Up-to-date management of neuroarthropathic joints

Ketan K Dhatariya

Key words
- Charcot
- Diabetic foot
- Management
- Neuroarthropathy

A neuroarthropathy joint (also known as Charcot joint, Charcot foot or a Charcot) is a rare but potentially devastating complication of diabetes. Because diabetes is becoming more common, it is likely to be encountered more frequently. However, in order to not miss the diagnosis, Charcot needs to be considered whenever someone with diabetes presents with a hot swollen foot. The treatment for a Charcot foot is immobilisation, ideally in a below-knee, non-removable plaster cast (where available) or in a removable below-knee walking boot. The ongoing management should be by a multidisciplinary specialist team with experience looking after the diabetic foot and should include optimisation of modifiable risk factors.

Jean-Martin Charcot was born in 1825 and worked in Paris as a neurologist. Whilst he was not the first to describe a neuropathic joint — JK Mitchell first suggested a link between arthropathy and rheumatoid disease in 1831[1] — JM Charcot remains the most well known. He has several conditions named after him, including Charcot's neurologic triad (associated with multiple sclerosis) and Charcot-Marie-Tooth disease (hereditary motor and sensory neuropathy). But he is best known in the world of diabetes for the Charcot foot (neuroarthropathic joint), which he first described in 1868[2].

A Charcot joint is usually a relatively painless but progressive, destructive arthropathy. It occurs in one joint at a time (i.e. is uniarticular). If it progresses, then it may involve other joints in the foot. Occasionally, more than one joint is involved simultaneously, due to an underlying symmetrical peripheral neuropathy. Having one foot affected means that the treatment or deformity can lead to changes in the biomechanics of the other foot, increasing the likelihood of a Charcot developing in that foot as well. It has been reported as occurring in 1 in 200 people with diabetes, although is likely to occur more frequently[2,3]. It does not just occur in the foot but can happen in other joints, including the elbow, wrist, knee and shoulder.

The most common cause of Charcot in the developed world is diabetes; however, leprosy is a common cause in the developing world. Rarely, medications can cause peripheral neuropathy[4].

Pathophysiology

A Charcot joint can occur at any place in the foot and there are a number of different classification systems that are used, such as the Eichenholtz or Brodsky classification system[5–9]. A Charcot joint consists of a vicious cycle of trauma and inflammation[3,10]. These processes are outlined in *Figure 1*. People who have peripheral neuropathy lose information about where their foot is in space. As a result, they often have a high stepping gait and firmly put their foot on the ground. Because they may not feel contact with the ground, they may hurt themselves without knowing as a result. This is often in the form of repetitive micro-trauma — small levels of

Authors

Ketan K Dhatariya is Consultant in Diabetes, Endocrinology and General (Internal) Medicine at the Elsie Bertram Diabetes Centre, Norfolk and Norwich University Hospitals NHS Foundation Trust, Norwich, UK

repeated injury to the microarchitecture within the bones of the foot — that can, over time, lead to larger wounds in the bones. Wherever there is trauma, there is an element of inflammation. However, because the degree of peripheral perfusion is controlled in part by the autonomic nerves, if those nerves are also damaged, then the degree of peripheral perfusion can be increased. With this combination of increased perfusion and inflammation, there is bone destruction due to osteoclastic activation leading to osteopenia and increased likelihood of developing fractures and subsequent foot deformity[3,4,11].

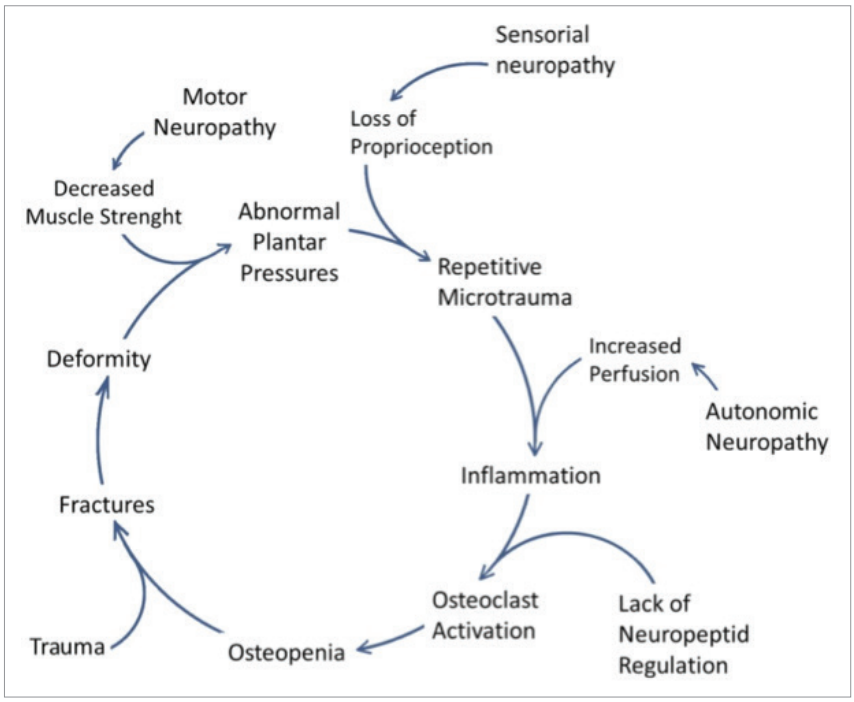
This deformity and alteration in the architecture within the foot then leads to a change in biomechanics, which in turn results in abnormal plantar pressures. Further compounding this is motor neuropathy, which can lead to a decrease in muscle strength within the small muscles of the feet[12]. These abnormal plantar pressures can again lead to small areas of trauma and the cycle starts again. With this constant trauma, there is a pro-inflammatory cascade within the foot, with the release of many inflammatory cytokines that can perpetuate the problem[11].

Diagnosis and presentation

If you are not aware of the condition, it is unlikely to be diagnosed. Recent guidelines from the UK National Institute for Clinical and Healthcare Excellence (NICE) suggest that any person with diabetes who fractures his/her foot or ankle may progress to Charcot, and that anybody with a hot, red, swollen or deformed foot in the presence of peripheral neuropathy or renal impairment should be suspected of having a Charcot[13]. A Charcot should be considered even when deformity is not present or pain is not reported.

The foot is often painless but pulses are usually present. Occasionally, the foot may ache, and having pain in a previously insensate foot should raise suspicions. It is unusual to have a Charcot in the face of peripheral vascular disease, especially where it is so severe as to require revascularisation[13]. However, individuals often have calcified arteries leading to elevated ankle brachial pressure indices. Whilst there is often no recollection of any injury at all, there may be history of a recent small injury such as a slip or trip, so a careful history needs to be taken. Other conditions for a hot, red, swollen foot are listed in *Table 1*.

Figure 1. An overview of Charcot foot pathophysiology[1]. Reproduced by kind permission of the authors.



NICE suggests that if a Charcot is suspected, the person should be referred to the multidisciplinary foot care team within 1 working day, and the team should see the patient within another working day[13]. The ideal treatment until the patient is assessed would be for the patient to be non-weight bearing until such a time as definitive treatment can be started by the specialist foot team.

Investigation and treatment

Charcot is a podiatric emergency because once deformity and bone destruction start, then it only stops when the Charcot process comes to an end or if the bones are kept immobile. Therefore, because movement of the bones can make the condition worse, it is better to treat somebody as though they have a Charcot until the imaging is available. Otherwise, the opportunity may be missed to prevent things from getting worse. If a Charcot diagnosis is suspected, then the patient should have a swift weight-bearing X-ray to see if there is a facture or Lisfranc ligament rupture *[Figure 2]*.

Table 1. Other conditions that may give rise to a hot red swollen foot in a person with diabetes
Cellulitis
Soft tissue injury
Deep vein thrombosis
Oedema from other causes (e.g. heart failure, or pelvic venous obstruction)
Gout
Infection (e.g. osteomyelitis — but remember that osteomyelitis and Charcot can co-exist

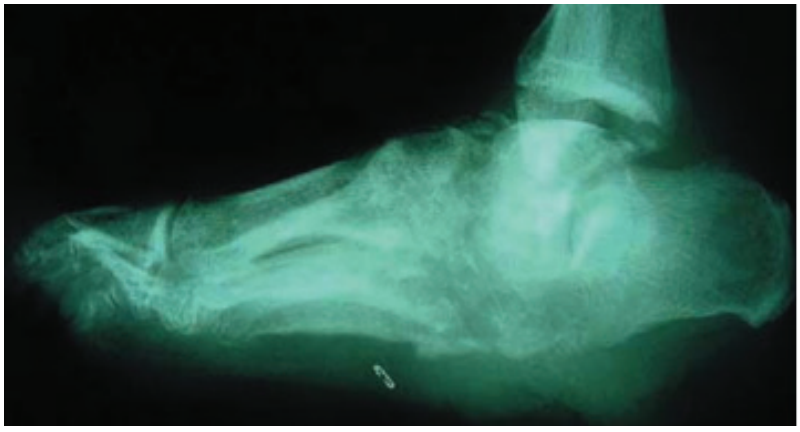
If the X-ray confirms a Charcot, then the first-line treatment is immobilisation using a total contact plaster cast to protect the foot from further trauma and inflammation. Many specialist foot teams do not have access to this, and if this is not available, they should be treated with a removable below-knee walking boot[3,15]. If, however, the X-ray is inconclusive or normal, then magnetic resonance imaging of the foot and ankle should be arranged; should this prove to show a Charcot joint, then once again the treatment would be to immobilise it in a total contact plaster cast.

Charcot can progress at different rates, and can get significantly worse over just a few weeks, or can deteriorate over a period of many months. Thus, immobilisation needs to continue until there is clinical resolution of the condition. If the diagnosis of an acute Charcot is made, then early diagnosis and immobilisation is associated with a lower incidence of foot fracture and deformity. A large study in the UK has shown that people with Charcot and ulceration are 12 times more likely to undergo an amputation than those with Charcot alone, with the annual rate of amputation being of 2.7% in people with Charcot[16].

Presence of the foot disease and enforced immobilisation can have a great psychological impact[17]. Charcot itself can give rise to high levels of anxiety and depression, leading to immobility, social isolation and unemployment — potentially even the loss of limbs or life. The mental health issues that can occur in people with diabetes-related foot disease have been shown to predict mortality[18,19,20]. This may be one of the factors influencing data showing that having a Charcot is related to a 14.4-year reduction in life expectancy compared with a population without diabetes[16].

Good diabetes control in terms of blood glucose, lipids and blood pressure are essential when treating the patient holistically and, of course, any wounds or infections need to be treated. The use of bisphosphonates to slow down osteoclastic bone resorption as a way of treating Charcot is now discouraged because of lack of evidence showing efficacy[21]. There is some evidence to suggest that surgery may be helpful, including tendo-achilles lengthening or arthrodesis, debridement, drainage, exostectomy or, indeed, amputation, but all of the studies undertaken to date have been fairly low quality and there are little consistent data on how to manage this condition surgically[22].

Figure 2. An X-ray of a Charcot foot. Note the collapse and destruction of the bones of the mid-foot, resulting in the classic "rocker-bottom" sole.



Resolution

There are no agreed criteria on how the resolution of Charcot is defined. However, having a temperature difference of less than 2°C between the two feet on three consecutive visits, each of which are 2 weeks apart, with no further changes on imaging, is a widely accepted resolution criteria[23]. Once Charcot has resolved, and this may take anything up to a year or 18 months, the foot is 'stepped down' from a total contact cast into a removable walking boot. Initially, patients should do no, or minimal, walking, then increase the amount of walking by 30 minutes per day in the boot for a week, and then per week by 30 minutes per day. Once they are walking for

about 3 hours or more and their temperatures stay normal, depending on the architecture of their foot, patients can either wear shop-bought footwear or bespoke footwear made individually for them. They do, however, need to be kept under regular review by the foot protection service[14]. Some authors feel that reconstructive surgery for quiescent Charcot is helpful[24].

Summary

A Charcot is a rare but potentially devastating and life-changing complication of diabetes. It presents as a hot, red, swollen foot, but unless the health professional is aware of the condition, it will never be diagnosed. Once a Charcot joint is suspected, the individual needs to be referred swiftly to the local specialist centre for immobilisation and further treatment. ■

1. Mitchell JK. On a practice in acute chronic rheumatism. *Am J Med Sci* 1831; 8: 55–64
2. Charcot J-M. Sur quelques arthropathies qui paraissent dépendre d'une lésion du cerveau ou de la moëlle épinière. *Archives de physiologie normale et pathologique* 1868; 1: 161–78
3. Jeffcoate WJ. Charcot foot syndrome. *Diabetic Med* 2015; 32(6): 760–70
4. Dhatariya K, Gooday C, Murchison R et al. Pedal neuroarthropathy in a nondiabetic patient as a result of long-term amiodarone use. *J Foot Ankle Surg* 2009; 48(3): 362–4
5. Eichenholtz S. *Charcot Joints.* Charles C. Thomas, Springfield, Illnois; 1966
6. Lee TH, Marcantonio ER, Mangione CM et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation* 1999; 100(10): 1043–9
7. Sella EJ Barrette C. Staging of charcot neuroarthropathy along the medial column of the foot in the diabetic patient. *J Foot Ankle Surg* 1999; 38(1): 34–40
8. Shibata T, Tada K, Hashizume C. The results of arthrodesis of the ankle for leprotic neuroarthropathy. *J Bone Joint Surg Am* 1990; 72(5): 749–56
9. Frykberg RG et al. Diabetic foot disorders: A clinical practice guideline (2006 Revision). *J Foot Ankle Surg* 2006; 45(5 Suppl): S1-S66
10. Kaynak G et al. An overview of Charcot foot pathophysiology. *Diabet Foot Ankle* 2013; 4(10): 21117
11. Jeffcoate WJ, Game FL, Cavanagh PR. The role of proinflammatory cytokines in the cause of neuropathic osteoarthropathy (acute Charcot foot) in diabetes. *Lancet* 2005; 366(9502): 2058–61
12. Bus SA, Yang QX, Wang JH et al. Intrinsic muscle atrophy and toe deformity in the diabetic neuropathic foot. A magnetic resonance imaging study. *Diabetes Care* 2002; 25(8): 1444–50
13. National Institute for Health and Care Excellence (2015) *Diabetic Foot Problems: Prevention and Management. NG19*. Available at: http://www.nice.org.uk/guidance/ng19 (accessed 19.12.2016)
14. Wukich DK, Raspovic KM, Suder NC. Prevalence of peripheral arterial disease in patients with diabetic Charcot neuroarthropathy. *J Foot Ankle Surg* 2016; 55(4): 727–31
15. Wu SC et al. Use of pressure offloading devices in diabetic foot ulcers: Do we practice what we preach? *Diabetes Care* 2008; 31(11): 2118–9
16. Game FL, Catlow R, Jones GR et al (2012) Audit of acute Charcot's disease in the UK: the CDUK study. *Diabetologia* 55(1): 32–5
17. Chapman Z, Shuttleworth CMJ, Huber JW. High levels of anxiety and depression in diabetic patients with Charcot foot. *J Foot Ankle Res* 2014; 7: 22
18. Winkley K et al. Five-year follow-up of a cohort of people with their first diabetic foot ulcer: the persistent effect of depression on mortality. *Diabetologia* 2012; 55(2): 303–10
19. Siersma V et al. Health-related quality of life predicts major amputation and death, but not healing, in people with diabetes presenting with foot ulcers: The Eurodiale study. *Diabetes Care* 2014; 37(3): 694–700
20. Vedhara K et al. Illness beliefs predict self-care behaviours in patients with diabetic foot ulcers: A prospective study. *Diabetes Res Clin Pract* 2014; 106(1): 67–72
21. Richard JL, Almasri M, Schuldiner S. Treatment of acute Charcot foot with bisphosphonates: a systematic review of the literature. *Diabetologia* 2012; 55(5): 1258–64
22. Schneekloth BJ, Lowery NJ, Wukich DK/Charcot neuroarthropathy in patients with diabetes: An updated systematic review of surgical management. *J Foot Ankle Surg* 2016; 55(3): 586–90
23. Moura-Neto A et al. Charcot foot: Skin temperature as a good clinical parameter for predicting disease outcome. *Diabetes Res Clin Pract* 2012; 96(2): e11-e14
24. Pinzur MS (2016) Surgical treatment of the Charcot foot. *Diabetes Metab Res Rev* 32(Suppl 1): 287–91