The Journal of Foot & Ankle Surgery ■■ (2017) ■■–■■

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Original Research

High Incidence of Recurrent Ulceration and Major Amputations Associated With Charcot Foot

Fredrik A. Nilsen, MD [1], Marius Molund, MD [1], Kjetil H. Hvaal, MD, PhD [2]

[1]*Surgeon, Section for Foot and Ankle Surgery, Department of Orthopaedic Surgery, Østfold Hospital, Grålum, Norway*
[2]*Surgeon, Section for Foot and Ankle Surgery, Department of Orthopaedic Surgery, Oslo University Hospital Ullevål, Oslo, Norway*

ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
amputation
complication
conservative treatment
diabetes mellitus
foot ulcer
weightbearing

ABSTRACT

Few studies have evaluated the long-term clinical outcomes of Charcot foot. The present study evaluated the long-term effects of Charcot foot in a population treated with early weightbearing in a removable Charcot restraint orthotic walker. A retrospective study of 62 consecutive patients (74 feet) treated for Charcot foot from January 2003 to March 2014 was conducted. Of the 74 affected feet, 48 (64.9%) had developed an ulcer. The total amputation rate was 25.7% (19 feet), and 11 feet (14.9%) underwent major amputations. The mortality rate was 19.4% (12 patients). Low Short-Form 36-item scores for all subcomponents were found. The major amputation rate was significantly greater for hindfoot than for midfoot manifestations. Charcot foot results in a high risk of chronic ulceration. The hindfoot Charcot manifestation was associated with a high rate of major amputations. Early weightbearing in a Charcot restraint orthotic walker as treatment of Charcot foot was not supported by the results from the present study.

Charcot foot, also known as Charcot neuroarthropathy (CN), is a condition that can be caused by different diseases that resulted in peripheral neuropathy. At present, the most common disease associated with Charcot foot is diabetes mellitus, with a prevalence of 0.08% to 7.5% (1). The prevalence of diabetes mellitus is increasing worldwide; thus, the associated end-stage complications are also increasing (2). To a great degree, CN is a condition that affects the bone, joints, and soft tissue of the foot and ankle. The risk of diabetic foot ulceration (DFU) and lower extremity amputation (LEA) increases if the midfoot collapses and the patient develops plantar bony prominences (a rocker bottom foot) before the Charcot foot consolidates (3). The first option for treatment of this disorder is casting or orthotic use, with the aim of preserving the normal foot architecture. Surgery is an option for correcting the deformity after consolidation, although some investigators have advocated surgery for the early stages of the disease (4,5). Anatomically, CN can affect the midfoot, hindfoot, and calcaneus and/or the ankle, and the most commonly used anatomic classification is that described by Brodsky (6). The long-term outcome after CN has been described as leaving the patient with reduced function and a high-risk of developing DFUs of the foot, with a large proportion of patients requiring secondary surgery (7).

We investigated the outcomes of patients treated with early weightbearing in off-loading devices, initially a total contact cast (TCC) until a removable Charcot restraint orthotic walker (CROW) could be produced. The primary aim of the present retrospective cohort study was to evaluate the long-term clinical outcomes associated with Charcot foot stratified by the Brodsky classification and the occurrence of DFUs and LEAs.

Patients and Methods

The primary aim of the present study was to evaluate the long-term outcomes of Charcot foot after early weightbearing in a CROW as determined by the occurrence of DFUs and LEAs. The secondary aims included determination of the outcomes using the American Orthopaedic Foot and Ankle Society (AOFAS) midfoot (for midfoot manifestations) and hindfoot-ankle (for hindfoot manifestations) scales (8,9) and the Short Form 36-item (SF-36) questionnaire (10,11) scores. Our regional ethics board approved the present study. All of us contributed in regard to participant recruitment, data abstraction, outcomes assessments, and statistical analyses.

Our institution has consistently used the same manufacturer (Ryen Ortopediteknikk A/S, Oslo, Norway) for the CROW offloading devices we used for the patients in the present investigation during the 11-year, 3-month period from January 2003 through March 2014. We used these records to cross-check all the patients with data included in our institution's electronic patient records (DIPS AS, PB1435, 8037 Bodø), searching for patients with the Charcot foot diagnosis (International Classification of Diseases, 10th edition, World Health Organization, codes M14.2 and M14.6) treated at our diabetic foot outpatient clinic. All patient records were individually reviewed to ascertain that only patients treated for Charcot foot were included, excluding all other indications for using a CROW for offloading the foot. Charcot foot was diagnosed in all patients

Financial Disclosure: None reported.
Conflict of Interest: None reported.
Address correspondence to: Fredrik A. Nilsen, MD, Section for Foot and Ankle Surgery, Department of Orthopaedic Surgery, Østfold Hospital, PB 300, Grålum 1714, Norway.
E-mail address: drfreanil1@me.com (F.A. Nilsen).

1067-2516/$ - see front matter © 2017 by the American College of Foot and Ankle Surgeons. All rights reserved.
https://doi.org/10.1053/j.jfas.2017.10.008

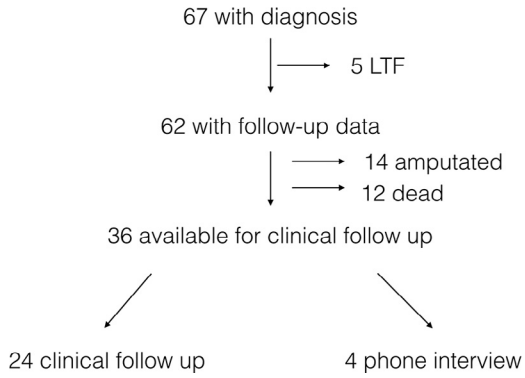

Fig. Flowchart for inclusion of the study population. LTF, lost to follow-up.

using the patient history, clinical examination findings, and plain radiographs, after excluding infection in the clinical evaluation. In some cases, Charcot foot was diagnosed after magnetic resonance imaging scans were reviewed. The medical records of all the patients with a confirmed diagnosis of Charcot foot were followed forward to identify the incidence of DFU and/or LEA. Amputations were categorized as major if at or above the ankle, intermediate if transmetatarsal to, but not including, the ankle joint, and minor if a single or multiple toe amputation. Multiple episodes of DFUs in a patient were counted as 1 episode per foot. Similarly, for patients who had undergone multiple amputations of the same extremity, the most proximal amputation level was counted. Patients who had developed a DFU and had undergone LEA, 1 episode for each category was counted.

All the patients in the present study had a diagnosis of Charcot foot, after which they were treated with offloading, initially in a TCC and, as soon as possible, a removable CROW, and allowed weightbearing as tolerated. Typically, the interval until the CROW was used was ~2 weeks. After consolidation of the disease and classification of the CN as Eichenholtz stage 3 (12), the stage at which the Charcot process becoming quiescent, all the patients were referred for fabrication of accommodative footwear and/or custom-molded foot orthoses for ongoing use. Patients who, on presentation, had a DFU or infection were treated with serial debridement and antibiotics, as needed.

Of 71 potentially eligible patients, 67 (94.4%) met our inclusion criteria and were included in our analyses. Of these 67 patients, 5 (7.5%) were lost to follow-up, for apparently random reasons. Therefore, a total of 62 patients (74 feet) were included in the present study. By spring 2015, 12 patients (19.4%) had died, and 14 patients (18.9%) had undergone a transmetatarsal or more proximal amputation.

The purpose of the clinical follow-up in the present study was to measure the AOFAS hindfoot-ankle scale and SF-36 questionnaire scores. Thus, the remaining 36 patients (53.7%) were contacted by mail and asked to attend the outpatient clinic for a study-related follow-up examination. Of these patients, 24 (35.8%) accepted the invitation, and 4 (6%) were available for a telephone interview. Therefore, 28 patients (41.8%) completed the SF-36 questionnaire, and 24 (35.8%) were evaluated using the AOFAS scale corresponding to the anatomic site of the Charcot changes (midfoot or hindfoot). The Fig. depicts the patient flow in the present investigation. The feet that developed DFUs and those that had undergone LEAs were stratified using the Brodsky classification.

Statistical analyses were performed using the Statistical Package for Social Sciences software, version 21.0 for Windows (IBM Corp., Armonk, NY). A comparison of the binary data for the incidence of DFUs and LEAs stratified by Brodsky type was computed using the χ^2 test. Differences were considered statistically significant at the 5% ($p \leq .05$) level. For comparison of the SF-36 component scores between the study population and the normative values for the Norwegian population (11), a 1-sample t test was used.

Table 2
Statistical comparison of incidence of diabetic foot ulcerations and lower extremity amputations between midfoot and hindfoot Charcot

Variable	Brodsky Type 1	Brodsky Types 2 + 3A
DFUs* (n)	28	17
LEAs* (n)	1	10

Abbreviations: DFUs, diabetic foot ulcerations; LEA, lower extremity amputations.
* Comparison of DFUs between Brodsky type 1 and Brodsky types 2 and 3A, $p = .71$; comparison of LEAs between Brodsky type 1 and Brodsky types 2 and 3A, $p < .01$.

Results

The mean age at the first identification of the diagnosis of Charcot foot was 55.2 (range 26 to 76) years. All the patients included in the present study had >2 years of follow-up data available. The mean follow-up duration was 8.9 (range 2 to 16) years. During the observation period, 12 patients (19.4%) died. The distribution of Brodsky Charcot foot types was type 1 in 44 (59.5%), type 2 in 18 (24.3%), type 3A in 7 (9.5%), and type 3B in 3 (4.1%) feet. Two patients(2.7%) displayed forefoot manifestations that were not described in the original Brodsky classification (6), with typical Charcot changes and symptoms from the metatarsophalangeal joints. A statistical description of the cohort is provided in Table 1.

The mean AOFAS midfoot scale score for the patients with midfoot Charcot was 62.5 ± 16. The mean AOFAS hindfoot score for the patients with hindfoot Charcot was 49.5 ± 14 (Table 1).

Of the 74 Charcot feet, 48 (64.9%) had had ≥1 episode of DFU related to the Charcot deformity during the follow-up period. The overall incidence of LEA was 25.7% (19 patients), with 11 major amputations (14.9%), 3 intermediate amputations (4.1%), and 5 minor amputations (6.8%). For the Brodsky type 1 Charcot foot, the incidence of DFU was 63.6% (28 feet), the incidence of an intermediate amputation was 6.8% (3 feet), and the incidence of a major amputation was 2.3% (1 foot). For patients with Brodsky type 2 and type 3A Charcot feet, the incidence of DFU was 66.7% (12 feet) and 71.4% (5 feet) and the incidence of major amputation was 33.3% (6 feet) and 57.1% (4 feet), respectively (Table 1). The difference between the incidence of DFU for Brodsky type 1 versus Brodsky types 2 and 3A Charcot feet was not statistically significant ($p = .71$). However, the difference between the incidence of LEA for Brodsky type 1 versus Brodsky types 2 and 3A was statistically significant ($p < .01$; Table 2).

When comparing the study population components of the SF-36 to the normative values for the Norwegian population, the results were significantly lower for physical functioning (Charcot population 57.4 ± 27.5 versus general population 87.3 ± 18.2; $p \leq .001$), role physical

Table 1
Statistical description of affected feet (N = 74 in 62 patients)

Anatomic Site	Brodsky 1	Brodsky 2	Brodsky 3A	Brodsky 3B	Sanders 1	Total
Affected feet (N = 74)	44 (59.5)	18 (24.3)	7 (9.5)	3 (4.1)	2 (2.7)	
Patients (n = 62)	38 (61.3)	15 (24.2)	6 (9.7)	3 (4.8)	2 (3.2)	
DFU	28 (63.6)	12 (66.7)	5 (71.4)	1 (33.3)	2 (100)	
Minor amputation	4 (9.1)	0	1 (14.3)	0	0	5 (6.8)
Intermediate amputation	3 (6.8)	0	0	0	0	3 (4.1)
Major amputation	1 (2.3)	6 (33.3)	4 (57.1)	0 (0)	0 (0)	11 (14.9)
AOFAS midfoot/hindfoot score	62.5 (n = 15)	49.5 (n = 5)	NA	NA	NA	NA

Data presented as n (%).
Total patient number, 62; however, 2 patients had bilateral manifestations with different Brodsky types; mean age 55.2 ± 11.4 years; 32 males, 30 females; 50 unilateral, 12 bilateral; mean follow-up, 8.9 (range 2 to 16) years; 10 patients had a bilateral manifestation of the same Brodsky type; Medical Outcomes Study short-form, 36-item questionnaire scores: physical functioning, 57.4; physical role; bodily pain, 58.1; general health, 54.0; vitality, 53.2; social functioning, ; emotional role, 61.3; mental health, 73.3.
Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society scale (score for each Brodsky type); DFU, diabetic foot ulceration; NA, not available.