BACKGROUND

- Soft tissue sarcomas of the popliteal fossa are rare, accounting for less than 5% of all soft tissue sarcomas of the extremities. Surgery in this anatomic area is challenging: performing a good resection with wide surgical margins is often difficult because of the periarticular location and the proximity to neurovascular structures.\(^3,6,9\)
- Such tumors formerly were treated with amputations\(^4\); however, better understanding of tumor biology and advances in chemotherapy and radiation therapy now allow limb-sparing procedures to be performed in most of these cases.

ANATOMY

- The popliteal space is diamond-shaped; on its superior aspect it is bounded by the semimembranosus and semitendinosus muscles medially and by the biceps femoris muscle laterally. Its inferior boundaries are the two heads of the gastrocnemius muscle. The roof of the fossa is the thin popliteal fascia; the floor is the posterior aspect of the distal end of the femur, the posterior capsule of the joint, and the popliteus muscle, which overlies the proximal tibia.
- The popliteal artery and vein enter the popliteal space from its medial aspect through the adductor hiatus and lie directly behind the posterior capsule of the knee joint.
- They run obliquely through the fossa and branch into two superior, a single middle, and two inferior genicular branches. After exiting the popliteal fossa the popliteal artery divides into its terminal branches: the anterior tibial, posterior tibial, and peroneal arteries. The popliteal vein lies between the tibial nerve and the popliteal artery. The short saphenous vein pierces the popliteal fascia to join the popliteal vein within the fossa.
- The tibial nerve enters the popliteal fossa lateral to the popliteal artery and approximately in the middle of the fossa. It crosses the artery to its medial aspect and remains at that location. The common peroneal nerve slopes down the superolateral border of the popliteal fossa toward the medial aspect and along the biceps femoris tendon, where it enters a tunnel within the substance of the peroneus longus muscle.

IMAGING AND OTHER STAGING STUDIES

Magnetic Resonance Imaging

- MRI is the imaging modality of choice for the diagnosis of popliteal soft tissue sarcomas. The typical finding is a soft tissue mass with a solid component, no communication to the knee, and central or irregular nodular gadolinium enhancement. Conversely, the classic presentation on MRI of popliteal cysts, which are the most frequently encountered masses in the popliteal fossa, is a well-defined, unilocular, fluid-filled cyst in direct communication with the knee joint; its peripheral walls are normally enhanced with gadolinium.
- MRI is also used to evaluate the size of the tumor and its relation to the neurovascular structures, the posterior knee joint capsule, and surrounding musculature and to assess local lymph node involvement (FIG 1A–C).

Plain Radiography and Computed Tomography

- Plain radiography and CT scans are performed to rule out invasion of the tumor into the adjacent bones.

Angiography

- Angiography (FIG 1D) is routinely used to assess the relation of the tumor to the popliteal artery, patterns of possible vascular displacement, the presence of vascular anomalies, and arterial and venous patency.

SURGICAL MANAGEMENT

Positioning

- The patient is placed in the prone position (FIG 2) and both lower limbs are draped. The contralateral leg is prepared for saphenous vein harvesting, which will be necessary for arterial reconstruction if the popliteal artery must be resected.
FIG 1 • MRI of a typical popliteal sarcoma. A. Normal MRI of the distal section of the popliteal (diamond) space through the medial and lateral gastrocnemius muscle insertions onto the femoral condyles. B. Large popliteal soft tissue sarcoma. C. Sagittal view showing the relationship of a popliteal sarcoma to the adjacent femur and knee joint (not involved in this case). D. Angiogram of an extremely vascular popliteal sarcoma. Arterial embolization may be useful. All of the small pedicles to the tumor must be ligated at the time of resection. The popliteal artery is rarely involved directly and is often preserved.

FIG 2 • Clinical photograph of a large popliteal sarcoma. A prone position is routinely used for surgical resection.

EXPOSURE

- An S-shaped incision is made, crossing from proximal-medial to distal-lateral at the level of the knee joint (TECH FIG 1A). The medial-proximal arm of the incision allows the popliteal vessels to be identified as they exit the adductor hiatus, and the lateral distal arm enables easy exposure of the peroneal nerve, posterior to the fibular head. In addition, making the distal arm of the incision lateral avoids damaging the greater saphenous vein, which runs on the medial aspect of the leg (TECH FIG 1B).
- The very thin and friable popliteal fascia lies in close proximity to the neurovascular bundle (especially the peroneal nerve, which lies just deep to the popliteal fascia at the level of the fibular head), making it a critical landmark. To identify the popliteal fascia, subcutaneous flaps are made. The landmarks and various structures of the popliteal fossa can often be palpated through the fascia, which is then cautiously incised accordingly. Failure to realize that the dissection is underneath the fascia and that only a few millimeters separates the blade from the vessels and nerves of the popliteal fossa can easily result in injury of those structures.
Chapter 34

POPLITEAL RESECTIONS

TECHNIQUES

**TECH FIG 1** • **A.** Incision used for resection of popliteal sarcomas. A wide exposure of the popliteal (diamond) space must be obtained to avoid inadvertent injury to important neurovascular structures. **B.** The medial and lateral hamstring muscles are mobilized and retracted with a wide self-retainer retractor. Similarly, the medial and lateral gastrocnemius heads are detached from the femoral condyles, retracted, or both. The two heads of the gastrocnemius muscles are split at the midline, taking care not to injure the now more superficial tibial nerve and vessels (located just anterior to the nerve).

**TUMOR RESECTION**

- The initial step of a popliteal fossa resection is exposure and identification of the neurovascular bundle. This allows the surgical team to mobilize the vulnerable structures before resection. Mobilization is usually accomplished by exposing the structures in the distal thigh and proximal leg and following them to the popliteal fossa.

(TECH FIG 2A,B). If the popliteal vessels are difficult to expose, an intraoperative Doppler ultrasound device can be helpful.

- After mobilizing the neurovascular bundle, the tumor is resected with a cuff of normal tissue if possible. Not uncommonly, however, the vessels, the nerves, or both are...
in close proximity to the tumor mass or adherent to its pseudocapsule. In such cases, the structures are dissected free and the nerve sheath and adventitia are removed and pathologically examined using frozen sections to determine the surgical margins (TECH FIG 2C,D).

- Vessels and nerves of the popliteal fossa must be resected if they are embedded in the tumor mass. The popliteal artery can be reconstructed with a saphenous vein graft taken from the contralateral leg. We consider reconstructing the popliteal vein to be unnecessary because the ipsilateral saphenous vein can compensate for its loss. Nerve involvement or vascular involvement is not an indication for primary amputation if these features can be adequately resected.1,2,5

SOFT TISSUE RECONSTRUCTION

- After the tumor is resected, the two heads of the gastrocnemius are sutured to each other and to the hamstring muscles to form a uniform muscle layer that covers the popliteal space (TECH FIG 3A). This wound closure technique minimizes the occurrence of deep wound infection by forming a muscular barrier between the skin incision and the popliteal space. The resected tumor specimen is shown in (TECH FIG 3B,C).

TECH FIG 3 • A. Closure of popliteal space. The medial and lateral heads of the gastrocnemius muscles are tenodesed below the sciatic nerve to cover the popliteal vessels. The medial (semimembranosus muscle) and the lateral hamstrings (biceps femoris muscle) are similarly tenodesed proximally to close the popliteal space and are also tenodesed to the gastrocnemius repair. This closure closes off all the dead space as well as protecting the popliteal vessels and provides a nice muscle base if a skin graft is needed. B. Gross specimen of the popliteal sarcoma. C. The tumor transected.
PEARLS AND PITFALLS

- Soft tissue sarcomas of the popliteal fossa commonly displace the usual anatomic landmarks. To locate the components of the neurovascular bundle, one must expose regions that are proximal and distal to the popliteal fossa, identify the major nerves and vessels, and follow them to the popliteal fossa.

- The sciatic nerve is proximally identified between the medial and lateral hamstrings; distally, the peroneal nerve is carefully identified posterior to the fibular head, immediately below the thin popliteal fascia, and the tibial nerve is found between the two heads of the gastrocnemius.

- The popliteal vessels are identified proximal to the popliteal fossa as they exit the adductor hiatus and distally between the two heads of the gastrocnemius muscle. We routinely detach the origin of the medial and lateral hamstrings and both heads of the gastrocnemius muscle to achieve a wide exposure. In the popliteal space the nerves are usually found posterior to the tumor mass and the vessels are usually anterior to it.

- While running through the popliteal fossa the popliteal artery branches into two superior, a single middle, and two inferior genicular arteries. The inferior genicular vessels pull the popliteal artery toward the joint capsule and usually must be ligated to allow its mobilization. The popliteal vein, which runs more superficial to the artery, lies between the popliteal artery and the tibial nerve.

- The two main venous tracts responsible for the venous drainage of the leg are the popliteal vein and the greater saphenous vein. During tumor resection, excision of the popliteal vein may be unavoidable; for this reason, care should be taken not to damage the greater saphenous vein, which might be the only remaining venous tract. Moreover, if the popliteal artery and vein are resected, the contralateral greater saphenous vein should be harvested to reconstruct the popliteal artery. Ligation of both the popliteal vein and the ipsilateral greater saphenous vein may lead to severe venous insufficiency.

POSTOPERATIVE CARE AND REHABILITATION

- After surgery, the patient is placed in a long, posterior splint in 15 to 30 degrees of knee flexion to relieve tension from the neurovascular bundle and skin incision.

- Physiotherapy for muscle strengthening and range of motion is not started until the skin incision is completely healed.

OUTCOMES

- Only four case series of soft tissue sarcomas were identified in the English literature. All of the studies found that the prognosis was equivalent to that of soft tissue sarcomas in other locations and the limb salvage rate was high.

- In a recently published case series of 29 patients with popliteal sarcomas with a median postoperative follow-up of 79 months, of the 16 patients with high-grade tumors 3 (19%) had local recurrences and 4 (25%) had distant metastases; of these, 2 died. None of the patients with low-grade tumors had local recurrences or distant metastases. The overall limb salvage rate was 86.2%; for the patients with high-grade tumors it was 75%.

COMPLICATIONS

- Superficial wound dehiscence is the most common complication. It usually occurs during adjuvant radiation therapy and sometimes necessitates local surgical debridement.

- Peroneal palsy is most commonly due to neuropraxia and usually resolves after several weeks.

- Knee range-of-motion limitation is usually secondary to adjuvant radiation therapy to the popliteal fossa. In our series of 29 patients with popliteal sarcomas, 14 of the 26 patients (53.8%) who underwent primary resections had full range of motion of the knee joint, 12 patients (46.1%) had mild to moderate limitations in knee flexion (120 to 90 degrees), and 4 patients (15.3%) had mild flexion contractures (5 to 15 degrees). No patient in our series required knee manipulation or contracture release.

REFERENCES