CASE REPORT

Midfoot reconstruction of Charcot foot: A five-year follow-up report

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Abstract

Charcot arthropathy is a degenerative condition associated with neuropathic feet. It is characterized by destruction and ensuing dislocation of the joints of the foot. At present, there is no gold standard method to stabilize the affected foot. We present a case of Charcot arthropathy in the midfoot with instability in the first tarsometatarsal joint of the left foot and fixed flexion of the interphalangeal joint causing repeated trauma over the distal phalanx and nail resulting in pain and deformity. The left midfoot was surgically reconstructed by internal fixation using screws and a plate, after medial ray fusion and interphalangeal joint fusion. The patient's progress was tracked at two months, six months, and five years post-surgery. Charcot foot in the patient was successfully stabilized by internal fixation and a follow-up after 5 years showed a completely healed wound with good alignment and fixation around the fusion site. The patient also reported improvement in pain, physical activity, and social interactions during 5-year follow-up.

Keywords: Charcot foot, Neuropathy, Midfoot Charcot management, Surgery

Introduction

Charcot foot or Charcot neuroarthropathy is a severe though rare complication of peripheral neuropathy, commonly affecting the foot and ankle joints [1]. The exact cause of Charcot foot remains uncertain, but it is believed to stem from recurring mechanical trauma or acute injury to insensitive bones, leading to progressive bone destruction and joint deformity. Alternatively, increased blood flow and arterial perfusion may contribute to osteopenia and demineralization. Activation of pro-inflammatory cytokines can enhance vascularity and trigger the Receptor-Activator of the Nuclear Factor-Kappa Beta (RANK)-RANK Ligand (RANKL) axis, promoting osteoclastic activity and subsequent bone loss [1].

The characteristic stages of Charcot foot transitioning from active to inactive disease phases include inflammation, fragmentation, coalescence, and consolidation. Charcot foot is easily misdiagnosed as osteomyelitis or deep vein thrombosis. A thorough medical history and a temperature difference from the unaffected foot may raise suspicion of Charcot foot, which can be confirmed using a technetium-99 bone scan to detect increased bone turnover activity near affected joints and X-ray imaging for assessing joint damage [1].

A multidisciplinary approach of surgical and non-surgical methods involving surgeons, diabetic teams, and vascular surgeons is required to attain the goal of maintaining a stable, properly aligned foot, allowing patients to carry out daily activities without amputation. Treatment typically involves immobilization, off-loading, and pharmacological therapy, with surgery reserved for advanced

stages to enhance quality of life [1, 2]. Although there have been advances in the field of anaesthesia and infection control related to orthopedic surgeries, there are several challenges and gap in evidence related to management of Charcot foot [3, 4]. Limited testing accuracy and inability to clearly distinguish the condition from infection make it challenging to diagnose. Additionally, opting for a surgical treatment, when to operate, and the type of surgery are also inconsistent, making it further challenging to manage Charcot foot [5]. Additionally, there is no preferred surgical method, viz. internal or external fixation, for Charcot foot reconstruction. We present a case of Charcot arthropathy in the midfoot where internal fixation was performed using screws and plates, and the progress was monitored by following up after 5 years.

Case Report

A 58-year-old man from Comoros (East Africa) who had been living in the United Arab Emirates for the past few years, with a background of Type 2 Diabetes Mellitus (T2DM), approached the Department of Foot and Ankle at Medcare Orthopedic and Spine Hospital in October 2018. He was previously diagnosed with Charcot foot 3 years back after suffering a traumatic foot injury. It was initially managed by offloading in another hospital. However, the patient reported severe pain and agony and was unable to walk without support. He was active and a full-time worker, and the pain and deformity of his foot had affected his ability to work, therefore, impacting his quality of life significantly.The patient had been suffering from T2DM for the past 20 years and had an incidence of stroke in 2016. Additionally, the patient was on oral medication for hypertension and hyperlipidemia, insulin (26 units), and oral diabetic medications (metformin hydrochloride 750 mg twice and dapagliflozin 10 mg once daily) for T2DM.

Investigations and diagnosis

The baseline fasting glucose of the patient was 175 mg/dL with an HbA1c of 9.3. The patient's adherence to glycemic control treatment was poor. An HbA1c count of <6 is ideal for successful wound healing [2], therefore, he was referred to an endocrinologist to optimize his blood glucose levels before any intervention. The patient's vascular assessment (arterial study) was performed using a duplex scan in both legs. The scan was done using a linear Fuji probe of 3-12 MHz in 8 modes, revealing peripheral vascular disease with ischemia in both legs, along with potent biphasic pulses on the iliac (velocity of 72 cm/s), femoral (velocity of 68 cm/s), and monophasic latent potential (velocity of 66 cm/s) on the posterior tibialis (velocity of 42 cm/s), and dorsal pedalis (velocity of 12 cm/s). He was then referred for a trans-femoral angioplasty. Further, an X-ray imaging revealed healed fractures with mild arthritic changes in the first and second tarsometatarsal joints (Figure 1), and a CT-scan (computed tomography) indicated instability in the first tarsometatarsal joint of the left foot. Fixed flexion of the hallux interphalangeal (IP) joint was causing repeated trauma over the patient's distal phalanx and nail, resulting in pain and deformity (Figure 2).

Figure 1: Pre-operative X-ray of the left foot showing healed fractures in the first, second, and third tarsometatarsal joints

Figure 2: Pre-operative CT scan of the left foot showing flexion and valgus at the hallux inter-phalangeal joint

The investigations confirmed signs of instability, severe arthritic changes, subluxation of the left first tarsometatarsal joint with planarization of the medial cuneiform, and dorsal subluxation in the base of the first metatarsal bone.

Surgical intervention

The patient achieved glycemic control (HbA1c-6.2) with improved adherence following which he was scheduled for surgery. After achieving satisfactory blood flow to the lower limbs, we stabilized the foot with internal fixation. This decision was made for medial ray fusion and IP joint fusion of his hallux. Internal fixation was chosen as it was convenient for the patient, didn't involve repeated administration of anesthesia, had a quicker recovery time, and lower risk of infections compared to external fixation, especially since the patient was diabetic and we could not risk a delay in healing and recovery.

We then surgically fused the medial ray to reduce the abduction of the forefoot. The implants used for the surgery were obtained from the salvation kit (Wright Medical Group Inc., U.S.). This system was used due to its anatomic design and strength. The implants used were osteoperve locking screw (dimensions: 4 mm × 2.4 mm, 5.5 mm × 3.2 mm, 5.5 mm × 40 mm, 5.5 mm × 45 mm, 5.5 mm × 50 mm, 4 mm × 20 mm), headed screw (4 mm × 50 mm), and a bridge midfusion plate.

The midfoot joint was enforced with a bolt, from the intramedullary of the first metatarsal bone to the medial ray, and the bridging was extended to the talonavicular joint and naviculocuneiform joint, together with the second and third tarsometatarsal joints. We planned to fuse the fourth and fifth tarsometatarsal joints with the cuboid to the lateral column, in the event of any instability, as there were clear arthritic changes in these joints. The patient was recommended physiotherapy post-surgery.

Follow-up

The healing was tracked over two months, six months, and five years after the surgery (Figure 3A, B, C). The patient-reported outcome measures were recorded using the Manchester-Oxford Foot Questionnaire (MOXFQ) [6], both before the procedure and five years post-surgery, where higher scores meant worse outcomes. Before the procedure, the patient had rated "most of the time" for almost all the questionnaire variables including pain in the foot and ankle, avoiding walking due to pain, being self-conscious about the foot, etc. Improvement was observed in the three domains of MOXFQ viz., pain, physical activity, and social interactions where the patient responded to "rare" occurrence of pain in the foot and ankle, inability to participate in social and recreational activities, etc. The MOXFQ scores before surgery and after 5 years of surgery are listed in Table 1, which had reduced considerably post-surgery.

Physical examination at 5-year follow-up showed good stability of the midfoot, supported by the X-ray image that revealed good alignment and fixture around the fusion site. Charcot can become active later, however, during follow-up after 5 years, the midfoot fixation remained intact without any displacement of the metalwork. The wound healed completely without incident and the metalwork around the fusion site was aligned appropriately.

Figure 3A: X-ray lateral and anteroposterior view of left foot 2 months post-surgery: Shows hallux fixation of proximal and distal phalanx, and internal fixation at the midfoot involving 1st, 2nd, and 3rd metatarsals, medial, intermediate, and lateral cuneiform bones

Figure 3B: X-ray image of left foot 6 months post-surgery showing healing at the location of internal fixation

Figure 3C: X-ray image of left foot 5 years post-surgery showing completely healed midfoot

Table 1: Manchester-Oxford Foot questionnaire scores of the patient before and after surgery

Domains	Scores	
	Before surgery	On 5-year follow-up
Walking/ standing problems (Total score, N=700)	530	260
Foot pain (Total score, N=500)	310	160
Social interaction (Total score, N=400)	290	170

Discussion

Charcot arthropathy is a disabling condition affecting the bone and joint architecture of the foot or ankle but the results have showed great variation [7]. In the present case, an early diagnosis and appropriate treatment option resulted in good and stable alignment of the midfoot joint and improved physical activity and quality of life. Managing Charcot foot begins with an appropriate diagnosis by determining the stage of the disease progression, wherein, our patient was diagnosed with Charcot which was at Eichenholtz Stage III reconstruction and consolidation, prompting an appropriate treatment regimen. Multiple factors need to be considered before surgical intervention including

detailed patient medical history, site of infection, glycemic control below 6% HbA1c, [2] and favorable vascular conditions (0.9-1 ankle-brachial index and transcutaneous pressure below 50 mmHg) [8]. An abnormal glycemic index in our patient was rectified before proceeding with surgery.

The surgical techniques recommended for Charcot foot involve external fixation using an external fixator, circular frame, Taylor spatial frame, and Ilizarov frame, and internal fixation using hind foot nails, hind or midfoot plate, midfoot beams, and screws [10]. We employed the internal fixation technique with midfoot plates and screws in our patient which is known to reduce the mean time for weight bearing. The concept of "superconstructs" may be integrated during internal fixation, whereby fusion is prolonged beyond the damage site to encompass unaffected joints. This method improves fixation by ensuring adequate deformity correction, alleviating soft tissue strain, and optimizing mechanical performance using the most robust fixation devices that the soft tissue can withstand [9]. The extension of fixation, by including the joints beyond the zone of damage during internal fixation is also known to improve the fixation construct [10].

Over the course of five years, we closely examined the patient's post-surgery progress. Our study emphasized a complete pre-operative evaluation that included an investigation of the patient's medical history, the stage of Charcot arthropathy, and the guarantee of optimal glycemic management. We validated that the patient's HbA1c levels were less than 6% prior to surgery, following recommended protocols for preventing diabetes complications. Furthermore, we evaluated vascular conditions using the ankle-brachial index and transcutaneous pressure measurements, which confirmed that they were within optimum ranges (0.9-1 and less than 50 mmHg, respectively) [2, 8]. The surgical strategy used in our case included successful and inventive internal fixation techniques. We used the concept of superconstructs, which increase fixation stability by extending fusion to unaffected joints. This technology significantly improves the biomechanical stability of the structure and reduces the possibility of difficulties associated with traditional repair procedures. Our surgical treatment used midfoot plates and screws, which are known for significantly shortening weight-bearing time compared to other methods. This approach was supported by research indicating that strict internal fixation results in greater stability and healing [8]. To prevent infection and support the cast, the patient's endocrinologist performed the initial postoperative dressing using a sterile no-touch technique, followed by regular monitoring. The podiatrist and surgeon performed postoperative follow-up, assessing the extent of wound healing every four weeks for a year. The patient developed an infection six months after surgery, which was treated with drugs administered intravenously. Postoperative care included prolonged offloading in a cast, followed by an air cast boot and physiotherapy for slow weight bearing, which resulted in a well-aligned fusion site and complete wound healing, as well as improved ability to walk without support. After 5 years, he was given a new Charcot shoe because the old one had worn out. Furthermore, his glycemic index had deteriorated, so he was referred back to an endocrinologist, who upped his insulin dose and advised regular follow-ups to guarantee adherence. Long-term outcomes of midfoot reconstruction with internal fixation

have received little attention in the literature. We also noticed that internal fixation resulted in an incidence-free short-term outcome for the patient, as opposed to delayed weight bearing, foot shortening, inadequate deformity treatment, and other procedures documented in the literature. This success was only interrupted by the onset of an infection, which can be treated [10].

In patients with Charcot arthropathy, we need to consider the patient history and stage of disease progression, along with glycemic control to devise the most suitable treatment and management method for both the stability of the affected foot and the quality of life. Long-term follow-up ensures sustained benefit of the treatment and addresses potential complications.

Conclusion

In the current case of midfoot reconstruction using internal fixation, pain, physical activity, and social interactions improved remarkably. The follow-up visit showed proper alignment and fixtures around the fusion site without any incidence.

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