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# Fibular Resections

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### OVERVIEW

Primary bone sarcomas of the fibula have traditionally been treated with above-knee amputations. Increased use of limb-sparing procedures stimulated an interest in the surgical anatomy in this area and the possibility that tumors of the fibula might be safely resected. This chapter describes the surgical anatomy and resection technique for malignant lesions of the proximal, mid-, and distal fibula.

## INTRODUCTION

The fibula is a rare anatomic location for both malig-
nant primary bone sarcomas and metastatic lesions.
The proximal fibula is most common area of the fibula
to be involved by tumors; this is followed by the fibular
diaphysis and the distal fibula. Osteosarcoma, Ewing's
sarcoma, and giant-cell tumor are the most frequent
tumor types to develop at this location.

Resection of a high-grade primary bone sarcoma of
the proximal fibula necessitates an en-bloc extra-
articular resection of the proximal fibula (i.e. resection
of the proximal fibula with the tibiofibular joint), the
anterior and lateral muscle groups, and the common
peroneal nerve, which is usually involved by the soft-
tissue extension of high-grade sarcomas. This
procedure is termed a Type II resection. Because it
necessitates the sacrifice of the common peroneal
nerve, a Type II resection results in foot drop (Figures
32.1, 32.2).[1] A Type I resection of the proximal fibula, on
the other hand, involves resection of the proximal
fibula with sparing of the covering muscle layer and
peroneal nerve.[2] This is appropriate for benign-
aggressive, low-grade malignant tumors and for meta-
static lesions of the proximal fibula because these

tumors do not have a significant extraosseous component
(Figures 32.1, 32.3). High-grade sarcomas of the distal
fibula, which are usually characterized by involvement
of tendons and nerves and lack of soft-tissue recon-
struction options, are usually treated with an amputa-
tion. Fortunately, high-grade sarcomas of the distal
fibula are rare.

Mechanical stability of the leg is not impaired follow-
ing proximal or intercalary resections of the fibula, and
reconstruction is therefore not indicated.[3–5] Resections
of tumors of the distal fibula, because of the lateral
maleolus being a component of the ankle joint
complex, do require reconstruction.[2,6]

## ANATOMIC CONSIDERATIONS AND PREOPERATIVE EVALUATION

In staging fibular tumors, emphasis is placed on the
extent of bone destruction, intramedullary involve-
ment, and soft-tissue extension. Special attention is also
given to the relation of the tumor to the nerves, blood
vessels, and tibia; tumor invasion of any of these
structures may rule out the possibility of a limb-sparing
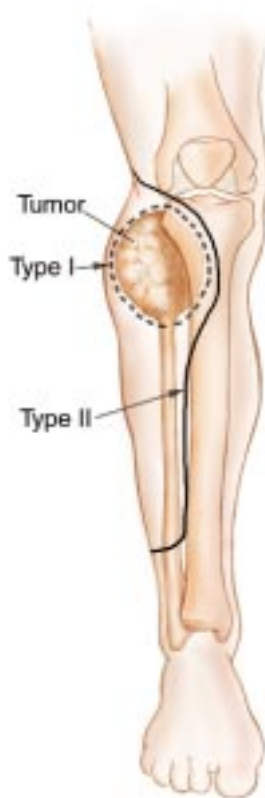procedure. Because of the thin cortices of the fibula and



**Figure 32.1**   Schematic diagram showing Type I and Type II proximal fibular resections.
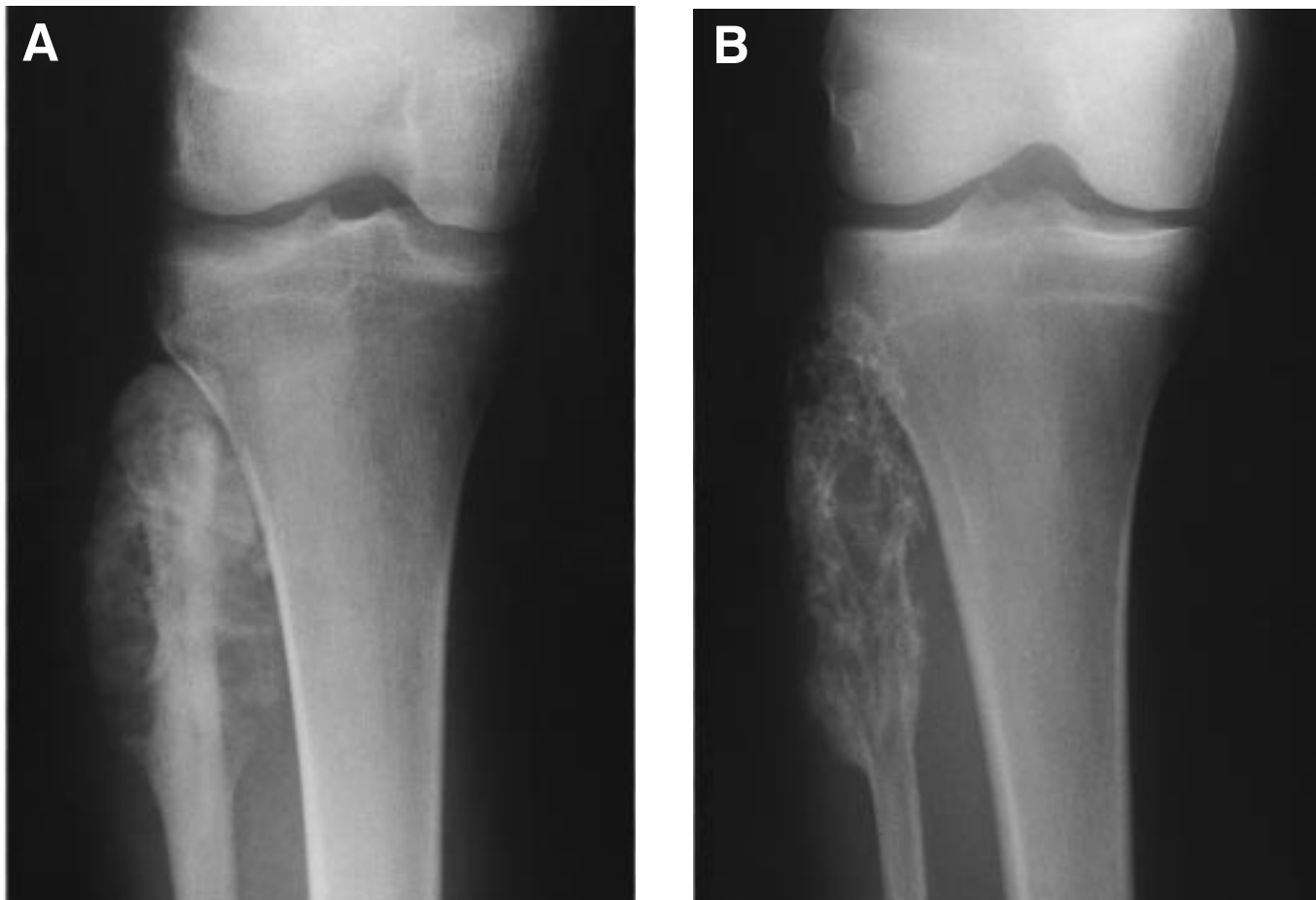
**Figure 32.2** *(see also following page)* Anteroposterior plain radiographs of the proximal fibula showing (**A**) high-grade osteosarcomas and (**B**) intermediate-grade fibrosarcoma. Intermediate and high-grade primary bone sarcomas are usually associated with cortical breakthrough and soft-tissue extension. (**C**) A sagittal section through an osteosarcoma of the proximal fibula showing a circumferential soft-tissue extension. Wide excision of these tumors would necessitate en-bloc extra-articular resection of the proximal fibula, the surrounding muscle layer, and the common peroneal nerve (Type II resection). Extra-articular resection is not necessary for benign-aggressive or low-grade malignant tumors of the proximal fibula, which generally do not invade the joint capsule or have an extensive soft-tissue component. (**D**) shows a surgical specimen of a Type II fibular resection. Note the covering layer of muscles.

multiple muscle attachments, benign-aggressive and malignant tumors often produce early cortical breakthrough and direct muscle invasion (Figure 32.4). High-grade sarcomas are likely to invade the tibio-fibular joint and posterior joint capsule and thereby necessitate an extra-articular en-bloc resection of these structures.

The patency of the anterior tibial, posterior tibial, and peroneal arteries, their anatomic relation to the tumor, and the presence of vascular anomalies are established prior to surgery using biplanar angiography; the extremity can remain functional, even if two of the three major vessels have been ligated. Type II resections of the proximal fibula cannot be performed in the presence of significant obstruction of the posterior tibial artery, because the anterior tibial and peroneal arteries will be sacrificed. In such cases a bypass procedure or an amputation should be considered.

To avoid compromising the option of limb-sparing surgery, the biopsy of a fibular lesion must be carefully planned. The biopsy tract must be the shortest way to the lesion; however, it must not violate more than one compartment and must be as remote as possible from the main neurovascular bundle of the leg. A proximal or a midfibular lesion is approached through the peroneal muscle group. To avoid contamination of the ankle joint, a distal fibular lesion is approached directly through its lateral aspect.

Figure 32.2C,D

Above-knee amputation is considered when: (1) a malignant tumor grossly invades the tibia; (2) there is extensive multicompartmental involvement, especially the posterior deep compartment; and (3) there is multicompartmental contamination from previous biopsy or attempted resection.

## SURGICAL GUIDELINES AND TECHNIQUE

A semisupine position (45° elevation of the operated side) is used to permit easy access to the anterior and lateral compartments and allow dissection of the popliteal space. The entire extremity, from the inguinal ligament to the foot, is included in the sterile field in order to allow evaluation of the distal foot pulses and execution of an above-knee amputation, if indicated.

### Incision

Wide exposure of tumor, as well as of the neurovascular bundle, is mandatory. A single utilitarian approach provides a safe and wide exposure of all four compartments of the leg and popliteal fossa and allows resection of tumors of the proximal and midfibula. The incision begins posteriorly, approximately 8 cm proximal to the midpoint of the transverse popliteal skin crease, curves gently forward and distally toward the anterior tibial crest, and passes anterior to the fibular head and over Gerdy's tubercule, to a point just lateral of the tibial crest. The incision extends 5 cm distal to the level of the planned osteotomy. If a primary bone sarcoma is resected, the previous biopsy tract with a 2–3 cm margin has to be included in the incision (Figure 32.5). A large lateral flap and a smaller medial flap are

**Figure 32.3** Anteroposterior plain radiograph of the proximal fibula showing a low-grade chondrosarcoma. Although the cortices are expanded, cortical breakthrough is not evident. A Type I resection is therefore feasible.

developed. Care must be taken to avoid opening of the deep fascia of any compartment at this point. Distal fibular lesions are approached via a curved incision around the lateral maleolus. Tumors of the distal fibula are not approached through a utilitarian incision; instead, the incision is placed parallel to the lateral border of the Achilles tendon, and posterior to the lateral maleolus (Figure 32.6).

## Proximal Fibular Resections

A Type I proximal fibula resection is reserved for benign-aggressive and low-grade malignant tumors. It includes intra-articular resection of the proximal fibula with 2–3 cm of normal diaphysis and a thin muscle cuff in all dimensions. The anterior tibial artery is occasionally sacrificed. The peroneal nerve and its motor branches can be preserved. A Type II resection is reserved for high-grade malignant tumors. This resection includes an extra-articular resection of the proximal fibula with 6 cm of normal diaphysis, the anterior and lateral muscle compartments, the anterior tibial artery, and, occasionally, the peroneal artery, and peroneal nerve.[1]

A Type II resection includes five consecutive steps: (1) exploration of the common peroneal nerve; (2) exploration of the popliteal space and artery; (3) excision of the anterior and lateral muscle compartments; (4) extra-articular resection of the tibiofibular joint; and (5) soft-tissue reconstruction (knee joint capsule, lateral gastrocnemius flap, lateral collateral ligament, and muscle tendonesis) (Figure 32.7). Variations of this technique, as used in Type I resection, are noted.

## Exposure of the Common Peroneal Nerve

The common peroneal nerve can easily be palpated near the fibular head as it passes around the inferior border of the biceps femoris muscle (Figure 32.8). If the nerve is to be preserved, as in a Type I resection, its course under the peroneus longus is identified and the peroneus longus tunnel is unroofed. After the motor branches of the peroneal nerve have been dissected, its articular branch is sacrificed to allow mobilization of the nerve posterior to the fibular head.

## Exposure of the Popliteal Fossa and Identification of the Vascular Anatomy

Tumors of the proximal fibula commonly reach the midline posteriorly. Because of the distortion of the popliteal vessels caused by the tumor, as well as the possible presence of vascular anomalies, identification of the vascular anatomy may be difficult and tedious.

The major vessels are exposed by detaching the lateral gastrocnemius muscle through its length adjacent to the fibula and, if necessary, releasing the proximal tendinous origin from the lateral femoral condyle. This exposes the underlying soleus muscle, which is similarly detached through its substance near its fibular origin. At the level of the popliteus muscle the neurovascular bundle can be easily identified. The anterior tibial artery is 2–3 cm distal to its inferior border. The peroneal artery is not seen at first because it lies in close proximity to the posterior aspect of the tibia and along the flexor hallucis longus muscle.

The posterior tibial nerve is closest to the surface and the popliteal veins are between the nerve and the posterior tibial artery that can be identified in the midline. It is crucial that the interval between the posterior fibular head and the posterior tibial and popliteal arteries be explored and evaluated early to determine whether a high-grade sarcoma is resectable.

If the popliteal or posterior tibial arteries are involved, the lesion is considered unresectable unless a vascular graft is considered.

All Type II resections necessitate anterior tibial artery ligation; Type I resections, by contrast, usually allow preservation of that artery. A Type II resection may also require sacrifice of the peroneal artery. The anterior tibial artery passes directly anteriorly through the interosseous septum, tying the vascular complex down and preventing mobilization. Applying traction on the popliteal artery, a simple maneuver, permits visualization of the anterior tibial artery origin. The anterior tibial artery and the two accompanying veins may then be ligated and transected, allowing the popliteal and posterior tibial arteries to fall away from the posterior surface of the mass. Completion of the vascular dissection proceeds distally.

### Excision of the Anterior and Lateral Musculature, Extra-articular Tumor Resection

The anterior and lateral musculature and the overlying deep fascia are excised. A Type I resection preserves these muscles as well as the branches from the peroneal nerve. The origin of the anterior muscles from the shaft of the tibia is transected by electrocauterization. The distal level of transection is at the musculotendinous junction. The lateral collateral ligament and the biceps
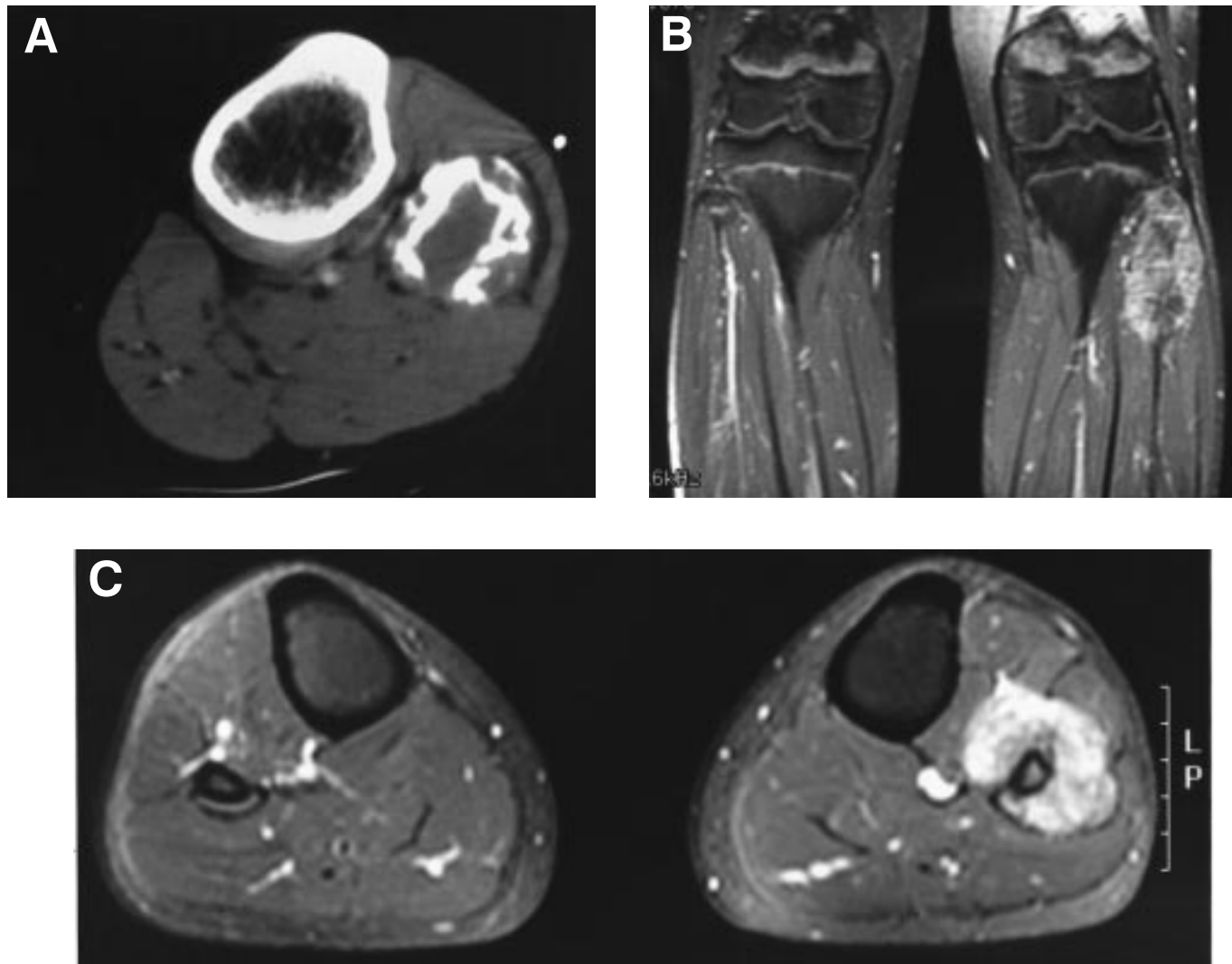


**Figure 32.4** (**A**) Computed axial tomography of the proximal fibula showing an intermediate-grade fibrosarcoma with cortical breakthrough and extraosseous extension. **B** and **C** are coronal and axial magnetic resonance images of the proximal fibula, respectively, showing a high-grade osteosarcoma with cortical breakthrough and extension to the anterior and lateral compartments of the leg.
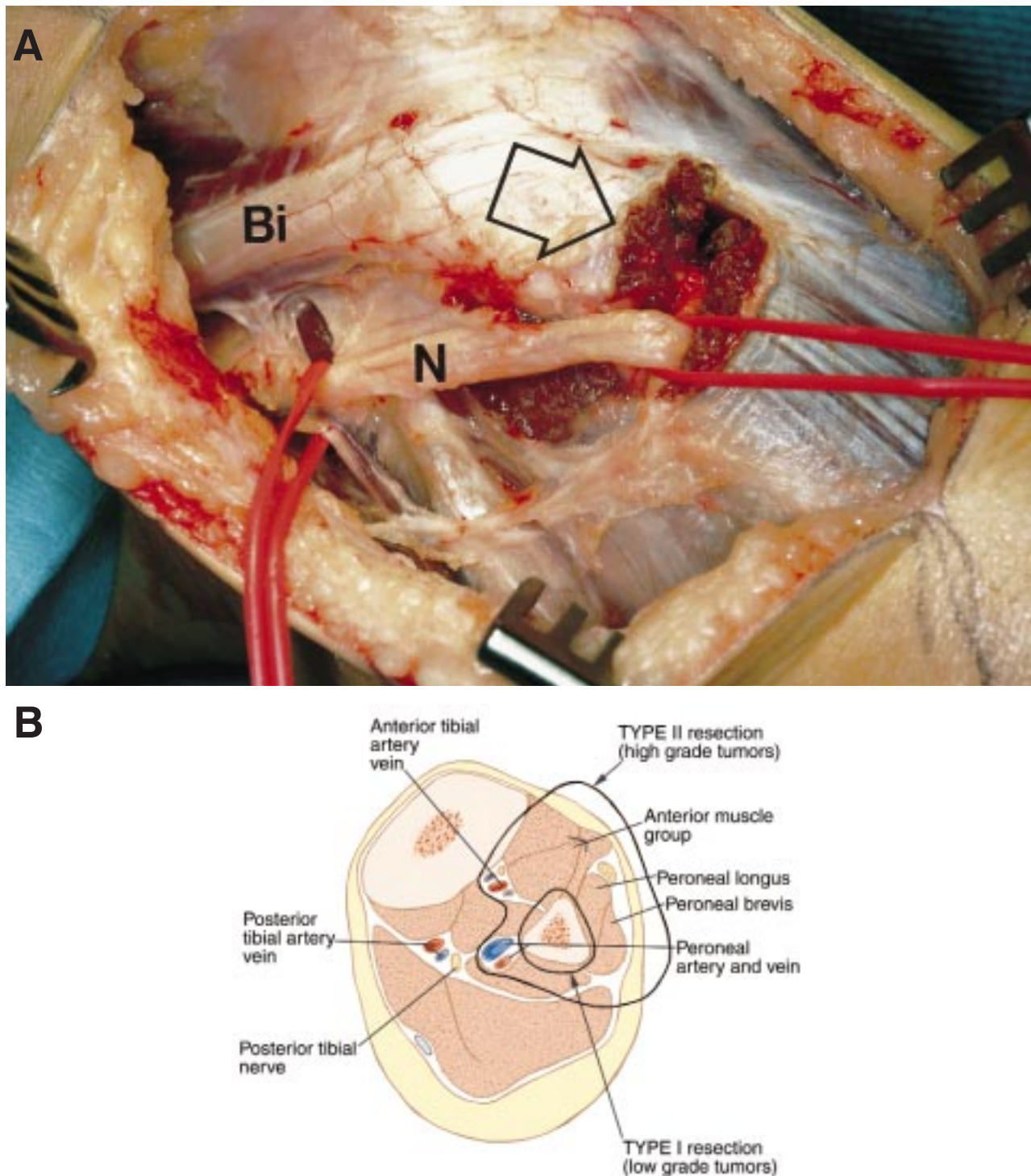
**Figure 32.5**    (**A**) Intraoperative photograph showing the peroneal nerve (N) as it enters the peroneus longus tunnel (open arrow). This tunnel has been opened to show the course of the nerve around the base of the fibular head. The biceps tendon (Bi) inserts on the fibular head away from the peroneal nerve. Vessel loops on the peroneal nerve are used to provide gentle traction for the dissection of the nerve branches as they circumnavigate the fibular neck. (**B**) Cross-sectional anatomy of the proximal leg showing Type I and Type II resections. A Type I resection (for low-grade tumors of the proximal fibula) includes the proximal fibula with a cuff of all adjacent soft tissues attaching to it. The major nerves and vessels, including the peroneal nerve, are preserved. Type II resection (for high-grade tumors) is a combination resection of the proximal fibula with the peroneal nerve, peroneal muscles, the entire anterior compartment musculature of the leg, and the anterior and (often) peroneal vessels. Figure 32.5A (above) is the first step in a Type I resection with preservation of the peroneal nerve.
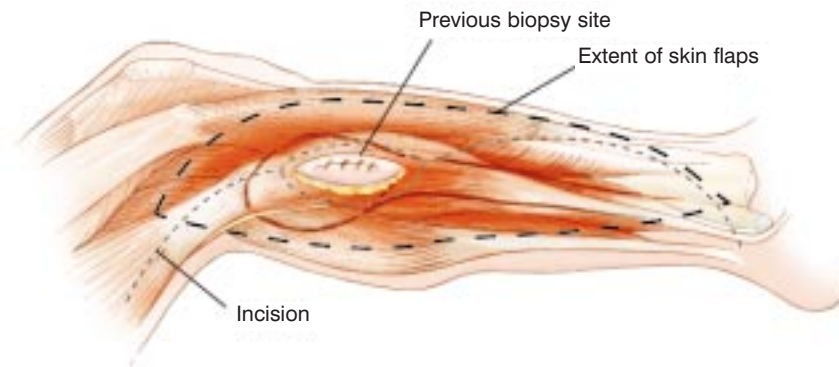
**Figure 32.6**  Incision and flaps. The incision extends from the biceps above the knee joint, over the mid-portion of the fibula, anteriorly to the crest of the tibia, and then curves posteriorly and distally to the ankle. This permits large anterior and posterior fasciocutaneous flaps to be developed. The anterior compartment of the leg, the lateral compartment (peroneal musculature), and the superficial posterior compartment consisting of the lateral gastrocnemius and soleus muscle are exposed. Through this incision the popliteal space and trifurcation can be explored. The biopsy site is removed en-bloc with the tumor mass.
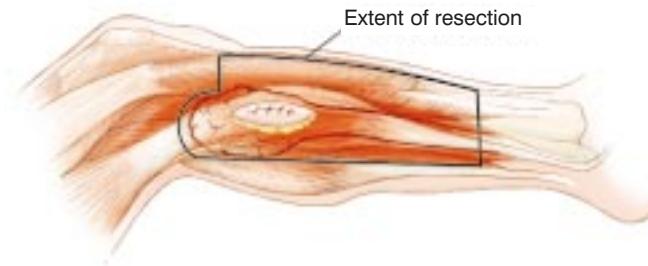


**Figure 32.7**  Extent of resection. A Type II resection includes the proximal two-thirds of the fibula, the anterior tibial muscle compartments, and a portion of the soleus muscle which attaches to the fibula as well as the peroneal nerve.
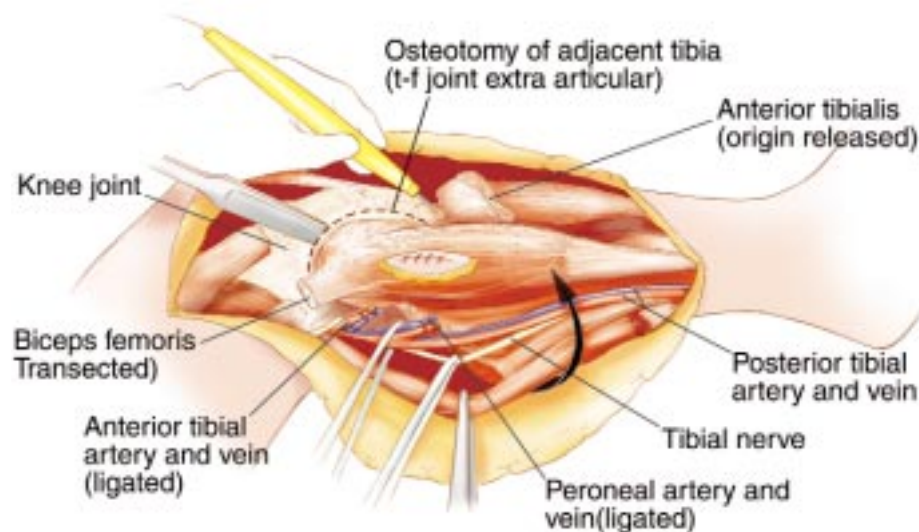


**Figure 32.8**  Schematic diagram of the Type II fibular resection. The resection of the proximal fibula begins with exploration of the popliteal trifurcation posteriorly. The anterior tibial artery and often the peroneal vessels are ligated if there is a large posterior component to the tumor. A resection then proceeds with release of all of the muscles attaching to the fibula posteriorly, with preservation of the tibial nerve. The peroneal nerve is ligated prior to its entry into the peroneus longus muscles. All of the tibialis muscles are released off of the tibia border and are retained on the specimen side. The final step is an extra-articular disarticulation of the tibiofibular joint with a curved osteotome or a high-speed burr, removing a portion of the lateral tibial plateau with the joint en-bloc. Care must be taken to avoid entering the knee joint.

tendon are released 2.5 cm proximal to their fibular insertion. The anterior tibiofibular capsule can then be identified; its posterior aspect lies under the popliteus muscle. While Type I resection preserves the tibio-fibular joint, it is resected during a Type II resection. A semicircular cut is made directly through the popliteus muscle toward the posterior aspect of the lateral condyle. Following osteotomy, it is important to inspect the lateral tibial condyle. If the knee joint capsule was exposed and opened, it should be repaired in order to prevent a potential synovial fistula. The capsule is reattached through drill holes to the posterior lateral condyle with nonabsorbable sutures. Three weeks of immobilization with the knee kept in 30° of flexion are recommended. Immobilization is not necessary following a Type I resection. Further reconstruction consists of repairing the lateral collateral ligament with nonabsorbable suture and closing and covering the exposed tibia and soft-tissue defect. This is best achieved by rotating the lateral gastrocnemius muscle into the defect. The lateral gastrocnemius muscle can be easily rotated to cover the defect after the muscle is released close to its origin through the muscle substance and from its tendinous insertion at the distal end. Care must be taken to preserve its proximal pedicle, the lateral sural artery, throughout the dissection (Figure 32.9).

Because they entail sacrifice of the common peroneal nerve, Type II proximal fibula resections result in a plantar flexion of the foot. In order to avoid the need for an ankle–foot orthosis, the authors pull the peronei and extensor digitorum longus tendons, thereby advancing the foot to a neutral position, and tenodese the tendons to the tibial shaft using a 3 mm Dacron tape (Figure 32.10).

## MID-FIBULAR (INTERCALARY) RESECTION

Intercalary fibular resections are performed using the middle and distal portions of the utilitarian incision. The same guidelines used for proximal fibular resections apply to intercalary resections, i.e. the covering layer of muscles can be spared following resection of benign-aggressive and low-grade malignant lesions that are not accompanied by cortical breakthrough and soft-tissue extension. High-grade malignant tumors, by contrast, necessitate en-bloc resection of the muscle layer.

To expose the mid-fibula, the fascia is opened in line with the utilitarian incision. The plane between the peronei and the soleus is defined by the septum separating the two compartments. The soleus is detached from its fibular origin and, along with the
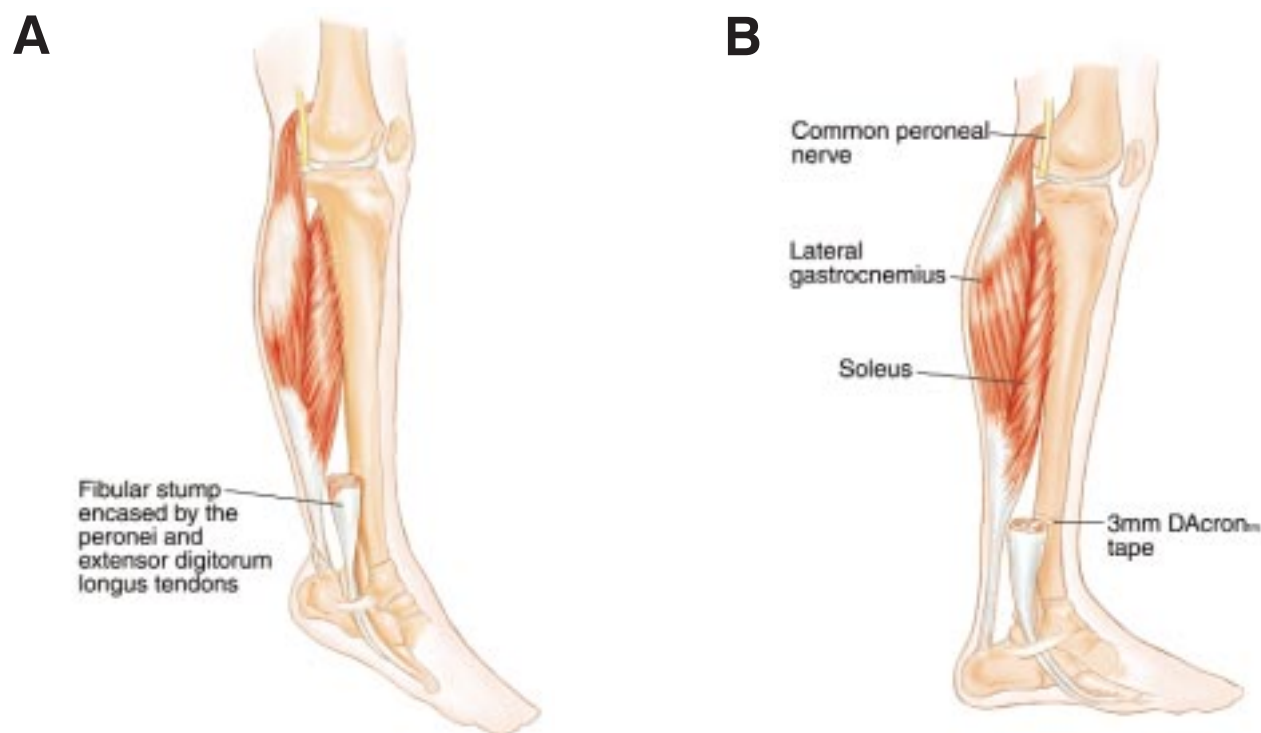


**Figure 32.9**   Surgical defect following a Type II resection. (**A**) Plantar flexion of the foot is common following Type II proximal fibula resection. (**B**) Tenodesis of the peronei and the extensor tendons to the tibial shaft with the foot in neutral position is routinely performed using a 3 mm Dacron tape. This procedure prevents plantar flexion and obviates the need for an ankle–foot orthosis.
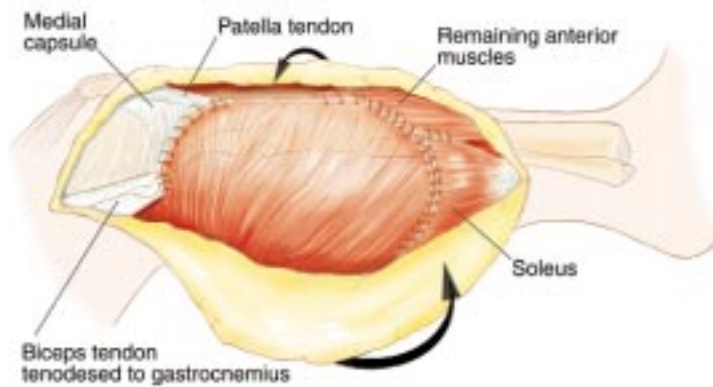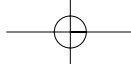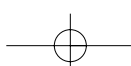
**Figure 32.10**   Lateral gastrocnemius muscle closure. Following resection of the fibula and adjacent muscles, the defect is closed by rotating the lateral gastrocnemius muscle anteriorly to the deep fascia covering the exposed tibia. The gastrocnemius muscle is sutured to the deep fascia as well as to the soleus muscle distally, and along the lateral capsule of the knee joint. The biceps tendon is then tenodesed to the gastrocnemius muscle.

**A**



**Figure 32.11** *(right, see also following page)*  A 45-year old woman presented with a 1-year history of constant pain along the lateral aspect of her leg. (**A**) Anteroposterior plain radiograph of the fibula showing fibrous dysplasia of the midfibula. Intercalary fibular resection, as revealed by (**B**) anteroposterior and (**C**) lateral photographs, resulted in complete resolution of her symptoms.
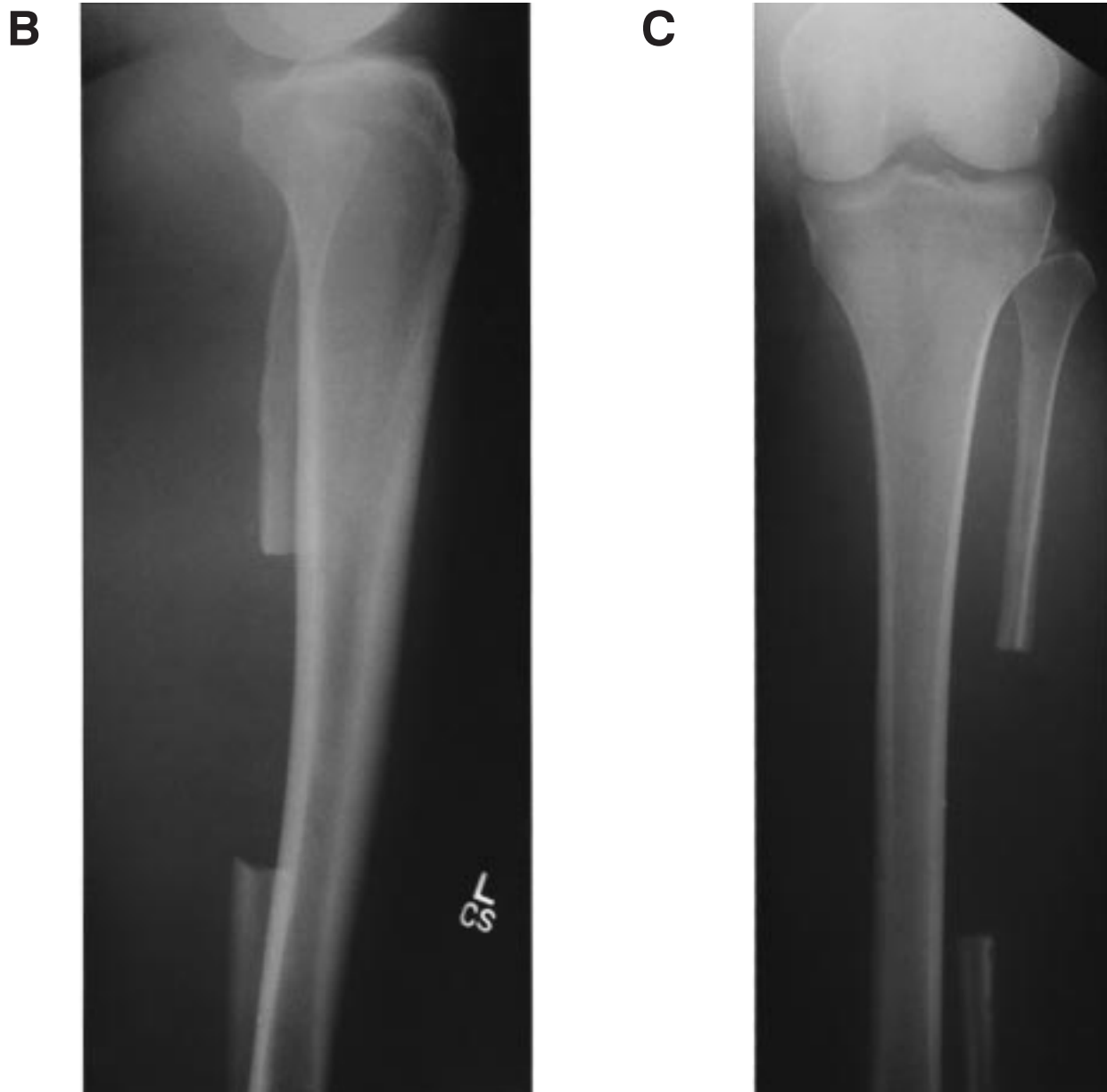
**B**



**C**



**Figure 32.11 B,C**

lateral gastrocnemius muscle, is retracted medially and proximally to reveal the posterior crest of the fibula (Figure 32.12). The flexor hallucis longus can be spared or resected, depending on the grade and local extent of the underlying tumor. The peronei are mobilized anteriorly, and retractors are positioned underneath the fibula. Resection is then performed at the level determined prior to surgery. Care must be taken not to damage the peroneal vessels, which are posterior and parallel to the fibula.

Proximal and intercalary fibular resections do not require osseous reconstruction. Distal fibular resections, which necessitate the sacrifice of a component of the ankle joint, do require reconstruction. The authors use the ipsilateral proximal fibula to reconstruct distal fibular defects. A Type I proximal fibula resection is performed, and the fibular head and neck are attached to the tibial plafond with a screw and to the fibular shaft with a plate (Figure 32.13).

## POSTOPERATIVE MANAGEMENT

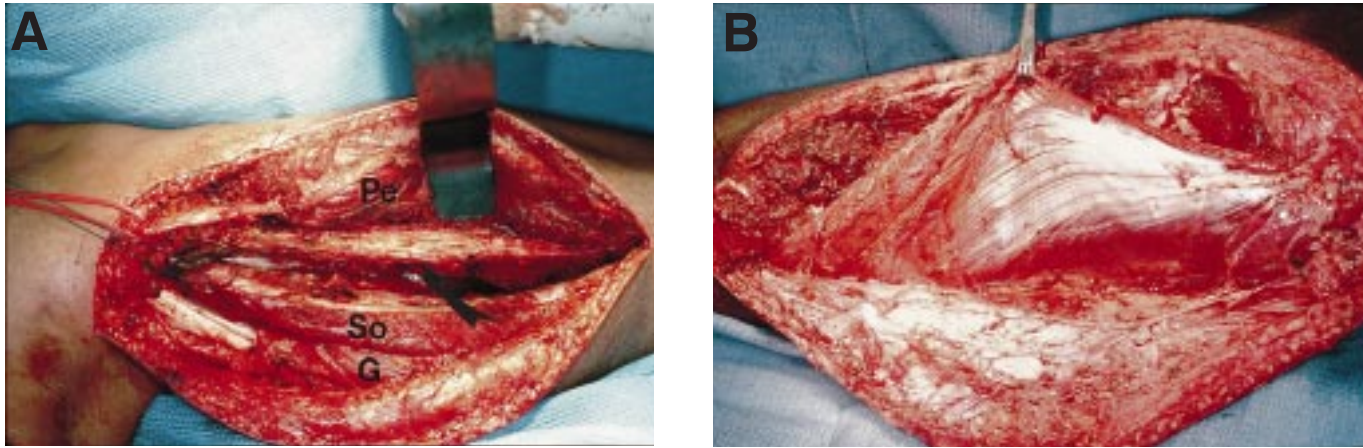Suction drainage and prophylactic antibiotics are continued for 3–5 days. The leg is kept elevated during this

**Figure 32.12**   (**A**) Operative photograph of intercalary fibular resection. The soleus (So) is detached from its fibular origin and, along with the lateral gastrocnemius muscle (G), is retracted medially and proximally to reveal the posterior crest of the fibula (arrow). The flexor hallucis longus can be spared or resected, depending on the grade and local extent of the tumor. The peronei muscles are mobilized anteriorly, retractors are positioned underneath the fibula, and the resection is performed at the level determined prior to surgery. (**B**) The lateral gastrocnemius muscle is rotated laterally to close the surgical defect.
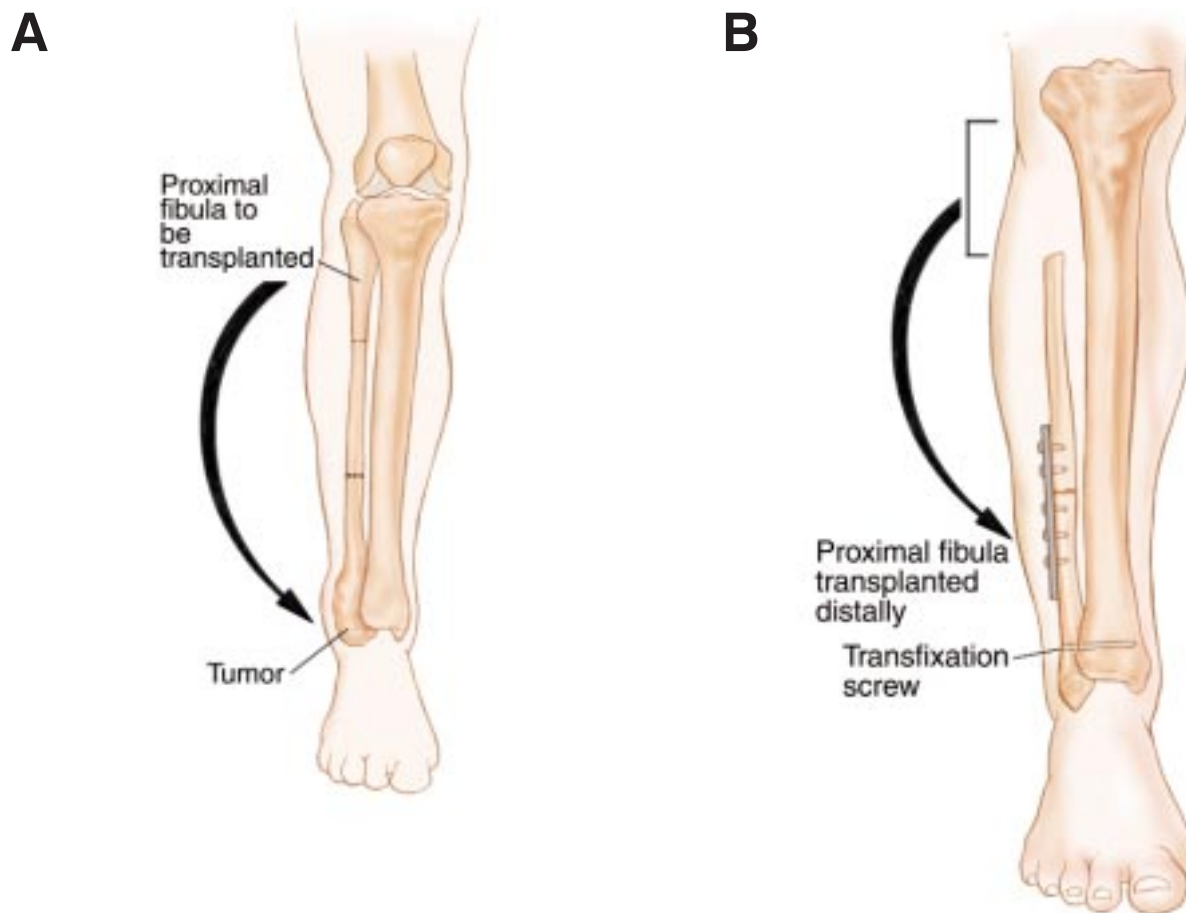


**Figure 32.13**   (**A**) A curved incision around the lateral maleolus is used for distal fibular resections. (**B**) The authors use the proximal fibula to reconstruct the distal fibular defect; a Type I proximal fibula resection is performed, and the fibular head and neck are attached to the tibial plafond with a screw and to the fibular shaft with a plate. This technique has permitted increased ankle stability following distal fibular resections.

**Figure 32.14**   Postoperative radiograph following a Type II fibular resection. *Note:* a portion of the adjacent lateral tibial metaphysis has been removed (arrow) indicating an extra-articular proximal tibio-fibular joint resection was performed.

time. The extremity is immobilized in 30° of flexion for 2–3 weeks to allow soft-tissue healing and posterior capsule reattachment. Full weight-bearing is allowed after the limb has been immobilized in a cast. An ankle–foot orthosis is required following a Type II resection unless tenodesis of the anterolateral compartment to the tibial shaft has been performed.

### SUMMARY

Fibular resections require close familiarity with the biology of the underlying disease, the surgical anatomy of the leg, and the expected functional outcome. High-grade sarcomas of the proximal fibula necessitate resection of the covering muscle layer, tibiofibular joint, and common peroneal nerve. These structures can be saved in most patients with benign-aggressive or low-grade malignant tumors. Proximal and intercalary resections do not require osseous reconstruction; distal fibula resections are reconstructed with the ipsilateral proximal fibula. The use of the lateral gastrocnemius flap for coverage of the surgical defect and tenodesis of the anterolateral compartment to the tibial shaft are recommended as a means of stabilizing the foot in a neutral position.

# References

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