

Charcot foot in a Hong Kong Chinese diabetic population

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Objectives To delineate the epidemiology of Charcot foot in Hong Kong Chinese diabetic patients, and to provide baseline data for benchmarking the clinic service for this special group of patients.

Design Retrospective cohort study.

Setting Regional hospital, Hong Kong.

Patients Diabetic patients with Charcot foot and age- and sex-matched diabetic foot clinic attendees between 1995 and 2007.

Main outcome measures Clinical presentations were compared in patients with Charcot foot and the controls.

Results Twenty-five patients were diagnosed with Charcot foot over 12 years; 60% were male. At the time of diagnosis, the mean age was 59 (standard deviation, 14; range, 38-85) years, with diabetes being diagnosed for a mean of 11 (standard deviation, 8; range, 0-30) years. Retinopathy was noted in 36% (n=9) and nephropathy in 20% (n=5) of the Charcot foot patients. No patient had peripheral vascular disease. This finding was statistically significant. Delayed presentation occurred in 11 patients. Presentation was usually unilateral. In the minority (n=3, 12%) with bilateral involvement, presentation was sequential. Charcot arthropathy affected the mid-foot in 64% of the patients. Superimposed infection was common (61%). Recurrent ulceration occurred in 11%, all of whom presented late. Only one patient underwent major amputation, but the 5-year mortality of Charcot foot patients could be up to 33%.

Conclusion Charcot foot was uncommon in this population. Late presentation was common and might be related to superimposed infection; such patients were prone to recurrent ulcers.

Introduction

Diabetes is a prevalent disease in Hong Kong. In a community-based study of the Hong Kong Chinese population, the age-standardised prevalence in 35- to 64-year-old subjects was 10.6% and was markedly higher (29.3%) in women aged 65 to 74 years.¹ This prevalence is comparable to that seen in western populations. Diabetic patients are prone to develop peripheral vascular disease and infections.^{2,3} In the United States, 30 to 50% of diabetic individuals have peripheral neuropathy, and up to 2.5% develop Charcot foot.⁴

Charcot foot was first described by the French neurologist Dr Jean-Martin Charcot in 1868.⁵ His description of bone and joint changes associated with neuropathy was based on his findings in patients with tertiary syphilis. In 1936 Dr William Jordan linked this type of neuroarthropathy to diabetes.^{4,6} This condition is now gaining attention as it not only leads to rapidly progressive deformities but also heightens the chance of major amputation.⁷

Currently available clinical data on Charcot foot are based on western populations, and to the best of our knowledge, there is no similar information on Chinese patients. Our study had two objectives. The primary objective was to delineate the epidemiology of Charcot foot in Hong Kong Chinese diabetic patients. The secondary objective was to provide baseline data for benchmarking the clinical service provided for this special group of patients.

Methods

The Kwong Wah Hospital multidisciplinary Diabetic Foot Clinic has been functioning since

Key words
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香港華籍糖尿病患者的Charcot足

- 目的** 探討香港華籍糖尿病患者的Charcot足的流行病學，並為這些病人提供設立基準醫護服務的基本數據。
- 設計** 回顧隊列式研究。
- 安排** 香港一所地區醫院。
- 患者** 1995年至2007年期間到糖尿病足診所診治的Charcot足病人，同時選取年齡及性別與Charcot足病人匹配的做對照。
- 主要結果測量** 有Charcot足及對照組的病人的臨床特點作一比較。
- 結果** 12年內共有25位病人有Charcot足，其中60%為男性。病人確診時的平均年齡59歲（標準差14歲；介乎38至85歲）；糖尿病年期平均11年（標準差8年；介乎0至30年）。Charcot足的病人中36%有視網膜病（n=9），20%有腎病（n=5）；並未發現有周圍血管病變，這結果達統計學上的顯著性差異。有11名病人延遲診治。大部份患者只有單腳患Charcot足；有3名病人（12%）的Charcot足涉及雙腳，但病發都是由一邊開始。Charcot足關節病影響64%病人的中足。病人普遍有重疊感染（61%）。11%有復發性潰瘍，全部都屬於來院較晚的一組。只有一名病人曾做截肢術，有Charcot足的病人的5年死亡率可達33%。
- 結論** 本地糖尿病患者患有Charcot足屬罕見。遲確診很普遍，有可能與重疊感染有關；這些病人亦較易有復發性潰瘍。

1995. The clinic serves as a regional referral centre serving a catchment area of 600 000 residents.⁸ Due to limited resources, the clinic restricts its service to patients with high-risk diabetic feet, as signified by: deformity, history of ulceration or deep infection (on the same side or contralateral foot). Despite being highly specialised, by December 2007 the clinic's client base had expanded to 858 patients.

The clinic patients undergo regular assessment, with the findings documented on a standardised form. Items recorded include: age, gender, type of glycaemic control, duration of diabetes, social background, ambulatory status, presence of retinopathy, nephropathy, neuropathy, peripheral vascular disease, ulceration and episodes of related hospitalisation and surgery (if any).

A diagnosis of diabetic nephropathy requires evidence of albuminuria in addition to a decrease in glomerular filtration rate, rather than just deterioration in renal function.⁹ Retinopathy is defined as present if either retina shows typical diabetic changes on fundoscopic examination.¹⁰ The clinical data used in this study were retrieved from the Clinical Management System, a database holding the diagnosis, investigation results, and types of procedures carried out on all public sector patients since 1997.¹¹ We defined neuropathy as loss of light

touch sensation by the use of a Semmes-Weinstein 5.07 monofilament (Hansen's Disease Foundation Inc, Carville, LA, US). Peripheral vascular disease was considered to be present if the ankle-brachial index was less than 0.90. Patients clinically suspected to have Charcot foot were entered into a special registry.

These patients were followed closely. Evidence of neuropathy was the prerequisite for diagnosing Charcot foot. Infection was ruled out if, after elevation of the foot for 10 minutes, swelling and erythema regressed.¹² If the finding was equivocal and blood inflammatory parameters such as the white cell count, erythrocyte sedimentation rate and C-reactive protein were elevated, more aggressive investigations were arranged, including a white cell scan and even a bone biopsy. Weight-bearing (when possible) radiographs were performed on all these patients. Serial monitoring was arranged, with the time intervals dependant on the speed of the evolving arthropathy. The process was classified into stages as: acute active or chronic stable^{13,14} and the location of the arthropathy recorded.⁴ Eichenholtz staging was not used because of its low clinical reliability.¹⁴⁻¹⁶ The location of the lesion was classified as 'ankle' if it was at the talar dome; 'hindfoot' included the calcaneum, subtalar joint, talonavicular joint, and calcaneocuboid joint; 'midfoot' covered the region distal to the talonavicular and calcaneocuboid joints and proximal to the mid-shaft of the metatarsal bones; 'forefoot' represented sites distal to the mid-shaft of the metatarsal bones.

Acute active Charcot foot was managed with a below-knee fibreglass cast (BKFC) and a non-weight-bearing protocol for at least 6 weeks, even for those with uninfected ulceration. Patients with infected ulcers were offered antibiotics, wound dressing and surgical debridement depending on the progress of symptoms and the response. These patients were prescribed bed rest and a non-weight-bearing walking protocol. Once the ulcer became clean, they were treated with a BKFC. The duration of use of the BKFC varied from 6 weeks to 4 months, depending on how long it took for the inflammation to subside and for the foot to become stable. Custom orthotic shoes were issued once the BKFC was taken off. Acute active Charcot foot demanded more constrained types of orthotic shoes, as well as a protected weight-bearing protocol. Accommodating orthotic shoes were given to the patients with chronic stable Charcot foot. They were allowed unrestricted walking.

Surgical intervention was not usually offered during the acute stage, unless infection demanded local surgical control. Those with a chronic stable Charcot foot but persistent or recurrent ulceration due to deformity were offered resection of the bony prominences. Patients with unstable joints in a chronic Charcot foot were advised to have surgical

arthrodesis.

To elucidate the characteristics of this group of patients in this retrospective cohort, a control group of sex- and age-matched patients attending the same multidisciplinary diabetic foot clinic was selected for statistical comparison. To enhance the statistical power, the ratio of cases-to-controls was set at 1:3.

Data analysis was performed with the Statistical Package for the Social Sciences (Windows version 10.0; SPSS Inc, Chicago [IL], US). Bivariate analysis was carried out using the paired *t* test for continuous variables and Chi squared tests for categorical variables. The log rank test was performed for Kaplan-Meier survival analysis. The Cox regression test was utilised to identify predictors for survival. A P value of less than 0.05 was considered significant.

Results

Our retrospective cohort study identified 25 patients diagnosed with Charcot foot during the 12-year period. They represented 2.9% of the patient load in the multidisciplinary diabetic foot clinic, giving an incidence of 3.5 new cases per million residents per year. Hence, 24 new cases of Charcot foot would be expected each year among Hong Kong Chinese diabetics. Given the age-adjusted 8.5% prevalence of diabetes mellitus in Hong Kong, the incidence of Charcot foot was projected as 0.041 cases per 1000 diabetic patients per year.¹⁷

The characteristics of the Charcot foot and control patients are summarised in the Table. Fifteen (60%) of the patients were male, and at the time of diagnosis their mean age was 59 (standard deviation [SD], 14; range, 38-85) years. All of them were ambulant and 15 (60%) could walk unaided without any appreciable limit.

They had been diagnosed as diabetic for a mean of 11 (SD, 8; range, 0-30) years by the time they presented with Charcot foot. Four (16%) of them were being managed with insulin injections. Their mean haemoglobin A_{1c} at the time they were first seen in the Diabetic Foot Clinic was 9% (SD, 2%; range, 6-15%). Nine (36%) of the patients had retinopathy and five (20%) had nephropathy. Among these patients, two (8%) had both retinopathy and nephropathy, but none had peripheral vascular disease in either leg. There were no significant differences in the patient characteristics of the study and control groups, apart from the absence of peripheral vascular disease in the former.

All patients had unilateral pathology at presentation, but three (12%) went on to develop the same pathology in the other foot, with lead times of 1, 4, and 5 years. The right side was affected in 15 cases and the left in 13. Twenty (71%) of the Charcot feet were encountered in the acute active phase; eight

TABLE. Characteristics of Charcot foot and control patients with diabetes

Characteristic	Charcot foot patients (n=25)	Controls	P value
Female	40%	40%	1.000
Mean (SD) age (years)	59 (14)	60 (13)	0.956
Insulin-dependent diabetes	20%	18%	0.764
Mean (SD) duration of diabetes (years)	11 (8)	7 (7)	0.052
Mean (SD) albumin level (g/L)	36 (4)	37 (5)	0.750
Mean (SD) haemoglobin A _{1c} level (%)	9 (2)	9 (2)	0.528
% Having peripheral vascular disease	0	18	0.002
% Having neuropathy	100	69	0.007
% Having retinopathy	36	49	0.403
% Having nephropathy	20	4	0.071
% Ambulatory	100	84	0.113

* SD denotes standard deviation

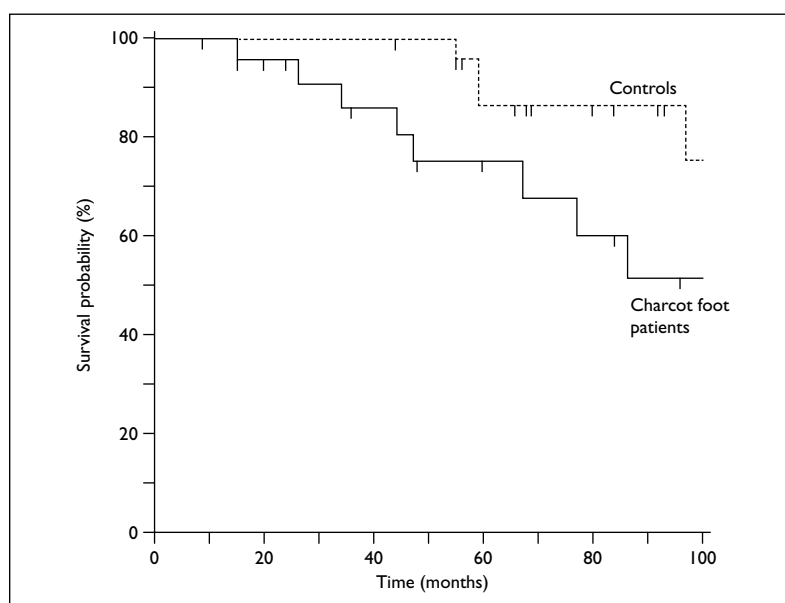


FIG. Kaplan-Meier survival curves for Charcot foot patients and controls. Marks on the lines represent censored (lost to follow-up) cases

were in a chronic stable state. Midfoot was the most commonly involved region (18 cases, 64%) followed by the ankle (10 cases, 36%). Delayed referral or diagnosis occurred in 11 (39%) of the patients.

Twelve (43%) of the patients with Charcot foot had a preceding history of ulcer; nine (32%) of the patients could recall an inciting injury. Superimposed ulceration, cellulitis and even osteomyelitis were common, and occurred in 12 (43%), 6 (21%), and 11 (39%) cases, respectively.

Despite their undergoing multiple episodes of debridement, major amputation was only performed in one patient following delayed onset septic arthritis of the ankle.

Ulceration recurred in three (11%) of the patients, who were managed surgically by means of exostectomy and toe amputation. All were in the chronic stable phase at initial presentation. Six (24%) of the Charcot foot patients died within 5 years, giving a 5-year mortality of up to 33% (Fig), which was statistically higher than in the control group. No factor predicted mortality in these Charcot foot patients.

Discussion

Charcot foot is an uncommon disease in western countries with a reported prevalence rate in diabetic patients varying from 3 to 25 per 1000.^{4,18,19} We found an even lower rate, which might reflect a genuinely lower prevalence, or lower awareness among both patients and clinicians leading to fewer cases being referred to our clinic. Traditional Chinese medicine practitioners may also be treating part of the patient load.

The patients with Charcot foot had been diabetic for longer periods than the controls (11 vs 7 years), and appeared to have more nephropathy (20% vs 4%). The respective differences were not statistically significant (0.052 and 0.071), however, which could be due to a type II statistical error caused by the small sample size.

The absence of peripheral vascular disease in the Charcot foot patients is characteristic of this condition; this finding was also reported by Fabrin et al.¹⁹ It appears that the presence of good circulation is a prerequisite for the development of Charcot foot. While this hypothesis might induce the medical industry to modulate the circulation to manage or prevent Charcot foot, this should also make medical professionals aware that good circulation in a diabetic foot does not imply freedom from major complications.

All of our patients had asymmetrical involvement, suggesting that unlike peripheral neuropathy, Charcot foot is not a purely systemic disease. Notably, our study identified a significant

portion (around two thirds) who had preceding ulceration or trauma; all were ambulant at the time they developed Charcot foot. These findings are in concordance with the past literature.^{15,19,20} It is entirely feasible that ulceration and trauma somehow trigger a pathological condition akin to reflex sympathetic dystrophy in susceptible diabetic patients with peripheral neuropathy and a good circulation. Being painless in nature, continuous unprotected walking further perpetuates the progression to full-blown deformity. The classic neuro-traumatic and neuro-vascular pathogenesis theories might in fact be confluent.^{14,16,21,22}

Soft tissue infection was a frequent complication, a feature reported in past studies. This may partly account for the significant number of patients in whom the diagnosis and referral was delayed.²³ As shown in this study, late referral predisposed patients to ulcer recurrence and additional surgical procedures. Although not quantified and presented, it was our impression that these patients also had more significant deformity and greater functional loss. Greater vigilance from primary care physicians, endocrinologists, and even orthopaedic surgeons might avert these complications.

Conclusion

The local incidence of Charcot foot is lower than that seen in western populations but the patient characteristics and the course of the disease are quite comparable. Peripheral neuropathy, having a good circulation, and being ambulant appear to be the prerequisites for developing Charcot foot. Infection and delay in diagnosing Charcot osteo-arthropathy are common. Heightened vigilance might hasten referrals and attain better outcomes.

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