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Below-knee Amputation

Paul Sugarbaker, Jacob Bickels and Martin Malawer

OVERVIEW

Below-knee amputation is usually performed for extensive high-grade soft-tissue sarcomas of the lower leg, ankle or foot. Primary bone sarcomas rarely occur in these locations. Extensive infiltration of tendons and ligaments and around bones in this area may preclude a functional extremity following wide excision. The almost universally good functional outcome of below-knee amputation makes it an even more realistic option. General considerations that were discussed for above-knee amputation also apply for below-knee amputation; design of skin flaps is determined by the anatomic extent of the individual tumor and the large majority of these patients heal uneventfully. Emphasis is on flap design and meticulous dissection, use of continuous epineural analgesia, myodesis of the major muscle groups of the distal tibia, meticulous wound closure, and application of a rigid dressing.

INTRODUCTION

Below-knee amputation was traditionally performed for malignant tumors of the ankle and foot (Figure 23.1). In recent years improvements in preoperative chemotherapy and adjuvant radiation therapy have led to better local tumor control and allowed the execution of limb-sparing surgery in the majority of these cases. Still, approximately 20–25% of these tumors are treated with an amputation. This rate, which is much higher than the 5–10% amputation rate for tumors around the knee, stems from two significant anatomic–biological differences between the two locations. First, thee are no true anatomic compartments around the ankle and foot. The lack of thick fascial septa and anatomic compartments results in wide spread of any tissue pathology that otherwise would be confined to a narrower space. Second, the anatomic distance between functional compartments (i.e. flexor and extensor tendons and muscles) is short, and most extensive tumors violate both compartments. These two facts explain why tumors of the ankle and foot grow diffusely and cross different regions of the foot early in their growth, and why wide excision usually results in a severe loss of function.

There are no strict guidelines, indications, or contraindications for below-knee amputations; decisions are made on a case-by-case basis. As with any other amputation, all patients are evaluated for a limb-sparing surgery, and amputation is performed only wen this option has been ruled out. General indications for below-knee amputation are extensive, infiltrative high-grade sarcomas of the lower extremities (Figure 23.2), extensive involvement of the lower leg with bone sarcoma (Figure 23.3), or recurrent disease that lacks a local excision option (Figure 23.4). In these cases negative margins cannot be attained without extensive removal of tendons, muscles, nerves, and other anatomic structures that provide function to the lower extremity. Major vascular or nerve involvement, however, is rarely an indication for an amputation, because of that distal point of the extremity, vascular and nerve structures are widely separated by bony structures. Rarely will amputation be initially performed for a low-grade tumor. The efficacy of adjuvant radiotherapy allows one to perform marginal excision of these tumors, which are unlikely to result in metastatic disease.

Figure 23.1 Below-knee amputation is performed for malignant tumors of the distal leg, ankle, and foot.

PREOPERATIVE EVALUATION

Complete staging studies are performed as described in Chapter 22. A preoperative consultation with a prosthetist and rehabilitation specialist, as well as a psychologist who is familiar with these patients, is extremely useful. The purpose of these sessions is to describe to the patient the various stages of recovery and the expected functional outcome. In addition, a meeting between the patient and a below-knee amputee from the same age group, and with the same underlying disease, is very encouraging. Because of the elective nature of these procedures, it is usually not difficult to arrange these consultations.

SURGICAL TECHNIQUE

The level of below-knee amputation in patients with primary bone sarcomas of the distal leg must be carefully determined. Below-knee amputation has to achieve

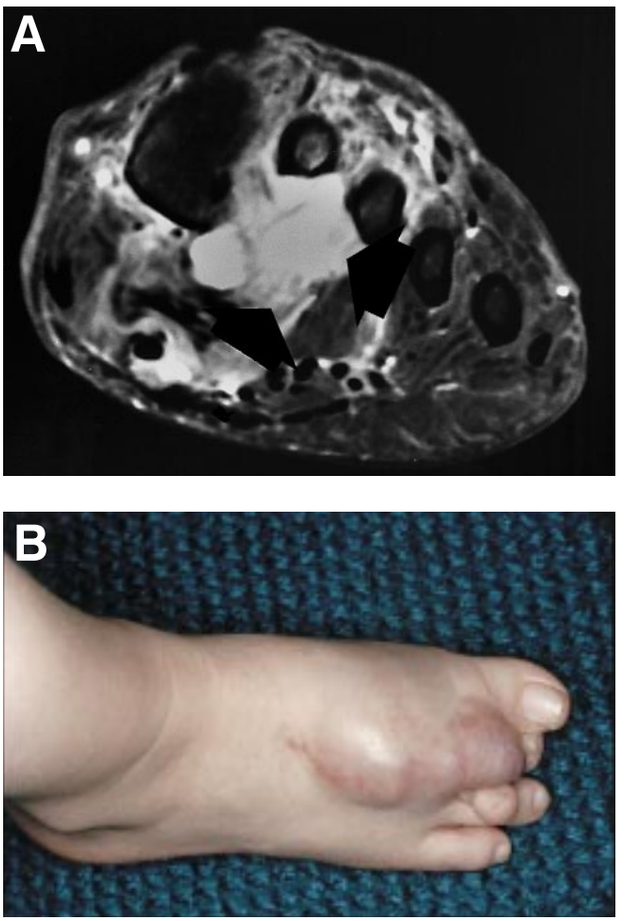

Figure 23.2 (**A**) T2-weighed magnetic resonance image of the foot, showing extensive high-grade malignant fibrous histiocytoma (MFH) of almost the entire plantar aspect of the foot. Extension to the dorsal aspect of the foot is noted. (**B**) Extensive high-grade angiosarcoma of the dorsal aspect of the foot.

wide margins, and the medullary and extraosseous extent of the disease must therefore be evaluated. If necessary, amputation at a higher level must be performed. A good outcome generally requires that the limb be of adequate length, i.e. at least 3 cm below the tibial tuberosity. It also requires good soft-tissue coverage and a rounded contour of the distal end of the tibia with a residual fibula several centimeters shorter (Figure 23.5). As a rule, the longer the stump, the better the functional outcome. Because the majority of tibial elongation during skeletal maturation stems from the proximal tibia, almost any level of below-knee amputation is acceptable in a child. With growth, a functional stump will be obtained, and adaptation of the patient is generally excellent. High below-knee amputation is acceptable for tumors below the level of the musculotendinous portion of the gastrocnemius muscles.

Figures 23.6–23.10 illustrate the execution of below-knee amputation and provide a detailed explanation of each step. Emphasis is on flap design, use of continuous epineural analgesia, myodesis of the major muscle groups of the distal tibia, meticulous wound closure, and application of a rigid dressing.

Because of the subcutaneous location of the tibia, and the relatively small volume of muscle in the anterior compartment of the leg, the authors prefer to use a long posterior flap, rather than the classic "fish-mouth" flaps. Amputations, especially in young patients, can be extremely painful; for this reason the installation of an epineural catheter and the use of continuous epineural analgesia are strongly recommended. The authors have extensive experience and excellent results with this modality, the technique of which was described in Chapter 22.

Functional myodesis of the major muscle groups of leg to the distal tibia will provide excellent soft-tissue coverage to the stump and allow an adequate range of motion of the knee joint. To help prevent wound-healing problems resulting from preoperative chemotherapy, and avoid any delay in administration of radiation therapy or postoperative chemotherapy, wound closure must be meticulous. Hematomas and seromas must be avoided by the use of adequate closed-suction drainage and the application of a rigid dressing.

REHABILITATION

Successful rehabilitation of a below-knee amputee requires a coordinated, multidisciplinary effort. It may take up to 6 months before the definitive prosthesis can be fitted. There are three stages in the recovery process. The goal of the first stage is to ensure optimal wound healing and conditioning of the residual limb through physical therapy in order to prepare it to accommodate the stress of the prosthesis. A special "stump-shrinker" sock is used to decrease the swelling, and a simple knee immobilizer or custom splint is used to avoid the development of a flexion contracture around the knee joint. The use of a removable splint allows participation in physical therapy, protection from contusion, and easy inspection of the wound. The use of an immediate postoperative prosthesis carries high risk with little gain; i.e. the risks of wound problems and pain-management difficulties outweigh the psychological benefits.

The second stage begins when the wound has healed and the residual limb is nontender and able to withstand the stress of a temporary prosthesis. This stage is dedicated to the gradually increasing wear time and enabling the patient to tolerate the prosthesis-

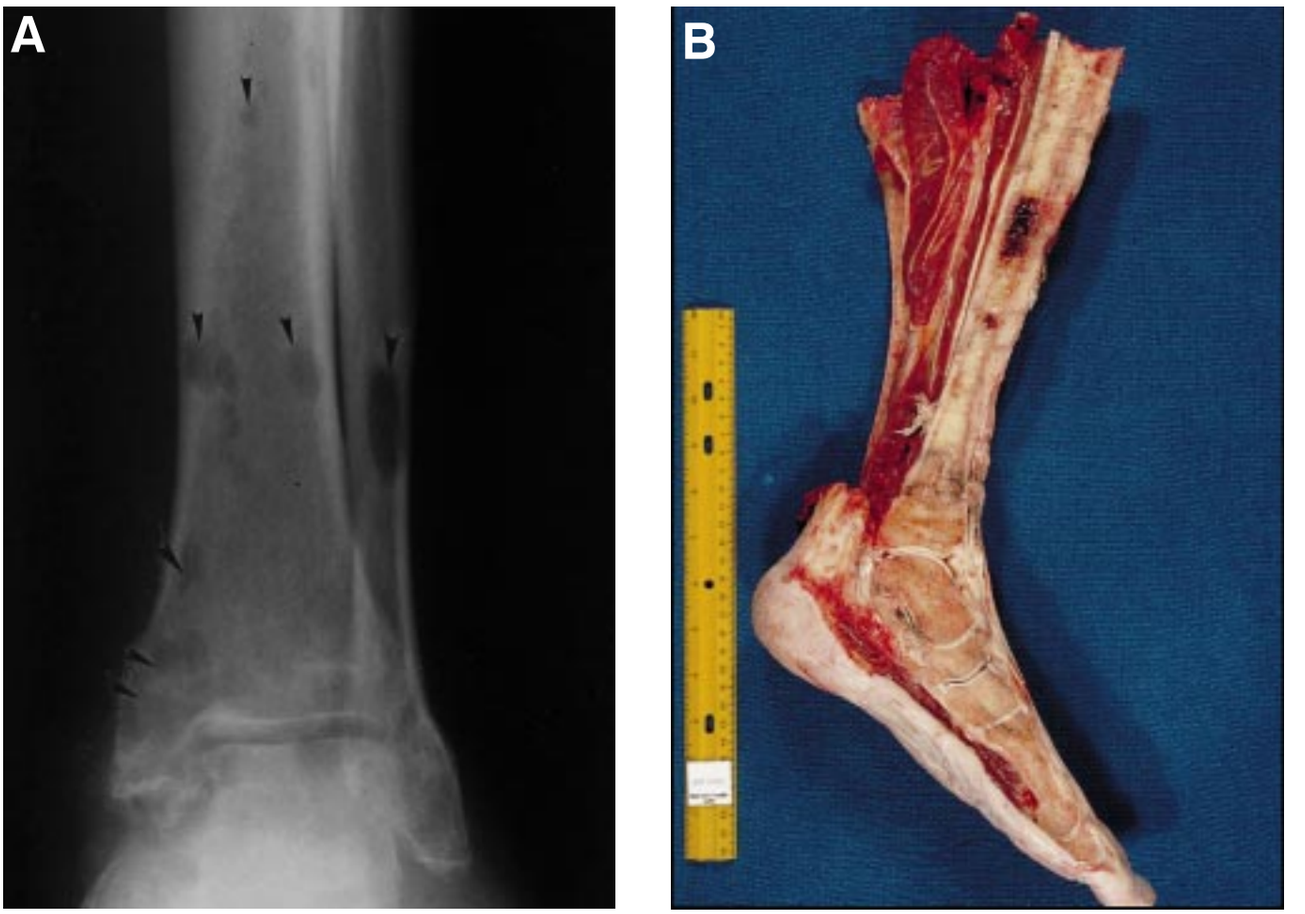

Figure 23.3 (**A**) Angiosarcomatosis of the leg and foot. Note the multiple lytic lesions of the distal third of the tibia, fibula, and talus. (**B**) Sagittal cut of the surgical specimen. The entire tibial medulla is occupied by the tumor. Note the anterior cortical breakthrough and soft-tissue extension.

Figure 23.4 *(left)* Locally recurrent carcinoma of the foot. This local recurrence, the patient's fifth, occurred only a few months following the previous resection within the irradiated field.

Figure 23.5 Osteotomy of the tibia and fibula. The longer the stump, the better the functional outcome. We routinely resect the fibula several centimeters proximal to the tibial osteotomy in order to construct a tapered and beveled stump.

Figure 23.6 Position and incision. The patient is supine on the operating table with slight elevation of the operated extremity. The skin incision is carefully marked out to provide well-vascularized and nonirradiated skin, as well as an underlying bulk of muscle tissue for coverage of the stump.

related stress on the residual limb. The patient wears the stump-shrinker sock whenever the prosthesis is not being worn. This prevents changes in the volume of the residual limb due to dependency, which might lead to prosthetic fit problems and pain. The second stage may last from 3 to 6 months. It ends when the patient is able to wear the prosthesis all day without pain and significant changes in the volume of the stump. Fitting of the definitive prosthesis, which is the third stage, takes place at that point. Premature efforts to fit the prosthesis will often require fabrication of a new socket because of volume changes in the residual limb. Selection of the components of the definitive prosthesis is dependent on patient-specific factors such as age, weight, type of daily activities, and desired sport activities.

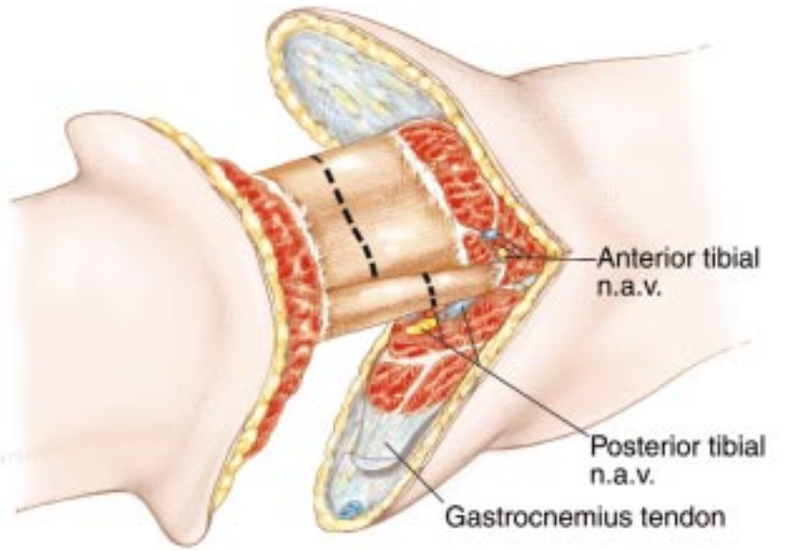

Figure 23.7 Soft-tissue dissection and bone transection. The skin, superficial fascia, and subcutaneous tissue are cut perpendicular to the skin surface. The muscles are transected with electrocautery. Vascular structures are ligated in continuity and divided. Major blood vessels are suture-ligated. Nerves are meticulously dissected and gently pulled 2 cm out of their surrounding muscle mass. They are double-ligated with monofilament nonabsorbable suture. The large muscle groups are tapered so that they can be secured over the cut ends of the bone. Osteotomy of the tibia is shown in Figure 23.5. If the amputation is performed for a primary bone sarcoma, intramedullary content from the edge of the stump should be sent for frozen section to verify that it is free of tumor. If the amputation is performed for a soft-tissue sarcoma, soft tissues from the surgical margins should be assessed in a similar manner. Following transection, the tibial edge should be beveled. As discussed in Chapter 22, the use of continuous epineural analgesia is highly recommended.

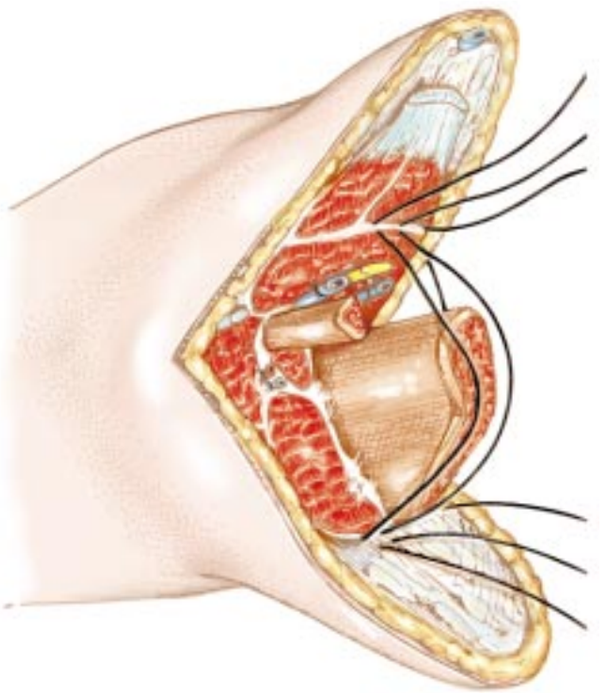

Figure 23.8 Myodesis over the distal tibia. Using drill holes in the distal tibia, the major muscle groups are attached to the bone with 3 mm Dacron tape. Muscle layers are closed over the entire circumference of the bony stump.

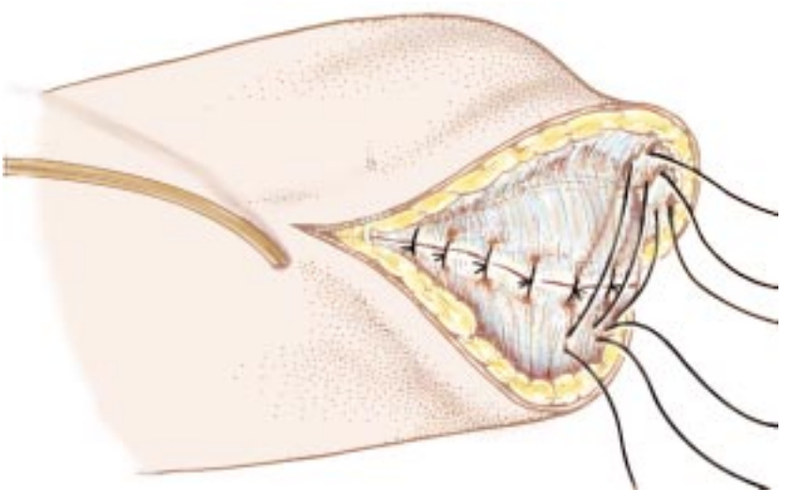

Figure 23.9 Closure of superficial fascia and skin over suction drains. It is important that the superficial fascia be meticulously closed. Skin flaps should be closed without any remaining skinfolds. Closed-suction drains are placed. These should not be sutured in place because they will be removed from beneath the rigid dressing within a few days.

Figure 23.10 Rigid dressing. A rigid dressing is used in the early postoperative period to reduce swelling and prevent flexion contracture. Early ambulation is begun in most patients.