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Nailed It!

Dynamic Medial Column Beaming via Flexible Fibular Intramedullary Nail

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Statement of Purpose

Surgical correction of Charcot neuroarthropathy presents a unique challenge to the foot and ankle surgeon. Reconstruction of these complex deformities often include significant structural augmentation, while also attempting to avoid the inevitable wound healing complications. Emerging concepts in Charcot reconstruction, like midfoot beaming, help address the specific complications of this compromised patient population. Minimal soft tissue dissection and load-bearing characteristics of beam screws make them ideal for incorporation into Charcot "superconstructs". One of the drawbacks to utilizing static beams in a rigid construct is the possibility for hardware failure with weightbearing forces. The same concept of minimal dissection and the ability to withstand axial compressive loads can be appreciated with flexible intramedullary rods for high-risk patients with fibular fractures. We hypothesized that a fibular nail acting as a medial column beam would be more adaptable to loading forces and have a lower failure threshold.

Literature Review

- Surgical treatment of Charcot Neuroarthropathy continues to pose a challenge to surgeons in our field. Bony dissolution and compounding comorbidities make fixation through bone affected with Charcot difficult. In the past decade, superconstructs have become popularized as the surgical treatment of choice to restore the foot in a plantigrade alignment for patients with severe deformity. These constructs bypass the area of injury and fuse surrounding healthy joints to afford the most stable fixation possible. [1]
- Superconstructs, as the name implies, involve a large amount of structural augmentation to achieve the desired result. When axial loading through the hindfoot is transferred to the midfoot during weight bearing, the dorsal aspect of the foot is placed under compression while the plantar aspect is placed under tension. In patients with Charcot, affected bone and soft tissue is inadequate to transfer this force without fragmentation and loss of joint alignment. Applying rigid fixation throughout the midfoot allows these forces to be transferred throughout the hardware, compensating for the surrounding, injured soft tissue, and working to maintain the transverse arch of the foot. [2]
- Beaming the medial column was first presented in 1997. [3] Midfoot fusion bolts are commonly used for column fixation but it has been reported that more than one bolt is necessary to avoid rotational instability and implant loosening. [4] While these constructs offer rigid support, complications involved with static beaming of the medial column continue to be documented. Transferred pain to the lesser metatarsal heads, screw breakage, and resultant nonunion and loss of reduction have been reported. [5]
- When the failure threshold of static beaming is reached, the construct will fail. Intramedullary nailing has been shown to be advantageous when used for ankle fractures as they allow for minimal soft tissue dissection and reduce the amount of osseous resection at the implantation site. [6] These nails also offer dynamic stability which can deform and reform under significant force. Recent studies have shown that intramedullary fibular nails can achieve the same rate of bony union at fracture sites with less wound healing complications and need for hardware removal. [7, 8] By incorporating an intramedullary fibular nail into a superconstruct, specifically ones with a locked or fused hindfoot, the flexible nature of the device could hypothetically be more forgiving than a static beam where midfoot compensation is concerned.

Case Study

- A case is presented of a 45-year-old uncontrolled diabetic, obese female with documented left ankle Charcot neuroarthropathy and past history of plantar ulceration. She has utilized a CROW boot for several years which has been affecting her quality of life and daily living and elected to proceed with surgical correction of her hindfoot deformity.
- The patient had a wholly unstable ankle on physical examination, with significant subluxation of the entire forefoot on the rearfoot during stance. She was unable to ambulate without a brace due to the flaccidity of the peritalar complex.
- Recent radiographs showed considerable rearfoot collapse with talar disintegration and superior displacement of talar head fragment. Serial radiography showed appreciable erosive changes to hindfoot and collapse of midfoot arch.
- <u>Surgical Technique</u>
  - The patient was placed in a prone position on the table. After thigh tourniquet application and surgical preparation, a posterior approach to the ankle and subtalar joints was performed. The Achilles tendon was lengthened in a Z-fashion.
  - The medial and lateral ankle gutters, tibiotalar and posterior facet of the subtalar joints were all denuded. A small osseous graft was removed from the distal posterior tibia via osteotomes for implantation anteriorly.
  - A Steinman pin was used to joystick the calcaneus to a more inclined position and held with temporary fixation. The medial column beam guidewire was retrograded up through the distal aspect of the first metatarsal head and exited the posterior aspect of the anterior tibial cortex, which was visible via the removed bone window.
  - Attention was then directed to the medial midfoot where dissection down to the talonavicular joint was performed and the posterior tibial autograft was placed in an effort to wedge the midfoot down.
  - The 145mm flexible fibular nail was then inserted from the posterior aspect of the tibia, through the midfoot and into the medullary canal of the first metatarsal. It was fixated with two screws via the targeting jig. The subtalar joint was arthrodesed with a 6.5 cannulated fully-threaded screw.
  - The posterior ankle fusion plate and associated screws were then implanted. Biological adjuncts were embedded where needed for accelerated postoperative consolidation. Irrigation followed by layered closure was then performed. A well-padded posterior splint was applied. The patient recovered from anesthesia uneventfully and did not require an overnight hospital stay.

Radiographs

Discussion

This case study presents a novel use of a flexible intramedullary fibular nail as a dynamic Charcot midfoot beam. Radiographs taken during the postoperative course reveal osseous consolidation without loss of correction. The patient completed 6 weeks of extensive physical therapy and was without healing complications. She has been brace and wound-free for the past few months with custom-molded diabetic shoe gear. By incorporating dynamic midfoot stabilization within the static components of our fixation, we believe the construct will be better able to accommodate axial loading, specifically in our obese patient. Our patient has not experienced any hardware failure to date.

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