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Prevalence and risk factors of Charcot Foot in patients with Diabetic Neuropathy

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There are evidences that Charcot foot is common among diabetic neuropathy (DN) patients. The aim of the study was to investigate the prevalence of the Charcot foot in patients with DN and to detect its associated risk factors. A sample of 839 patients with diabetes mellitus (DM) was selected from Dr. Edrees Foot Spa & Clinic in Jeddah, KSA. The patients' medical records were reviewed retrospectively. All information was recorded on the day of initial presentation regardless of how it changes later or any new information became available after further investigation. The extracted information included patients' age, gender, type of DM, fasting blood sugar (FBS) range in the last three months, duration of DM, presence of neuropathy, current ulcer, type of footwear, and the development of Charcot foot. The findings revealed significant correlations between Charcot foot and age, onset of diabetes, FBS and neuropathy ($p < .05$). On the other hand, there was no significant correlation of Charcot arthropathy and gender, footwear or duration of diabetes ($p > .05$). There was high prevalence of Charcot foot among patients with diabetic neuropathy. The risk factors of Charcot foot were early onset of diabetes, young age, DN and uncontrolled FBS.

Keywords: Charcot foot, Diabetes mellitus, Diabetic neuropathy, Foot ulcer, Footwear

INTRODUCTION

Diabetes mellitus is defined as elevation of the blood glucose level and lead to a reduced quality of life. It is one of the most common underlying factors that is related to lower extremity problems. There are a number of complications encompasses diabetes, such as ulceration, peripheral vascular diseases, infection that lead to amputation. Diabetic patients are also exposed to a serious limb-threatening complication which is neuropathy. It is an inflammation and degeneration of the peripheral nerves and may develop in all types of DM (insulin and non-insulin dependent) (The expert committee on the

diagnosis and classification of diabetes mellitus, 2003).

Diabetic Neuropathy is a complication of chronic DM characterized by pain and impaired sensation and movement in the limbs. It plays a marked role in falling as patients often experience balance disorder, impairment of feet sensation lead to reducing control of their balance properly during daily activities. Poor balance can be related to proprioception impairment, movement-strategy dysfunction, biomechanical structural disorders, and disorientation. Postural instability caused by peripheral neuropathy increases the impact of microtraumas and wounds. Distal symmetric

neuropathy is the most common form of DPN which is a serious complication of diabetes that leads to physical impairments, such as slower reaction times, lower ankle strength and mobility, increase postural instability, and changed walking patterns (El-Wishy and Elsayed, 2012).

Charcot arthropathy of the foot is a complication of chronic DM which is a progressive, non-infectious destructive disease of joints, the foot and ankle is the most commonly affected (Hong et al, 2015). It is a severe joint disease in the foot that can lead to fracture, permanent deformity, limb loss, skin breakdown, recurrent ulceration, and other morbidities. It is known to have worse effects on physical function, social, emotional, and mental health (Pound et al, 2004). It is characterized by varying degrees of bone and joint disorganization secondary to underlying neuropathy, trauma, and perturbations of bone metabolism. The Charcot foot in diabetes poses many clinical difficulties in its diagnosis and management (Rogers et al. 2011). It has no singular cause, but there are many factors that predispose to its development. According to previous studies, the risk factors for diabetic Charcot arthropathy are multifactorial. Obesity with peripheral neuropathy, comorbid renal failure, older age group and race have been reported as significant predictors of diabetic Charcot arthropathy in a large cohort study (Stuck et al. 2008). The natural history of Charcot neuroarthropathy passes from acute phase through a stage of coalescence in which the bone fragments are reabsorbed, the edema decrease and the foot cools, into the stage of reconstruction, in which the final repair and regenerative modeling of bone takes place leaving a stable chronic Charcot foot. Intervention must be made in the earliest phase to prevent subsequent deformity because the time course of these events is variable (Rosenbaum et al. 2011). Treatment patterns and current footwear use of patients with Charcot osteoarthropathy of the foot and ankle consisted of total contact cast and a pre-fabricated walking boot, accommodative and custom accommodative foot orthoses and/or surgery (Pinzur et al. 2000).

Early identifications of the predictors of Charcot arthropathy in diabetic patients may help in preventing such serious medical complication.

Aim of the study

The aim of the study was to investigate the prevalence and risk factors of Charcot foot in patients with DN

MATERIALS AND METHODS

Subjects

A sample of consecutive 839 patients with DM (239 females and 600 males) was selected from Dr. Edrees Foot Spa & Clinic in Jeddah, KSA.

Inclusive criteria:

Patients diagnosed with DM (type I or II) with or without current foot ulceration, and the duration of illness for longer than five years.

Exclusive criteria:

Foot fractures or traumatic injuries, poliomyelitis, or rheumatoid arthritis were excluded.

Methods

A total of 1000 patients' medical records, with confirmed diagnosis of DM, were reviewed retrospectively. The records were filled out according to the Annual diabetic's foot examination and only 839 files had complete needed items. All information was recorded on the day of initial presentation regardless of how it changes later or any new information became available after further investigation. The permission and a written consent form were taken from every patient to use their information in the study.

The following information was extracted from the records: Patient's age, gender, type of DM, fasting blood sugar range in the last three months, duration of DM, presence of neuropathy, current ulcer, type of footwear, and the development of Charcot foot.

Peripheral neuropathy was evaluated by using Semmes Weinstein monofilament (SWM) (5.07 mg nylon wire) by exerting force when bowed into a "C" shape against the skin for one second. Patients who can't reliably detect the application of the monofilament to designated sites on the plantar surface of their feet are considered to have lost protective sensation (Feng et al. 2009).

The current ulcer was graded according to Wagner classification (Andrew and VileiKyte, 2001) and the type of footwear was divided to non-medical and medical shoe. Finally, Charcot foot was clinically diagnosed by exclusion of manifestations of other joint and bone diseases and radiographs.

Data Analysis

The obtained data was presented as percentages, means and standard deviations. Pearson correlation test was used for correlation. *p*-value of less than or equal to 0.05 was considered statistically significant. Data was analyzed and presented by SPSS version 16 and Microsoft office excel 2007 respectively.

RESULTS

Demographic characteristics of the patients

A summary of overall percentages of sample characteristics is shown in table (1) including age, sex, type and duration of DM, presence of neuropathy, history of ulcer, history of amputation, type of footwear and presence of Charcot foot.

Table 1: General characteristics of the patients.

Age	Mean ±SD	60.56 ± 12.09
Sex	Male	71.51 %
	Female	28.49%
Type of diabetes	Type I	2.3%
	Type II	97.7%
Duration of diabetes	Mean±SD	19.017 ± 11.5 (yrs)
Presence of Neuropathy	Yes	63.4%
	No	36.6%
History of ulcer	Yes	44.3%
	No	55.7%
History of amputation	Yes	21.8%
	No	78.2%
Footwear	Non-medical shoes	89.2%
	Medical shoes	10.8%
Charcot foot	Yes	33.2%
	No	66.8%

Correlations

Charcot foot and other factors

The results showed that Charcot foot was not significantly correlated with either the patients' gender ($r=1.00$, $p=.76$) or duration of diabetes ($p>.05$). On the other hand, a highly significant negative correlation was shown between the age of the patient and the presence of Charcot foot ($r = -.094$ $p=.003$).

The outcomes also revealed that patients who have diabetic neuropathy were more susceptible to have a Charcot foot ($r=.148$, $p=.001$). There was also significant correlation between early onset of diabetes and presence of Charcot foot. In

addition, there was significant and positive correlation between increase range of fasting blood sugar and presence of Charcot foot ($r= .050$ $p=.048$). On other hand, no significant correlation between type of footwear and Charcot foot ($p>.05$).

Duration of diabetes and neuropathy

The results showed highly significant positive correlation between duration of diabetes and neuropathy ($r =.11$, $p=.001$).

Footwear and current ulcers

The findings showed highly significant correlation between patient who wear non-medical shoes and increase severity of current ulcer ($r= -.69$, $p=.015$). On the opposite, there was no significant correlation between footwear and occurrence of current ulcer ($r =.19$, $p=.29$).

DISCUSSION

Charcot neuroarthropathy of the foot and ankle is an aggressive process with destruction of bone and joints and leads to deformity (El-Gafary et al. 2009). Early diagnosis is essential and initial presentation of unilateral warmth and swelling in a neuropathic foot is extremely suspected development of Charcot joint (Watkins, 1998).

To the best knowledge, there has been no previous study of the incidence of Charcot foot and its associated risk factors among Saudi population. The current study aimed to investigate the prevalence of the Charcot foot in patients with DN and also to detect relation of Charcot foot and other factors like footwear, duration of diabetes, and the degree of ulcer.

A relatively high prevalence of Charcot foot was shown in the current study sample (33.2%). This is agreed with Pakarinen et al. (2002) who conducted a study on a total of 36 feet of 32 patients who were diagnosed as diabetic Charcot neuroarthropathies. They reported that 29 of cases were diagnosed in the dissolution stage, two were in coalescence stage, and five were in the resolution stage.

Furthermore, Sinacore (1998) carried out a study on thirty diabetic subjects with 35 acute-onset neuroarthropathic foot fractures, subluxations or dislocations. A number of subjects (30%) had mid foot or forefoot plantar ulcers that accompanied their acute Charcot arthropathy. The majority (70%) did not have a current plantar ulceration. Two subjects (7%) had acute arthropathies involving both feet and other two subjects (7%) had more than one arthropathy

location in the same foot.

As shown in results of present work, there was significant inverse correlation between the age of the patient and the presence of Charcot foot. Results revealed that participants with Charcot foot were most likely to be in the middle age and early diagnosed with DM. This disagreed with Al-Mousa and associates (2015) who found no significant correlation between age and Charcot foot in diabetic patients. However, several studies have found that the younger age group is more prone to diabetic Charcot arthropathy than older people (Foltz et al. 2004 and Stuck et al, 2008). Also, in other study on the risk factors of Charcot arthropathy, Nehring et al. (2014) reported that age have a significant effect on patients with Charcot arthropathy. This finding could be explained by that young aged patient is more active than elderly people with increased daily living activity load and stress on the foot.

Moreover, the findings showed no significant correlation between Charcot foot and the duration of DM. On the contrary, Al-Mosa et al. (2015) reported that diabetes duration was significantly longer among cases with Charcot foot. The results of the current study might be interpreted by that participants with longer duration of diabetes may have a good glycaemic control thus minimizing complications of diabetes.

Also, it was revealed that Charcot foot was significantly and positively correlated with the presence of peripheral neuropathy in the diabetic patients. This is agreed with Molines (2010) who reported that Charcot foot is a serious complication affecting diabetic patients with peripheral neuropathy. Sympathetic neuropathy leads to denervation of arterioles, causing increased blood flow, hyperemia, bone rarefaction, and increased susceptibility to osteoclast-mediated resorption and fragmentation. While the development of Charcot arthropathy is likely attributable to a combination of these processes, other theories also may play a role (Rosenbaum, DiPreta, 2011).

Additionally, the present work revealed a significant positive correlation between the duration of diabetes and neuropathy. Similarly, Valensi and co-workers (1997) found that the correlation between the duration of diabetes and peripheral neuropathy was significantly high. It was suggested that vascular factors might participate in the development of nerve lesions. Diabetes causes microangiopathy of the vasa nervosa which lead to atherosclerosis of the vasa nervosa lead to Ischaemia of the vasa nervosa.

Also, metabolic changes occur due to the production of toxic ketone bodies, leading to nerve damage (Elwan, 2007).

In accordance with the findings of present research, participants with Charcot foot had higher fasting blood sugar range. This is also agreed with Al Mousa et al. (2015) who declared that blood glucose level was significantly higher among patients with Charcot foot.

In addition, the patients who wore traditional footwear were significantly more likely to have severe degree of foot ulcer. This comes in accordance with Mueller (1997) who found that therapeutic footwear protected the foot of the patient with DM from injury and prevented skin breakdown.

In accordance, Fauzi et al. (2016) reported that a history of prior diabetic foot problems is the greatest risk factor for developing diabetic Charcot arthropathy, compared with other risk factors such as diabetes characteristics and sociodemographic profiles. Similarly, other researches have postulated that a considerable percent of diabetic Charcot arthropathy had a previous history of foot problems like foot ulceration, surgery and/or amputation, along with loss of sensation (Fabrin et al.2000; Foltz et al. 2004 and Leung et al. 2009).

Finally, it is recommended that the risk factors should be completely addressed in every diabetic patient so that, Charcot foot can be early predicted and prevented. Further studies could be conducted with investigating other factors like patients' body weight, height, hypertension, smoking and vascularity of the foot. Also, the stage of Charcot arthropathy could be specified and correlated with the diabetic neuropathy.

CONCLUSION

There was high prevalence of Charcot foot among patients with DN. The risk factors of Charcot foot were early onset of diabetes, young age, presence of peripheral neuropathy and uncontrolled fasting blood sugar

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

EE designed the study frame work,

contributed in the writing process and editing, contributed in analyzing and presenting data.

KE diagnosed the patients and contributed in the study general design

OA carried out the clinical part of the study and collected data.

RA carried out the clinical part of the study and collected data.

NR revised the manuscript and contributed in data interpretation

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