Circular External Fixation as a Primary or Adjunctive Therapy for the Podoplastic Approach of the Diabetic Charcot Foot

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KEYWORDS

• External fixation • Diabetic Charcot foot • Charcot neuroarthropathy
• Podoplastic approach • Diabetic neuropathy • Plastic surgery

KEY POINTS

- External fixation can provide simultaneous compression, stabilization, and surgical offloading.
- Staged reconstruction is recommended in the ulcerated and/or infected diabetic Charcot foot.
- The podoplastic approach can achieve a combined skeletal and soft tissue reconstruction for surgical reconstruction of the diabetic Charcot foot.
- A multidisciplinary health care team that deals in the overall medical and surgical management of the diabetic patient is necessary for the patient's successful outcome.
- Close postoperative monitoring and management of the patient's medical comorbidities are vital throughout the recovery process.

Diabetic Charcot neuroarthropathy (DCN) foot and ankle deformities continue to be one of the most challenging clinical problems that face foot and ankle specialists. Conventional treatment options involve immobilization and local wound care modalities in order to achieve healing of wounds ranging from a variety of means to produce a healthy moist wound environment aimed at healing through secondary intention. Immobilization of the DCN lower extremity often involves limited or non-weight-bearing in a

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total contact cast; however, there is little evidence to support this treatment. The goal of DCN management is to achieve a stable, plantigrade, and braceable lower extremity, which is free from ulceration and infection. Several studies have shown that traditional methods of DCN management involving long-term accommodative nonsurgical treatments are unsuccessful at improving the quality of life of affected individuals.[1,2] In order to achieve the goals of management, surgery is often indicated in the unstable and symptomatic DCN. The use of internal, external, or combined fixation is usually dependent on the presence of a wound and/or osteomyelitis, anatomic location, vascular status, ambulation, medical comorbidities, and morbidity status. In certain cases, osseous exostectomies with or without plastic surgery closure and/or external fixation for surgical offloading might be indicated as the definitive procedures for the DCN.

CIRCULAR EXTERNAL FIXATION AS A PRIMARY TREATMENT FOR THE DIABETIC CHARCOT FOOT

Patients with DCN have poor bone quality and localized osteoporosis, as well as being poor immune hosts. Standard rigid internal fixation does not always lend itself to favorable osseous purchase in this population and has been shown to have decreased pullout strength.[3] In addition, complete foot and/or ankle arthrodesis is not routinely achieved in the DCN, which over time with repetitive loading will lead to implant failure and breakage.

Ulceration caused by an underlying DCN deformity, infection, instability, and a nonplantigrade foot are several indications that may require surgical intervention. Location of fracture, nonunion, and deformity vary, and surgical reconstruction should be tailored to the individual patient. The first step in any reconstruction is thorough preoperative planning and evaluation of deformity. When deformity and instability are present, there is literature that shows these patients do progress toward ulceration.[4–7] A direct surgical approach including excision of the ulceration and/or infected bone is usually the preferred method of treatment because it allows access to the underling abnormality that needs to be corrected.

Osseous correction is achieved with exostectomy, osteotomy, and/or arthrodesis, whereas advanced deformities often require a combination of all 3. Once osseous correction is achieved intraoperatively, the osseous segments can be temporarily fixated with a Steinmann pin or pins; wounds are closed, and circular external fixation is applied and modified based on the surgical procedure performed. In a cadaveric model, it has been shown that the compression achieved through external fixation averaged 186% of the compression of screws alone.[8] Another advantage is that the compression can be increased postoperatively in a clinical or surgical setting when desired through manipulation of the external fixation system.

The beginning of external fixation begins proximally, in the distal tibia. A double tibial ring block is preferred for most of the DCN reconstructions because of the increased stability of the construct. Two tibial rings, connected by threaded rods, are placed to the distal tibia. Care must be taken to avoid the posterior ankle recess, which extends approximately 2 cm from the ankle joint, because wires within this area are technically intra-articular and could lead to septic joint. Smooth wires and/or half pins are then used to transfix the tibia and are mounted to the rings.

With the use of a midfoot ring, external fixation is able to correct for abduction/adduction of the midfoot, varus/valgus of the midfoot and/or hindfoot, and equinus. There are several options for connection of the midfoot ring to the tibial ring block, and the use of Ilizarov hinges allows for stable connection while applying compression and correcting the underlying deformity. In the setting of midfoot correction, further

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