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Charcot neuroarthropathy of ankle and foot; Bangladesh experience

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Introduction

In 1883, Jean-Martin Charcot first described Charcot neuroarthropathy. Willium Reily Jordan in 1936 described the relation of Charcot with diabetes mellitus. We can put the diagnosis of Charcot neuro arthropathy clinically when we see loss of normal foot sensation, ulceration with foot deformity. The factors that causes bone and joint destructions includes peripheral neuropathy. Autonomic neuropathy, osseous malignant, repetitive trauma, metabolic abnormalities, renal disease, osteoporosis, glycosylation of bone proteins and collagen.[1,2]

There are two theories that causes Charcot neuroarthropathy.

1. Neurovascular theory and
2. Neurotrmatic theory.

Sympathetic denervation increases peripheral blood flow leading to arterio venous shunting that causes hyperemia and bone resorption. The vessels are dilated which increases peripheral blood flow. Acute or repetitive trauma may invite Charcot neuroarthropathy, ulceration occurs in osseous prominences. We must rule out osteomyelitis from ulcers. Charcot neuroarthropathy in combination with osteomyelitis gives poor prognosis. The real Orthopaedic management of Charcot neuroarthropathy includes:

i. Debridement
ii. Ostectomy
iii. Arthrodesis
iv. Tendon Achilles lengthening and
v. Open reduction and Ilizarov external fixation.

Internal fixation does not give better outcome; For reconstruction of Charcot deformities Ilizarov is the best choice and gradual controlled coordinated correction is always advisable.

Clinical manifestations

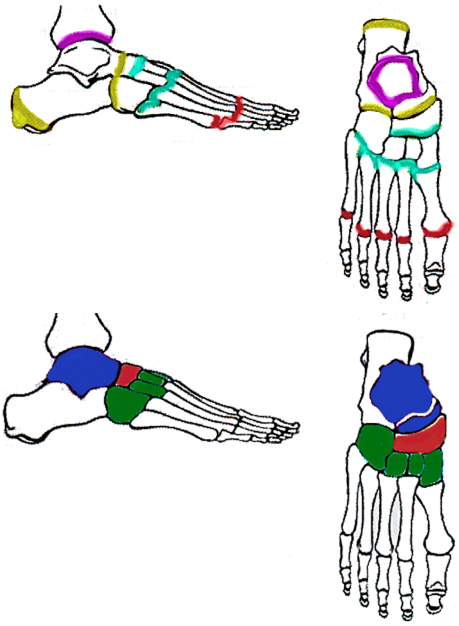
Acute and chronic neuroarthropathy are seen in six locations. These six regions are:

i. Ankle
ii. Tarsometatarsal joint
iii. Metatarsophalangeal joint
iv. Mid foot
v. Subtalar
vi. Calcaneal regions.

The Charcot foot is wider and larger in size than normal foot. If it remains untreated will become more deformed. Acute Charcot neuroarthropathy presents as a red, hot, swollen foot (Stage 1). Acute may be with or without foot and ankle deformities.[3]

Chronic Charcot joint is always accompanied by foot and ankle deformity with ulceration (Stage 2 and Stage 3).

Plantar ulcers are commonly seen in Charcot neuroarthropathy of foot. Chronic ulcerations lead to deep infection and osteomyelitis. In case of osteomyelitis we must do debridement and reconstruction should be done with magical Ilizarov Technique. We must assess the anatomic locations of the deformity, ulcerations and osteomyelitis.



In case of osteomyelitis we must do debridement and reconstruction should be done with magical Ilizarov Technique. We must assess the anatomic locations of the deformity ulcerations and osteomyelitis. X-ray assessment always helps in determining the stages of Charcot

diseases. The bones of hindfoot and midfoot are superimposed because of subluxation or dislocations of these joints. Axial view of midfoot, hindfoot and ankle helps in determining the Charcot neuroarthropathy.

Materials and methods

From january1990 to december 2021, 112 patients were performed surgeries (84 males, 28 females) with Ilizarov apparatus in diabetic foot patients with Charcot's joints (Eichenholtz stage II and III). The mean age of patients was 57(range 36-65 yrs.) of which all patients were diabetic. Deformity, resorption of bones and instability of the ankle joint that results in a non-plantigrade foot was considered as the operative indication.

Classification

Charcot neuroarthropathy can be classified according to the stages and anatomic location of deformity.

Stages

Eichenholtz classified the Charcot neuroarthropathy on clinical examination and radiographic findings.[4,5]

Stage- 1

Stage- 2

Stage- 3

Stage- 0

Stage- 1: Development phase, characterized by fragmentation of bones and cartilage, joint effusions, subluxation and dislocation, soft-tissue edema, hyperemia, bone resorption, and intra-articular fractures.

Stage- 2: Coalescence phase, characterized by decreased soft-tissue edema, healing of fractures, and organization bone fragments.

Stage- 3: Reconstruction phase, characterized by new bone formation and remodeling of bone.

Shibata et al. added another stage:

Stage- 0: Acute phase, characterized by swelling, warmth, joint instability, and normal radiographic anatomy of foot and ankle.

Treatment options

Conservative treatment options: Wound case, total contact casting, braces are commonly used to obtain closed tissue envelope of the foot and ankle; surgical intervention is indicated when conservative and recurrent ulceration is present.

Surgical treatment options:

Our aim is to-

a. Restore alignment

b. Stability and

c. Prevent amputation.

We are doing surgical procedure on the basis of case selection. The anatomic location of the deformity, the pressure or absence of osteomyelitis, the stability of Charcot deformity is very important. Equinus is a major deforming force with Charcot foot deformities. With Charcot foot deformities, a severe gastrosoleus equinus contracture is present. Subluxation and dislocations are very common in foot bones which produce a misshapes foot with osseous prominences. Ostectomy is the important procedure to minimize osseous prominences for limb preservation in our goal. Surgical reconstruction is necessary in stage 2 and 3.

Ilizarov external fixation has been used for easy stabilizations of acute Charcot joint subluxation and dislocations. Ilizarov offloads the ulcerations and maintaining anatomic position of bones by which we can avoid further deformity and patient can be able to partial weight bear. Because of osseous mid foot deformities the exact location of deformity are difficult to determine. Charcot deformity in the joint is a stable deformity, but in midfoot region Charcot deformity is an unstable that leads to plantar central and plantar lateral ulcerations in the ankle. Subluxation Charcot neuroarthropathy affects the foot which becomes difficult to manage.

Whenever we see recurrent ulceration, deformity, instability and infection we must think for surgical intervention. Our goal is to reconstruct a Charcot foot and ankle after eradicating the ulcer and infection by applying the Ilizarov apparatus to realise the dislocated and subluxated foot joint. After doing proper osteotomy we can undergo osseous realignment. For mid foot rocker bottom foot deformity correction, we can remove a wedge from a medial and dorsal side. For midframe joint deformity, a similar type of wedge ostectomy can be performed. Ilizarov is the best option which can be used gradually for correcting deformity after doing ostectomy.

Arthrodesis is a very important option in all kinds of reconstructive surgery in Charcot foot and ankle deformity. In internal fixation cases the rate of failure is high that's why our choice is the Ilizarov technique by which we can get excellent result by using the thin biocompatible smooth (1.8 or 1.5mm) and olive wires.

Surgical instrumentation (Acute VS gradual correction)

Deformity correction can be easily done by Ilizarov device. The first stage of reconstructing the Charcot foot is to obtain correction and the 2nd stage is to maintain the correction. Our choice is the Ilizarov external fixation for deformity corrections till the Ilizarov methodology and frame is the best for foot and ankle neuroarthropathy.

Ilizarov allows for fine tuning of regional deformity correction. The precise phase for deformity correction must be obtained.

Acute correction

Historically, open reduction with internal fixation was the mainstay for treatment of Charcot foot deformities. Large open incisions were made to remove the excess bone and to reduce the fragmented or dislocated bone. In addition, screw fixation or plantar plating was traditionally performed in an attempt to stabilize the Charcot joint. These invasive surgical procedures typically resulted in a nonanatomic correction (e.g., shortening of the foot or incomplete deformity correction) and occasionally resulted in neurovascular compromise, incision healing problems, infection, and the use of casts or boots for nonweight bearing patients. Although performing open reduction has disadvantages, in cases of tarsometatarsal Charcot deformity, it is advantageous. Typically, Charcot neuroarthropathy of the tarsometatarsal joints is associated with mild-to-moderate deformities

because the tarsometatarsal joints are structurally interlocked. Acute realignment achieved by performing a wedge resection and applying Ilizarov fixation produces a stable foot.

Ilizarov fixation

During the last decade, important advances have been achieved in the technology, preoperative deformity planning, a basic science of external fixation, especially regarding its use for deformity correction. Increased knowledge and improved technology have tremendously expanded the indications and applications of Ilizarov fixation, and deformity correction principles to treat Charcot neuroarthropathy of the foot and ankle.

Ilizarov apparatus allow for fine-tuning; of residual deformity correction outside the operating room. With internal fixation, the precise plan for deformity correction must be obtained at the time of surgery and cannot be altered during the postoperative period. Ilizarov apparatus constructs can allow early weight bearing, which can lessen the severity of disuse osteoporosis and allow for access to the soft tissues for wound care.

Ilizarov fixation can be used for stabilization of an acute correction or for gradual deformity correction. The initial use of Ilizarov fixation was for static fixation purposes only after acute correction was obtained with either open osteotomy or arthrodesis. The disadvantages of this approach are the large amount of bone resection required, which shortens the foot, and the large incisions required, which increase the rate of infection and the potential for wound healing problems.

Gradual correction

One advantage of using an Ilizarov apparatus is to gradually correct the foot deformity, the technique is minimally invasive, especially for patient with multiple previous incisions. Gradual correction also allows for anatomic correction without loss of foot length or bone mass. Ilizarov fixation allows for partial weight bearing and limits neurovascular compromise because the correction occurs slowly over a period of time.

For an unstable Charcot foot or an incompletely coalesced Charcot foot correction can be done gradually. Despite the radiographic appearance of coalescence, majority of patients with Charcot deformities can undergo distraction without ostectomy to realign the anatomy of the foot.

The 1st stage consists of osseous realignment achieved by performing ligamentotaxis. Distraction and realignment restore the osseous structure and allow for soft tissue healing. The second stage consists of removing the Ilizarov fixator while simultaneously performing minimally invasive arthrodesis of the affected joints with percutaneous insertion of Ilizarov fixation. A Charcot midtarsal joint is realigned with gradual Ilizarov fixation, fused with minimally invasive techniques. Gradual distraction technique during the past four years and 11(“c achieved good to excellent success.

Frame constructs

A static frame (i.e., a Charcot stabilization construct) should include a distal tibial ring with a closed foot ring. This construct is generally used to treat patients with Charcot neuroarthropathy of the ankle or Charcot neuroarthropathy of the ankle combined with subtalar and or midfoot Charcot deformity.[6,7]

Complications

External fixation complications

Patient with neuropathic conditions require close monitoring (i.e., weekly or biweekly) to assess tor fixation failure and pin-site infection. Infections around the pin sites of the Ilizarov fixation device are common and are treated by administering oral antibiotics. The infections rarely require removal of the pins or surgical debridement.

Malalignment

Obtaining proper anatomic alignment in the axial, sagittal, and transverse planes is critical. The severity of Charcot deformities makes it challenging to obtain accurate anatomic correction. Failure to accurately realign the foot and ankle can lead to recurrence of Charcot neuroarthropathy or recurrence of ulceration.

Ulceration/Osteomyelitis

Aggressively debriding the ulceration/osteomyelitis to the level of healthy bleeding tissue should always be performed. Ilizarov fixation allows for wound healing while the deformity is being corrected.

Fixation failure

Internal and external fixation (e.g., pin, wire, ring) breakage is not an uncommon complication and can occur when the biomechanical forces of the fixator are exceeded by the lengthening/ deformity-correction process or by excessive weight bearing. This complication can be avoided by placing the fixator in a biomechanically advantageous position, using multiple points of fixation, and limiting weight bearing in neurologically compromised patients.

Wound-healing problems

Problems with incision healing can be avoided with an atraumatic surgical technique and proper preoperative planning of incision placement. For example, when performing an acute shortening of the midfoot by removing a large hone wedge, a transverse incision should be used to prevent the skin tension that would occur with a longitudinal incision.

Results

We observed that solid fusion was obtained in all 110 patients out of 112, at an average of 18 weeks duration (range, 14-20 weeks). No major complications occurred.

Discussion

Charcot neuroarthropathy of the foot and ankle can be devastating for the patient and extremely challenging for a surgeon to manage. Medical advancements to prevent neuropathy and eliminate the disease would be the ideal solution. In the meantime, improvements in technology will provide better fixation options and an enhanced understanding of the metabolic factors of Charcot neuroarthropathy will improve pharmacologic treatment. Ilizarov is a viable alternative tool that allows micromotion to fixation area. Arthrodesis by Ilizarov gives excellent outcome. Ilizarov has the ability for compression and distraction and allows ambulation. Ilizarov prevents osteopenic changes when biomechanical stress and compression is given to the bone. Hyperemic phase of the Charcot foot will promote osseous bridging. Charcot disease with multiple degenerative areas is the best choice for Ilizarov fixation.

Citation: Bari MM, Shahidul I, Kalam AMA, et al. Charcot neuroarthropathy of ankle and foot; Bangladesh experience. *MOJ Orthop Rheumatol.* 2022;14(1):7–13. DOI: 10.15406/mojor.2022.14.00569

Figure 1

a) 43 years old female, Exposed bone of right ankle Charcot neuroarthropathy
b) Debridement and Fixation of Ilizarov
c) Radiographic view of right ankle
d) 15 days after fixation with Ilizarov, healing process going on
e) Radiographic view after 15 days
f) Removal of Ilizarov apparatus
g) Radiographic view of ankle after 2 months
h) Radiographic view of ankle after 3 months
i) Excellent healing of right ankle arthrodesis after 3 months.

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Figure 2

a. 45 years old male, Lisfranc neuroarthropathy of left foot, radiographic view of neuroarthropathy with rocker bottom foot
b. TTT (Tibial Transverse Technique)
c. Radiographic view of TTT (Tibial Transverse Technique)
d. Patient is in standing position with Ilizarov apparatus
e. External view of the leg with Ilizarov apparatus
f. Radiographic view of Lisfranc joint with Ilizarov apparatus
g. h, g) Radiographic view of tibia after 10 days distraction
i. Radiograph of Tibia after removal of apparatus
j. Radiograph of foot after removal Ilizarov apparatus
k, l. External view of the foot after 2 months follow up
m, n. External view of the foot after 3 months follow up, rocker bottom foot is corrected.

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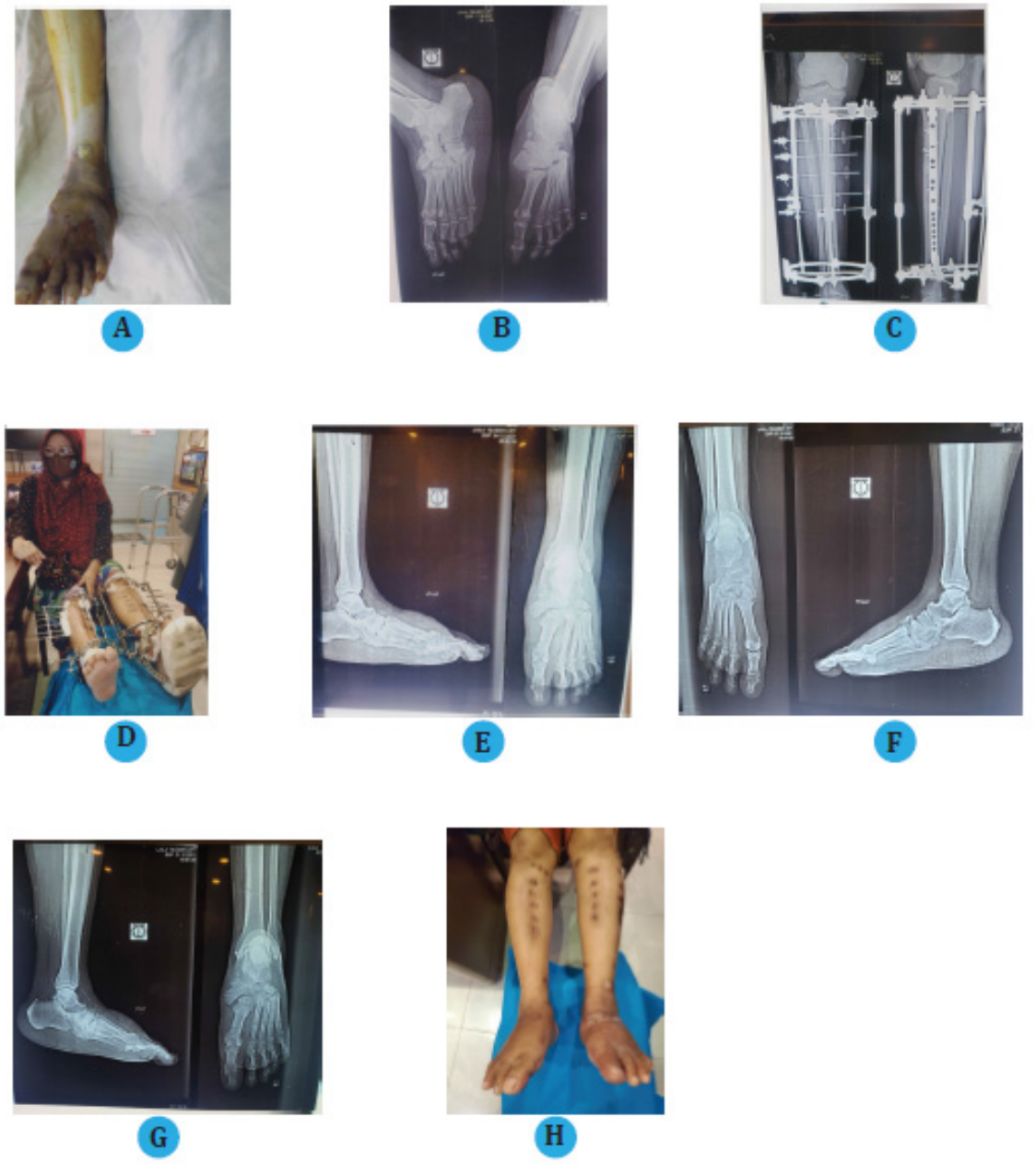

Figure 3

a. 47 years old lady, Diabetic deformed left foot discoloration of skin
b. Same patient with Lisfranc joint neuroarthropathy, radiographic view
c. Radiographic view of TTT (Tibial Transverse Technique)
d. Patient with Ilizarov apparatus in both leg and Ilizarov apparatus in left foot
e. Radiographic view of left foot after rocker bottom foot
f, g. After removal of Ilizarov apparatus, radiograph of both ankle and foot.
h. External view of both leg and foot after treatment.

Acknowledgments

None.

Conflicts of interest

The authors declare no conflicts of interest.

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