SURGICAL MANAGEMENT OF INFECTION IN THE DIABETIC PATIENT

Kieran T. Mahan, D.P.M.

INTRODUCTION

The severe complications resulting from infection in the diabetic patient are well known. Amputation and serious systemic compromise can result from rapidly progressive infections. It is clear that there are numerous reasons for this vulnerability in the diabetic patient. These include the impairment of neutrophil function and a decrease in leukocyte mobilization resulting in a generalized decrease in ability to respond to infection.

There is evidence that there may be other deficiencies of the immune system which also prevent the diabetic patient from mounting a proper response to infection. In addition, the twin problems of neuropathy and peripheral vascular disease have significant impact upon the ability to respond to infection. Peripheral vascular disease can include both microangiopathy and also large vessel disease.

In the ischemic diabetic patient an infection can be innocent in appearance but nonetheless rapidly progressive. This is because the body is unable to mount the type of response that would present with the usual symptoms of heat, pain, and abscess formation.

Diabetic neuropathy is also significant in its impact on diabetic patients because of the head start that it allows an infection to receive prior to the patient or his physician's discovery. For example, in a patient with a neuropathic foot, a foreign body may be present and result in ulceration. This can lead to a rapidly progressive plantar space infection. Because of the neuropathy, the patient may be unaware of the presence of infection until it has advanced significantly. In addition, neuropathy interferes with normal vaso motor tone.

PRINCIPLES OF MANAGEMENT: LOCAL AND SYSTEMIC MEASURES

Several measures can be instituted prior to or in conjunction with surgical therapy. Rest, both general and local, assist the body to deal with the assault on the equilibrium. Normal fluid and electrolyte balance must be maintained and anemia should be corrected as needed. In addition, it is clear that control of hyperglycemia is critical for long term success.

Local measures include elevation of the part to reduce edema and the application of local moist heat. Heat should be applied intermittently to accelerate localization of the infection by stimulating vascularization of the area. Constant heat to an area can increase edema and excessive heat can produce necrosis. This is particularly true in the diabetic patient. It is presumed that the surgeon has meticulously evaluated the peripheral vascular tree as an initial step in the triage of the infected diabetic patient. Although the use of these local and systemic measures can be helpful, incision and drainage is even more critical than in other patients.

SURGICAL THERAPY

Acute infection in the diabetic patient is a potentially dangerous surgical emergency because of the propensity of the infection to travel along fascial planes far removed from the site of the external drainage. The surgeon may not know the full extent or severity of an infection until after the completion of the incision and drainage. In addition, the infection can progress with great rapidity along the fascial planes and can cause extreme damage to the local pedal vascular tree.

Surgical intervention can involve one or more of the following:

1. incision and drainage of abscesses,
2. excision of devitalized tissue,
3. decompression of tension in an enclosed space or compartment,
4. relief of an obstructed passage, and
5. removal of a foreign body.

Incision and drainage is the mainstay of infection therapy. Although not all infections require it, incision, drainage, and exploration is more critical in the diabetic than in the non-diabetic patient. Frequently, the diabetic patient will fail to form extensive abscess, but rather will present extensive penetration of the infection along the fascial planes. Incision and drainage acts to improve the local wound conditions by allowing host offenses to eliminate the infection. The incision and drainage acts in the following ways: it reduces toxic products, it reduces the local bacterial count, and it improves local tissue viability by reducing ischemic pressure necrosis. Under these circumstances the role of the antimicrobials is to prevent spread of the infection and to treat residual elements of infection after incision and drainage.

Incision and drainage should be performed as soon as possible in the diabetic patient. It is neither necessary nor wise to wait until an infection has localized in a diabetic patient before performing incision and drainage. The importance of timeliness is based on the following:

1. the compromise to the patient's immune system makes abscess formation less likely, and encourages progression of the infection proximally,
2. the decrease in the peripheral vascular supply may be further compromised by pressure from infected tissue on the plantar arterial arch.

The key word in describing incision and drainage of diabetic infections should be *aggressive.* This means both wide exposure and thorough removal of the abscess and any infected or necrotic material. The concept that a simple 1 or 2 cm opening along an ulceration could prove adequate for incision and drainage is incorrect. Although this may allow for decompression of an abscess, it does not permit adequate exposure of fascial planes to insure that there is no proximal spread. The initial incision and drainage must be the definitive procedure.

The incision and drainage is usually performed without tourniquet or epinephrine hemostasis because of the lowering of host offenses that accompanies the use of both. In certain instances, however, tourniquet use may be helpful during the initial exposure in order to facilitate identification of vital structures. This may be particularly helpful when the infection has spread into the areas surrounding neurovascular bundles. The initial incision is made with sharp dissection. Deep dissection is then usually performed with blunt exposure until the wound is completely exposed. The wound is explored to determine the extent of migration of the infection in each direction. The depth of the wound is particularly important. Capsule and periosteum are left intact unless there is evidence that they have been breached by the infection. Minimal cautery and ligature are used for hemostasis because of the effect on healing of tissues.

The adjacent plantar space is explored to determine whether or not there has been any violation of the space. The medial plantar space includes the abductor hallucis and the flexor hallucis brevis. The lateral plantar space includes the abductor digiti minimi and the flexor digiti minimi. The lateral space is approached through a lateral incision. Medial and central plantar space infections are approached through a plantar medial approach.

The central plantar space is the largest of the spaces and includes the flexor digitorum longus, flexor digitorum brevis, the quadratus plantae, the lumbricales, the medial and lateral plantar nerves, and the plantar arterial arch. It is the location of the plantar arterial arch that is particularly critical. When the infection progresses in this enclosed space, it can cause pressure on the plantar arch which will cause occlusion and result in loss of the digits due to ischemia. In addition, the infection can progress up the long flexors into the posterior compartment of the leg from the central plantar space.

After wounds are completely exposed, copious irrigation is performed to reduce both particulate and bacterial wound contamination. Three factors are important in the effectiveness of this process: fluid pressure, fluid volume, and the irrigant solution material. The pressure of the fluid determines the intensity of mechanical lavage. Numerous studies have demonstrated that greater fluid pressure increases the percentage of bacterial matter that is removed by the irrigation. Very gentle irrigation is ineffective in removing bacteria.

The asepto bulb syringes have been compared to syringe and needle irrigation both in vivo and in vitro. Because of the greater fluid pressure on the wound surface, syringes with 18 gauge needles are more effective in wound lavage than the bulb type syringe. Both continuous and pulsatile irrigation systems are available. Fluid volume is also important; irrigation of an infected wound should be performed with a sufficient volume to insure adequate wound lavage.

The third factor in wound lavage is the irrigation material itself. Saline can be used for mechanical debridement, however, it is not bactericidal and can be toxic to tissues. Topical antibiotic irrigation has the advantage of delivering a bactericidal solution to the wound. Topical administration provides slow absorption but tissue levels remain bactericidal for longer periods of time. Potential risks include hypersensitivity, local and systemic toxicity, and development of resistant bacterial strains.

Kanamycin has an excellent spectrum for gram negative organisms and is a popular irrigation material. Irrigation in areas with a larger surface area could be a problem with Kanamycin because of its ototoxicity and nephrotoxicity. Cefazolin is efficacious against gram positive organisms. Povidone iodine has several advantages as an irrigation material. Spectrum of activity is large, it is bactericidal, inexpensive, and well-tolerated by tissues on a short term application. Patients with thyroid disease, or sensitivity to iodine must not be irrigated with this solution. Recommended concentrations in the literature vary from 10% and 25% of the stock solution strength. As the wound is being irrigated general currettement should be performed to loosen debris and nonviable tissue.

As stated earlier, the initial incision and drainage should be definitive in character. However, there may be times when a second debridement must be performed some time later. Indications for a secondary debridement include continued abscess formation or spread of an infection to an enclosed compartment, failure of the wound to improve despite appropriate antimicrobials, and/or residual tissue necrosis. When a patient has persistent fever of the wound, or continues to have active drainage with no signs of improvement, then two primary considerations must be immediately

evaluated. Either the antimicrobial is inappropriate to the organisms or the wound requires a second debridement. Occasionally, both of the above may be true.

Once the wound appears clean the surgeon can either pack the wound open or close the wound over a suction irrigation system. In the diabetic patient the author usually prefers to leave the wound packed open and performs daily dressing changes. The wound is packed with an iodoform impregnated material which is loosely gathered and packed, then soaked with a bactericidal solution. Usually, daily dressing changes are performed under strict sterile technique. This includes the use of masks, gloves, drapes, and full sterile protocol. At this time the packing is removed, the wound is irrigated, and the wound is repacked loosely. As the wound becomes cleaner the packing materials are changed to a plain gauze so that the iodophor will not inhibit any granulation tissue.

An additional consideration in the diabetic patient is the timing of the surgery in relationship to revascularization of the ischemic foot. In the patient with a large abscess formation, incision and drainage should be performed immediately on a limited basis for reduction of the volume of bacterial and toxic products. However, in most other circumstances revascularization should either precede or accompany incision and drainage. Kozak and associates (from the Joslin Clinic) noted that 35% of their patients with diabetic infections required revascularizations. It is imperative that the surgeon look very critically at all aspects of the vascular system in evaluating the diabetic patient for surgery.

When a wound becomes clean rapidly after incision and drainage and antimicrobial therapy, delayed primary closure may be performed. Secondary tension healing is reserved for those wounds that are particularly resistant to healing or contaminated with particularly virulent bacteria. Delayed closure is usually performed in 7 to 14 days after incision and drainage. Usually, this is only performed after two to three negative cultures and a clean appearance of the wound is present.

In performing the closure, buried suture is minimized. PDS suture is a monofilament, absorbable suture that is ideally suited for this. Skin closure is performed with a polypropylene or nylon monofilament suture using simple interrupted sutures. Closure strips are even more desirable than sutures as a closure material when possible. A closed suction drain can be used to minimize dead space, reduce hematoma, and monitor the wound through continued cultures of the drainage.

RECONSTRUCTION

Generally the diabetic infection is either a result of interdigital or nail infections that have progressed proximally, or due to neuropathic ulcerations that have become infected. Consequently, when planning closure of the diabetic infection, it is important to plan ahead to provide adequate coverage over weight-bearing areas. In addition, follow-up care with appropriate accommodative appliances and possible reconstructive osteotomies should be planned at this time.

An interesting concept in that regard has been proposed by Ralph Ger. Dr. Ger has popularized the use of intrinsic muscles of the foot for muscle flaps in the areas of diabetic infection. In addition to his experience with the use of certain of these muscle flaps for coverage of difficult areas such as the heel, he has observed what many of us have experienced: when an infection persists, despite what is thought to be initial adequate treatment, there is usually a spread of the infection from the foot to the leg along the tendon sheaths. Consequently, exploration of tendon sheaths should be performed aggressively in order to rule such spread.

SUMMARY

The principles of surgical management of diabetic infections are similar to those for other types of infections. Important differences include the importance of the initial incision and drainage for wound exploration, and the prevalence of ischemic peripheral vascular disease. Such circumstances require meticulous vascular evaluation at the time of decision for surgical intervention. The initial surgical management must be definitive in order to prevent continued progression of the infection.

References

Bernhard LM, Bakst M, Coleman W, Nickamin A: Plantar space abscesses in the diabetic foot: diagnosis and treatment. *J Foot Surg* 23:283-290, 1984.

Ger R: Newer concepts in the surgical management of lesions of the foot in the patient with diabetes. *Surg Gynecol Obstet* 158:213-215, 1984.

Kaufman J, Breeding L, Rosenberg N: Anatomic location of acute diabetic foot infection: its influence on the outcome of treatment. *Am Surg* 53:109-112, 1987.

Kozak GP, Hoar CS Jr, Rowbotham JL, Wheelock EC Jr, Gibbons GW, Campbell D: *Management of Diabetic Foot Problems.* Philadelphia, WB Saunders, 1984.

LeFrock JL, Joseph WS: A team approach to infections of the lower extremity in the diabetic patient. *J Foot Surg* 26:S1-S50, 1987.