CASE STUDY

Charcot Reconstruction Utilizing the PRECISION® Guided Joust™ Beaming Screw System

Surgeon Author: Lee M. Hlad, DPM, FACFAS
Ankle & Foot Associates, Waycross, GA

FEATURED PRODUCTS: PRECISION® Guided Joust™ Beaming Screw System and Monster® Hindfoot Screw System

Introduction

The Paragon 28® Joust™ Beaming Screw System consists of beams and instrumentation designed for use in bone fixation appropriate for the size of the device.

There are inherent challenges in addressing Charcot arthropathy including:

- Bone fragmentation and dislocation, and soft tissue injury
- Loss of bone density
- Altered bone and soft tissue biology leading to difficulty in healing

The Joust™ Beaming Screw System was designed with these challenges in mind. The Joust™ Beaming Screw System offers surgeons 220 unique beam options to address varying anatomy and deformities. The beams are constructed from Type II Anodized Ti-6Al-4V titanium to offer increased fatigue performance during loading.[1] Solid and cannulated beaming options are available to match the surgeon's preferred choice of beam in this construct. The system includes both partially and fully threaded beams allowing the surgeon to select for compression or stabilization. Three different diameters of beams are offered (Ø5.0 mm, Ø5.5 mm, and Ø7.2 mm) allowing for beaming across the midfoot and in additional areas of the hindfoot. All beams are headless to minimize prominence and have a sharp tip to aid in the ease of insertion.

Placement of a beam along the length of the medial column can be technically challenging. The Joust™ Beaming Screw System offers the patent-pending PRECISION® Guide to assist the surgeon in placement of a medial column beam at a desired trajectory and endpoint while offering the ability to reduce the joints along the medial column (Figure 1).

Finally, the system also includes instrumentation to facilitate the surgeon's preferred method of implanting the beam (solid or cannulated).

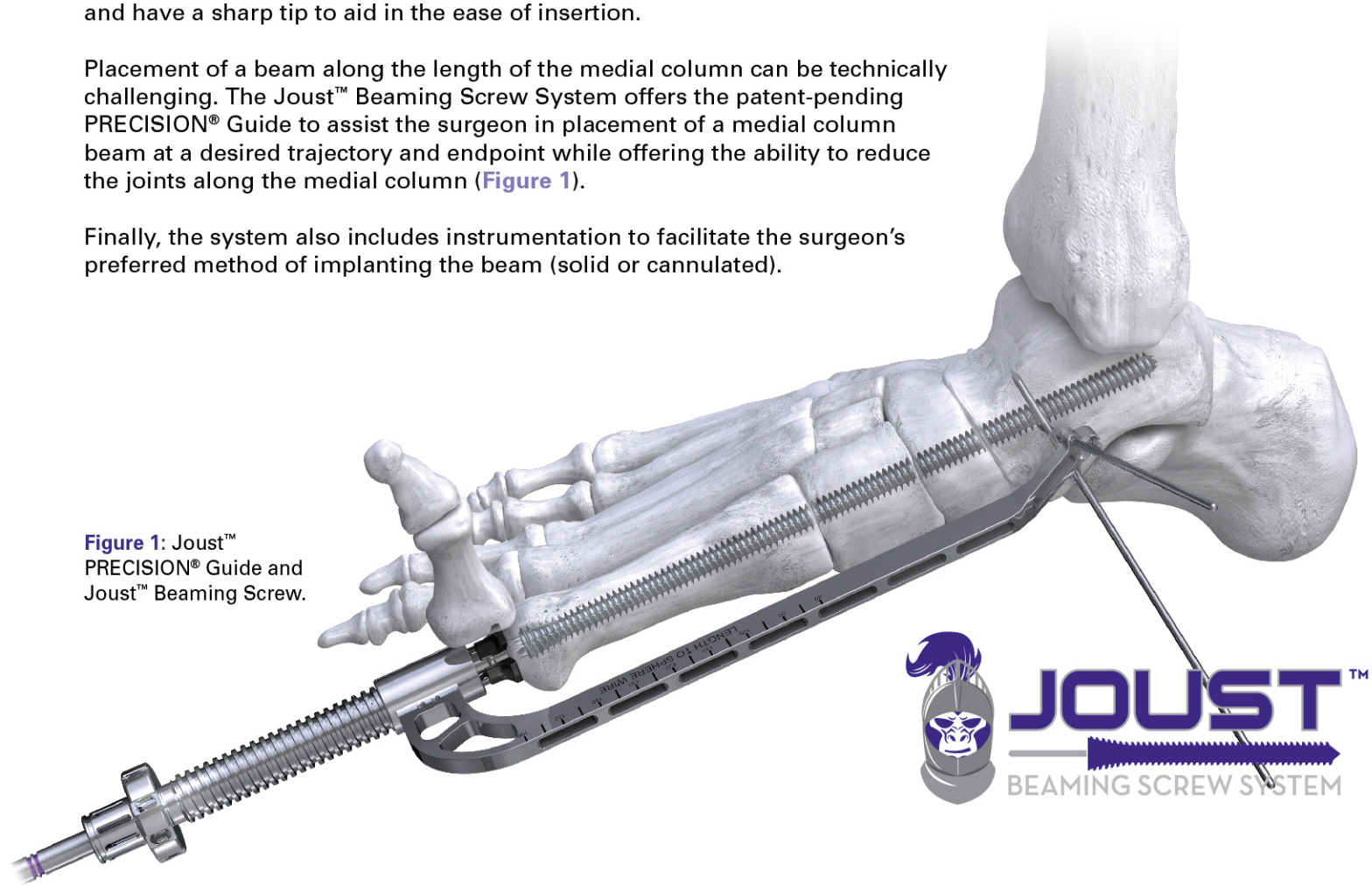


Figure 1: Joust™ PRECISION® Guide and Joust™ Beaming Screw.

Presentation

A 51-year-old female presents with a two-year history of severe Charcot foot with recurrent medial arch ulceration. She has previously been treated with total contact casting, offloading boots, custom Charcot Restraint Orthotic Walker (CROW) boots, offloading ankle and foot orthotics, and multiple grafts to the medial arch wound.

The patient was admitted to inpatient due to cellulitis of the left foot and leg. The patient exhibited acute exacerbation of her venous disease with the cellulitis and had lymphangitis of the left leg. The patient had a large 5 cm x 3 cm ulceration of the medial arch that did not probe to bone. At the time of consultation, the patient was receiving broad spectrum IV antibiotics, vancomycin and zosyn. The initial consultation and referral were for hallux ulceration with osteomyelitis.

Clinical Exam

At the time of consultation, the patient had a hallux ulceration with full thickness wound that probed to bone. Additionally, the patient had a large medial arch ulceration not probing to bone (Figure 2). Ulceration of the arch was 5 cm x 3 cm x 0.3 cm. The foot was without lymphedema but had cellulitis to the ankle. At the ankle, there were significant venous changes to the leg (Figure 3). The patient had hardening of the skin with lipodermatosclerotic changes to the distal leg. The patient had excessive motion of the midfoot at Chopart's joint with complete talar head extrusion. The patient had significant abduction of the forefoot on the hindfoot and a very tight gastroc soleal complex.

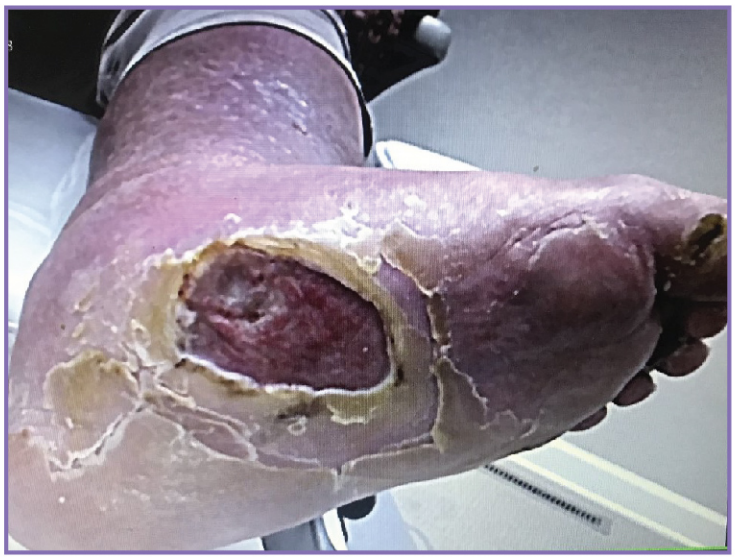


Figure 2: Preoperative clinical examination showing medial arch ulceration.

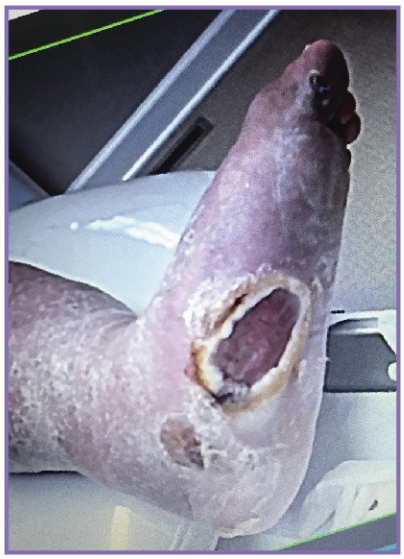


Figure 3: Preoperative clinical examination showing medial arch ulceration and venous changes proximally.

Radiographic Imaging

Radiographs showed significant collapse through the midfoot with dislocation of the talonavicular (TN) joint. (Figure 4 A-B)

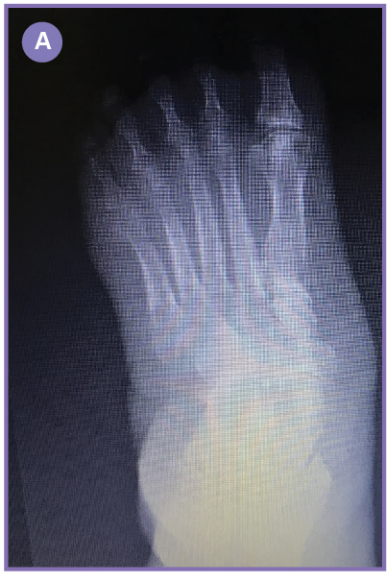


Figure 4A: Preoperative AP x-ray showing midfoot collapse.

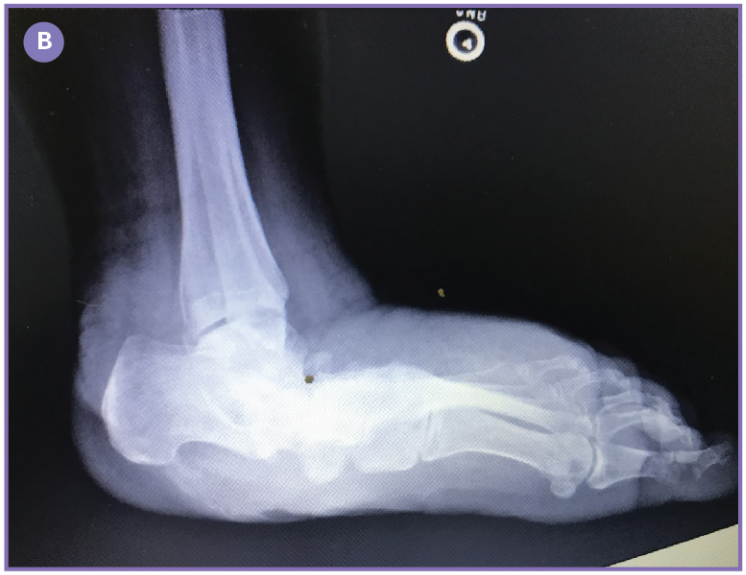


Figure 4B: Preoperative lateral x-ray showing midfoot collapse and dislocation of the TN joint.

The hallux distally showed signs of cortical erosion, but no reaction was noted through the midfoot consistent with osteomyelitis.

Magnetic resonance imaging (MRI) was performed on the midfoot and forefoot confirming osteomyelitis of the distal hallux but also confirming no osteomyelitis of the midfoot. The midfoot did exhibit changes consistent with neuropathropathy.

Initial Management and Decision-Making

There are many considerations practitioners should use in evaluating a patient with suspected Charcot neuropathy. First, the presence or absence of infection in the foot must be confirmed. If infection is confirmed, then damage control needs to be taken and the surgeon must identify where the infection is and debride until cultures are negative. In this case, the patient presented with hallux osteomyelitis, which was removed, therefore eliminating spread to the foot. If there is concern for deep infection in the midfoot, bone biopsy should be performed in the initial setting. Advanced imaging can be performed, and in this case an MRI was performed. Another good option depending on availability is computed tomography scan with nuclear medicine overlay (single-photon emission computerized tomography).

Next the practitioner must decide whether an open or percutaneous approach will be used. It is the recommendation of this author that if the patient has an active wound, that if possible, an open approach should be the method employed to allow excision of the infected region. Closure of the region is achieved by advancement flaps or other rearrangements that will allow primary soft tissue closure. Otherwise, caution should be exercised when doing open techniques with open wounds. Percutaneous approaches are more desirable if a wound is present. The author tends to use a two staged approach to address the deformity where percutaneous correction is achieved with use of external fixation and then correction is maintained with use of internal fixation. The author screens all patients for vascular issues prior to large reconstructions with initial ankle brachial index measures followed by arterial duplex if needed.

Surgical Technique

In the first stage of this procedure, the operative table was set up for the dirty portion of the case. The patient was positioned supine, prepped and draped to the knee and the knee exposed for position of the foot. Wound debridement was performed first at the medial arch to obtain depth and vascular characteristics of the wound. Intraoperative doppler was used to map out the medial and lateral plantar artery as well as perforator in the distal leg and ankle.

Following wound debridement, the wound was covered with clear op-site dressing and attention was then directed to the hallux. The hallux was disarticulated at the metatarsophalangeal joint (MPJ) and then closed to eliminate potential infection of the forefoot. Posterior open tendon achilles lengthening was performed and the calcaneus was temporarily pinned from the calcaneus into the posterior tibia in extra articular fashion to hold neutral position of the hindfoot (Figure 5).

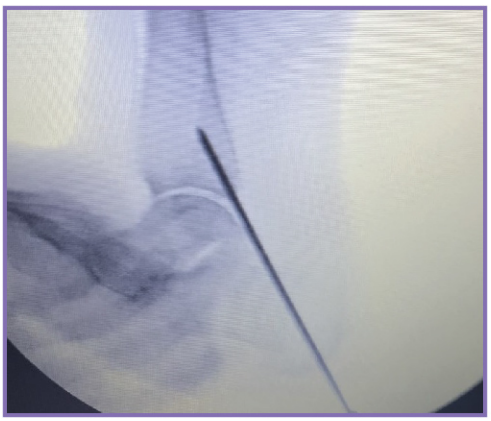


Figure 5: Interoperative positioning of a K-wire to hold neutral position of the hindfoot.

The surgeon noted the impact to the hindfoot this gross deformity of the forefoot caused in dorsiflexion to neutral. At this time, computer assisted external fixator was applied as a butt frame. A Gigli saw was passed prior to the forefoot ring application and then forefoot ring and wires were attached to the external fixator. Midfoot Gigli saw osteotomy was performed through the midfoot tarsal bones in a percutaneous fashion. The external fixator was then run gradually over the next three weeks to invert and plantarflex the foot to recreate an arch and then removed prior to the second surgery.

Consistent with the author's preferred staged approach, the patient returned to the operating room for the second stage of the procedure. The hallux incision site had healed, and the wound showed dramatic improvements following the first surgery.

The foot was prepped for the second surgery using betadine. A mini-open technique was used to prepare the medial column, subtalar (STJ), and calcaneocuboid (CC) joints (Figure 6). Each joint was prepped with a standard transverse incision using the Paragon 28 joint preparation instrumentation including the Honey Badger (a reverse cartilage removal osteotome), bone fenestration drill bit, and fenestration chisel. Following preparation, a stabilization K-wire was introduced from the posterior calcaneus and retrograded into the distal tibia to hold neutral position of the calcaneus and talus. This K-wire was used to hold the position of the hindfoot in neutral to allow for optimal forefoot position to be achieved. A K-wire was then introduced in a retrograde fashion from the metatarsal head through the medial column reducing each individual joint along the column. One pearl this author notes, is that the entire column can be reduced using the Joust PRECISION Guide and Reduction Tube, however it is the author's preference to individually reduce each segment of the column manually. Fluoroscopy is used throughout reduction and placement of the medial column K-wire. The author recommends that the medial column wire be positioned before the subtalar screws are placed as this will allow the medial column beam to extend through the body of the talus. The author recommends that the medial column beam be placed with the hallux in dorsiflexion and the incision made under the first MPJ be large enough to retract the flexor hallucis longus tendon (FHL) medially.

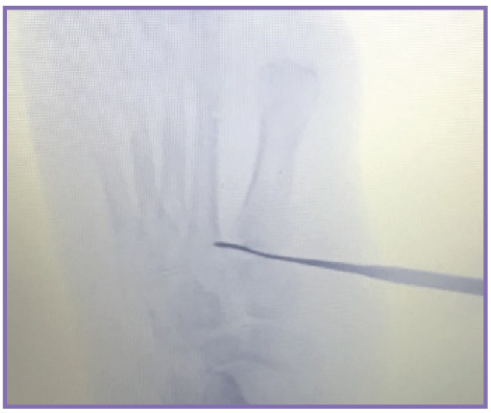
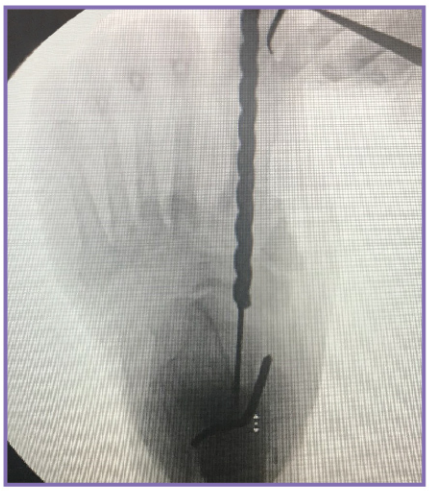


Figure 6: Joint preparation of the medial column.

In these cases, the author doesn't recommend splitting the FHL as this can result in rupture of either side of the tendon. Also, when dorsiflexion occurs, the surgeon often must go through a portion of the base of the proximal phalanx and hallux and when drilling often will take a small portion off the base of the proximal phalanx due to lack of dorsiflexion. Once the K-wire has been acceptably positioned in the medial column, the surgeon must consider permanent fixation. If the surgeon elects to manually compress the medial column, they may utilize the Joust PRECISION Guide and Reduction Tube to reproducibly reduce and compress.

Exclusively foot & ankle Paragon 28®

JOUST™ BEAMING SCREW SYSTEM



Following placement of the K-wire in the medial column, drilling will be completed to the posterior aspect of the talus for the Ø7.2 mm beam (Figure 7). The author recommends selection of a beam 8-10 mm shorter than the beam size measured with the depth gauge as compression across the joints of the medial column reduces the column length and will allow the head of the beam to be positioned at the surgical neck. It is the author's preference, if fusing the medial column only with beams, that a solid beam be used. To facilitate placement of this solid beam, the K-wire will be removed following drilling. The Joust™ PRECISION® Guide and Reduction Tube can be used to hold reduction allowing for accurate and reproducible placement of the solid fully threaded beam.

Figure 7: AP x-ray showing drilling of the medial column.

The author recommends the beams be put in under power but often the torque requirements exceed that which can be generated with battery power. Final seating of the beam can be accomplished with a T-Handle which is included the system. Following placement of the beam, the author recommends a range of motion (ROM) test be performed at the MPJ level to ensure that the head of the beam is not in the joint. Intraoperative x-ray may be used to confirm the beam head position as well.

Attention should then be directed to the remaining joints to attain a plantigrade foot. In this case the author elected to address the STJ following the medial column reconstruction. The STJ had already been prepared when doing the mini open medial column as well as CC joint preparation. A technique utilizing two Monster® 7.0 mm Hindfoot Screws was employed by the author where the first screw was placed perpendicular to the STJ and positioned from the posterior tubercle of the calcaneus to the medial side of the talus. A second screw was then placed through the body of the calcaneus and into the lateral talar body.

A Monster® Ø7.0 mm Hindfoot Screw was then used to address the lateral column and placed across the CC joint completing the super-construct triangle (Figure 8 A-C). This screw may be inserted in a retrograde fashion with the K-wire being placed at mid-diaphyseal region of the 4th and 5th metatarsal interspace and then retrograding from the dorsal central cuboid into the calcaneal neck and terminating in the posterior aspect of the calcaneus. Alternatively, an antigrade technique can be used by introducing the K-wire just lateral to the medial posterior STJ screw and aiming towards the 4th toe. The author has found that this trajectory doesn't typically interfere with the STJ screws. With all parts of the reconstruction, the surgeon prefers to utilize lag technique with fully threaded beams and screws, alternating between cannulated and solid options depending on bone condition.

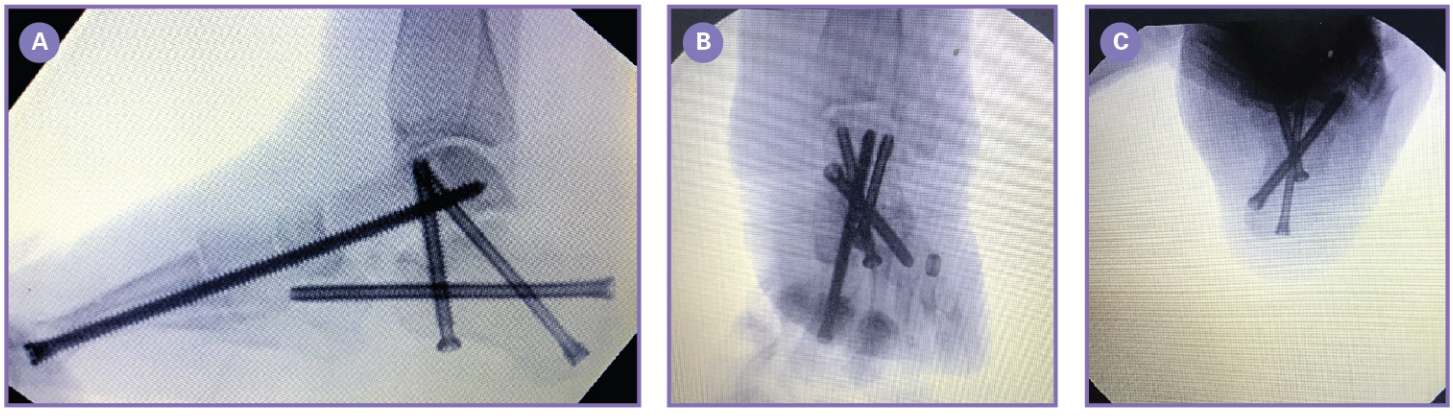


Figure 8: (**A-C**) Lateral and dorsal images showing placement of the medial column beam and subsequent placement of Monster® Screws to complete the construct and restore a plantigrade foot.

Exclusively foot & ankle Paragon 28®

JOUST™ BEAMING SCREW SYSTEM

Post-Operative Protocol

The post-operative protocol in these cases is very patient dependent. In this case, the patient was kept touch toe weightbearing for two weeks until the percutaneous incision healed. If the wound would have been completely healed, the patient would have started walking in a boot at two weeks, been casted for a CROW walker at that time and continued in a boot until she received a custom device.

Due to the presence of a wound, the patient was kept touch toe weightbearing. Grafts were applied in the office until healing was confirmed. Subsequently the patient walked six weeks postoperatively and fell suffering an open tibia fracture of the mid diaphyseal region as a result of not wearing the prescribed boot. The fracture was located between the pin sites from the external fixator. She underwent open reduction internal fixation (ORIF) with antegrade nail. The tibia and open wound site on the middle of the leg healed without issue. The patient is now 10 months post op and has no wounds on either leg or foot (**Figure 9 A-C**).

Figure 9: (**A-C**) 10 month postoperative images demonstrating correction and healing of the plantar ulcer.

This patient now has a stable braced foot that is wound-free. The multiple reconstructive procedures which were done to address the Charcot foot and subsequent fall and open tibia fracture were challenging, although not atypical when working with this patient population. The patient will use a CROW walker for a period of one year following the procedure and will then be allowed to use diabetic shoes for "vacation" days and 2-3 hours a day if desired so long as no change is noted on plain films over the next 6-12 months. All patients following this type of Charcot reconstruction are critically evaluated with serial x-rays quarterly for two years following surgery.

References

[1] Whitten, Andy. Evaluation of the Effects of Anodization on the Fatigue Performance of Titanium Alloy. Fatigue and Fracture of Medical Metallic Materials and Devices, STP 1559. West Conshohocken, PA: ASTM International; 2013: 109-121.

Exclusively foot & ankle Paragon 28®

For the contraindications, potential complications and adverse reactions, warnings and precautions associated with this device, please refer to the device specific instructions for use at http://www.paragon28.com/ifus

Paragon 28, Inc.
14445 Grasslands Drive
Englewood, CO 80112, U.S.A.
855.786.2828 | www.paragon28.com

CE 2797

Paragon 28 Medical Devices Trading Limited
First Floor Block 7 Beckett Way
Park West Business Park
Dublin 12, D12, X884, Ireland
+353 (0) 1541 4756

P26-CS-0001 Rev A