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Pantalar Arthrodesis Using the Fuse It Arthrodesis Plug in Charcot

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Received: December 21, 2018; **Published:** January 29, 2019

Abstract

Charcot's neuroarthropathy is a difficult complication of diabetes and continues to become more common as the population ages and diet changes. The natural history of the condition has often produced catastrophic bone destruction leading to severe deformity and ultimately amputation. However, limb salvage has numerous benefits and is becoming more common as surgical techniques become more refined. We present the first reported case of pantalar arthrodesis for Charcot's neuroarthropathy using a "Fuse It" arthrodesis plug, augmented with synthetic bone graft and an external frame.

Keywords: Charcot; Pantalar; Arthrodesis; plug; Fuse It; Integrant

Abbreviation

CN: Charcot's Neuroarthropathy

Introduction

Diabetes related diseases are a difficult and growing problem. The reported rate of amputation in Australia is one every three hours, with the rate having risen 14% in ten years [1,2]. Charcot's neuroarthropathy (CN) is a key contributor. In the ankle it commonly results in instability and progressive deformity, subsequently leading to ulceration, osteomyelitis and historically, eventual amputation [3]. Fortunately, the relative rate of transtibial amputations for CN continues to fall. This may be partially due to the refinement of foot and ankle salvage techniques [4-6]. Over the last 20 years, limb salvage through arthrodesis has gained traction as an alternative to primary amputation for this condition [3,7-9].

The mainstay for salvage is arthrodesis, with numerous techniques previously described including hindfoot nailing, rigid fixation with plating and/or screws, commonly augmented with bone graft [7,10,11]. Use of concomitant internal and external fixation has also been described [12].

We present a case of limb salvage of a Charcot hindfoot by pantalar arthrodesis using the "Fuse It" plug (Integrant, NSW, Australia) (Figure 1)] and "Frame It" external fixateur system (Integrant, NSW, Australia). We believe this is the first description of the specialised fusion plug for pantalar fusion.



Figure 1

Design rationale

The Fuse It plug is a conical titanium plug with conical fenestrations to allow for bone in growth. In bone defects it can be placed as a structural spacer with Integrant synthetic bone impacted both within and around it. The external frame compresses bone further into the fenestrations.

Case Study

JM is a seventy-one year old retired female who was referred for amputation for CN of the right hindfoot causing “agonising” pain at rest requiring narcotic analgesia. The ankle had recently become deformed and an x-ray had revealed an angulated pathological fracture of the ankle joint (Figure 2A). She was affected by poorly controlled Type 2 Diabetes Mellitus, as well as rheumatoid arthritis managed on leflunomide.

Preoperatively Mrs JM’s physical examination revealed a markedly swollen hindfoot in non-correctable valgus, accompanied by an antalgic gait and Grade 2 positive anterior draw with the ankle both at neutral and thirty degrees. There was also fixed hallux valgus and arthritis of the first metatarsophalangeal joint. Imaging confirmed Charcot’s arthropathy of the hindfoot and hallux rigidus. The midfoot and neurovascular examination were unremarkable. The skin was intact with no evidence of ulceration. The technique for salvage was pantalar arthrodesis and bone grafting through an Integrant Fuse It plug in the subtalar joint and in the lateral ankle joint where there was severe bone loss.

Through an anterior approach the joint surfaces were denuded, and a Fuse It plug placed in the anterolateral talar defect. Marked destruction of the talar dome had resulted in bone loss requiring device 2cm in diameter. An anterior plate was applied and provisional fixation made. A mini-lateral approach to the subtalar joint allowed a second Fuse It plug to be placed in the sinus tarsi. Both Fuse It plugs were filled with Integrant synthetic bone graft. The plate was then fixed into position with a 6.5 mm home run screw inserted into the calcaneus and 3.5 mm screws from the anterior talus to the calcaneus. 6.5 mm specialised hind foot screws were inserted to gain further fixation (Figure 2B). Prophylactic antibiotics were prescribed for six weeks.



Figure 2: A - Preoperative AP and lateral radiographs demonstrating severe varus hindfoot Charcot; B - External compression frame 10 week duration applied 1 week after pan talar fusion surgery. C- Postoperative AP and lateral postoperative radiographs with frame removed demonstrating Fuse It plug, and internal fixation for pantalar arthrodesis.

One week later, an external frame was applied using 3 mm wires. We call this a “hard wire frame” and believe it to be superior to the fine wire tensioned frames as the larger wires do not cut through softer Charcot bone like finer wires do. Further, less compressive power is lost through wire bend with the bigger wires. The frame is dynamic and can improve position and is also useful to enforce a non-weight bearing period.

At 8 weeks weightbearing was introduced. By twelve weeks bony union across all three joints had been achieved and the frame was removed. By five months the patient was walking unaided in a high laced hiking boot, with no pain and without analgesia - a marked improvement.

Mrs JM’s perioperative management included referral to a diabetes educator, meticulous wound management, physiotherapy for gait training and lymphoedema management. Plaster was not used.

Discussion

This technique has three main benefits; salvage, early mobilisation and time to union.

Mckenzie and colleagues demonstrated the economic benefits of salvage compared with prosthetic costs following amputation [9]. When compared with amputation, limb salvage provides improved gait mechanics, and has been demonstrated to result in a similar energy expenditure to normal walking [13]. This is considered especially important in diabetic patients who are often overweight and have comparatively limited cardiac reserve [7].

In patients with neuropathy who are already struggling with proprioceptive feedback when they walk loss of a limb further tips the balance against the patient being an independent ambulator.

In this case, the Fuse It device when combined with a Taylor Spatial frame variant provided a structure stable enough for early weight-bearing. Some authors believe that internal fixation may not provide adequate stability, but the external frame avoids this issue by being outside the zone of disease [10,14]. There is no conclusion in the literature about optimal timing for surgery, and different authors have had success regardless of timing. We believe early weight bearing in this population limits medical complications of surgery and speeds rehabilitation.

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Bone grafting is often performed to encourage fusion, but synthetic and cancellous grafting solutions provide minimal structural support [15]. Literature around subtalar distraction arthrodesis has investigated the use of bone blocks in distraction arthrodesis. However, these risk collapse of the graft and subsequent varus malunion and donor site morbidity [16]. In contrast, the Fuse It plug is made of Ti-6Al-4V, can withstand significant force and provides more reliable structural stability. The plug can be filled with any type of bone graft and its fenestrated surface facilitates osseous integration through the implant, as well as ingrowth onto its surface similar to Huckstep’s tumour prosthesis [17]. Though this is a single case report, it may promise higher rates of fusion when compared with some other methods of dealing with large defects in the foot and ankle such as femoral head allograft [18].

Incidentally, we found the Fuse It plug’s structural stability allowed more reliable correction and maintenance of alignment both intra-operatively and postoperatively. Its utility in distraction arthrodesis has been previously described [16].

A number of perioperative factors contributed to Mrs JM’s successful outcome. Meticulous wound care was essential. In keeping with the Philadelphia Consensus leflunomide was ceased 6 weeks prior to surgery [19]. Perioperative blood sugar level and lymphoedema control perioperatively is likely to have had a positive impact on union and wound healing.

Conclusion

Salvage for Charcot's neuroarthropathy of the hindfoot has numerous benefits and is becoming more common as surgical techniques advance. The Fuse It plug in combination with a Frame It Taylor Spatial frame can successfully facilitate pantalar fusion by providing both subtalar stability, bone ingrowth into the device, and structural stability for bone grafting. This allows earlier mobilisation in these patients and excellent time to union. Though more research is required investigating the use of this device, our initial experience is promising.

Conflicts of Interest

Senior author is a designer for Integrant.

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Volume 10 Issue 2 February 2019

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