CHAPTER 45

BASIC PRINCIPLES AND TECHNIQUES OF FOREFOOT AMPUTATIONS

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Locomotion is the primary function of the lower extremity, and foot preservation is a major goal of the podiatric surgeon. According to published statistics over 20,000 amputations are performed annually on diabetic patients. Of these, 65% are leg amputations, 31% toe amputations, and 4% foot amputations. Of these amputations, 30% will die during the first three years, and 60% after five years.

Since the amount of energy expended in walking increases as the level of amputation progresses proximally, foot preservation becomes one of the major goals of the podiatric surgeon. As podiatrists, we are all aware of the excessive load placed on the remaining contralateral limb after leg amputation.

PURPOSE

The purpose of this presentation is to present the principles and techniques of forefoot amputation surgery emphasizing the intraoperative procedures and outlining the surgical techniques of digital amputations, hallux amputations, first metatarsal amputations, and lesser metatarsal amputations.

One of the major objectives of forefoot amputation is to maintain a functional stump which is capable of adequate wound healing, thus preventing the need for additional amputation at a more proximal level. Generally, most investigators agree that the more distal the site of amputation, the less energy that is required in walking, and the more functional the postoperative result.

GENERAL PRINCIPLES OF TECHNIQUE IN FOREFOOT AMPUTATIONS

Most surgeons agree on certain basic principles in amputation surgery in order to obtain a successful result. These may be categorized in the following anatomical groups: skin, muscle function, nerve endings, blood vessels, the bony prominences, and infected tissues.

Skin

Great care must be taken by the surgeon to minimize trauma to the skin, by avoiding unnecessary instrumentation or excessive handling of the tissues. In amputation surgery, anatomical dissection with separation of tissue layers is avoided in order to preserve the deep circulation and viability of the tissues. During surgery, consideration must be given to each tissue encountered and the role that it would play in providing function following amputation. It is imperative that all diseased tissue is excised, and that no dead space remains prior to final skin closure. It is important to determine whether the wound should be packed open, or closed by secondary healing, delayed prior closure at a later date, or closed primarily at the time of surgery.

If the wound is closed it should be with a nonreactive material, usually a monofilament suture, with no tension on the wound edges. The flap should have adequate length for appropriate closure without tension, which requires surgical planning. In the presence of peripheral vascular disease, the surgery must be meticulous with delicate handling of all tissues. Strict aseptic technique should be utilized to avoid wound infection which may lead to a disastrous result. In the presence of serious infection and ischemia, packing the wound open usually provides a lower rate of wound complications or sepsis. Staging the time and level of amputation is imperative. In the presence of infection, appropriate antibiotics given preoperatively and postoperatively help assure appropriate healing of the wound edges.

Preservation of Muscle Function

Preservation of muscle function is extremely important when a transmetatarsal or midfoot amputation is performed. When the insertion of the tibialis anterior and peroneus brevis tendons are violated during a midfoot amputation, there is a high incidence of muscle imbalance which commonly presents as an equinus or equinovarus

deformity. In a severe foot infection, there may be extensive necrosis of major muscle function necessitating a more proximal amputation such as a below the knee or above the knee amputation.

Nerve Endings

Painful and disabling stump neuromas are common following amputation. All sensory nerves encountered should be sharply incised at a proximal level, protecting them from any potential external force such as the patient's prosthesis or shoe. The incised nerve ending should be allowed to retract proximally to avoid reinnervation of the skin or distal anatomical structures.

Blood Vessels

Hemostasis is essential during amputation surgery to avoid complications of hematoma formation which may increase the risk of wound dehiscence and secondary infection. Blood vessels should be cauterized or ligated, however, efforts should be made to limit the amount of absorbable suture utilized in the wound. Frequent lavage with cool sterile water during the operation and the placement of the extremity in slight Trendelenburg assists in the hemostasis. A tourniquet is rarely used. However, if it is used, it is deflated before final wound closure or packing to assure adequate hemostasis.

Bony Prominences

Adequate surgical planning is necessary to assure that no remaining bony prominences are evident in potential weight-bearing areas. Appropriate power instrumentation and remodeling of any irregular surfaces prior to closure are essential.

Removal of Diseased Tissue

It is essential that all necrotic or diseased tissue is removed at the time of amputation to prevent further complications from infection, or in more severe cases necrotizing fasciitis. Appropriate intraoperative cultures including gram stain, culture and sensitivity for aerobes and anaerobes, acid fast, and fungal cultures are imperative. In the presence of osteomyelitis, appropriate bone specimens should be sent for definitive diagnosis by pathology as well as bone cultures to isolate the infective organism. It should be noted that when the patients are on preoperative antibiotics, the cultures may show no growth, even in the presence of chronic disease. When removing diseased bone, adequate margins must be obtained proximal to the diseased area to assure adequate resection. The importance of appropriate bone biopsy and bone culture cannot be over-emphasized.

SURGICAL TECHNIQUE FOR FOREFOOT AMPUTATIONS

Digital Amputations

Digital amputations are one of the most common forefoot amputations performed. However, in the presence of peripheral vascular disease or diabetes, digital amputations more commonly progress to a more proximal amputation. In the presence of peripheral vascular disease and in the absence of wet gangrene, in many instances the surgeon may allow the toe to undergo auto-amputation.

As discussed previously, it is essential to determine the adequate level of amputation to maintain a functional stump that is capable of adequate wound healing. Surgical incision planning is important. The author prefers the use of a distal Symes type of incision, beginning just above the midline of the toe medially and laterally, running distally to the base of the proximal phalanx. It is then extended distally both medially and laterally, joining plantarly and distally in a transverse fashion, joining both ends of the previous dorsal incisions. This assures adequate closure over the metatarsal head. It is essential that the incisions be carried deep and directly to bone with no attempt for anatomical dissection with separation of layers. All nerves and tendons should be incised sharply proximally, and allowed to retract proximally. Figure 1 demonstrates the dorsal approach to digital amputation, and Figure 2 the plantar approach to amputation of the great toe or lesser toes.

A common complication of digital amputations is subsequent amputation of remaining digits due to progression of the disease process, or a surgical result which may not provide the optimal result during gait.

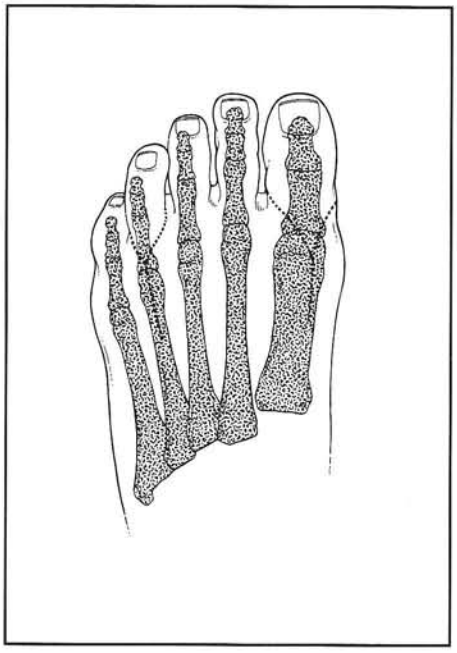

Figure 1. The dorsal approach to digital amputation.

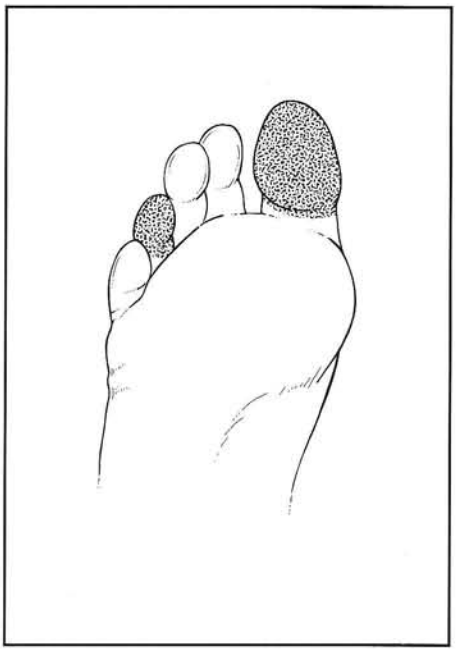

Figure 2. The plantar approach to amputation of the great toe or lesser toes.

Hallux Amputation

The following case presentation demonstrates the surgical technique of a total hallux amputation. A 70-year-old male presented with a chief complaint of a non-healing painful plantar ulceration of the right hallux for approximately eight months duration. Persistent redness and drainage with increased skin temperature were noted. Significant past medical history included polycythemia and a history of myocardial infarction one-and-a-half years prior. The patient had been an insulin-dependent diabetic for one-and-a-half years, and had a previous amputation of the left hallux one year ago for a similar problem. Upon admission to the hospital, the patient was febrile, and was diagnosed as having osteomyelitis of the right hallux with ascending cellulitis.

Incisional planning involved a dorsal medial approach to the first metatarsophalangeal joint, extending over the base of the proximal phalanx (Fig. 3). Skin incisions were carried directly into bone, avoiding any soft tissue undermining or dissection. All nerves and tendons were resected proximally, followed by disarticulation of the metatarsophalangeal joint and submission to pathology for report. The usual intraoperative cultures were obtained, and the wound was thoroughly irrigated with copious amounts of sterile water, followed by primary closure of the wound with a non-absorbable synthetic suture. Excessive tension on the skin margin was avoided. Since adequate hemostasis was provided, no tubes or drains were necessary. Dry, sterile, compressive dressings were applied, followed by redressing of the wound in three days, and discharge from the hospital with instructions for strict non-weight bearing on crutches.

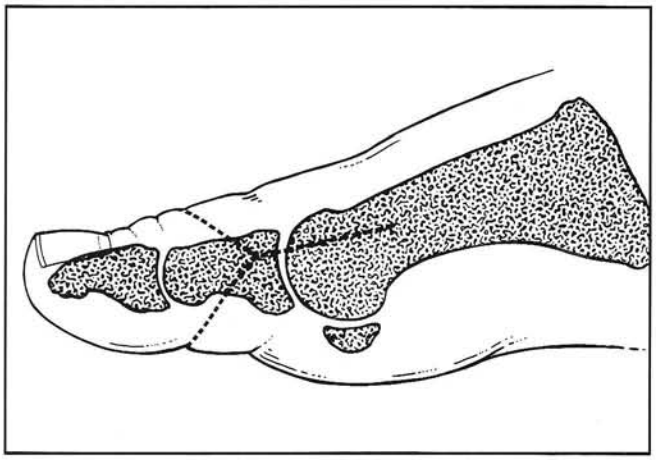

Figure 3. Incisional planning for hallux amputation.

First Ray Resection

Resection of the first ray is considered when infection extends proximally to the metatarsophalangeal joint. A 65-year-old insulin-dependent diabetic was admitted to the hospital with a diagnosis of ascending cellulitis and osteomyelitis first ray of the left foot. The patient's chief complaint at the time of admission was pain, swelling, and redness involving the left foot, with nausea, fever, chills, and a loss of appetite. Significant past medical history included insulin-dependent diabetes, hypertension, coronary arterial disease, and post-coronary artery bypass surgery. Following seven days of IV antibiotics, the patient was deemed ready for surgery.

Figure 4. The surgical approach for the procedure was through a linear excision extending from the metatarsal cuneiform articulation distally to the metatarsophalangeal joint, with medial and lateral extension encompassing the great toe and joining on the plantar aspect of the great toe.

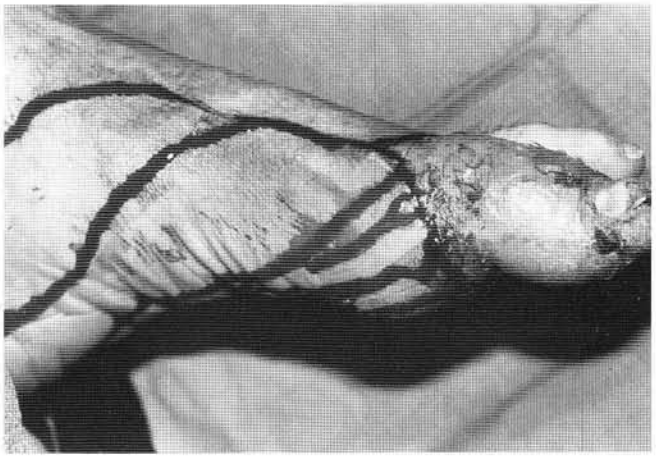

Figure 5. Adequate bleeding was noted at the time of the skin incision, which was a strong indication that the patient had adequate circulation for appropriate healing of the wound following amputation.

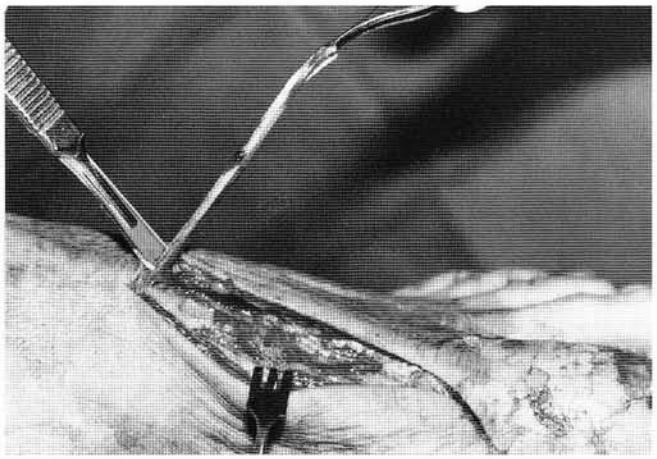

Figure 6. Both of these incisions were carried directly from skin to bone without any undermining of the tissues. The extensor tendon was identified and incised proximally and allowed to retract.

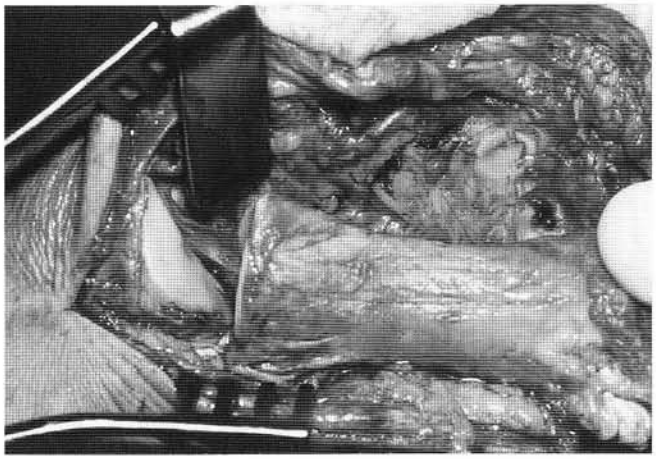

Figure 7. The first metatarsal was identified and disarticulated at the first metatarsal cuneiform joint.

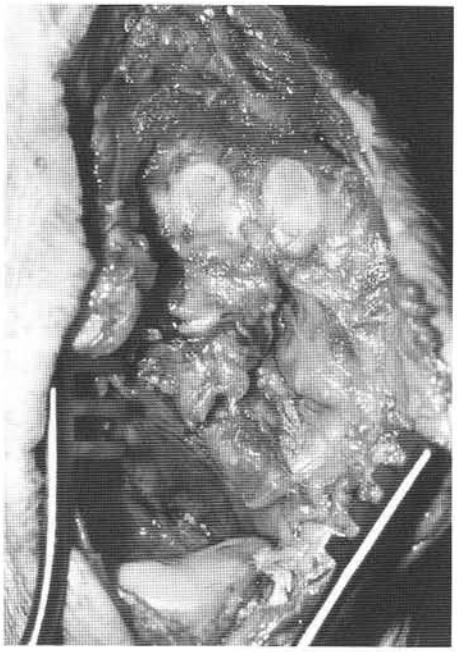

Figure 8. The sesamoid apparatus was identified and excised.

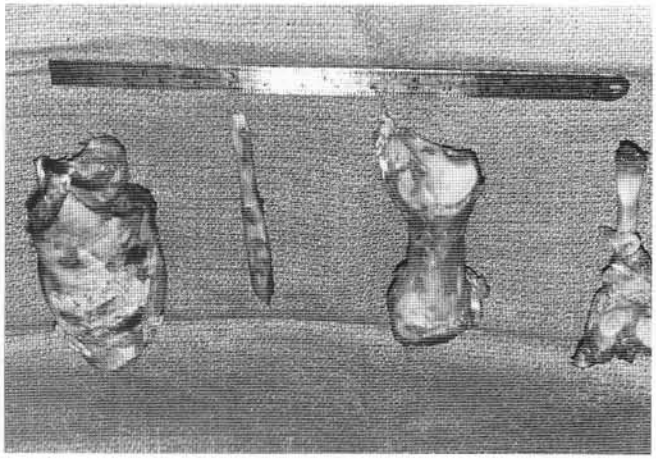

Figure 9. Specimens submitted to pathology included the diseased hallux, extensor tendon, first metatarsal and flexor tendon, and sesamoid apparatus.

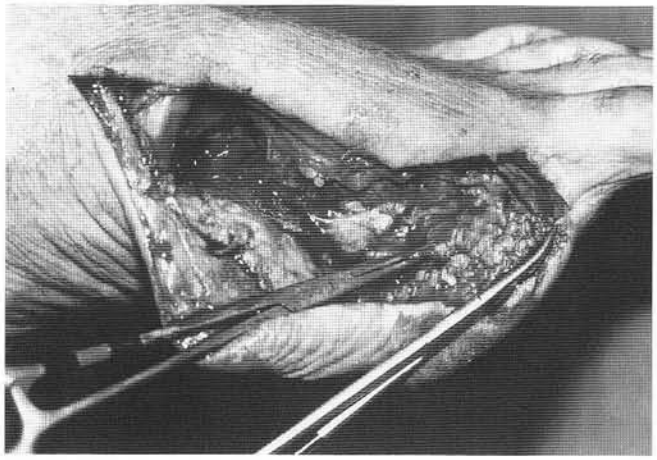

Figure 10. Hemostasis was provided by electric cautery prior to packing of the wound.

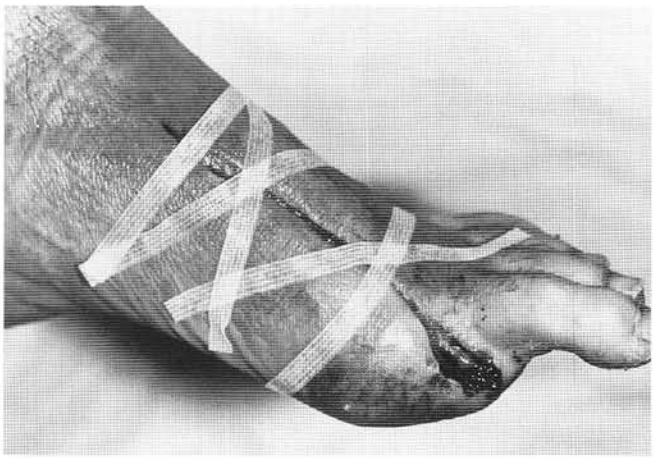

Figure 11. The area was not closed primarily, and was packed with sterile gauze. Redressing and gradual closure was performed over a three week period with steristrips, following daily irrigations and three negative cultures.

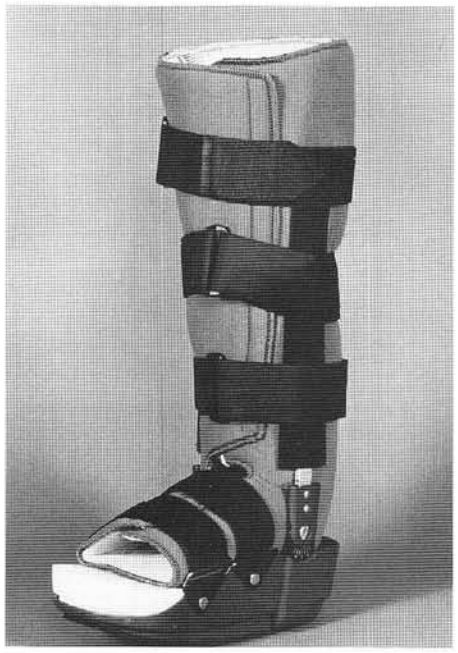

Figure 12. The patient remained non-weight bearing until the wound was closed in seven weeks. Partial weight bearing in a padded Cam walker was then instituted.

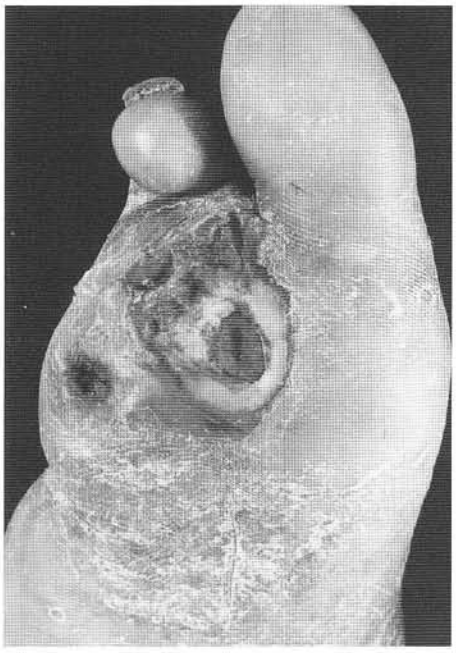

Figure 13. A 40-year-old male, insulin-dependent diabetic for fifteen years, was admitted to the hospital with a non-healing ulceration with cellulitis of the right foot. The patient's previous surgical history included amputation of portions of the third, fourth, and fifth metatarsals of the right foot two years prior to admission.

Lesser Ray Amputations.

Lesser ray amputations, like first ray amputations, are indicated when the infection extends into the web space and involves the metatarsophalangeal joint. Resection of the first metatarsal and lesser metatarsals may lead to a functional imbalance requiring additional surgery, due to increased pressure under the remaining metatarsals. This common occurrence is demonstrated by the following case presentation, in which a lesser ray amputation contributed to additional ulcerations under the remaining metatarsal heads.

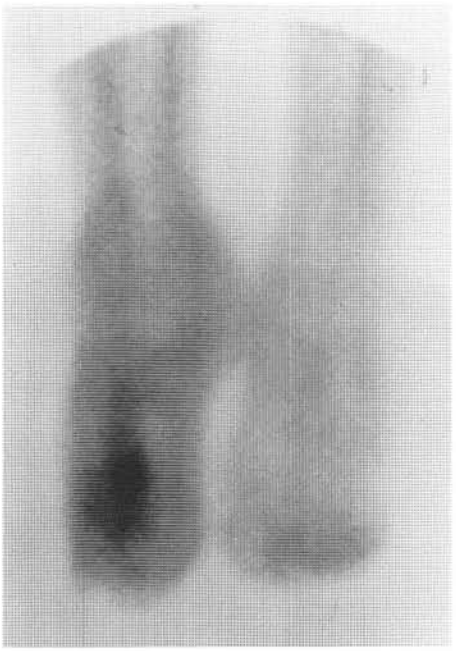

Figure 14. Bone scans were positive for osteomyelitis. Intraoperative cultures were taken as outlined previously.

Figure 15. Preoperative radiograph.

Figure 16. Postoperative radiograph.

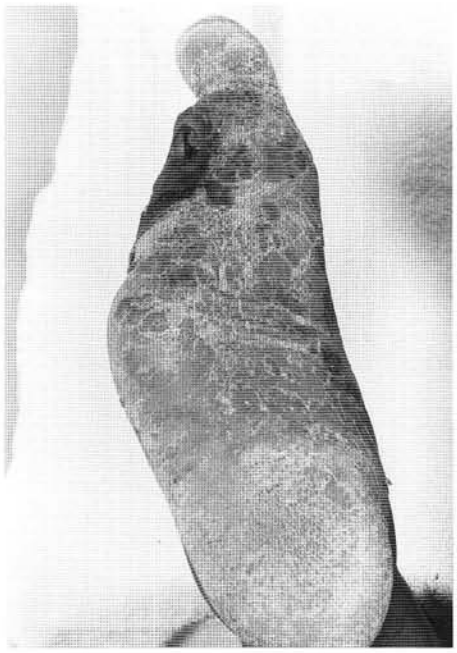

Figure 17. The patient was packed open at the time of surgery, followed by secondary healing.

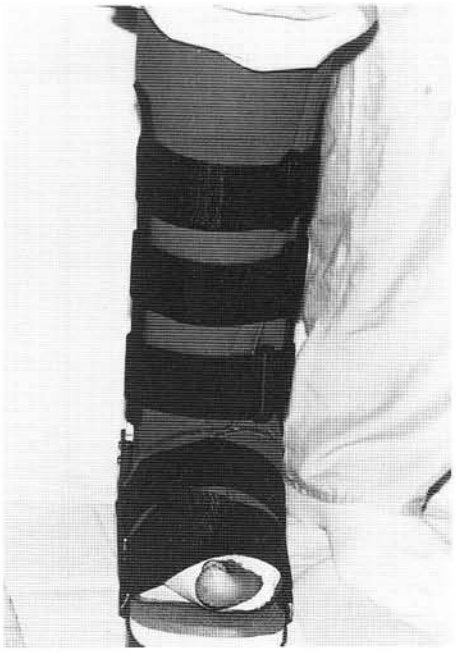

Figure 18. The patient became ambulatory in a Cam walker. Wound closure is noted three months postoperatively with no recurrence of infection.

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