Charcot Beaming After Previous Partial Ray Amputations

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Statement of Purpose

Charcot reconstruction through intramedullary beaming is a well published technique. Typically, intramedullary beaming is performed on patients who have not previously undergone lower extremity amputations. This case study describes a Charcot reconstruction attempt in a patient with previously amputated 2nd and 3rd rays.

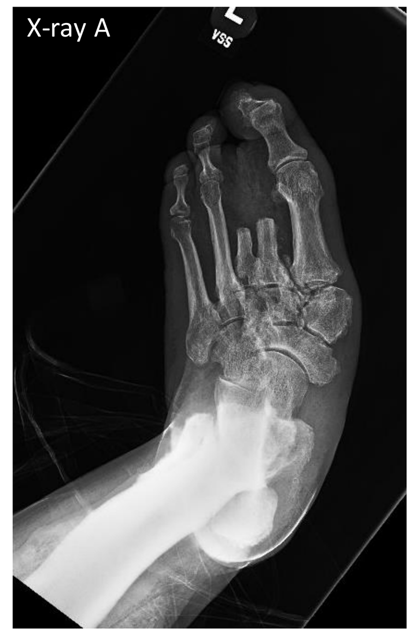
Literature Review

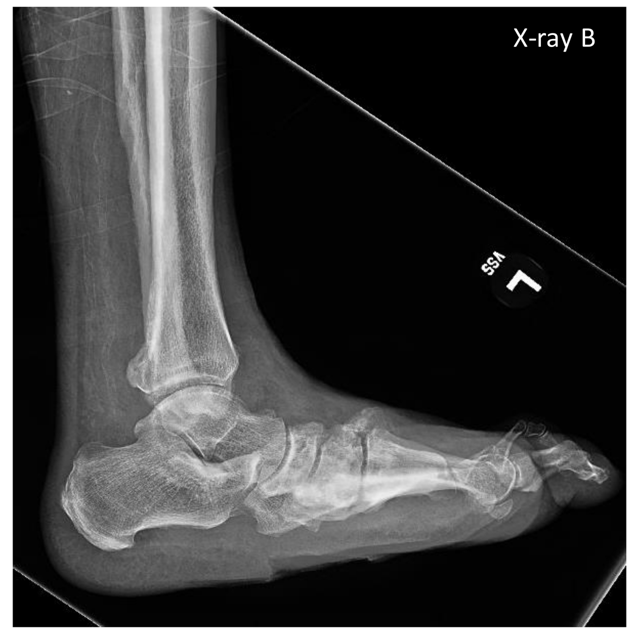
Charcot arthropathy was first described by French neurologist Jean-Martin Charcot. The condition presents as a progressively destructive, noninfectious inflammatory process that affects the weight bearing joints of individuals with polyneuropathy[1]. The condition may mimic adult acquired flatfoot with loss of medial longitudinal arch height, hindfoot valgus and forefoot abduction. Additionally, Charcot arthropathy may include loss of lateral longitudinal arch, plantar subluxation of the cuboid, plantar ulceration, bone destruction and eventual bone coalescence[2]. The condition can encompass 3 phases: acute, developmental and consolidation.

Treatment for Charcot aims at maintaining or re-creating a stable, plantigrade foot through either nonoperative or operative means[3]. Operatively, recreation of the medial longitudinal arch can be achieved through deformity correction fixated with solid screws, cannulated screws, conventional plates, locking plates or a combination of plates and screws[4]. Charcot "beaming" uses long solid or cannulated bolts or screws placed retrograde through the first metatarsal, bridging of the medial column to the talus to achieve medial column stability[4] and was first presented at the American College of Foot and Ankle Surgeons Scientific Seminar in 1997. Grant et al. additionally describes lateral column beaming through the bases of the 3rd and 4th metatarsals[5]. Concomitant procedures during Charcot reconstruction may include subtalar joint arthrodesis or arthroeresis, planing of the foot, tendoachilles lengthening, external fixator application and application of biomaterials to aid in fusion. Determination of the surgical approach depends on careful evaluation of the patient's deformity and soft tissue envelope. Beaming provides the additional benefit of less dissection and less hardware exposure in the event of wound healing complications or future skin breakdown.

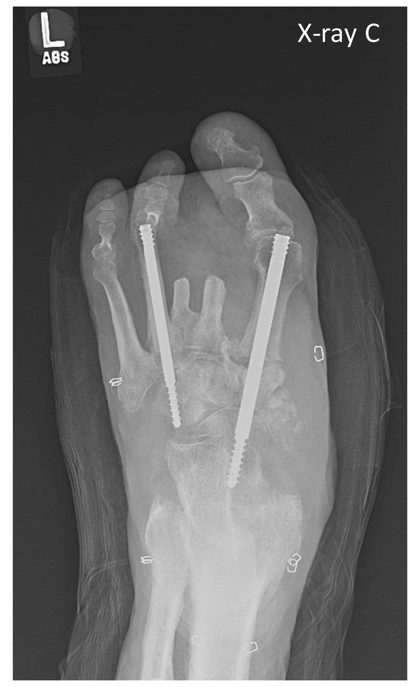
To the author's knowledge, little work has been done to evaluate the outcomes of Charcot beaming in the presence of previous partial metatarsal amputations, and as to whether previous amputations can impact the biomechanical stability of beaming.

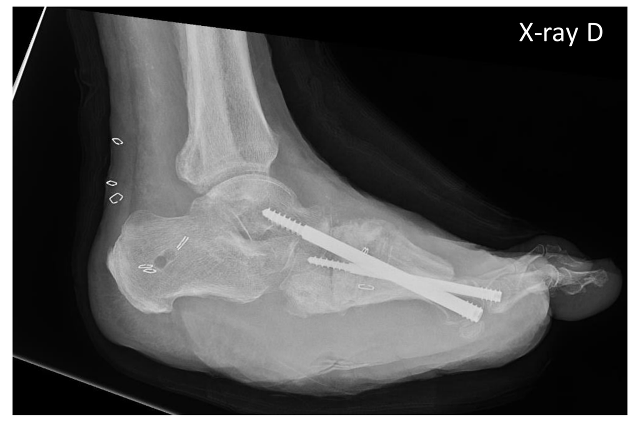
Case Study



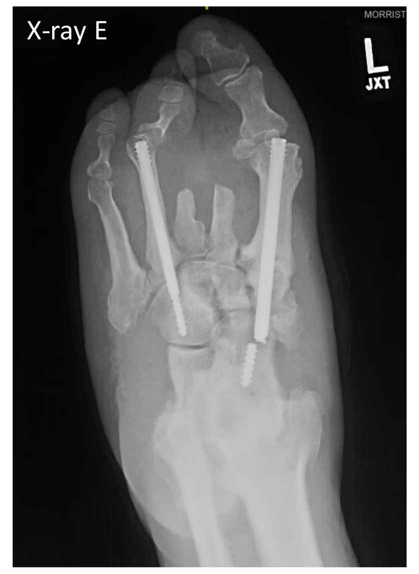


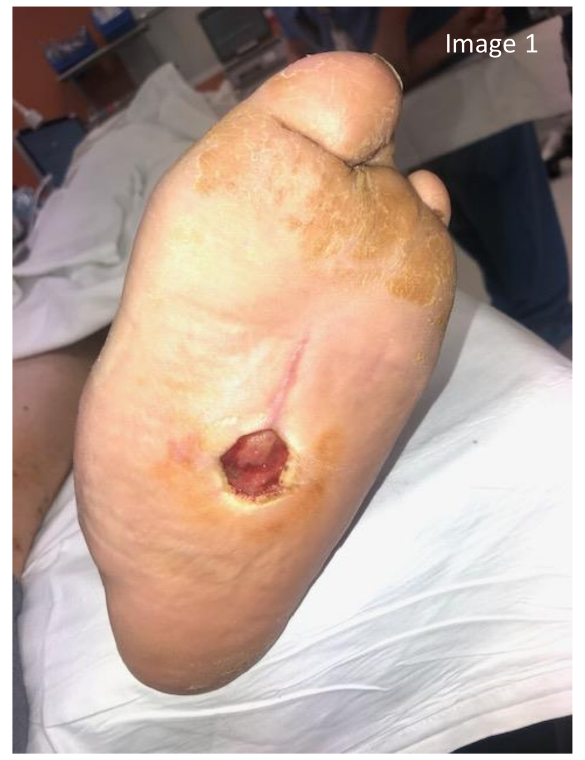
X-ray A and B: *Non-weightbearing radiographs on initial presentation*





X-ray C and D: *Post beaming and external fixator removal*





X-ray E: *Final radiograph of broken hardware.* **Image 1.** *Plantar foot appearance at final follow up*

Case Summary: One patient with previous partial 2nd and 3rd ray amputations and plantar superficial midfoot ulceration who underwent Charcot reconstruction. The final construct included intramedullary beaming of the first and fourth rays with joint preparation and midfoot wedge resection, external fixator application and plantar midfoot excisional wound debridement. At time of removal of external fixator, plantar wound was nearly healed. Approximately one year following index procedure, the patient returned to office with medial beam broken at the runout and plantar midfoot ulceration with abscess. At final follow up, the broken hardware was asymptomatic, however the plantar midfoot wound probed to bone, had osteomyelitis of underlying bones and measured 3.4cm x 3.7cm x 0.2cm.

History of Present Illness: 56M presented on 3/14/2018 for evaluation of left plantar midfoot ulceration after previous physician recommended below knee amputation. The patient had a non-healing plantar midfoot ulceration and had been receiving local wound care. The patient underwent amputation of rays 2 and 3 for treatment of osteomyelitis 2 months prior to presentation. Review of systems were negative.

Past Medical History: Type II Diabetes, HbA1c: 9.0 (3/28/2018), Charcot arthropathy, Nephrolithiasis

Ankle Brachial Index (3/20/2018): Right 1.26, Left 1.49

Radiographs (1/16/2018): Status post amputations. No acute osteomyelitis (X-ray A and B).

Dermatologic	Superficial plantar midfoot ulceration measuring 3cm x 3cm x 0.1cm (Wagner Stage IA). No erythema, edema, purulence, crepitus, fluctuance, maceration, undermining, probe to bone.
Neurologic	Vibratory and protective sensation diminished.
Orthopedic	Rocker bottom foot with collapse of medial longitudinal arch, abduction of the foot and gastrocsoleus ankle equinus
Vascular	Dorsalis pedis and posterior tibial pulses 2/4 bilaterally. Capillary refill brisk to remaining digits.

3/28/2018
- Midfoot wedge resection and arthrodesis using 2x intramedullary bolts
- External fixation
- Tendoachilles lengthening

6/6/2018
- External fixator removed (X-ray C and D)
- Nearly complete healing of plantar ulceration

6/6/2018 – 4/4/2019
- Patient lost to follow up

4/4/2019
- Patient presents to office with plantar midfoot ulceration with surrounding erythema and positive probe to bone
- Sent to hospital for evaluation and workup

4/4/2019
- Patient presents to hospital, radiographs reveal failure of the medial bolt at screw run out (X-ray E)
- CT reveals possible osteomyelitis of cuboid, tibia and fibula

4/5/2019
- Patient underwent incision and drainage of foot with discovery of laterally tracking abscess.
- Bone biopsy of tibia taken which resulted negative for osteomyelitis

4/6/2019
- Patient refuses below knee amputation or second Charcot reconstruction attempt

7/29/2019
- Patient underwent wound debridement and graft application (Image 3)

Analysis & Discussion

Charcot neuroarthropathy presents a complex biomechanical challenge for lower extremity reconstruction. Adding to this complexity, patients who have undergone previous partial or full ray amputations need careful consideration and surgical planning. Published methods for beaming aim to recreate and stabilize the foot through the medial and lateral longitudinal arches through intramedullary bolts. This case outlines a limb salvage attempt in a patient with multiple previous ray amputations.

The subject underwent midfoot osteotomy, realignment arthrodesis and intramedullary stabilization through rays 1 and 4. This construct aimed to create a stable "tripod" effect for the foot. The subtalar joint was left unfused as it appeared rectus and stable and would allow for rearfoot compensation during ambulation. Postoperatively, the patient's course was uneventful until lost to follow up. When the patient presented approximately 1-year post reconstruction, the patient had residual unhealed plantar wound and broken hardware in the setting of noncompliance.

To the authors' knowledge, few studies have specifically addressed biomechanical implications of partial ray amputations. A systematic review by Dillon et al. describes altered gait mechanics with partial foot amputations but does not relate these changes to Charcot deformity or weight distribution along the remaining metatarsal parabola[6]. Ramseier et al. evaluated four non-neuropathic patients after resection of malignant tumors of the phalanges and metatarsals, using a pedobarographic device[7]. The study included two subjects with central ray amputations with resultant lateral displacement of pressure compared to the contralateral limb during ambulation.

This case illustrates the unique challenges faced during Charcot reconstruction in the setting of missing rays. Future studies should include biomechanical evaluation of Charcot beaming constructs in the face of previous ray amputations. Additionally, future studies should compare rates of hardware failure with and without subtalar joint fusion in subjects with healthy subtalar joints.

References

1. Charcot JM. Lecons sur les malidies du systeme nerveux. Archives de Physiologie 1868.
2. Grant, W. P., Garcia-Lavin, S., & Sabo, R. (2011). Beaming the Columns for Charcot Diabetic Foot Reconstruction: A Retrospective Analysis. The Journal of Foot and Ankle Surgery, 50(2), 182–189. doi:10.1053/j.jfas.2010.12.002
3. Pinzur MS. Current concepts review: Charcot arthropathy of the foot and ankle. Foot Ankle Intl. 2007;28(8);952-959.
4. Lowery, N. J., Woods, J. B., Armstrong, D. G., & Wukich, D. K. (2012). Surgical Management of Charcot Neuroarthropathy of the Foot and Ankle: A Systematic Review. Foot & Ankle International, 33(2), 113–121. https://doi.org/10.3113/FAI.2012.0113
5. Rooney J. Hutabarat SR. GRujic L. Hansen ST. Surgical reconstruction of the neuropathic foot. Foot Ankle. 202;12(4):213-223
6.. Dillon, M. P., Fatone, S., & Hodge, M. C. (2007). Biomechanics of Ambulation After Partial Foot Amputation: A Systematic Literature Review. JPO Journal of Prosthetics and Orthotics, 19(Proceedings), P2–P61. doi:10.1097/jpo.0b013e3180ca8694
Financial Disclosure: None
7. Ramseier, L. E., Jacob, H. A. C., & Exner, G. U. (2004). Foot Function After Ray Resection for Malignant Tumors of the Phalanges and Metatarsals. Foot & Ankle International, 25(2), 53–58. doi:10.1177/107110070402500203

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