CHAPTER **48**

DELAYED PRIMARY CLOSURE TECHNIQUES FOR COMPLEX FOOT AND ANKLE WOUNDS

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GENERAL PRINCIPLES

Most surgeons agree on certain basic principles in the performance of delayed primary closure of wounds in order to obtain a successful result. These may be categorized in the following anatomical groups: skin, blood vessels, and diseased tissue.

Great care must be taken by the surgeon to minimize trauma to the skin, by avoiding unnecessary instrumentation or excessive handling of the tissues. During surgery, consideration must be given to each tissue encountered and the role it would play in providing function following delayed primary closure. It is essential that all diseased tissue be excised and that no dead space remains prior to final skin closure. It is important to determine whether the wound should be packed open, closed by secondary healing, delayed primary closure at a later date, or closed primarily at the time of surgery. When in doubt, the surgeon should leave the wound open.

If the wound is closed, a nonreactive material such as monofilament suture should be used, with no tension placed 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. In the presence of infection, appropriate antibiotics given preoperatively and postoperatively help assure appropriate healing of the wound edges.

Delayed healing may be avoided by proper wound closure techniques. The surgeon should avoid inversion of the skin margins to help prevent delayed healing or wound dehiscence. The optimal skin closure should be end-to-end skin closure with direct approximation of the skin margins of the wound and slight eversion of the skin margins. Sutures which are too tight and too few in number are also a potential cause of delayed healing which may lead to wound dehiscence.

The placement of the skin incision is important in preventing postoperative complications including delayed healing. Incisions placed at right angles to the relaxed skin tension lines are more likely to produce greater scar formation. In these instances, the choice of a horizontal or vertical mattress type suture is recommended to increase the tensile strength of the skin closure. The surgeon should plan incisions parallel to the relaxed skin tension lines if possible. Anatomic dissection and proper tissue handling is essential in preventing wound complications. The experienced surgeon will dissect layer by layer identifying the anatomical structures while preserving the neurovascular supply to the tissues.

The use of proper surgical technique, hemostasis, intraoperative irrigation, and proper compressive dressings help prevent the formation of dead space in the surgical wound. The dead space may become filled with blood. In addition to the immediate concerns regarding hematoma, coagulated blood will eventually be converted to a fibrous mass before full resorption. This tends to encourage excessive fibrosis at the surgical site. There are occasions when the surgeon may utilize relaxation incisions to prevent tension on the wound before final closure. The relaxation incisions are placed parallel to the primary surgical incision to allow primary closure of the surgical wound without necrosis or damage to the skin margins, hopefully preventing delayed healing and wound dehiscence. An alternative to the use of relaxation incisions in delayed primary closure is the use of tissue expanders inserted into the wound to allow expansion of the tissues. Following removal of the tissue expanders, the skin margins may then be approximated with less tension. Tissue expanders must be utilized with caution in the lower extremity, and are contraindicated in poor quality tissues.

Hemostasis is essential 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 hemostasis.

It is essential that any necrotic or diseased tissue be removed 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 culture are imperative.

CRITICAL ELEMENTS IN GAINING CONTROL OF THE HEALING PROCESS

RICE is an acronym for rest, ice, compression, and elevation. An understanding of the physiological effects of these basic elements will assist the surgeon in obtaining the most optimal surgical result.

Rest refers to physiological immobilization, which restricts movement. Resting an injured area or surgical site postoperatively for the first several days not only helps to stop excessive bleeding, but also promotes healing of damaged tissues. Immobilization can be instituted with simple bandaging techniques, splints, or casting. If saline-soaked sponges are used directly over the wound, the bandage not only provides compression, but also an initial moist environment for the tissues. Fluids are pulled into deeper layers of gauze by an osmotic effect, leaving the wound itself free of drainage accumulation.

Cryotherapy following surgery reduces pain by decreasing the conduction velocity of the nerve fibers. Muscle spasms are also controlled postoperatively with the use of ice as it reduces the responsiveness of the muscle to stretching by blocking nerve conduction. Ice further produces a reflex vasoconstriction of the sympathetic fibers, thus decreasing painful swelling and bleeding following trauma or surgery. The normal postoperative inflammatory reaction is also diminished. However, excessive use of cryotherapy may actually retard the healing process by sustaining vasoconstriction.

Compression dressing, when applied appropriately, can help control excessive postoperative edema. The compressive bandage should be applied in concentric layers utilizing increased compression distally at the level of the digits, and decreased compression proximally. It is important to have adequate layers of gauze coverage and to minimize any direct contact of inelastic materials such as Kling directly on the skin. Compressive dressings when applied evenly and without wrinkles or excessive tension will allow the normal postoperative inflammatory response without compromising circulation to the surgical site. An improperly applied compressive bandage can cause skin irritation and ulceration over potential danger zones such as the tibialis anterior tendon, first metatarsocuneiform joint, and the base or head of the fifth metatarsal. The Jones compression dressing is an excellent adjunct in postoperative care. Concentric layers of 4 inch cast padding and 6 inch ace wraps are utilized to immobilize the foot and lower leg in a supportive, yet very comfortable surgical dressing.

The venous hydrostatic pressure in a standing adult male is approximately 90 mm of mercury at the level of the foot. In the postoperative foot, this pressure may contribute significantly to the development of postoperative edema and pain. This is why elevation is the single most important factor in controlling excessive edema and preventing other complications. Elevation reduces internal bleeding and helps with the venous blood return to the heart. Postoperative throbbing can be readily alleviated by elevation of the foot above the level of the heart. Lymphatic drainage is also facilitated by elevation of the extremity. The urethane foam cast elevator (Spanaid) is commonly used for positioning and elevating the extremity following surgery.

CASE PRESENTATION

A sixty-nine-year-old insulin dependent diabetic with peripheral vascular disease presented to the hospital with sepsis and an acute deep abscess of the dorsal and plantar aspect of the right foot. This necessitated extensive debridement of bone and soft tissue in order to prevent loss of limb or death by sepsis.

Prior to delayed primary closure, aggressive surgical debridement with removal of all diseased tissues including soft tissue and bone is essential in obtaining a successful result. Bed rest with appropriate intravenous antibiotics and aggressive local wound care is imperative in providing a wound capable of successful healing following delayed primary closure. Negative perioperative wound cultures prior to delayed primary closure are also important in obtaining a successful result.

SURGICAL TECHNIQUE

The procedure was performed under intravenous sedation with an ankle nerve block. The patient was in a supine position and the foot placed in a slight Trendelenburg position to provide hemostatis. A tourniquet was not utilized. The essential aspects of the surgical technique of delayed primary closure are outlined in the following figures.

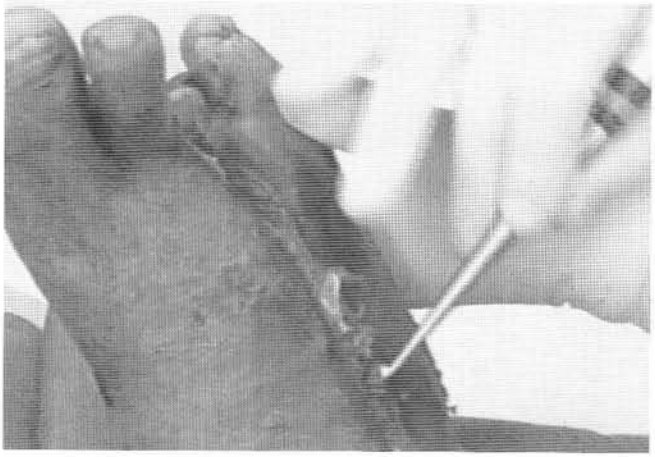

Figure 1. Surgical debridement of the wound edges with a large bone curette to a level of active bleeding

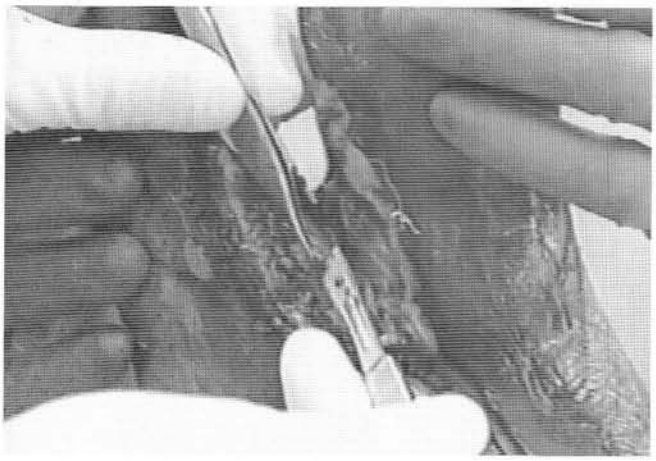

Figure 2. Surgical removal of necrotic tissue via sharp dissection with careful undermining of the skin margins

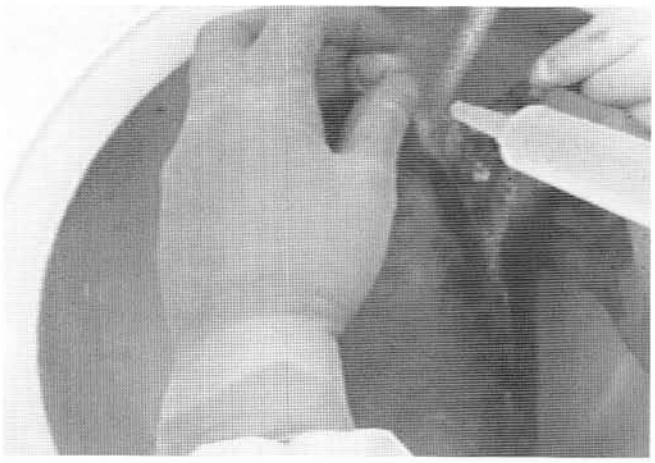

Figure 3. Copious irrigation with cold, sterile water

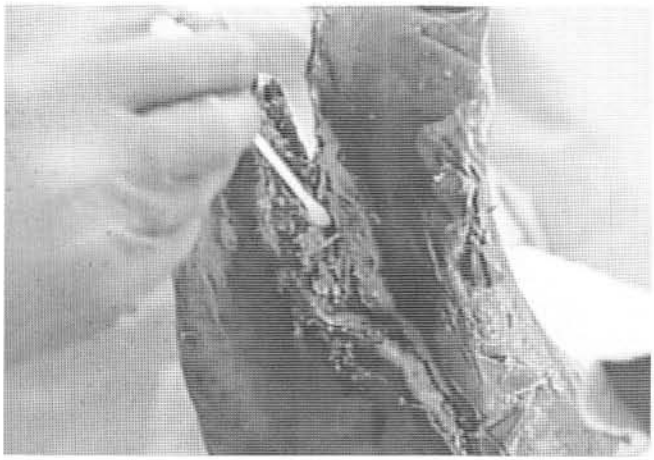

Figure 4. Intraoperative cultures for aerobes, anaerobes, gram stain, acid fast stain, and fungal cultures

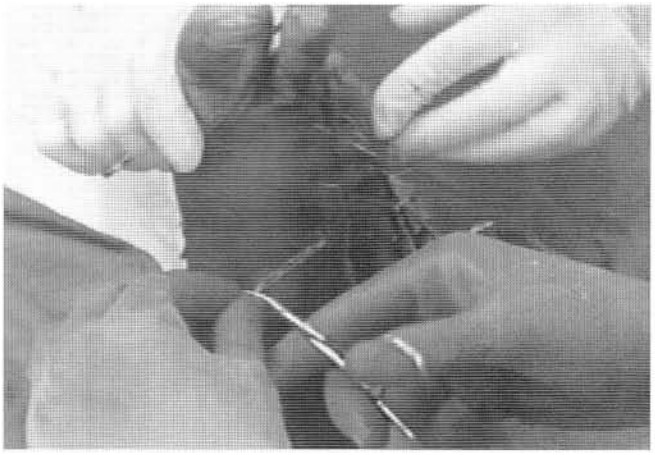

Figure 5. Approximation of the wound edges with nonabsorbable sutures (cerclage stainless steel wire)

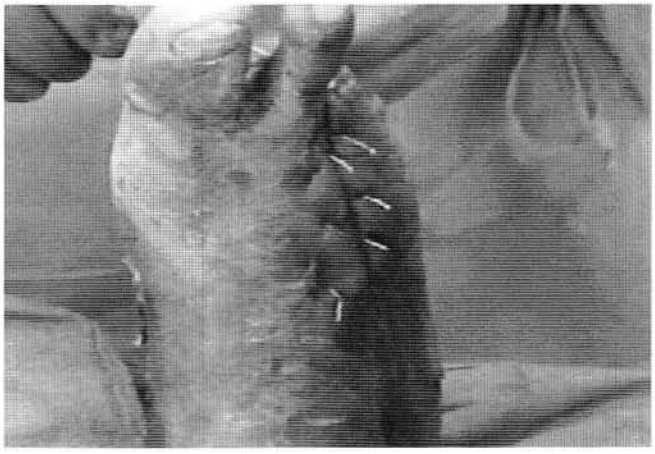

Figure 6. Suture technique consisted of multiple vertical mattress sutures

Figure 7. Packing of the proximal wound with sterile gauze

Figure 8. Sterile dressing application with concentric layers with gradient pressure distally to proximally

SUMMARY

The principles and techniques of delayed primary closure of a complex foot wound were presented. When a severe diabetic foot infection involves the dorsal and plantar spaces of the foot, emergent incision and drainage is necessary to prevent loss of limb or death by sepsis. Following successful incision and drainage, bed rest and/or non-weight bearing ambulation, local wound care, and appropriate antibiotic therapy, the patient may be a candidate for delayed primary closure. Adherence to these basic principles help assure a successful result.

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