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Assessment of foot deformities in patients with type 2 diabetes mellitus

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ABSTRACT

Background: Affection of lower extremity in diabetic patients leads to development of several foot deformities. The knowledge so far about the particulars of foot deformity in diabetic population is limited. The current study aimed to assess prevalence of foot deformities in known diabetics and to compare it with non-diabetic population. It also aimed to know its association with various risk factors.
Methods: Foot was evaluated for presence of deformity in 80 patients with type 2 diabetes mellitus and was compared with the control group of 80 non-diabetic individuals. Type of deformity was noted and its prevalence was compared between the two groups. Statistical analysis was done to see the association of foot deformity with various risk factors.
Results: Prevalence of foot deformity was more in diabetics as compared to normal population ($p<0.004$). Forefoot was involved in majority of cases (84.93%) and nail deformities were most commonly seen (38.35%). Deformities were less common in patients who were aware of diabetic foot care measures ($p<0.004$) and were more common in presence of diabetic neuropathy, vasculopathy and uncontrolled glycaemic index.
Conclusions: All patients with diabetes should be screened for presence of neuropathy as this is the most common factor for development of a foot deformity and hence a foot ulcer. Other helpful screening measures include assessment for peripheral vascular disease and monitoring of glycaemic index (HbA1c). Patients should be educated about the diabetic foot care measures to avoid potential complications.

Keywords: Foot deformities, Diabetes mellitus, Peripheral neuropathy, Foot ulcer

INTRODUCTION

Diabetes mellitus is a major health problem world-wide, affecting people in all age groups. In India, more than 60 million individuals are currently diagnosed with the disease which is more than any other country in the world.[1,2] Lower extremity problems represent the most common source of morbidity and hospitalization in diabetic population.[3-5] The prevalence of foot ulcer in diabetic population has been reported to be around 4-6%.[2,3] These diabetic ulcers can be easily prevented by identifying the risk factors and taking appropriate preventive measures but once ulceration occurs, its cure is extremely difficult. Furthermore, diabetics are 15 times more likely to undergo a lower extremity amputation when compared to their normal counterparts.[6]

Foot deformity is a known risk factor for development of callosities and ulcers. The abnormal bony prominence developed by these stretched deformities leads to abnormally high pressure and when combined with insensitivity of foot, causes tissue breakdown and ulceration.[7,8] The involvement of the foot in systemic diabetic neuropathy can lead to objective differences in the foot structure and severe alterations in gait cycle patterns which together combine to cause the biomechanical impairment of foot.[9,10] Both sensory and motor components of peripheral nervous system are affected. Motor neuropathy leads to weakness of the intrinsic muscles of foot and disturbs the balance between the flexor and extensor compartments.[11] This can cause several deformities like hammer toe, claw toe, pes cavus, flat foot and hallux valgus.[12] These foot complications can be

serious and disabling, the most feared consequence being a lower extremity amputation (9.9% to 21.5%).[13,14]

The knowledge so far about the prevalence of foot deformity and its association with different clinical parameters in diabetic population is limited. The current study aimed to assess the prevalence of foot deformities in known diabetics and to compare it with non-diabetic population. It also aimed to know the association of foot deformity with various factors like age, sex, duration of disease, mode of treatment, presence of neuropathy and presence of vasculopathy.

METHODS

A prospective study was conducted in the department of orthopaedics and medicine at a tertiary care hospital between 2018 and 2020. The study group included patients with type 2 diabetes mellitus attending diabetic and orthopaedic clinic. Patients with foot ulceration or infection and those who had undergone amputation of lower extremity were excluded from the study. The non-diabetic individuals who were matched for age and gender constituted the control group. The prevalence of foot deformities in both groups was compared. The type of foot deformity and the region of foot involved was noted.

Neurological assessment of foot was done for insensitivity by a 10 gm nylon monofilament which buckled on giving a force of 10 gm when applied perpendicular to various sites of foot (Figure 1). Measurements were taken at plantar aspect of 1st, 3rd and 5th digits, plantar aspect of 1st, 3rd and 5th metatarsal heads, medial and lateral sides of plantar aspect of mid foot, plantar area of heel and dorsal aspect of mid foot. The failure to feel monofilament at four out of ten sites on the foot was taken as an indication of loss of protective sensation (Armstrong 1998).[15,16] The measurement of vibration perception threshold was assessed using a bio-thesiometer (an apparatus used for vibration threshold measurement).[17,18]

. Figure 1: 10 gm monofilament used for assessing sensory neuropathy.

Peripheral arterial pulsations of posterior tibial and dorsalis pedis artery were assessed by Doppler ultrasonography using a handheld Doppler and ankle brachial pressure index (ABPI) was measured.

Biochemical test for glycated haemoglobin (HbA1c) indicated control of blood sugar in past three months. It was measured by using Roche Hitachi 904 clinical chemical analyser.

Association between foot deformity and diabetes was calculated using chi square test. Relative risk of diabetes mellitus in causing foot deformities was also determined and 95% confidence interval was calculated. Comparison of other continuous and discrete variables was done using the t-test and Chi square test respectively. Statistical significance was determined by a p value <0.05.

RESULTS

In this prospective study, there were 80 subjects in each group. The prevalence of foot deformity in diabetic and control group was 33.8% (27/80) and 12.5% (10/80) respectively and this difference was statistically significant ($p<0.001$) (Table 1). There was no significant difference between the prevalence in male and female patients. The difference between the affection of right and left foot was also not significant. We found 66 deformities in total out of which 55 (83.3%) were present in forefoot, seven (10.6%) in mid foot and four (6.1%) in hind foot (Table 2).

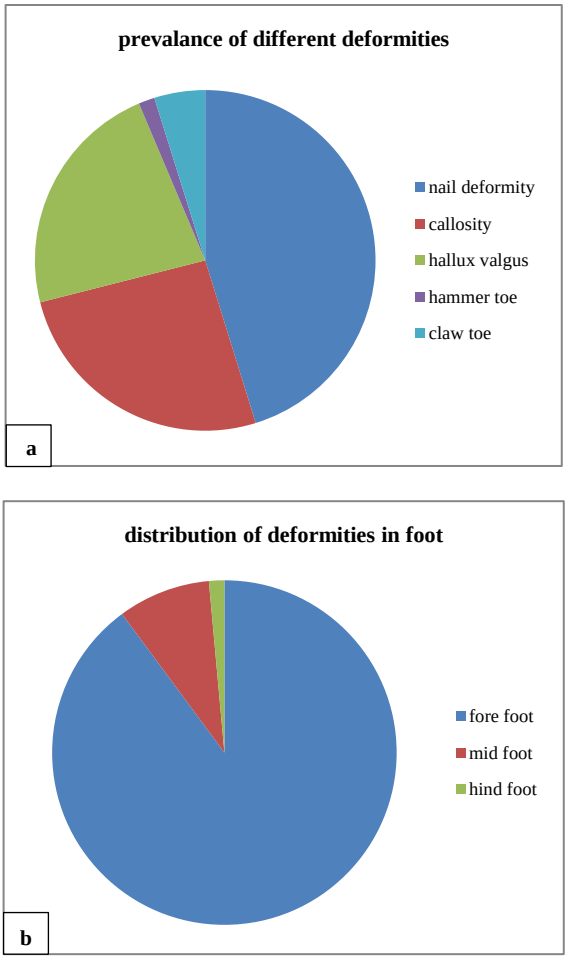

Figure 2 (a and b): Prevalence of foot deformities and their distribution in different region of foot.

Figure 3: Various foot deformities seen in our diabetic population; (a) pes planus; (b) claw toes; (c) hallux valgus; (d) Charcot's arthropathy; (e) nail changes; (f) hindfoot valgus; (g) callosity.

Table 1: Demography of study participants.

Characteristics	Diabetics (%)	Non-diabetics (%)	P value
Mean age (years)	59.42	57.05	0.93
Gender			
Male	37	39	0.91
Female	43	41	0.91
Body Mass Index (BMI)	27.25	27.12	1.2
Smoker	15	16	0.98
Presence of foot deformity, N (%)	27 (33.8)	10 (12.5)	<0.001
Total (n)	80	80	

Table 2: Different type of foot deformities observed in various regions of foot.

Region of foot	Number N (%)	Deformity
Forefoot	55 (83.3)	Nail abnormality, callosity, claw toe, hammer toe, hallux valgus, joint instability.
Midfoot	7 (10.6)	Pes cavus, flat foot, callosity, joint instability
Hind foot	4 (6.1)	Cracking, fissuring of heal, callosity, joint instability, Charcot foot.

There were 28 nail deformities (42.4%), 16 callosities (24.2%), 14 hallux valgus (21.2%), 3 claw toe (4.5%) and 1 hammer to toe (1.5%) (Figure 2). Two patients had Charcot's foot and both had bilateral involvement. The prevalence of deformities increased with the duration of diabetes. Maximum number of deformities were present in patients with duration of disease between 6-10 years (11 out of 25, 44%) and all 6 patients with duration of disease over 20 years had some kind of foot deformity (100%).

There was no statistically significant difference between the patients on regular treatment and those who were taking treatment irregularly. Also, there was no significant difference between the patients on oral hypoglycaemic agents (OHA), those on insulin or those on both OHA and insulin. The prevalence in the patients who were aware about the foot care measures was 17.9% whereas it was 48.8% in those who were unaware about it ($p<0.004$). However, awareness about the diabetic footwear had no significance. All 27 patients having foot deformity also had neuropathy and its prevalence increased with the duration of disease. Two patients with deformity had absent distal pulsations whereas 5 had ankle brachial index less than 0.9. The average ABI in diabetic group was 1.0045 on left side and 1.0111 on right side. The HbA1c in our study was 8.81% and 18 patients having deformity (67%) had HbA1c more than 9.

DISCUSSION

Prior studies have mentioned the prevalence of lower extremity complications in the diabetic population by focusing on the number of limb amputations performed annually.[19] The prevalence of lower extremity complications was twice in diabetics as compared to non-diabetics and it affected 30% of diabetic population over 40 years of age.[20,21] Ogbera et al reported prevalence of foot deformities as 26.4% in patients with type 2 diabetes mellitus, while the study by Mansour et al mentioned 46.7% prevalence of diabetic foot abnormalities.[22,23] In a similar study by Ababneh et al Hallux valgus was found in 17.4%, claw/hammer toe in 16%, prominent metatarsal head in 14.2%, limited joint mobility in 9.4%, pes cavus in 3.2%, and Charcot foot in 2.1% of patients with type 2 diabetes mellitus.[24] Mekonnen et al had reported an overall prevalence of diabetes related foot deformities to be 36.5%.[25] In their study, the most common structural foot deformities were claw/hammer toe (12%), followed by callus (9%), hallux valgus (8.5%) and pes cavus (7%). However, none of these studies have compared the results with normal population. In our study, prevalence of foot deformity in diabetic population was 33.8% as compared to 12.5% in control. While prior studies, Ogbera et al had reported a slight male preponderance, there was no such trend in our study. In current study, forefoot was most commonly involved with a prevalence of 83.3% followed by mid foot and hind foot. Nail deformities were most common (42.4%) followed by callosities (24.2%) and hallux valgus (21.2%). Although higher duration has been considered a high-risk sign, none of the studies had made a direct correlation between duration of diabetes and development of foot deformities. The current study proved a direct correlation between development of foot deformities and duration of disease. Patients with diabetes for 6-10 years had maximum number of deformities and all patients having duration more than 20 years had one or more foot deformity. The fact that the patient was diabetic was more important. The regularity of treatment did not seem to change the results. Patients developed deformities despite being on regular treatment. Though insulin use had been considered as a predictor of foot deformities by Mansour et al we did not come across any previous study showing any co-relation between the development of foot deformities and the treatment modality or the regularity of treatment.[23] Our study being an outpatient study, most of the patients were on OHA. There was no significant difference between the prevalence of deformities in the patients on OHA and those on insulin or on both modalities of treatment. Also, there was no familial predisposition regarding development of foot deformities. Earlier studies by Barth et al, Litzclman et al and Pieber et al had reported reduced foot problems with foot care education.[26-28] The current study also evidenced low prevalence of foot deformities in the patients having foot care awareness. However, awareness regarding type of diabetic footwear didn't prove useful.

Earlier studies had indicated that the prevalence of neuropathy may vary between 14-63% depending upon the type of population studied and the criteria used to define diabetic neuropathy.[29-31] In Seattle diabetic foot study, monofilament insensitivity in diabetic patients was as high as 60%.[32] Vibration threshold more than 25 V was a potential indicator of neuropathy and development of foot ulcers. In current study, three indicators were used to access neuropathy, sensory perception using monofilament, vibration potential threshold more than 25 V and absence of deep tendon reflexes. Decreased sensory perception was found in 37% population, 44% had vibration potential over 25 V and 40% had absent deep tendon reflexes. This showed that foot deformities developed only in the presence of advanced neuropathy as evidenced by above indicators.

Peripheral vascular disease (PVD) had been noted in 18.4% of the subjects with diabetes.[25] Ankle brachial pressure index (ABPI) of 0.9 or less was usually considered to be diagnostic of PVD.[33] In a study by Holewski et al only 22% of diabetic patients showed ABI less than 0.9, which was similar to the finding in current study (16.25%).[34] Moreover, only 7.4% cases with foot deformities had bilateral pedal pulses absent. This showed that checking pulses alone may not be enough to identify patients with peripheral vascular disease since two-third of patients with abnormal ankle brachial index had palpable pedal pulsations. This also showed that the majority of patients do have neuropathic foot rather than a neuro-ischaemic foot.

Most of the earlier studies had mentioned poor glycaemic control as one of the most important factors in the genesis of diabetic complications.[32,35] Peters et al reported mean HBA1C level as 8.8±2% in patients with peripheral neuropathy.[35] In another study by Perkins et al HbA1c level of more than 9% was taken as cut off for poor glycaemic control which was a significant predictor of severity of distal sensory motor polyneuropathy.[36] The average glycaemic index in current study was 8.81% and 67% of patients had a value over 9%. This suggested a co-relation between poor glycaemic control and development of foot deformities.

CONCLUSION

The prevalence of foot deformity is significantly more in patients with type 2 diabetes mellitus when compared to their normal counterparts. A longer duration of disease increases the risk of developing peripheral neuropathy and foot deformity. All patients with diabetes should be screened for presence of peripheral neuropathy as this is the most common factor for development of a foot deformity and hence a foot ulcer. Other helpful screening measures include assessment of peripheral vascular disease by measuring ankle brachial index and monitoring HcA1c. Educating the patients about diabetic foot care measures can be helpful in avoiding potential complications.

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