

# Podiatry Today

## Do Superconstructs Offer More Biomechanically Sound Fixation Principles For Charcot?

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**Author(s):** John F. Grady, DPM, FASPS, and Katy Trotter, DPM

Charcot foot and ankle reconstruction is a challenge few surgeons are willing to undertake and yet the demand for the specialty is ever increasing. The correlation between diabetic neuropathy and Charcot neuroarthropathy is no mystery. On the other hand, the exact cause and progression of the joint destructive process continue to elude the foot and ankle practitioner.



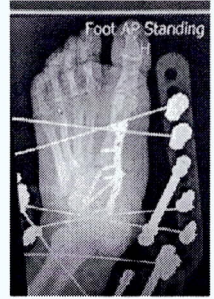
The increased morbidity and decreased quality of life associated with Charcot neuroarthropathy are well known with amputation risks of 7 percent without and 28 percent with ulceration at presentation respectively.<sup>1</sup> While there are certainly patterns of deformity, the disease and the manifestations are different for each patient, making treatment protocols difficult to establish. While there is no optimal surgery we can clearly define, one can certainly optimize the surgical management.

The purpose of this article is first to make a case for earlier, more aggressive surgical intervention for the trained foot and ankle surgeon. The second objective is to make the case against using external fixation and bolting as a sole means of fixation as these modalities have gained popularity in recent years. The third objective is to propose defining patient outcomes based on quantitative data, specifically the talar first metatarsal angle on radiographs. The final objective is to present case studies of surgically managed patients to demonstrate the types of success that one can achieve by following tried and true fixation techniques, specifically looking at plantar plating for midfoot Charcot neuroarthropathy.

Tenets of management include control of inflammation, achievement of osseous stability and maintenance of a plantigrade foot to promote a functional, non-ulcerative, weightbearing limb.<sup>2</sup> Traditionally, physicians employ conservative measures, including custom shoes and offloading devices, during the acute stages of the disease while reserving surgical interventions for the later coalescence and residual stages. When specifically looking at Charcot neuroarthropathy in the midfoot, which is the most common location, reportedly 60 percent of patients with a plantigrade foot deformity can have successful management without surgical stabilization, according to Pinzur.<sup>3</sup> For those with a non-plantigrade foot and a nonlinear lateral talar-first metatarsal axis on weightbearing radiographs, Pinzur noted that surgical correction is best.<sup>3</sup>



While these measures are the current standard of care, the ability of these measures to halt the disease process and prevent progression is questionable. Hastings and colleagues studied radiographic parameters from the time of initial presentation of Charcot neuroarthropathy and over the course of two years, and found primarily worsening medial column alignment.<sup>4</sup> In addition, complication and reoperation rates are high in later stages of non-plantigrade midfoot disease with one recent study — following patients over the course of four years — finding a soft tissue complication rate of 76 percent, hardware complications at a rate of 43 percent and 1.5 complications per foot requiring reoperation.<sup>5</sup> We suggest that one may avoid such complications if surgical intervention begins earlier in the recognition of the disease.



Varying surgical interventions include exostectomy, ulcer debridement, Achilles tendon lengthening, gastrocnemius recession and joint fusions via screws, plates, bolts and external fixation.<sup>2</sup> In a systematic review, Sammarco assessed all level IV and V evidence over a 46-year period involving surgical management of Charcot neuroarthropathy in the foot and ankle, but made no direct comparisons regarding fixation types.<sup>6</sup>

### What You Should Know About Superconstructs And Other Fixation Methods

In more recent years and as physicians better understand the physiology of Charcot neuroarthropathy, physicians attempt to create a stabilization through “superconstructs.” We can define a superconstruct by four main factors.<sup>7</sup> One should apply the device in the most optimal, mechanically functional position. The device should be the strongest device that the soft tissue envelope can tolerate. One should position the device beyond the zone of injury and ensure adequate bone resection to allow for proper reduction of a deformity. Sammarco states that such devices are advantageous when there is weak dysvascular bone at high risk for failure.<sup>7</sup> One such device is the plantar plate.



While plating is not new to the armamentarium of Charcot reconstruction, it is in more frequent use on the dorsal and medial aspect of the foot due to ease of application. Classic teaching and physics educate us that plantar plating in the foot is biomechanically more advantageous with placement on the tension side. Marks and colleagues concluded that plantar placement of a plate is biomechanically superior to crossed screws in stiffness and load to failure.<sup>8</sup> A study by Campbell and coworkers also described successful use of plantar plating resulting in a solid fusion of Charcot midfoot dislocations.<sup>9</sup> Furthermore, a locking plate becomes the most reasonable implant as it does not require good bone quality for a successful application and closely correlates with the principles of the superconstruct.

Two alternative fixation methods that may have less than optimal outcomes include those of external fixation alone and medial column fusion bolts. External fixation may be beneficial to apply in the acute phase to quiet the inflammatory process prior to realignment arthrodesis.<sup>10</sup> External fixation may also be an adjunct but has limited utility as a means of sole fixation.

Wukich and colleagues advocate a percutaneous correction via a neutral ring fixator specifically for patients with a non-plantigrade foot with poor bone quality.<sup>11</sup> At a minimum follow-up of one year, 24 of the 26 patients achieved a favorable outcome as measured by the ability to maintain ambulatory status and being ulcer- and infection-free. Complications in eight patients ranged from tibial stress fractures to death. Wukich and coworkers also noted the development of plantar ulcerations in four of the patients, all of whom required repeat surgery with exostectomy. These authors note that the lateral talar first metatarsal axis improved to  $10.42 \pm 11.86$ , which is notable but perhaps not sufficient as evidenced by the reulceration.

In addition, patients with diabetes are at a sevenfold risk for developing any wire complication, most commonly pin tract infections.<sup>11</sup> In a review of 15 patients over a one-year period, 31 percent developed a serious pin tract infection and 25 percent developed pin fractures.<sup>12</sup> In another study, Eschler and coworkers assessed the use of a Midfoot Fusion Bolt (Synthes) to address midfoot instability in patients with Charcot arthropathy



with an average 27-month follow-up.<sup>13</sup> While the seven-patient sample size was small, six of these patients demonstrated complications including soft tissue infection, amputation and implant-related failures. Although reulceration did not occur, these authors could not recommend the single intramedullary rod as a sole means of arthrodesis in the Charcot foot.

### What Studies Show About The Lateral Talar First Metatarsal Angle And Its Correlation To Deformity Severity

The literature is abundant with definitions of patient outcomes based on qualitative data alone. Unfortunately, there are few study outcomes based on quantitative data. With this information, one has the ability to correlate this data to rate of recurrence, limb functionality and independence, and have a greater understanding of optimizing surgical results.

Reproducible radiographic angles, specifically the lateral talar first metatarsal angle, are well known to correlate to the severity of deformity.<sup>14,15</sup> Bevan and Tomlinson reported that patients with a lateral talar first metatarsal angle of greater than -27 degrees were at greater risk of ulceration.<sup>16</sup> Wukich and colleagues expounded on these findings, noting that sagittal plane deformities are more likely associated with foot ulceration than transverse plane deformities.<sup>14</sup> Hastings and coworkers also noted that the lateral talar first metatarsal angle changes most during the first six months of acute Charcot and even greater changes occur after one year.<sup>4</sup>



Arch reconstruction is paramount to reproduce a rectus, stable, functional foot for patients with midfoot Charcot neuroarthropathy. Our unpublished retrospective study assessed 10 procedures involving joint reconstruction and plantar plating in eight patients with Lisfranc joint deformity. These procedures occurred between 2002 through 2012 with researchers specifically studying talar first metatarsal angles on radiographs. In this study, the average improvement was 17.84 degrees on the AP projection and 19.28 degrees on the lateral projection taken 35 months postoperatively. All patients have gone from a life of wound care, nearing the precipice of severe infection and limb loss on multiple occasions, to a life that allows resumption of their daily lives and activities, albeit in protective shoes.

### A Closer Look At Cases Of Deformity Correction For Midfoot Charcot Neuroarthropathy

The following are case reports demonstrating medial column stabilization arthrodesis using plantar plating with or without medial and plantar (biplanar) wedge osteotomies for deformity correction of midfoot Charcot neuroarthropathy.



The first case involves a 65-year-old woman with type 2 diabetes, who was referred to the office for longstanding Charcot neuroarthropathy and a plantar lateral midfoot ulceration, which was recalcitrant to conservative measures. Preoperatively, the lateral talar first metatarsal angle was -35 degrees and the patient had a dislocated talonavicular joint as well as a plantarly subluxed cuboid.

In order to reduce the deformity, we performed a gastrocnemius recession in combination with a medial column fusion, including the first metatarsocuneiform joint, the naviculocuneiform joint and talonavicular joint. This brought the patient out of the rocker bottom deformity and gave her a new arch and a rectus forefoot-to-rearfoot relationship. We used a plantar reconstruction plate and locking 3.5 mm screws to fixate the medial column, and reinforced the fixation with cancellous screws across the talonavicular joint. We applied an external fixator for eight weeks in order to protect the fusion sites.

The lateral talar first metatarsal angle improved to -6 degrees with an overall improvement of 29 degrees. This significant sagittal plane improvement of 29 degrees to plantarflex the first ray was enough to reduce the subluxed cuboid and create a non-ulcerative foot.



The second case is that of a female nurse with diabetes who had been in a wheelchair for two years preoperatively due to her bilateral Charcot foot deformity with recurrent ulcerations and three previous hospitalizations. Preoperatively, her feet demonstrated severe deformity of the tarsometatarsal joint with a collapsed medial column and abducted forefoot. Previous treating physicians had offered a below-knee amputation as the only solution to her Charcot deformity.

For her left foot, her preoperative radiographs demonstrate a talar first metatarsal angle of -15 degrees on the AP view and -6 degrees on the lateral view. Intraoperatively, the senior author performed a biplanar wedge osteotomy at the Lisfranc joint and applied a plantar plate. The latest X-ray occurred 34 months postoperatively. The post-op weightbearing images demonstrate an improvement on the the AP and lateral views of the talar first metatarsal angle to 5 degrees and 0 degrees respectively.



After bilateral reconstruction, the final clinical pictures demonstrate a functional rectus foot. The patient has never had another ulcer, returned to work as a nurse and has continued to work since her surgery 18 years ago.

### In Conclusion

While external fixation or bolt fixation as a sole means of fixation are the current trend, plantar plating with or without a biplanar wedge arthrodesis for medial column stabilization is the more enduring procedure. The complications and risks of using alternative measures as sole means of fixation are too great to justify in an operative situation fraught with uncertainty. We propose an intraoperative reduction of the lateral talar first metatarsal angle to reproduce the arch and rectus forefoot-to-rearfoot relationship. We also suggest reviewing the changes in these angles in order to better follow patient outcomes and long-term results.

*Dr. Grady is the Director of the Foot and Ankle Institute of Illinois and the Director of the Foot and Ankle Institute for Research in Oak Lawn, Ill. He is also the Director of the Jesse Brown Veterans Affairs Medical Center Residency Program in Chicago.*

*Dr. Trotter is a third-year resident within the Jesse Brown Veterans Affairs Medical Center Residency Program in Chicago.*

### References

1. Saltzman CL, Hagy ML, Simmerman B, et al. How effective is intensive nonoperative initial treatment of patients with diabetes and Charcot arthropathy of the feet? *Clin Orthop Relat Res.* 2005; 435:185-190.
2. Lowery NJ, Woods JB, Armstrong DG, Wukich DK. Surgical Management of Charcot neuroarthropathy of the foot and ankle: a systematic review. *Foot Ankle Int.* 2012; 33(2):113- 121.
3. Pinzur MS. Neutral ring fixation for high-risk nonplantigrade Charcot midfoot deformity. *Foot Ankle Int.* 2007; 28(9):961-966.
4. Hastings MK, Johnson JE, Strube MJ, et al. Progression of foot deformity in Charcot neuropathic osteoarthropathy. *J Bone Joint Surg Am.* 2013; 95(13):1206-13.
5. Eschler A, Gradi G, Wussow A, et al. Late corrective arthrodesis in nonplantigrade diabetic Charcot midfoot disease is associated with high complication and reoperation rates. *J Diabetes Res.* 2015; epub April 27.
6. Sammarco VJ. Superconstructs in the treatment of Charcot foot deformity: plantar plating, locked plating, and axial screw fixation. *Foot Ankle Clin N Am.* 2009; 14(3):393-407.
7. Sammarco VJ, Sammarco GJ, Walker EW, et al. Midtarsal arthrodesis in the treatment of Charcot midfoot arthropathy. *J Bone Joint Surg Am.* 2010; 92(Suppl1):1-19.
8. Marks RM, Parks BG, Schon LC. Midfoot fusion technique for neuroarthropathic feet: biomechanical analysis and rationale. *Foot Ankle Int.* 1998; 19(8):507-10.
9. Campbell JT, Schon LD, Parks BG, et al. Mechanical comparison of biplanar osteotomy with screw

- fixation for the correction of metatarsus primus varus. *Foot Ankle Int.* 1998;19(5):293-9.
10. Panagakos P, Ullom N, Boc SF. Salvage arthrodesis for Charcot arthropathy. *Clin Podiatr Med Surg.* 2012; 29(1):115-135.
  11. Wukich DK, Belczyk RJ, Burns PR, et al. Complications encountered with circular ring fixation in persons with diabetes mellitus. *Foot Ankle Int.* 2008; 29(10):994-10005.
  12. Osterhoff G, Boni T, Berli M. Recurrence of acute Charcot neuropathic osteoarthropathy after conservative treatment. *Foot Ankle Int.* 2015; 34(3):369-364.
  13. Eschler A, Wussow A, Ulmar B, et al. Intramedullary medial column support with the Midfoot Fusion Bolt (MFB) is not sufficient for osseous healing of arthrodesis in neuroosteoarthropathic feet. *Injury.* 2014; 45(Suppl1): S38-43
  14. Wukich DK, Raspovic KM, Hobizal KB, et al. Radiographic analysis of diabetic midfoot Charcot neuroarthropathy with and without midfoot ulceration. *Foot Ankle Int.* 2014; 35(11):1108-1115.
  15. Schon LC, Easley ME, Weingeld SB. Charcot neuroarthropathy of the foot and ankle. *Clin Orthop.* 1998; 349: 116-31
  16. Bevan WP, Tomlinson MP. Radiographic measures as a predictor of ulcer formation in diabetic Charcot midfoot. *Foot Ankle Int.* 2008; 29(6):568-573.

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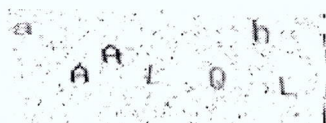
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