Advanced Foot and Ankle Fixation Techniques in Patients with Diabetes

Nicholas J. Bevilacqua, DPM[a,*], John J. Stapleton, DPM[b,c]

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• Internal fixation • External fixation • Charcot foot
• Diabetic limb salvage • Foot and ankle trauma
• Revisional foot and ankle surgery • Complications

Over the past decade, there has been increasing interest in various surgical procedures and techniques for the treatment of the high-risk diabetic foot. Once considered ill advised, reconstructive foot and ankle surgery has assumed an important role in the overall management of these higher-risk patients.[1] Surgical procedures for this group have evolved from simple exostectomies to complex, corrective, reconstructive procedures. Advances in fixation techniques and technology have facilitated the evolution and complexity of procedures for diabetic foot and ankle trauma and Charcot neuroarthropathy.

The Charcot foot is a classic example of a deformity attributed to diabetes. Charcot arthropathy occurs in approximately 30% of those with peripheral neuropathy and in only 1% of the diabetic population.[2,3] Charcot arthropathy is a rapidly progressive and debilitating complication and may lead to gross deformity.[4] Early diagnosis is paramount in preventing structural collapse, and any delay in diagnosis affects outcomes. Initial management includes immobilization, offloading, and stabilization. However, in situations in which a patient presents with unstable fractures and dislocations with obvious deformity, surgical intervention may be required.

Bone mineral density is often reduced in patients with Charcot neuropathy. It is unrealistic to expect traditional internal fixation techniques alone to maintain compression across a fracture site or arthrodesis site, and fixation failure with loss of correction is common. In this situation, adjusting techniques and using supplemental fixation may enhance osseous stability. Static and dynamic external fixation constructs offer

[a] North Jersey Orthopaedic Specialists, 730 Palisade Avenue, Teaneck, NJ 07666, USA
[b] Foot and Ankle Surgery, VSAS Orthopaedics, Allentown, PA, USA
[c] Penn State College of Medicine, Hershey, PA, USA
* Corresponding author.
E-mail address: Nicholas.bevilacqua@gmail.com

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uniform compression and allow for placement of fine wires away from the affected bone or joint. Bridge plating with newer-generation locking plates can overcome several of the disadvantages of conventional plate fixation and provides a construct sufficiently stable to allow for osseous healing.

Recent advances in lower limb fixation methods and technologies have effectively expanded the reconstructive surgical options for the high-risk diabetic foot. Locking plate technology, external fixation, and supplemental fixation have enhanced the surgical treatment options in this high-risk population. Evolving techniques have focused on increasing the stability of fixation in poor bone quality. Sammarco[5] introduced the concept of superconstructs, in which traditional principles of fixation are abandoned to enhance stability and decrease the chance of fixation failure.

This article presents advanced techniques and current fixation constructs that are advantageous for the management of diabetic foot and ankle trauma and Charcot neuroarthropathy. Both these pathologies are often intimately related, and the fixation constructs that are needed often require sound biomechanical concepts coupled with innovative approaches to achieve bone healing and limb salvage.

BIOLOGICAL AND MECHANICAL ASPECTS OF FIXATION CHOICES

The use of internal and/or external fixation to provide osseous stability to promote bone healing among the diabetic population poses many challenges. The surgeon must understand the advantages and disadvantages of the selected fixation and recognize how the particular fixation will affect the biological cascade of events necessary for bone healing. All osteotomies, arthrodesis sites, and fractures require mechanical stability along with sufficient vascularity to create an environment that is conducive to osseous healing. In the person with diabetes and peripheral neuropathy, there is a heightened risk for fixation failure and postsurgical complications in general. There is the potential for development of Charcot neuroarthropathy and, as a result, fixation choices should be carefully considered. This patient population requires an understanding of the pathophysiology of the disease process and its inherent challenges. There is an increased need for superconstructs in this patient population, but the surgeon still has to appreciate the different effects each fixation construct has on osseous stability. Superconstructs are designed to improve stability of the fixation, and Sammarco[5] defined them as follows: (1) fusion extended beyond the zone of injury to include joints that are not affected, (2) bone resection performed to shorten the extremity to allow adequate reduction of the deformity without tension on the soft tissue envelope, (3) use of the strongest fixation device that may be tolerated by the soft tissue, and (4) fixation devices applied in a position that maximizes mechanical function. In addition, the surgeon cannot discount the importance of meticulous surgical technique and the preservation of the local vascularity to the particular bone segment.

Recent advances in techniques for the application of external fixators, particularly multiplanar, circular, and external fixators, have improved osseous stability. External fixation may maximize blood supply but may provide less osseous stability compared with internal fixation. Also, problems may arise after the external fixator is removed because continued mechanical stability is required throughout the bone healing process. Alternatively, the use of rigid compressive plates and screws provides maximum stability but may have a deleterious effect on the local blood supply and may pose a threat to the overlying soft tissues.

Locking plate technology provides a fixed-angle construct similar to an external fixator and has been called an internal-external fixator. The locking mechanism between