

Clinical management of acute diabetic Charcot foot in Denmark

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ABSTRACT

INTRODUCTION: Charcot foot is a severe complication to diabetes mellitus and treatment involves several different clinical specialities. Our objective was to describe the current awareness, knowledge and treatment practices of Charcot foot among doctors who handle diabetic foot disorders.

METHODS: This study is based on a questionnaire survey sent out to healthcare professionals, primarily doctors, working with diabetic foot ulcers and Charcot feet in the public sector of the Danish healthcare system.

RESULTS: The survey obtained a 52% response rate. A temperature difference of > 2 °C between the two feet was the most used method of diagnosing Charcot foot. Along with clinical inspection, temperature difference was also the measurement used for monitoring of healing. None of the suggested formalised classification systems were used to any extent. Most responders use detachable bandages for offloading (83%). All centres use some form of a multidisciplinary team, with the most common permanent members being orthopaedic surgeons (71%), wound specialist nurses (76%), podiatrists (65%), endocrinologists (47%) and diabetes specialist nurses (41%).

CONCLUSION: WE conducted a survey of the diagnosis and treatment practices of acute diabetic Charcot foot at diabetes foot clinics in Denmark. The responders seem to follow the international recommendations and guidelines on management of the acute diabetic Charcot foot, despite a lack of Danish guidelines.

FUNDING: none.

TRIAL REGISTRATION: not relevant.

Charcot osteoarthropathy (Charcot foot) is characterised by spontaneous-fatigue bone fractures, progressive deformity and destruction of weightbearing bones and joints in the feet. The common denominator is peripheral neuropathy [1-3]. In the Western world, most cases currently occur in individuals with diabetes mellitus, with an incidence of about 0.25% [4, 5]. Charcot foot is a severe diabetes complication that is associated with increased mortality [6]. Patients who develop Charcot foot have often had suboptimal management of their diabetes and have a history of hyperglycaemia and several concomitant late diabetic complications [7, 8]. Treatment of acute Charcot foot consists primarily of long-

term restricted walking and immobilisation with an off-loading cast [9-11], which might be detrimental to the patient's overall health.

Employing a multidisciplinary team in the diagnosis, treatment and follow-up of patients with Charcot foot has been recommended in several guidelines to optimise disease management [8, 12-14].

To obtain an overview of the diagnosis and treatment practises of Charcot foot in a clinical setting in Denmark, we conducted a questionnaire study. Our objective was to describe the current awareness, knowledge and treatment practices of Charcot foot among doctors who handle diabetic foot disorders. We also wanted to assess the need for updating the treatment in line with the latest recommendations.

METHODS

The survey was conducted using the free online software surveymonkey.com. The questionnaire was created for the study by author KKM based on international guidelines and recommendations [8, 10, 15]. It was sent out to healthcare professionals, primarily doctors, working with diabetic foot ulcers and Charcot feet in the public sector of the Danish healthcare system. A single copy was initially sent to each department of endocrinology and orthopaedic surgery in Denmark, as well as to three centralised wound treatment centres (Marselisborg, Odense and Bispebjerg). Author KKM selected the recipients by identifying the doctor responsible for coordinating treatment of diabetic foot ulcers at each department. We sent a second wave of invites including other doctors at the same department in case of no response or opt out.

The survey included a total of ten questions, with a combination of open-ended and closed-ended items. Eight questions contained multiple choice options, the items of which were not mutually exclusive. As it was possible for the same responder to provide several answers to some questions, the total number of replies to each question may exceed the total number of responders. In addition, it was possible for the responders to skip questions entirely. The total number of responders to each question is noted in the results section.

Trial registration: not relevant.

ORIGINAL ARTICLE

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Dan Med J
2016;63(10):A5273

RESULTS

We successfully contacted 52 different departments and received a total of 27 replies (including first and second wave invites), giving the study a 52% response rate.

No personal data were gathered about the responders apart from department and workplace. No responders were from the same department. Of the 27 responses, 17 responders confirmed that they were treating Charcot foot inhouse. Nine out of the remaining ten departments have in place a standard referral procedure to another department treating Charcot foot after diagnosis.

Diagnostic methods

Some items in this category have more than 17 responses (the number of responders treating Charcot foot). This reflects the fact that the departments who do not treat Charcot foot nevertheless diagnose the condition before referring the patient to another department for treatment.

A temperature difference of $> 2^{\circ}\text{C}$ between the two feet is the most commonly used method of diagnosing Charcot foot, with 19 responders using it always or often. Regarding imaging diagnostics, X-ray is the most



TABLE 1

Charcot foot classification, monitoring and treatment. The values are n.

	Permanent part of the team	On short notice call	External consultant	Never used	Always	Often	Rare	Never
<i>Which specialists are involved in the treatment of the acute Charcot foot? (N = 17)</i>								
Endocrinologist	8	7	1	0	–	–	–	–
Orthopaedic surgeon	12	4	1	1	–	–	–	–
Vascular surgeon	3	3	3	5	–	–	–	–
Dermatologist	0	0	4	10	–	–	–	–
Diabetes specialist nurse	7	5	2	1	–	–	–	–
Wound specialist nurse	13	2	0	2	–	–	–	–
Podiatrist	11	2	2	1	–	–	–	–
Bandager	2	4	8	2	–	–	–	–
Bandage technician	2	2	4	6	–	–	–	–
Shoemaker	4	2	7	2	–	–	–	–
Plastic surgeon	0	0	6	8	–	–	–	–
<i>Which method do you use for diagnosis of acute Charcot foot? (N = 20)</i>								
Temperature difference $> 2^{\circ}\text{C}$	–	–	–	–	18	1	0	0
X-ray	–	–	–	–	11	7	2	0
Magnetic resonance imaging	–	–	–	–	3	12	3	1
Bone scintigraphy	–	–	–	–	7	2	4	5
Leucocyte scintigraphy	–	–	–	–	1	0	11	7
Special blood tests: RANK-L, TNF- α , ILs	–	–	–	–	0	0	2	16
<i>How do you monitor healing in acute Charcot foot? (N = 17)</i>								
Temperature difference $> 2^{\circ}\text{C}$	–	–	–	–	15	1	0	0
X-ray in set intervals	–	–	–	–	5	1	3	4
X-ray when needed	–	–	–	–	5	2	4	3
Bone scintigraphy	–	–	–	–	1	0	5	7
Clinical inspection	–	–	–	–	14	0	0	1
Special blood tests: RANK-L, TNF- α , ILs	–	–	–	–	0	0	2	13
<i>Which classification system do you use for acute Charcot foot? (N = 16)</i>								
Eichenholz	–	–	–	–	0	0	1	10
Brodsky	–	–	–	–	0	0	0	10
Sanders/Frykberg	–	–	–	–	1	0	0	9
Rogers/Bevilaque	–	–	–	–	0	0	0	10
Radiological	–	–	–	–	1	1	0	9
None of the above	–	–	–	–	9	3	0	3
<i>Which method of off-loading do you employ for acute Charcot foot? (N = 18)</i>								
Wheelchair	–	–	–	–	2	6	6	2
Hospital admission	–	–	–	–	1	3	8	1
Total contact cast	–	–	–	–	2	3	5	2
Removable off-loading device	–	–	–	–	7	8	3	0
Therapy shoes	–	–	–	–	1	3	7	4
Patients' own shoes	–	–	–	–	0	0	1	13

ILs = interleukins; RANK-L = receptor activator of nuclear factor kappa-B ligand; TNF- α = tumour necrosis factor alpha.

common tool, with 18 responders using it always or often, while 15 responders use magnetic resonance imaging (MRI) for diagnosis always/often. Specialised blood tests like the receptor activator of nuclear factor kappa-B ligand, interleukins or tumour necrosis factor alpha are rarely/never used ($n = 20$, see **Table 1**).

Monitoring of healing in the acute Charcot foot

The most common measurements used for monitoring regression in the acute Charcot foot are measurement of the temperature differences between the feet (100%) and clinical inspection (100%). More complicated measures like bone scintigraphy and specialised blood tests are rarely/never used (92% and 100%, respectively) ($n = 17$, see **Table 1**).

Use of established classification systems

The systems suggested for classification are Eichenholz, Brodsky, Sanders/Frykberg and Rogers/Bevilaque. None of the suggested formalised classification systems are used to any extent. Two responders confirmed using an unspecified radiological system for classification ($n = 16$, see **Table 1**).

Methods for off-loading

Most responders use removable off-loading devices (e.g. AirCast) for offloading (83%). Off-loading in a wheelchair is used always/often by half of the responders (50%), possibly during hospital admission. Some form of off-loading is used by all responders, i.e. patients are never discharged with their own footwear only ($n = 18$, see **Table 1**).

Multidisciplinary team and specialist involvement

The most common permanent team members are orthopaedic surgeons (71%), wound specialist nurses (76%) and podiatrists (65%). Endocrinologists and diabetes specialist nurses are either permanent team members (47% and 41%, respectively) or on call on short notice (41% and 29%, respectively) ($n = 17$, see **Figure 1**).

Monitoring of development

The most common way of monitoring the switch from acute to chronic Charcot foot is by temperature change (100%), and 65% always or often use X-rays also. Scintigraphy or MRI is rarely or never used (81%) ($n = 16$).

Surgical procedures

53% of the responders declared that their department is involved in surgery on the Charcot foot. Most are involved in smaller procedures and basic amputations, while 18% did larger reconstructural surgery as well.

Both plaster casts, internal fixation and external fixation with Ilizarov or Taylor frame are used by the de-

partments doing reconstructural surgery ($n = 18$, see **Table 2**).

DISCUSSION

The present survey was conducted in order to describe the current diagnosis, treatment and monitoring practices in Denmark of acute diabetic Charcot foot. As discussed by others [16], the actual treatment and diagnostic tools used for Charcot foot may vary despite the rather uniform guidelines in the literature. This is further underlined by the data presented here, which show different approaches to the treatment and substantial variation in the involvement of multidisciplinary teams.

Specific blood tests for Charcot foot activity are still mainly in the experimental stage. The questionnaire focused on markers of inflammation and bone metabolism. While a recent study [17] investigated some of these biomarkers in diabetes patients with Charcot foot, the exact relationship between them and disease activity currently remains unclear. More common blood tests, such as C-reactive protein and leukocyte count to diagnose possible osteomyelitis were not encompassed by this questionnaire.

We have not asked about the use of bisphosphonates or other anti-osteoporotic medications. The use of these are not recommended for the treatment of acute Charcot foot in Denmark, as there is not sufficient evidence in support of their beneficial effect, if any [18, 19].

FIGURE 1

Multidisciplinary teams and specialist involvement. Involvement of the various specialists in the treatment of acute Charcot foot – 17 departments.

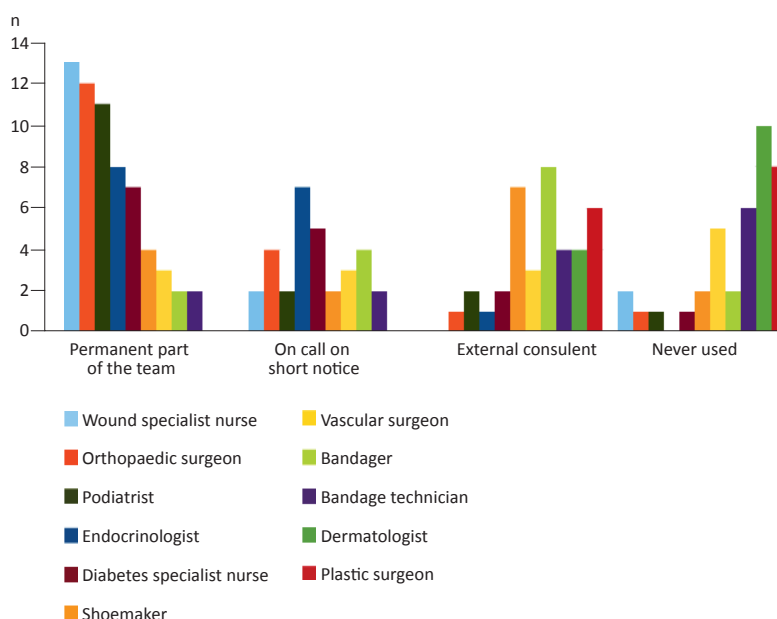


TABLE 2

Surgical practices in Charcot foot treatment. The values are n.

	Yes	No	Always	Often	Rare	Never
<i>Which surgical procedures do your department perform on acute Charcot feet? (N = 18)</i>						
Surgery not performed	8	9	–	–	–	–
Minor surgery	9	5	–	–	–	–
Reconstructive surgery	3	10	–	–	–	–
Amputations	8	5	–	–	–	–
<i>If you perform reconstructive surgery, which methods of fixation are then used post-surgery? (N = 7)</i>						
Plaster cast	–	–	0	3	0	4
Internal fixation	–	–	0	3	0	4
External fixation with Ilizarov	–	–	0	2	0	5
External fixation with Taylor frame	–	–	0	2	0	5
Other external fixation	–	–	0	0	1	5

Surgery on Charcot foot is performed to control deformities and prevent ulceration, primarily when the foot is in remission, i.e. has become a “chronic Charcot foot”. Many surgical procedures have been used, all with a low level of efficacy [20]. A removable cast was the preferred method of off-loading, and the high rate of use of off-loading and immobilisation is in line with several recommendations [8, 15, 18, 21].

Our survey provides an overview of the management of Charcot foot in Denmark. However, the survey had a low response rate and may therefore not represent treatment practices all over the country. In addition, the responses were unevenly distributed geographically as most responders (18/27) work at hospitals near the two largest cities in Denmark (Copenhagen and Aarhus). This may be so because these cities have the highest concentration of departments working with Charcot foot. As a relatively rare disorder, the treatment and monitoring of Charcot foot is generally centralised in a few major centres. On the other hand, it is possible that the non-responders on average have less focus on this particular area and may overlook the diagnosis, and therefore did not reply to the questionnaire. By only getting answers from those of the invited responders who have the strongest focus on Charcot foot, data will be skewed “positively”.

However, we can see that the departments at or near the three major centres for diabetic foot ulcer treatment in Denmark (Copenhagen, Aarhus and Odense) generally have a higher response rate, and that the departments in nearby hospitals, in the periphery around each centre, refer their patients to the “local” centre. On the other hand, several departments placed geographically further away from the diabetic wound treatment centres (in another region) tend to treat their patients themselves.



A. A typical presentation of acute Charcot foot with diffuse unilateral hyperaemia. B. A chronic Charcot foot. The bone structures have collapsed, leaving a so-called “rocker bottom” foot.

CONCLUSION

Our survey of diagnosis and treatment practices of acute diabetic Charcot foot at diabetes foot clinics in Denmark shows that this condition is mainly diagnosed by measurement of temperature differences between the feet and by clinical assessment. These measures are used to monitor the effect of treatment as well. No formal classification systems are used. Patients are treated primarily by off-loading with removable devices, and the treatment is performed by teams consisting of orthopaedic surgeons, wound specialised nurses, podiatrists, and with endocrinologists and diabetes specialised nurses as well. Only two centres reported the use of a classification system. In clinical practice, the classification systems of Charcot foot often only give minimal support in

diagnosis and treatment. The rare use of classification even in specialised centres probably also reflects that no local or central databases are used. The Danish Health Authority encourages the use of databases in the treatment of the diabetic foot, and in the coming years this is likely to bring a more frequent use of classification systems.

No official treatment guidelines for acute Charcot foot exist in Denmark. Despite this, the responders seem to follow international recommendations and guidelines on the management of acute diabetic Charcot foot. While this is better than could have been suspected, there is still room for improvement. This may be achieved by implementing a set of national guidelines based on the international recommendations.

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ACCEPTED: 6 July 2016

CONFLICTS OF INTEREST: none. Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk

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