flaps. The patient is placed in the prone position. An ellipse of skin is outlined so that there is a 2 cm margin of skin around the old biopsy site. The extents of the skin flaps are dissected, care being taken to taper the flaps, as one encounters the lateral margins of the dissection. It is helpful to mark on the skin the extent of the dissection of the skin flaps so that one does not inadvertently exceed this during the dissection. The medial extent of the dissection is the gracilis muscle, and the lateral extent is the iliotibial tract.

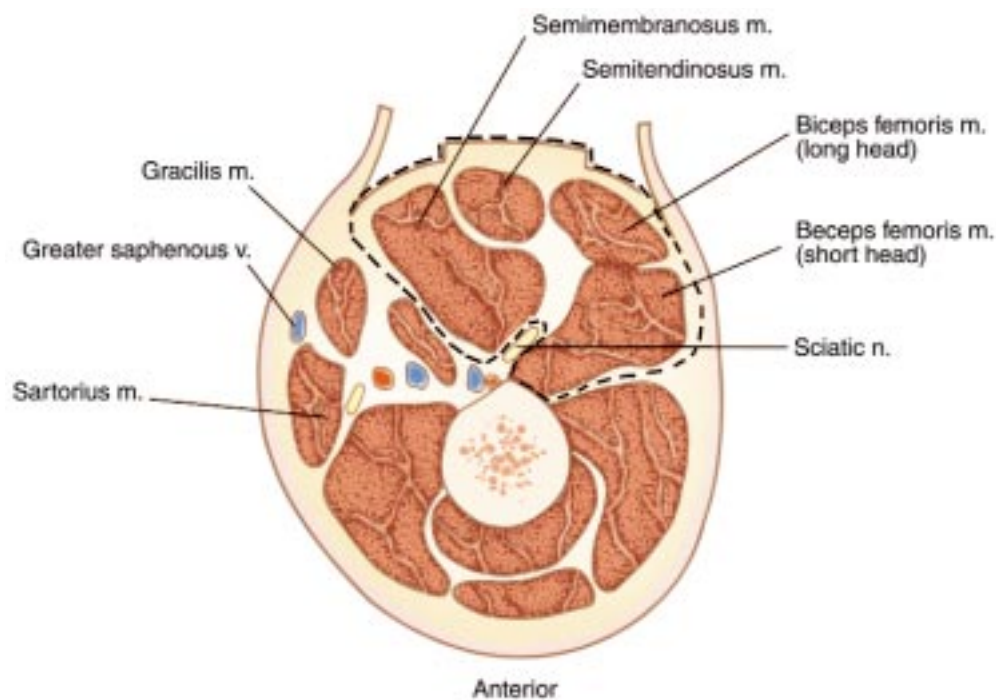


Figure 15.6 Cross-section of the mid-thigh. The proximity of the sciatic nerve to large sarcomas within the posterior compartment is clearly indicated by this diagram.

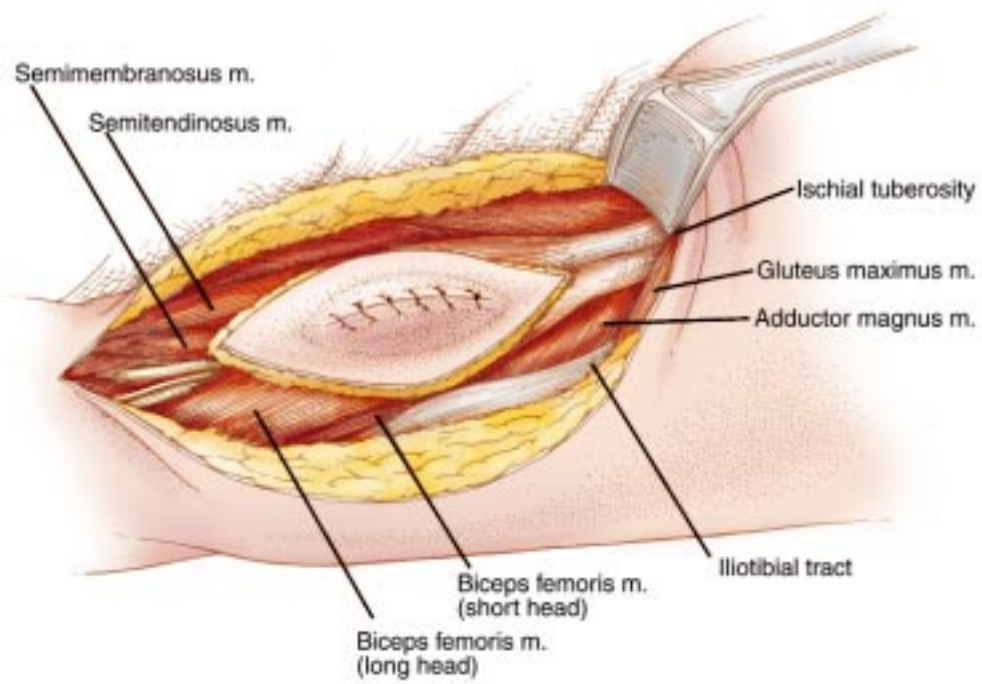
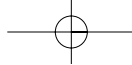
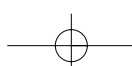
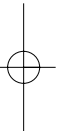


Figure 15.7 Creation of the skin flaps. The medial (semitendinosus and semimembranosus muscles) and lateral (biceps femoris long head and short head) muscles are exposed.



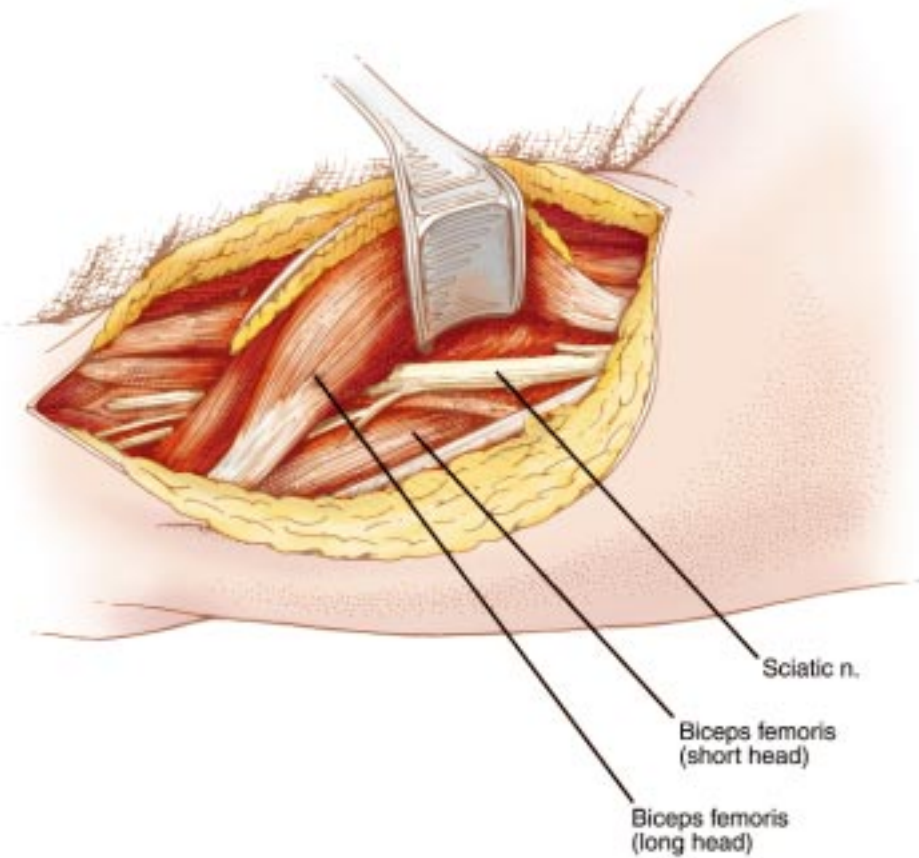


Figure 15.8 Defining the muscles of the posterior compartment. The extent of the dissection is in part determined by the sarcoma, but resection generally involves the long head of the biceps femoris, semimembranosus, and semitendinosus. It is possible for a portion of the lateral quadriceps mechanism to be included with the specimen. Likewise one or more muscle bundles of the abductor muscle group may be included with the muscle group, if this will afford a more generous margin. The three muscles mentioned are superficial to the sciatic nerve, and their origin is from the ischial tuberosity. A tumor-free margin of resection depends on a plane free of tumor contamination superficial to the posterior limits of this compartment. It is clear that the next adjacent structure is the sciatic nerve itself.

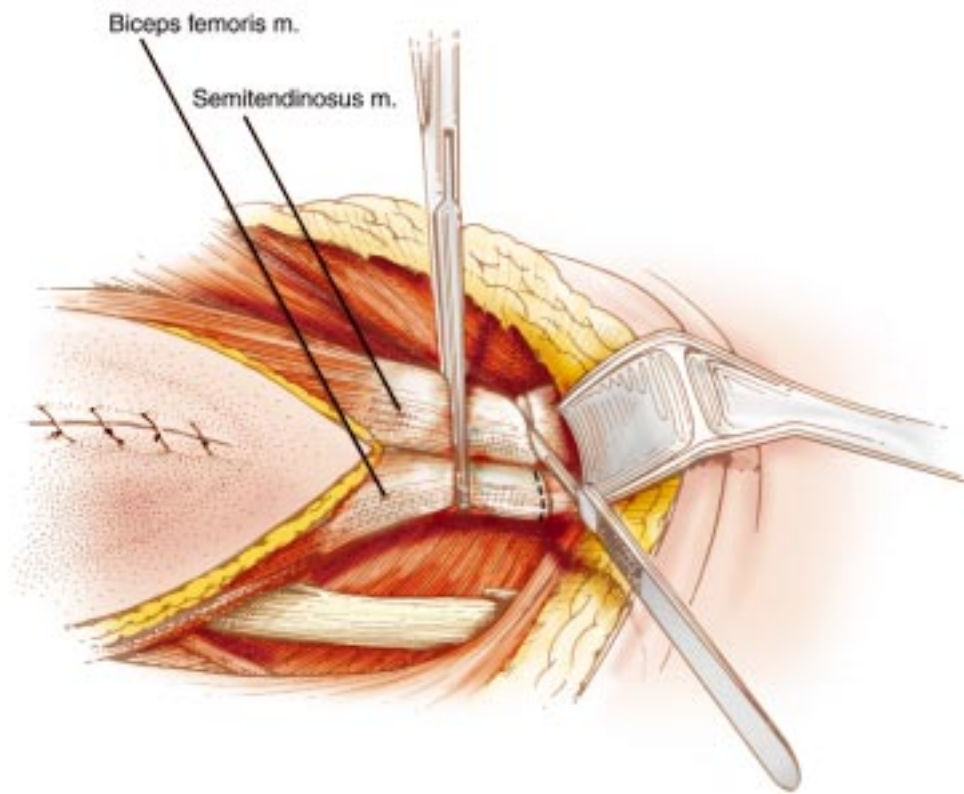


Figure 15.9 Transection of muscle origins. Dissection begins by exposing the ischial tuberosity. This is easily identified on the skin surface. The hamstring muscles are released at their origin from the ischial tuberosity.

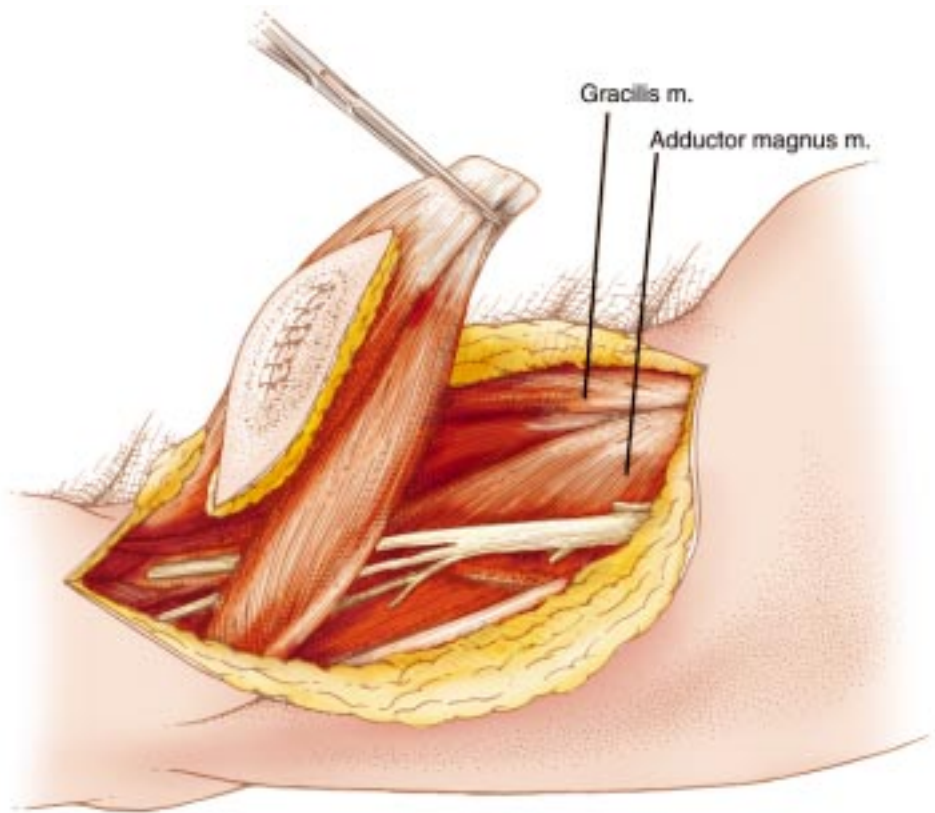
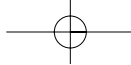
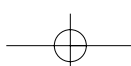
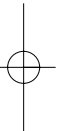
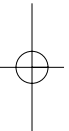


Figure 15.10 Dissection of the muscle group from cephalad to caudal aspects. The muscle groups are secured with a clamp, and strong traction is placed on the muscle group. Blood vessels and nerves that enter the hamstring muscle are ligated and divided. By a blunt and sharp dissection the entire muscle group is elevated. The sciatic nerve, the short head of the biceps laterally, and the abductor muscles medially form the base of the dissection.



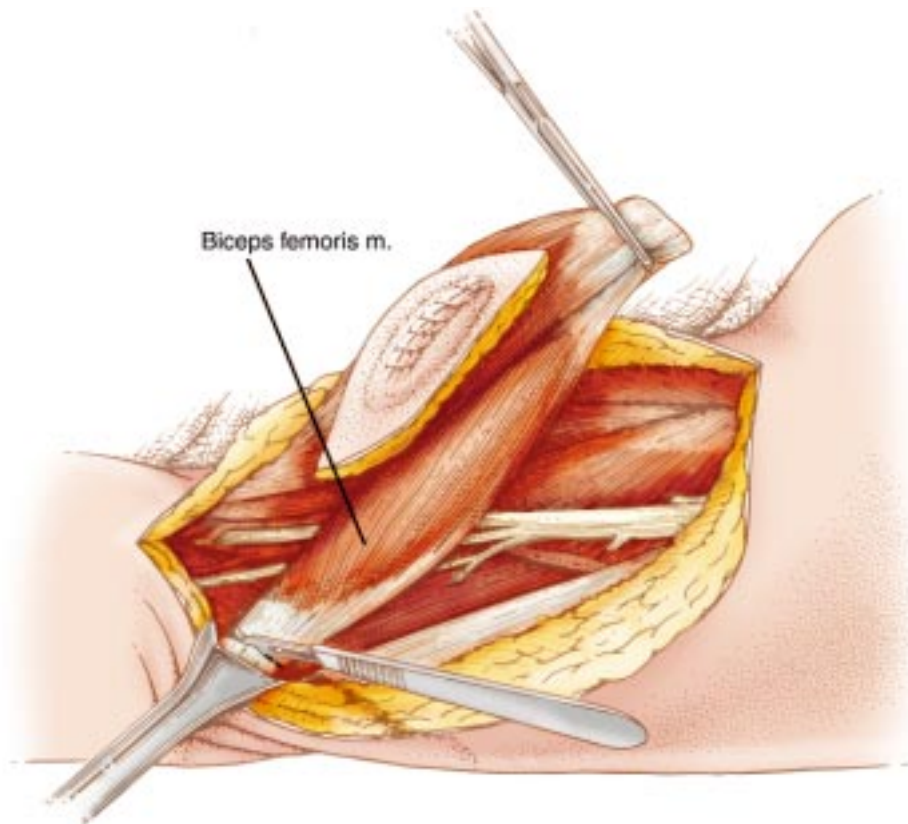
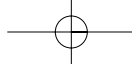


Figure 15.11 Transection of muscle insertions laterally. The long head of the biceps femoris muscle is transected through its tendinous portion on the lateral aspect of the thigh. One must take care to avoid injury to the common peroneal nerve.

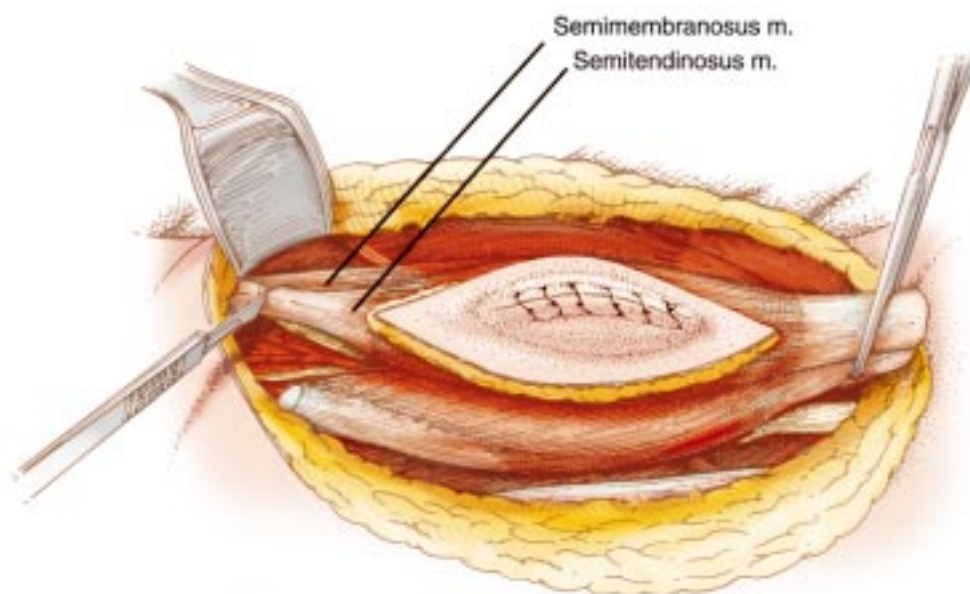
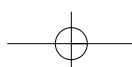


Figure 15.12 Transection of muscle insertions medially. The insertions of the semimembranosus muscle and semitendinosus are divided through their tendinous portions medially. The medial head of the gastrocnemius muscle is exposed.



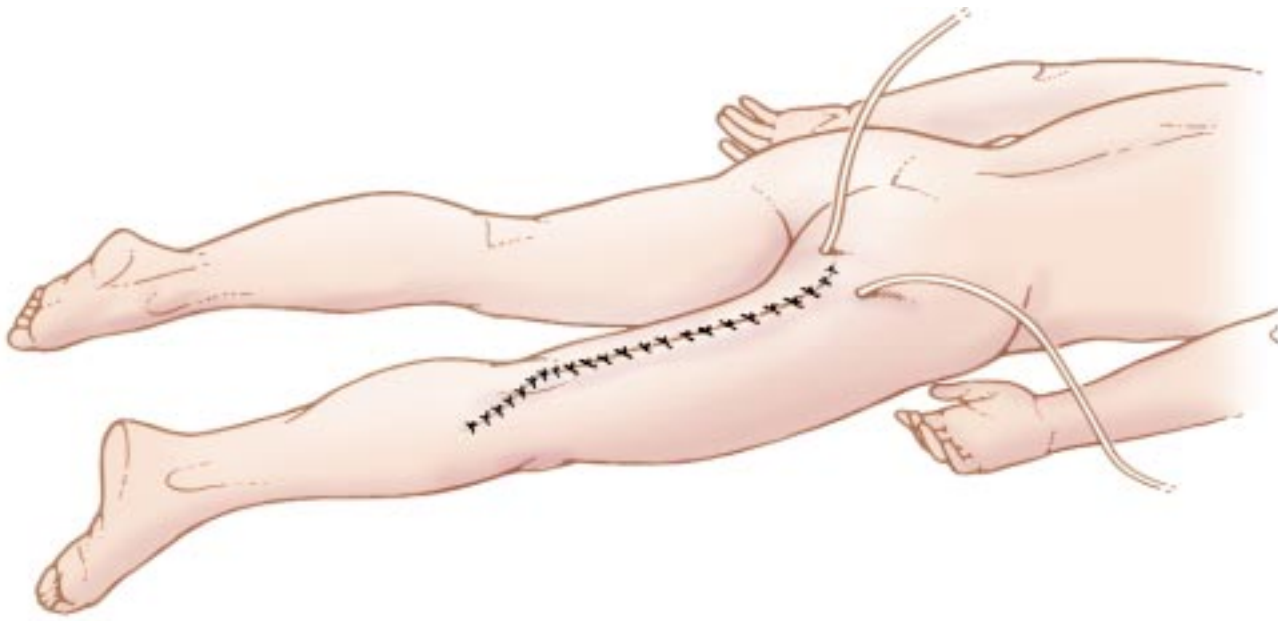
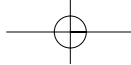
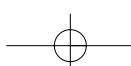
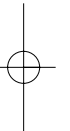
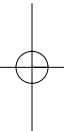


Figure 15.13 Closure. The superficial fascia and skin are meticulously closed. Generous suction drainage is achieved through suction drains. Care should be taken not to make the skin exit sites for the suction drains through the skin flaps; rather, these should be just above the gluteal crease.



DISCUSSION

Tumors of the posterior thigh are almost always resectable. The sarcomas arising in this area are often small, though they may become extremely large. Fortunately, the sciatic nerve is often displaced around an adjacent muscle or the pseudocapsule and can usually be preserved. Direct sciatic nerve involvement is rare.

Induction chemotherapy is recommended for high-grade sarcomas prior to attempt at resection. If the tumor is confined to one muscle belly, a true myomectomy can be performed. If the tumor is extramuscular and involves two or three muscle bellies, all the muscles can be resected with good margins. The sciatic nerve sheath should be excised in the portion that is closest to the tumor to determine if there is any tumor involvement of the sheath. A complete sciatic nerve sheath resection can be performed. Alternatively, the sciatic nerve itself may be resected without having to proceed to an amputation. The function following a sciatic nerve removal is extremely good, with knee flexion being supplied by the remaining sartorius and gracilis muscles as well as the gastrocnemius muscles.

The sciatic nerve is the most significant structure in the posterior compartment. There are no imaging studies that can reliably demonstrate the relationship of the tumor to the sciatic nerve. Both the MRI and CAT can be useful, although the deciding factor to proceed with a resection or amputation can sometimes only be made at the time of exploration of the posterior thigh. During exploration it is possible to determine the relationship of the sciatic nerve to the tumor, or true sciatic nerve involvement. It is rare for the sciatic nerve to be directly infiltrated by tumor.

The relative contraindications to a posterior thigh resection are usually a combination of factors:

ischiorectal extension, popliteal space extension, possible sciatic nerve involvement, and/or femur involvement. Any one of these anatomic restraints can be incorporated into an adequate resection, but a combination usually indicates that an amputation is warranted. The level of amputation is above the pelvis; that is, a hemipelvectomy. Fortunately, today, most posterior thigh sarcomas can be treated by induction chemotherapy followed by resection and/or radiation therapy postoperatively. Function following a posterior thigh resection is usually very acceptable to the patient.

Imaging studies are very reliable for most tumors of the posterior thigh (Figure 15.2). The most significant structure is the sciatic nerve that can best be visualized with a CAT or MRI. Often the posterior thigh should be explored prior to proceeding with an amputation in order to determine the degree of involvement with the sciatic nerve. Hemipelvectomy is usually required if there is large extracompartmental extension either into the anterior thigh or the medial compartment. Other sites of extracompartmental extension include the ischiorectal space and the retrogluteal area.

The posterior compartment is an extremely quiet area for tumors, with few restrictions to resectability. The surgical technique essentially removes the entire hamstring musculature from its origin on the ischium to its insertion onto the fibular head and medial aspect of the knee joint. The sciatic nerve is usually preserved. The function following a posterior thigh resection is usually excellent with good knee flexion being maintained by the remaining musculature of the sartorius muscle, gracilis and gastrocnemius muscles. If the sciatic nerve has to be removed, knee flexion is still possible and only an AFO is required.

