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Screening of Charcot Foot and associated Risk Factors in Assiut Diabetic Foot Care Clinic

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ABSTRACT

Background: Charcot foot is considered the most serious complications of poorly controlled diabetes mellitus. Till now, there is paucity in assessment of frequent and risk factors of such complications in our locality.

Objective: This study aimed to estimate the percentage of Charcot foot in patients attending Diabetic Foot Care Clinic and to evaluate the risk factors for its development.

Patients and methods: A cross-sectional study was conducted at Diabetic Foot Care Clinic over one-year duration between 2015 and 2016. The study enrolled a total of 720 diabetic patient came for evaluation for diabetic foot. All patients were subjected to history taking and physical evaluation especially foot examination. Characteristics of any foot lesion was recorded with neurological evaluation of the affected foot.

Results: Out of 720 patients came to the clinic with diabetic foot, 100 (13.8%) patients were diagnosed to have Charcot foot. Patients with Charcot foot had significantly higher age, frequency of male sex, type 2 diabetes that is poorly controlled. Predictors for Charcot foot in the current study were old age, presence of hypertension, use of oral hypoglycaemic agents, low albumin level, poorly controlled diabetes mellitus and hyperlipidemia

Conclusion: Diabetic Charcot arthropathy is associated with multifactorial risk factors and requires a concerted effort from multidisciplinary teams. Special scrutiny, foot care and education are imperative, especially in chronic diabetic patients with micro- and macro-vascular complications. Further prospective research with matched peripheral neuropathy groups should be conducted.

Keywords: Diabetes mellitus, Charcot foot, Assiut Diabetic Foot Care Clinic.

INTRODUCTION

Diabetes mellitus is a long-term illness that can lead to a variety of consequences, including peripheral artery disease, foot ulcers, peripheral neuropathy, and Charcot osteoarthropathy. The incidence of these problems is predicted to rise [(1)].

Charcot osteoarthropathy is a major limb-threatening consequence of diabetes mellitus that is often neglected. It's marked by painless swelling in the feet and ankles, as well as bone and joint deterioration. It can cause bone and joint deformities as a result of underlying neuropathy, trauma, or any change in bone metabolism [(2)]. The "rocker bottom deformity," which is a collapse of the midfoot, is the most common deformity linked with Charcot foot. X-rays are important in determining the diagnosis of Charcot foot and differentiating it from osteomyelitis. Charcot foot can also be diagnosed using other imaging techniques such as CT scans, MRIs, and PET scans [(3)]. In this study we aimed to estimate the percentage of Charcot foot in patients attending Diabetic Foot Care Clinic and to evaluate the risk factors for its development.

PATIENTS AND METHODS

A cross-sectional study was conducted at Diabetic Foot Care Clinics of Internal Medicine Department, Assiut University Hospitals through the period between May 2015 and May 2016.

Study subjects:

Out of 720 patients came to the Clinic of Diabetic Foot, 100 patients were diagnosed to have Charcot foot. So, frequency of Charcot foot in the current study was 13.8%. Based on the presence of Charcot foot, the patients were divided into two groups:

Group I included patients with Charcot foot (100) and **Group II** that included patients without Charcot foot (620).

Inclusion criteria: All diabetic patients attending diabetic foot care clinic (100 patients)

Exclusion criteria: Patients with other diseases affecting joints (rheumatoid arthritis and systemic lupus erythromatosus or osteoarthropathy)

Methodology:

All patients were subjected to through history taking (age, sex, residence, weight, height and body mass index) with full clinical evaluation include duration of diabetes mellitus, therapeutic history either oral hypoglycemic drugs or insulin, history of previous ulcerations and amputations.

Also, complete general physical and systemic examination was carried out. Physical examination of the lower limb was carried out both dorsal and planter surfaces of the foot were examined for swelling, erythema, increase in temperature and any musculoskeletal deformity which were later on confirmed by X-rays. Evidence of neuropathy is determined by decreased or absent sensation to pin prick, light touch or vibration **(Table 1).**

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Table (1): Neuropathy Disability Score in Patients with Diabetes

Sensation	Score
Vibration threshold (apply 128-Hz tuning fork to apex of great toe) Normal (can distinguish between presence and absence of vibration) Abnormal	0 1
Temperature (to dorsum of foot, apply a tuning fork placed in a beaker of ice water or warm water) Normal (can distinguish between hot and cold) Abnormal	0 1
Pinprick (apply pin proximal to great toenail to barely depress skin) Normal (can distinguish sharpness or lack of sharpness Abnormal	0 1
Achilles' reflex Present Present with reinforcement Absent	0 1 2
Total for one foot	0-5

Decreased or absent protective sensation of the foot can be confirmed quite quickly using a Semmes-Weinstein 10-g (also known as 5.07-gauge) monofilament wire. The 10-g monofilament correlates with the threshold of protective sensation. If the patient cannot feel the monofilament (when it is applied with just enough pressure to bend the monofilament) on at least four of 10 sites, the test is abnormal, and the patient is considered to be at risk for ulcer formation.

Ankle brachial pressure index (ABI) was measured by using handheld Doppler device. In addition to laboratory investigations including lipid profile, glycosylated hemoglobin, erythrocyte sedimentation rate, urea and creatinine and HSCRB.

Ethical consideration:

This work was conducted in accordance with Code of Good Practice and the guidelines of Declaration of Helsinki, 7th revision, 2013. Also, approval by Institutional Review Board, Faculty of Medicine, Assiut University was obtained (No.17101189). Patients signed informed consents.

Statistical analysis

Date entry and data analysis were done using SPSS version 24 (Statistical Package for Social Science). Data were presented as number, percentage and mean ± standard deviation. Chi-square test and Fisher Exact test were used to compare between qualitative variables. Independent sample t-test was used to compare quantitative variables between groups. Using person correlation to determine significance between P-value is considered. $P \leq 0.05$ is significant.

RESULTS

Baseline Data of studied groups (table 2):

Mean age of those patients with Charcot foot was 65.08 ± 13.32, while it was 56.98 ± 11.98 years for patients without Charcot. It was noticed that duration of DM was significantly prolonged in those with Charcot foot (16.89 ± 1.78 years) than those patients without Charcot foot (12.78 ± 2.95 years). There was male predominance in both groups where 70% of those with Charcot foot and 60% of those without Charcot foot were males. Absence of comorbidities was more frequent in those patients without Charcot foot. HTN, IHD, CKD and COPD presented in 69%, 23%, 23%, 12% and 7% of patients with Charcot foot respectively and 37.5%, 24.1%, 8.8%, 1.6% in patients without Charcot foot respectively with significant difference in HTN and COPD. It was found that 87% and 67% of patients with Charcot foot and those without Charcot foot had type II DM and 50% of patients with Charcot foot were on oral hypoglycemic drugs therapy, while 65% of patients without Charcot foot were on insulin therapy.

Table (2): Baseline Data of studied groups

Item	Group I (n= 100)	Group II (n= 620)	P value
Age (years)	65.08 ± 13.32	56.98 ± 11.98	**0.02**
Sex			**0.01**
Male	70 (70%)	372 (60%)	
Female	30 (30%)	248 (40%)	
Duration of DM (years)	16.89 ± 1.78	12.78 ± 2.95	**0.03**
Comorbidities			
Nothing	30 (30%)	290 (47%)	**0.00**
HTN	69 (69%)	233 (37.5%)	**0.01**
IHD	23 (23%)	150 (24.1%)	0.34
CKD	12 (12%)	55 (8.8%)	0.67
COPD	7 (7%)	10 (1.6%)	0.09
Type of DM			**0.00**
Type I	13 (13%)	197 (33%)	
Type II	87 (87%)	415 (67%)	
Therapy			**0.01**
Oral drugs	50 (50%)	186 (30%)	
Insulin therapy	40 (40%)	403 (65%)	
Both	10 (10%)	31 (5%)	

Data was expressed in form of mean (SD) and frequency (percentage). P value was significant if < 0.05. **GI,** included those patients with Charcot foot ; **GII,** included those patients without Charcot foot; **HTN,** hypertension; **IHD,** ischaemic heart disease; **CKD**, chronic kidney disease; **COPD,** chronic obstructive lung disease.

Laboratory Data in both Studied Groups (table 3):

Serum albumin was significantly lower in patients with Charcot foot than in patients without Charcot foot 29.30 ± 2.11 versus 33.34 ± 3.05 g/dl; P= 0.02. Also, creatinine, and cholesterol were significantly lower in those patients with Charcot foot. Diabetes mellitus was poorly controlled in the patients with Charcot foot where HbA1c was 8.88 ± 1.23 % while it was 7.01 ± 2.06 % in those patients without Charcot foot (P= 0.02).

Table (3): Laboratory Data in both Studied Groups

Item	Group I (n= 100)	Group II (n= 620)	P value
Hemoglobin (g/l)	11.45 ± 2.76	11.11 ± 2.33	0.22
Platelets (10^3/l)	267 ± 18	288 ± 23	0.21
Bilirubin(mg/dl)	1.01 ± 0.2	0.9 ± 0.1	0.12
ALT (U/L)	67 ± 4.98	60 ± 13.32	0.47
AST (U/L)	77 ±7.89	76 ± 12.553	0.17
Albumin (g/dl)	29.30 ± 2.11	33.34 ± 3.05	**0.02**
Creatinine (mg/dl)	3.32 ± 0.1	1.99 ± 0.15	**0.04**
Cholesterol (mg/dl)	237.62 ± 37.63	197.62 ± 37.63	**0.01**
Triglyceride (mg/dl)	160.9 ± 8.73	140.9 ± 8.73	**0.00**
HDL (mg/dl)	48.5 ± 8.52	58.5 ± 10.52	0.23
LDL (mg/dl)	80.56 ± 18.79	67.56 ± 15.79	0.76
HbA1c (%)	8.88 ± 1.23	7.01 ± 1.06	**0.02**

Data was expressed in form of mean (SD) and frequency (percentage). P value was significant if < 0.05. **GI,** included those patients with Charcot foot; **GII,** included those patients without Charcot foot; **AST,** aspartate transaminase; **ALT,** alanine transaminase; **HDL,** high density lipoprotein; **LDL,** Low density lipoprotein; **HbA1C,** glycosylated hemoglobin

Data of Patients and foot examination with Charcot Foot (table 4):

Out of 100 patients with Charcot foot, 75 (75%) patients had bilateral Charcot foot and 61 (61%) patients had acute Charcot foot.

Detection of neuropathy: Mono filament test was preserved in 37 (37%) patients, diminished in 39 (39%) patients and lost in 24 (24%) patients. In majority of patients (58%) vibration test was lost while pin prick test and ankle reflex were lost in 59% of patients. Mean of neuropathy disability score in patients with Charcot foot was 3.89 ± 0.89.

Detection of peripheral artery disease:

Dorsalis pedis artery was palpable in 60 (60%) patients while it was absent in 40 (40%). Normal ankle brachial index presented in 79 (79%) patients and decreased in 31 (31%) patients.

Foot inspection:

It was noticed that each of foot ulcer and redness presented in 20 (20%) patients while hotness presented in 38 (38%) patients. Majority of patients (58%) had signs of inflammation including edema. Rocker bottom presented in 23 (23%) patients while 12 (12%) had history of amputation of one toe or more.

Table (4): Data of Patients and foot examination with Charcot Foot

Item	Frequency (%)
Laterality	
Unilateral	75 (75%)
Bilateral	25 (25%)
Type	
Acute	61 (61%)
Chronic	39 (39)
Mono filament test	
Preserved	37 (37%)
Diminished	39 (39%)
Lost	24 (24%)
Vibration test	
Normal	42 (42%)
Lost	58 (58%)
Pin prick test	
Normal	41 (41%)
Lost	59 (59%)
Ankle reflex	
Normal	41 (41%)
Lost	59 (59%)
Neuropathy disability score	3.89 ± 0.89
Dorsalis pedis artery	
Palpable	60 (60%)
Absent	40 (40%)
Ankle brachial index	
Normal	79 (79%)
Decreased	31 (31%)
Foot inspection	
Ulcer	20 (20%)
Redness	20 (20%)
Hotness	38 (38%)
Inflammation and edema	58 (58%)
Rocker bottom	23 (23%)
Amputation of toe (s)	12 (12%)

Data was expressed in from of frequency (percentage)

Logistic regression analysis for prediction of Charcot foot in patients with diabetic foot (table 5): The current study showed that the predictors for Charcot foot in patients with diabetic foot were old age, presence of HTN, use of oral hypoglycaemic agents, low albumin level, poorly controlled DM and hyperlipidemia.

Table (5): Predictors of Charcot foot in patients with diabetic foot

Item	Odd's ratio	95% Confidence interval	P value
Age (years)	1.09	2.09- 4.09	**0.00**
Sex	2.34	1.33- 5.99	0.87
Duration of DM	1.87	0.11- 0.98	0.23
HTN	0.98	1.91- 4.95	**0.00**
Oral therapy	1.87	2.44- 7.09	**0.02**
Type II DM	0.34	0.34- 1.54	0.78
Hyperlipidemia	1.45	0.11- 0.99	**0.01**
HbA1C	1.98	1.03- 5.98	**0.00**
Creatinine	1.23	0.67- 1.98	0.56
Albumin	1.45	3.87- 5.95	**0.01**

DISCUSSION

Diabetic Charcot arthropathy is a devastating disorder characterised by the gradual deterioration of weight-bearing bones and joints, which leads to significant instability, repeated ulcerations, and/or amputation. It is often linked with peripheral neuropathy. According to numerous research, the prevalence of diabetic Charcot arthropathy ranged from 0.08% in the general diabetic community to over 13% in specialty diabetic foot clinics [(4)]. Patients go undetected due to doctors' lack of training and lack of awareness of the natural history of diabetic Charcot arthropathy, hence the incidence rate is unknown [(5)]. Charcot arthropathy is a complication of diabetes mellitus that worsens the patient's morbidity and death. Long-term Charcot foot affects a patient's bodily functions and quality of life, according to a long-term follow-up research [(6)].

Although peripheral neuropathy is thought to be a precondition for Charcot arthropathy, not all diabetes individuals with peripheral neuropathy will develop Charcot joint. The pathophysiology of Charcot arthropathy has developed from a fusion of neurotraumatic and neurovascular ideas to the present, far more widely accepted inflammatory explanation [(7)]. These theories help to explain why Charcot arthropathy often occurs unilaterally at first onset, whereas peripheral neuropathy has symmetrical involvement. However, the pathogenesis and aetiology of diabetic Charcot arthropathy remain unclear. Thus, independent predictors of this disease should be identified among the diabetic population in order to provide adequate and specific measures to prevent this debilitating condition.

The current study was performed at period between May 2015 and May 2016 in Assiut Diabetic Foot Care Clinic to estimate frequency and risk factors of Charcot foot. Out of 720 patients came to the clinic with diabetic foot, 100 patients were diagnosed to have Charcot foot. So, frequency of Charcot foot in the current study was 13.8%.

Comparisons of the patients' socio-demographic profiles, diabetes characteristics and foot factors were made to predict the independent risk factors of diabetic Charcot arthropathy. Our results showed that patients with a history of prior diabetic foot problems had the highest propensity for developing diabetic Charcot arthropathy. Other study have similarly reported that a certain percentage of diabetic patients with Charcot arthropathy had a previous history of foot problems such as ulcer, surgery and/or amputation of the foot complex, along with a loss of protective sensation [(4)]. Foot ulcer in diabetic patients with loss of protective sensation commonly occurs at the plantar aspect because of the abnormal high plantar pressure. Delayed management and the absence of adequate pressure offloading of the foot ulcer may further delay wound healing, instigate infection and perpetuate the progression of foot deformity. A non-healing, infected foot ulcer may require surgical debridement and amputation [(7)]. A few case reports have highlighted that a history of prior foot surgery, even without preceding foot ulcers, may instigate Charcot arthropathy as a result of altered weight-bearing forces, abnormal plantar pressure distribution and an ongoing inflammatory process [(8)]. The common link that ongoing minor repetitive trauma and previous foot problems have with an insensate foot is that both act as triggering factors of inflammatory cascade and the continual production of proinflammatory cytokines, which can further accentuate the expression of receptor activator of the nuclear factor-kappa B ligand system. This phenomenon ultimately leads to osteolysis and osteopenia, resulting in bone breakdown [(9)]. Therefore, our finding of increased incidence of diabetic Charcot arthropathy in patients who have a history of foot problems is consistent with the novel inflammatory theory for the development of diabetic Charcot arthropathy [(10)].

In the present study, analysis of diabetes characteristics suggested that chronicity of diabetes mellitus may show a predilection for Charcot arthropathy. Duration of diabetes mellitus of > 10 years, insulin treatment, HbA1c level > 6.5%, and the presence of retinopathy and nephropathy are significantly associated with Charcot arthropathy ($p < 0.05$).

The current study showed that the predictors for Charcot foot in patients with diabetic foot were old age, presence of HTN, use of oral hypoglycaemic agents, low albumin level, poorly controlled DM and hyperlipidemia. In a recent study on the risk factors of Charcot arthropathy, **Nehring *et al.*** [(11)] found that age appears to have a significant effect on patients with Charcot arthropathy as compared to Charcot-free patients. However, several studies have found that the younger age group is more prone to diabetic Charcot arthropathy than older people. This age trend is also consistent in our diabetic population, where the age group > 60 (mean age 65.08 ± 13.32) years showed a significantly higher propensity for Charcot arthropathy [(12)]. There have been conflicting reports concerning the association of diabetic foot Charcot arthropathy with a younger age group and longer duration of diabetes

mellitus (> 10 years). Our findings are similar to those of a large-scale study by **Stuck *et al.*** [13] which reported that the incidence of diabetic foot Charcot arthropathy was higher among diabetics aged 55–64 years and those who have had diabetes mellitus for six years or more.

In the present study, both diabetics with and without Charcot arthropathy had a high incidence (~80%) of peripheral sensory neuropathy symptoms, which can be mild to severe (based on NSS). The usual involvement of peripheral sensory neuropathy in diabetes mellitus is bilateral, but the most common presentation in Charcot arthropathy is unilateral at first onset. This natural history of diabetic Charcot arthropathy suggests that it is not a systemic pathology and that not all patients with diabetic peripheral neuropathy will eventually develop Charcot arthropathy [14].

Our study findings suggested that the interaction and combination of multiple factors (including history of prior diabetic foot problems, diabetes chronicity, age > 60 years old, presence of nephropathy and retinopathy, and prolonged ambulation) further heightened the risk of development of diabetic Charcot arthropathy of the foot. Risk stratification for diabetic foot may enable physicians and podiatrists to make better decisions on foot-care management, intervals of follow-up, and the provision of offloading devices and protective footwear that prevent foot problems, thus reducing the incidence of new foot lesions and preserving the limb from amputation and deformity [15]. Early detection and management with offloading devices and protective weight-bearing are also pertinent in preventing further bone destruction in Charcot arthropathy [16].

The present study faced some limitations. First, the study recruited only patients with chronic Charcot arthropathy for the case group and retrospectively reviewed the predictors of Charcot arthropathy. Second, there may be possible bias due to missing data in the disease profile and recall bias when collecting information for the NSS questionnaire (such as history of diabetic foot problems and duration of ambulation), which might have affected the results. Furthermore, information from the time of onset of diabetic foot problems to the diagnosis of diabetic Charcot arthropathy was unavailable. Another limitation of the study was the absence of data on the history of foot problems in the contralateral foot, since the majority of the diabetic foot Charcot arthropathy patients presented with unilateral involvement. In future studies, this data should be included to strengthen the association of risk factors, since the presentation of diabetic foot Charcot arthropathy is commonly unilateral, while peripheral neuropathy usually presents with symmetrical involvement. To minimize the aforementioned bias, a larger-scale cohort study should be conducted in the future. Given that not all diabetic patients with peripheral neuropathy eventually develop diabetic Charcot arthropathy, further prospective studies with matched peripheral neuropathy groups should be conducted in order to focus on the predictors of this debilitating condition.

CONCLUSION

The present study demonstrated that a history of diabetic foot problems, especially foot ulcers and a combination of foot ulcers and surgery of foot complex, independently elevated the risk of developing diabetic foot Charcot arthropathy.

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