CHAPTER 26

THE SYME'S AMPUTATION TECHNIQUE

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In his original paper describing amputation at the level of the ankle joint in 1842, James Syme laments at the number of limbs that he had previously cut off which might have been saved with an alternative procedure. Undoubtedly, this is a feeling shared by many foot and ankle surgeons whose own patients went on to either a below-the-knee or above-the-knee amputation for conditions that were not amenable to either forefoot or midfoot amputations. As a profession, we have become very adept at performing amputations in the distal and middle portions of the foot; yet, we often if not always, overlook the ankle amputation as a viable treatment option for our patients.

The reasons for under-utilization of the Syme's amputation are multifactorial; perhaps there is a perception that the wound healing is routinely difficult and prolonged, or that the residual stump is difficult to fit with a prosthesis. The authors believe that these concerns are misconceptions which are ill-conceived. The senior author (GVY) has successfully used this procedure in a variety of foot and ankle conditions that would have otherwise required a higher-level amputation. The purpose of this paper is to provide a brief overview of the Syme's amputation and a detailed description of the surgical procedure.

Following its introduction in the late nineteenth century, many surgeons largely discarded the Syme's level amputation. This was due mainly to the high number of wound failure rates and difficulty fitting the residual stump with a functional prosthesis. Since that time, two major technological advancements have helped to rekindle interest in the procedure. The first deals with the improved assessment of the various wound-healing parameters that help the surgeon to accurately predict the success of various amputation levels. The other development was an improvement in the materials, methods and techniques used to manufacture the prosthetic devices, providing an improved functional outcome for the amputee. Indeed, the procedure did not experience widespread popularity again until the late 1980s when Wagner reported excellent results with the procedure in an unpublished series of more than 500 patients. While this number may be met with some degree of skepticism, it emphasizes a strong commitment of the successfulness of the procedure. Since that time, numerous authors have affirmed the clinical utility of the procedure.

The Syme's amputation is indicated in patients suffering from a myriad of foot and ankle conditions including congenital deformity, trauma/crush injury, soft tissue and osseous sarcomas of the foot, neuroarthropathy, ischemia, nonhealing ulcerations, osteomyelitis and the fetid foot. (Figs. 1-3) Healing of the amputation has traditionally not been problematic in patients undergoing the procedure for reasons other than peripheral vascular disease and/or diabetes-related manifestations. However, in cases where the procedure is being performed for the latter entities, it is important to confirm the patient's healing capacity for this level of amputation. Such requirements have been outlined by Dickaut et al. and modified by Pinzur et al.

These wound-healing parameters are designed to predict whether the patient has the immunocompetence, nutritional status and arterial inflow to heal the amputation. Immunocompetence is predicted by a total lymphocyte count greater than 1500. A serum albumin level of greater than 3.0 gm/dl is required, assuring minimum tissue nutrition. Adequate blood flow for healing is indicated by an ABI > 0.5 and/or a transcutaneous oxygen concentration of at least 20-30 mm Hg. Lastly, optimization of the blood glucose level should be achieved.

In 1954, Spittler et al. described a two-stage approach to the Syme's amputation that was performed for infected war wounds. In the first stage the ankle joint was disarticulated and "loose closure" was performed. The second stage was performed 6 to 8 weeks later at which time the malleoli were removed through medial and lateral elliptical incisions, and the wounds closed. While the two-stage procedure is useful in cases with aggressive soft tissue infection, the one-stage

Figure 1A. Lateral radiograph of 25-year-old construction worker who sustained a severe crush injury. Numerous fracture dislocations of the midfoot and forefoot resulted. Due to the severe nature of injury to bone and soft tissue the foot was not salvageable.

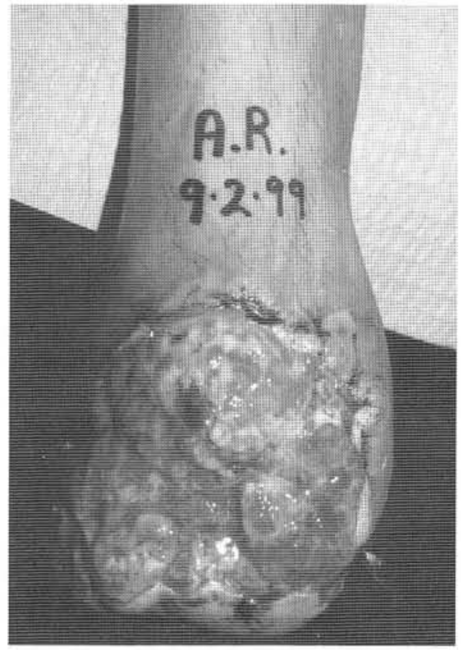

Figure 1B. Clinical photograph of the same patient who refused an above-the-knee amputation leaving him with a guillotine amputation at the midtarsal joint level. This was subsequently converted to a Syme's amputation.

Figure 2. Lateral radiograph of an insulin-dependent diabetic patient with severe neuroarthropathy complicated by underlying infection for several years. Because of numerous medical complications reconstructive surgery was not a viable option. Patient desired a Syme's amputation over a below-the-knee amputation, which was successfully performed, although a prolonged recovery process ensued due to wound healing complications.

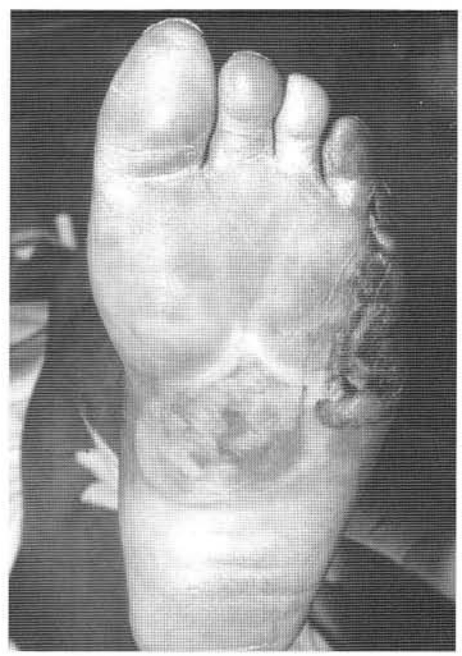

Figure 3. Fetid foot with extensive infection throughout the forefoot and midfoot areas involving bone and soft tissue. Following an emergent incision and drainage and partial amputation of the forefoot, a Syme's amputation was performed several days later, which healed uneventfully.

procedure is more often employed today. Typically, the one-stage procedure employs a fish-mouth incision about the ankle joint that preserves the plantar fat pad and allows for the disarticulation of the ankle joint and resection of the malleoli. One of the most important criteria for performing this procedure is the presence of a viable plantar fat pad of the heel, as this will be the ultimate weight-bearing interface between the tibia/fibula and prosthetic device. Various modifications to the standard incisional approach such as an anterior flap and manipulation of the incision to prevent "dog-ears" have also been described.

Postoperatively, the first several weeks are critical for the Syme's amputation. It is during this time that the wound is most at risk for dehiscence or sloughing. Hematoma and seroma formation are not uncommon occurrences, and must be dealt with appropriately. Meticulous hemostasis and the use of a surgical drain will help to minimize this occurrence. Inadvertent transection of the posterior tibial artery proximal to the distal aspect of the plantar flap may also compromise healing in the early days following the procedure. However, provided vascularity is maintained in the flap, predictable stability of the wound is typical following healing of the initial incision site. Late complications may also occur. They include mobility/improper location of the plantar fat pad, stump sensitivity, neuroma formation and phantom pain. These complications are not, however, unique to this type of amputation, but are associated with amputations in general.

SURGICAL TECHNIQUE

The surgical procedure is performed with the patient in a supine position. A calf or thigh pneumatic tourniquet may be used if no contraindications are present. A modified fish-mouth type incision that preserves the plantar fat pad is outlined about the ankle joint.(Fig. 4) The key landmarks for creating this flap are the inferior aspects of the malleoli. A point 1 cm inferior and 1 cm anterior to the tip of the lateral malleolus is marked. Next, a point 1.5 cm inferior and 1 cm anterior to the tip of the medial malleolus is marked. These points are then connected with a straight line drawn across the anterior of the ankle. It is important that the incision is not proximal to the distal aspect of the tibia. The plantar incision is oriented 90 degrees from the dorsal incision and drawn out across the plantar portion of the foot extending from the two points below the malleoli. The plantar incision should be carried out to the level of the calcaneocuboid joint to ensure adequate length of the plantar flap. When designing this flap, it is better to err in the direction of too long a flap, which can always be remodeled and shortened prior to skin closure. A flap which is too short will be problematic; wound closure will be difficult as will wound healing.

Although most of the literature advocates that the incision be made directly to bone, the authors prefer controlled-depth incisions. With this approach,

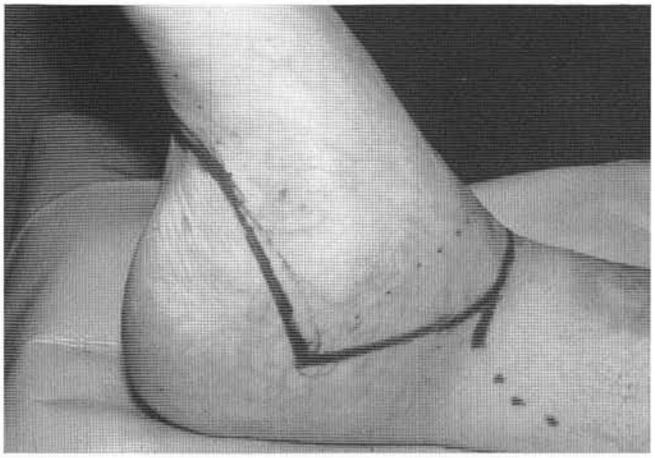

Figure 4A,B. Incision planning for a one-stage Syme's amputation of the patient shown in Figure 2. A slight modification was made laterally to allow excision of the lateral sinus tract and ulcer site.

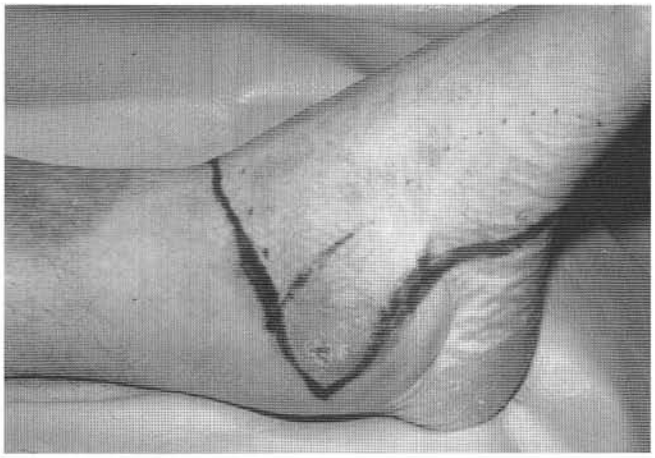

Figure 4B.

Figure 4C. A generous plantar flap is shown which was further modified when closure was performed.

improved hemostasis and anatomical dissection are achieved. The anterior incision is performed first. No undermining of the incision is performed. Dissection is carried down through the subcutaneous tissue to the level of the deep fascia. Superficial nerves crossing the anterior ankle joint (the saphenous, medial and intermediate dorsal cutaneous nerves) are identified, sharply transected and allowed to migrate proximally. The fascia is incised and the anterior tendons crossing the ankle joint are identified clamped, pulled distally, sharply transected and allowed to migrate proximally; these include the tibialis anterior, the extensor hallucis longus, the extensor digitorum longus and if present the peroneus tertius. The anterior tibial artery is identified and ligated. The deep peroneal nerve is cut under traction and allowed to migrate proximally. The anterior ankle joint capsule is now exposed.

The plantar incision is developed next. Again, the use of a controlled-depth incision is recommended. The incision is deepened through the subcutaneous tissues of the heel. On the lateral aspect, the peroneal tendons are identified, placed under traction, severed and allowed to retract proximally. The lateral dorsal cutaneous nerve and lesser saphenous vein are also transected and allowed to retract proximally following ligation of the vein. Dissection of the plantar flap is complete at this point once the plantar fascia is visualized.(Fig. 5)

Attention is then redirected to the anterior aspect of the ankle joint and the capsule is incised. The dome of the talus is now visualized. Disarticulation of the ankle joint is performed by transecting the medial and lateral ankle ligaments from the talus. Great care must be taken when transecting the medial collateral ligaments to avoid inadvertent transection of the posterior tibial artery, veins and nerve that lie in close proximity. Preservation of the artery at its maximal length is imperative as it is the sole blood supply to the plantar flap. At this point, blunt dissection of the posterior tibial neurovascular bundle should be performed to isolate the structure. The flexor tendons are isolated, placed under distal traction, transected and allowed to migrate proximally.

The foot is then plantarflexed and the posterior ankle joint capsule and peri-articular structures transected. Placing a bone hook into the talus and applying traction may accomplish increased exposure to the posterior aspect of the ankle joint. A large threaded Steinmann pin driven into the head of the talus and used, as a "joystick" to manipulate the talus is also a useful technique. (Fig. 6) The insertion of the Achilles tendon is identified and released from the calcaneus. It is important to remember that there is little subcutaneous tissue between the Achilles tendon and posterior skin. Repeated button-holing the skin in this area could doom the procedure to failure because of damage to the heel pad. For this reason, the authors use a combination of blunt and sharp dissection in this area. A Crego elevator may be useful in freeing the insertion of the Achilles tendon. Following transection of the tendon, further plantarflexion of the talus with the Steinmann pin allows subperiosteal dissection of the calcaneus from its underlying soft tissue attachments.

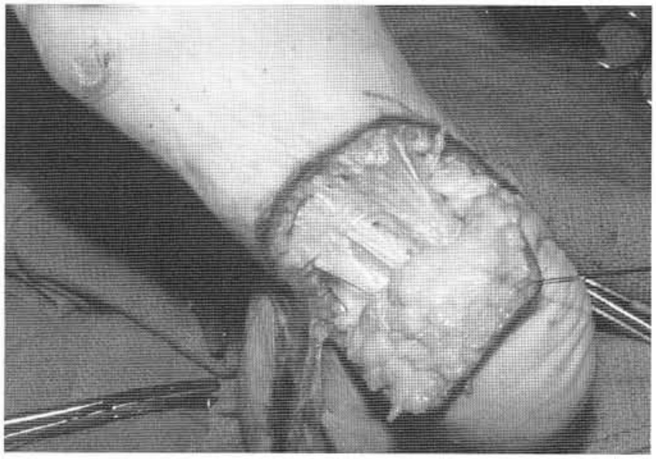

Figure 5. Dissection through the subcutaneous tissue of the plantar flap to the level of the plantar fascia. Note minimal disturbance of the plantar fat pad itself, preserving the hydraulic chambers of the pad for maximum function postoperatively.

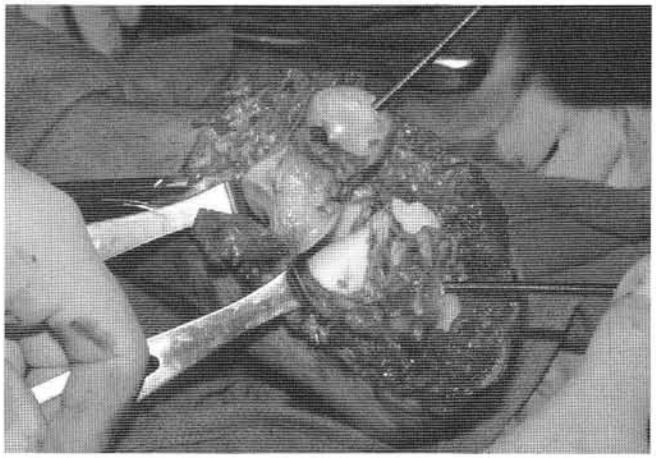

Figure 6. Extirpation of the talus and calcaneus of a different patient undergoing a Syme's amputation. Note the use of large threaded Steinmann pins to help maneuver the bones facilitating release of all soft tissue attachments. A large bone hook is also helpful when performing this part of the procedure.

At this point, the plantar fascia and underlying muscles are still attached to the calcaneus. Careful dissection is performed and the posterior tibial artery identified and traced as distally as possible. Ideally, the artery will be dissected out into its medial and lateral branches. The two branches of the posterior tibial artery are transected at the distal aspect of the flap and ligated. The posterior tibial nerve is placed under traction, transected sharply and allowed to migrate proximally.

With the flaps created, attention is then directed toward the resection of the tibia and fibula. Although the articular cartilage of the distal tibia may be retained and the malleoli simply resected, the authors prefer to use a larger power saw to resect both malleoli and the tibial plafond perpendicular to their long axis.(Fig. 7) These bone cuts are made parallel to the ground-supporting surface. The authors feel that removal of the articular cartilage from the distal tibia allows for better adherence of the plantar fat pad postoperatively. In cases of severe infection where spread to the tibia is of concern, the cartilage at the distal end of the tibia may be left intact. Further remodeling of the distal end of the tibia and fibula will be required to square off the osseous component of the stump. Remodeling of the lateral aspect of the fibular malleolus and the medial aspect of the medial malleolus will provide a narrower, more cosmetic stump that facilitates an optimal fit of the prosthesis.

Prior to closure, drill holes are made in the distal anterior aspect of the tibia, and the Achilles tendon and other remaining soft tissues are secured with nonabsorbable suture.(Fig. 8) This helps maintain decreased mobility and maintains the position of the fat pad at the end of the osseous stump.

If a tourniquet is utilized, it is deflated at this time and additional hemostasis achieved as necessary; while the smaller vessels respond well to electrocoagulation, the larger lumen vessels should be ligated. A large lumen closed-suction drain is introduced through a separate stab incision and placed in the area of the former ankle joint. The deep fascia and residual collateral ligamentous tissues are reapproximated over the remaining bone with absorbable synthetic suture of choice.

At this time, the plantar flap is advanced and debulking of the residual intrinsic musculature is performed as necessary.(Fig. 9) The subcutaneous tissues are reapproximated. The skin is closed with either simple interrupted sutures of 3-0 synthetic

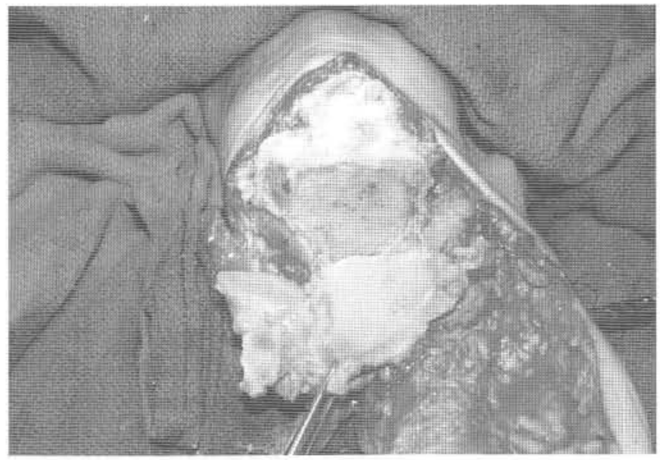

Figure 7. Resection of the malleoli and distal tibial plafond. Note the angular contouring of the medial and lateral aspects of the malleoli.

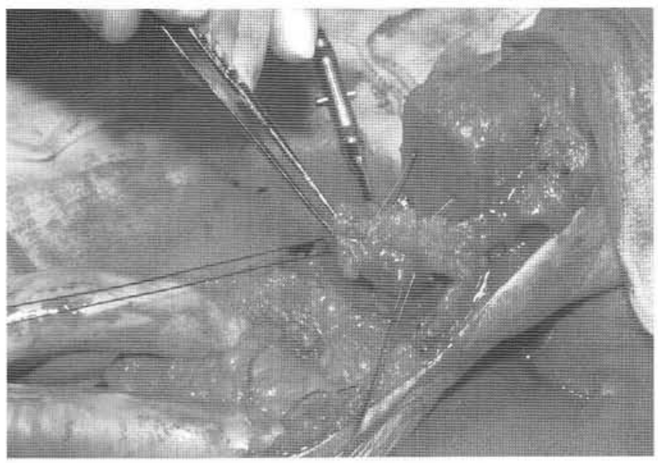

Figure 8. Reattachment and closure of the deep tissues over the distal osseous stump. The tourniquet has been released and additional hemostasis performed with electrocautery and ligatures.

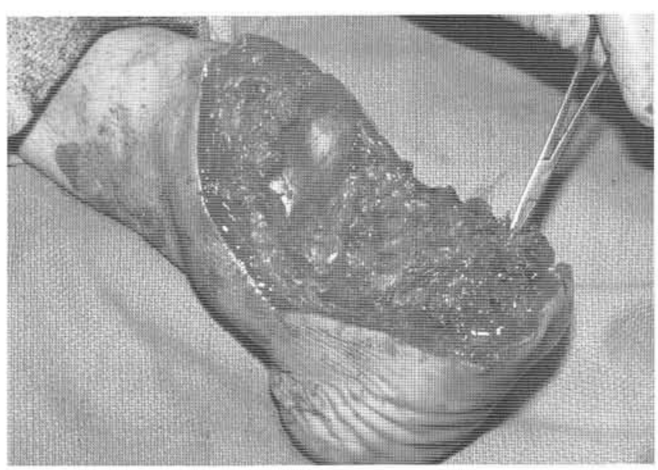

Figure 9. Typical appearance of the flaps and tissue after resection of all bone, transection of all tendons and neurovascular structures and release of the tourniquet. (Same patient as shown in Figure 1).

monofilament nonabsorbable suture of choice or, if preferred, skin staples.(Fig. 10) It is common for "dog-ears" to be present on the medial and lateral aspects of the incision; these can be remodeled, but should be done so with great care to avoid any compromise to the circulation of the plantar flap. It is common to allow these "dog-ears" to simply remodel with time on their own accord, or to return to the operating room for scar revision as needed.

Initially, the wound is dressed in a well-molded modified Jones compression dressing to minimize edema and hematoma or seroma formation.(Figs. 11-13) The patient is maintained non-weightbearing for a period of 3-6 weeks until the wound has completely healed. Sutures are generally removed around three weeks postoperatively. The patient can be placed in a short leg cast and weightbearing as tolerated is permitted. The cast is changed at two-week intervals until resolution of all soft tissue edema and stump shrinkage has occurred. Once the stump has stabilized, the patient is referred to an orthotist/prosthetist for the fabrication of a permanent prosthetic device.(Figs. 14-16)

With the prosthesis in place, minimal gait training is required. This is largely due to the fact that the heel pad has been preserved, along with some maintenance of normal proprioceptive pathways. Short periods of ambulation without the prosthesis, such as getting up to go to the bathroom in the middle of the night, are possible.

SUMMARY

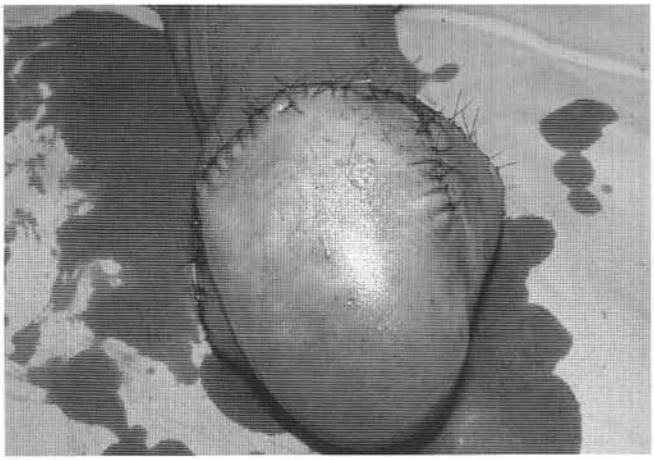

Figure 10. Appearance of the stump following closure. Note placement of the plantar heel pad beneath the distal aspect of the tibia.

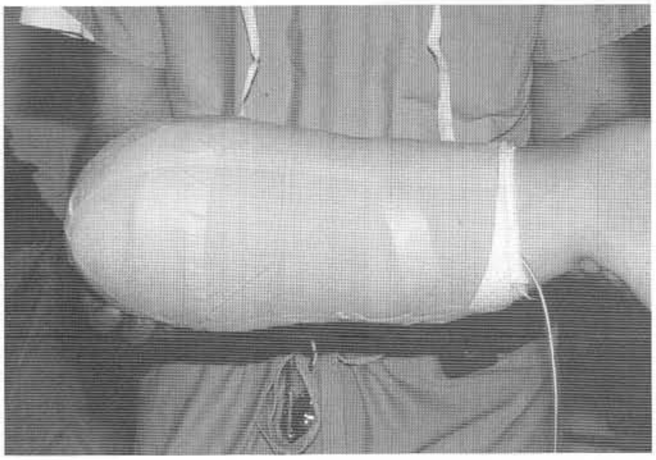

Figure 11. Appearance of the extremity following application of the first several layers of a modified Jones Compression Bandage to provide even compression and help to remodel the distal stump. This type of dressing along with a surgical drain helps to minimize hematoma formation.

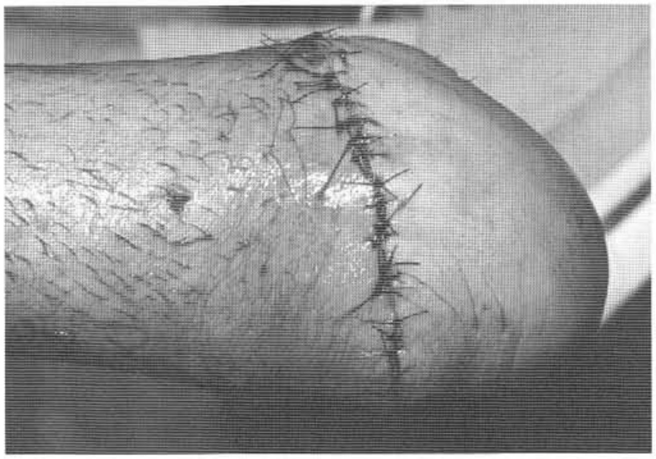

Figure 12. Appearance of the distal stump one week postoperatively. Continued compression is required to facilitate stump remodeling and tissue adaptation.

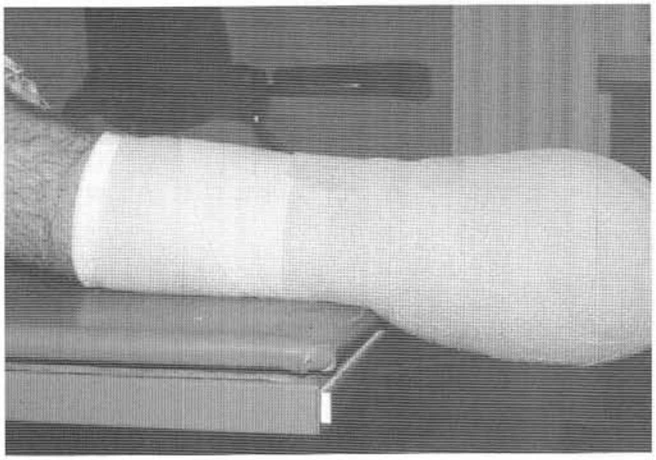

Figure 13. Modified Jones Compression Bandage employed for several weeks following a Syme's amputation. This includes several ace bandages and multiple layers of elastic cast padding held in place with self adhering elastic wrap on the outer layer to minimize mobility.

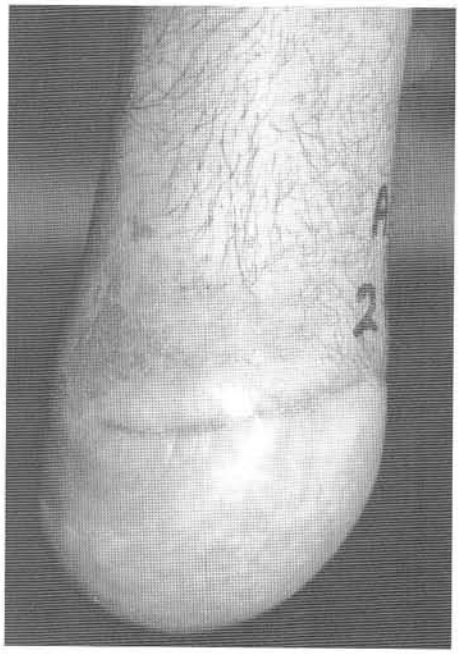

Figure 14. Clinical appearance of the stump 2 months postoperatively of the patient shown in Figure 1. No wound complications were encountered with healing postoperatively.

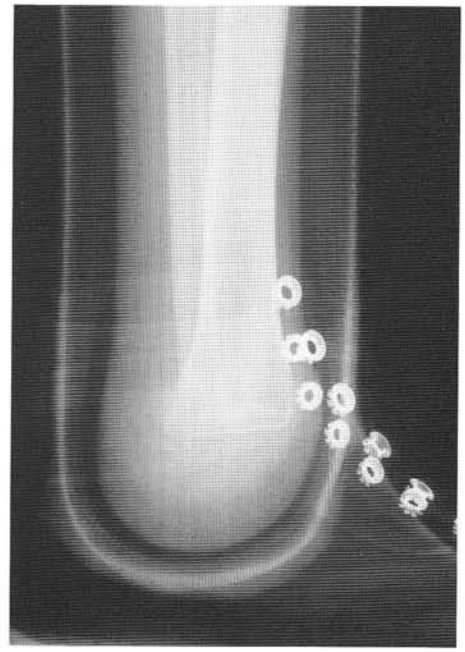

Figure 15A & 15B. Radiographs of the distal stump several months postoperatively. The x-rays were taken with the prosthesis being worn by the patient.

Figure 15B.

Figure 16. Clinical appearance of the stump of the patient shown in Figure 3 several weeks postoperatively just prior to fitting of the prosthesis. The incision healed without wound complication. No remodeling of the flaps was necessary.

The Syme's procedure has proven to be a valuable asset in the surgical treatment of severe foot and ankle deformities that would otherwise require a higher level of amputation. Predictable healing of this procedure can be expected if the proper wound healing parameters are met. The ankle amputation is more likely to be accepted by patients as opposed to higher-level amputations, although female patients may be disappointed with the final cosmetic appearance.

The procedure provides a more energy efficient gait than higher-level amputations and requires minimal postoperative physical therapy. The ease of rehabilitation is associated with the decreased energy demands required from this amputation level when compared to a more proximal level of amputation. In fact, ambulatory energy consumption has been shown to be only 10% higher than that of a non-amputee.

Advances in prosthetic materials and technology have enabled the creation of highly functional prosthetic devices. However, it is important to remember that creating a prosthetic device may require a higher skill of orthotist/prosthetist. Accordingly, the surgeon must ensure that a qualified orthotist/prosthetist is available to ensure a well-fitting, functional device.

Finally, one of the most beneficial aspects of the procedure is that patients can be weightbearing for short periods of time without the prosthetic device. The ability to perform this procedure may result in more efficient patient care. If this amputation should fail, it can be converted to a traditional below-the-knee or above-the-knee amputation without difficulty.

BIBLIOGRAPHY

Bowker JH, SanGiovanni TP: Minor and major lower limb amputations in persons with diabetes mellitus. In Bowker JH, Pfeifer MA, (eds) *Levin and O'Neal's The Diabetic Foot* 6th ed. Mosby, St. Louis, MO pp. 627-632, 2001.

Brodsky JW, Berke GM: Amputations and prosthesis of the foot and ankle. In Myerson MS, ed. *Foot and Ankle Disorders* WB Saunders, Philadelphia pp. 990-1005, 2000.

Durham JR: Extremity amputation for vascular disease. In Rutherford RB, (ed) *Vascular Surgery* WB Saunders, Philadelphia pp.1696-1699, 1989.

Pinzur MS, Morrison C, Sage R, Stuck R, Osterman H, Vrbos L: Syme's two-stage amputation in insulin-requiring diabetics with gangrene of the forefoot. *Foot Ankle* 11:394-396, 1991.

Pinzur MS, Smith S, Osterman H: Syme ankle disarticulation in peripheral vascular disease and diabetic foot infection: the one-stage versus the two-stage procedure. *Foot Ankle* 16:124-127, 1995.

Pinzur MS: Restoration of walking ability with Syme's ankle disarticulation. *Clin Orthop.* 361:71-75, 1999.

Robinson KP: Disarticulation at the ankle using an anterior flap. A preliminary report. *J Bone Joint Surg Br* 81:617-620, 1999.

Stuck RM: Syme's ankle disarticulation: the transmalleolar amputation. *Clin Podiatr Med Surg* 14:763-774, 1997.

Syme, J: Surgical cases and observations: Amputation at the ankle-joint. *Clin Orthop Rel Research* 256:3-6, 1990.