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Prevalence of Musculoskeletal Manifestations in Diabetes Mellitus Type 1: A Cross-Sectional Study

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ABSTRACT

Introduction: Musculoskeletal complications are most seen in patients with a longstanding history of DM type 1.

Aim: This study aimed to determine the prevalence of musculoskeletal manifestations associated with DM type 1 in Belagavi district.

Materials and Methods: Out of a total of 200 participants with Diabetes Mellitus type 1, 95 participants with musculoskeletal problems were assessed for range of motion, pain, and muscle strength of the most affected joint. They were also screened for any deformities in the upper and lower limbs as well as interviewed for any activity limitations in functional tasks. The objective outcomes used were chippaux index and weight distribution during gait.

Results: Our results showed that, musculoskeletal deformities were observed in 60% of the participants. 14.74% of the participants presented with restricted and pain-free ROM, 89.47% had pain and 98.95% showed generalized muscle weakness. The most common deformity seen in the upper limbs and lower limbs was salaam deformity and pes cavus respectively. According to chippaux index, 27.37% participants presented with tendency to cavus foot whereas 14.74% with tendency to flatness. Medial weight bearing of foot was observed in 17.89% participants, whereas lateral weight bearing was seen in 28.42% participants. Also, range of motion and deformity were found to be significantly associated p=0.012.

Conclusion: The study concluded that musculoskeletal manifestations occur with a greater frequency in patients with Diabetes Mellitus type 1 in Belagavi district and that, ROM and musculoskeletal deformities are significantly associated.

Key words: Diabetes mellitus type 1, Musculoskeletal manifestations, Deformities, Chippaux index, Weight bearing

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INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both [1]. The global diabetes prevalence is estimated to be 9.3% whereas that in India ranges from 5–17%, with higher levels found in the southern part of the country and in urban areas [2,3]. The metabolic disturbances in diabetes, which includes glycosylation of proteins, microvascular abnormalities with damage to blood vessels and nerves and collagen accumulation in skin and periarticular structures, result in changes in the connective tissue. Musculoskeletal complications are most seen in patients with a longstanding history of diabetes mellitus type 1 (DM type 1) [4].

These musculoskeletal manifestations can cause pain and loss of function at the involved sites. The musculoskeletal disorders seen in these patients which can be divided into three categories: a) disorders which represent intrinsic complications of diabetes, such as limited joint mobility or diabetic cheiroarthropathy, stiff hand syndrome, and diabetic muscular infarction, b) disorders with an increased incidence among diabetics, such as Dupuytren's disease, shoulder capsulitis, neuropathic arthropathy, osteopenia (DM type 1), flexor tenosynovitis,

septic arthritis, acute proximal neuropathy, proximal motor neuropathy, pyomyositis and the diffuse idiopathic skeletal hyperostosis (DISH) syndrome and finally c) disorders for which a possible association with diabetes has been proposed but not proven yet, such as osteoarthritis and the carpal tunnel syndrome.

The most common type of cheiroarthropathy observed is adhesive capsulitis (31%), followed by carpal tunnel syndrome (30%), flexor tenosynovitis (28%), salaam deformity (22%), and Dupuytren's contracture (9%) [5-7]. These manifestations may go unrecognized or simply be overlooked in daily clinical practice. Thus, clinicians should be aware of the possible musculoskeletal complications of diabetes to intervene and provide the best care for affected patients. The prevalence of musculoskeletal complications due to DM type 1 in Belagavi has not been estimated. Hence, our study aims to determine the prevalence of musculoskeletal manifestations associated with DM type 1 in Belagavi district.

MATERIAL AND METHODS

A cross sectional study was conducted with an aim to estimate the prevalence of the musculoskeletal manifestation in patients with DM type I. The study was approved by the Institutional Ethical Committee before the commencement of the study. A free one-day camp was organized by the diabetic center along with pediatric physiotherapy department of a tertiary care hospital.

A total of 200 participants with DM type 1 in and around Belagavi were assessed by the diabetic center and a total of 95 participants with musculoskeletal problems were referred for physiotherapy evaluation. The participants were assessed for range of motion (ROM), pain and muscle strength of the most affected joint. The ROM of the affected joint was assessed by asking the participant to perform active movements of the joints and was graded as 1: Full and Pain Free, 2: Full and Painful, 3: Restricted and Pain Free, 4: Restricted and Painful. The participants were also interviewed for presence or absence of pain. A generalized assessment of strength was performed for the participants complaining of weakness.

The participants were screened for any deformities in the upper and lower limbs. The deformities such as hallux valgus, hallux varus, pes cavus, pes planus, salaam deformity, etc. were recorded on observation. They were also interviewed for any activity limitations in functional tasks such as ambulation, bed mobility, dressing, bathing toilet activities and writing.

The objective outcomes used were chippaux index and weight distribution during gait. The chippaux index is a standard tool which was used to assess the height of the longitudinal foot arch [8]. Static footprints of the participants were collected on a piece of paper and impregnated with ink, between the subject's foot and the paper [9]. To calculate the chippaux index, a line tangent to the internal edge of the footprint was drawn. From the point of contact of this line with the digito-planar eminence, a line was drawn that crossed the eminence through its broadest part. Then, a line parallel to the previous one was drawn, that passed through the narrowest point of the isthmus of the sole of the foot. The index was the quotient obtained on dividing the value of the isthmus line by the value of the breadth line of the forefoot and was expressed in percentage. The scores were further categorized as: Chippaux Index <25%: Tendency to cavus foot, 25% < Chippaux Index < 45%: Normality range, Chippaux Index > 45%: Tendency to flatness and/or pronation [10]. Following the chippaux index, the medial and lateral weight distribution during gait was also assessed.

Descriptive analysis of the data was done using Ri386 3.63. Categorical variables were compared using chi-square test. P-value <0.05 was considered as significant.

RESULTS

Out of 200 diabetic patients, a total of 95(47.5%) patients (51 males, 44 female) presented with musculoskeletal problems. The mean age of these participants was 16.05 ± 6.17 years. Majority of the participants were students with a percentage of 70.53%. The mean duration of diabetes type 1 was 5.65 ± 4.9 years (Table 1).

Among 95 participants, 14 (14.74%) presented with restricted and pain-free ROM, 1(1.05%)

Table 1: Demographic details of participants with DM type 1.

Age (in years)		16.05 ± 6.17
Gender	Male	51 (53.68%)
	Female	44 (46.32%)
Duration of DM (in years)		5.65 ± 4.9
Occupation	Student	67 (70.53%)
	Household	9 (9.47%)
	business	4 (4.21%)
	farmer/cattle rearing	7 (7.37%)
	service	3 (3.16%)
	Others*	3 (3.16%)
*Indicates mason, hotel worker, factory worker		

Table 2: Prevalence of musculoskeletal manifestations in participants with DM type 1.

ROM	Full and Pain Free	80 (84.21%)
	Full and Painful	1 (1.05%)
	Restricted and Pain Free	14 (14.74%)
Joint involved	PIP	6 (6.32%)
	DIP, PIP	8 (8.42%)
	KNEE	1 (1.05%)
	MCP	1 (1.05%)
Pain	Present	85 (89.47%)
	Absent	10 (10.53%)
Weakness	Present	94 (98.95%)
	Absent	1 (1.05%)
Activity Limitation	Present	1 (1.05%)
	Absent	94 (98.95%)

showed full and painful ROM and 80 (84.21%) had full and pain-free ROM. The joints most involved were PIP and DIP 8.42%, only PIP 6.32%, MCP 1.05% and Knee joint 1.05%, suggesting that the PIP and DIP together were more significantly involved. Musculoskeletal pain was present in 85 (89.47%) participants and 94 (98.95%) showed generalized muscle weakness. Only 1.05 % of the total participants presented with difficulties in functional activities (Table 2).

Musculoskeletal deformities were observed in 57 (60%) of the participants with diabetes mellitus type 1. The deformities seen in the lower extremity were pes cavus in 25 (43.86%) participants, hallux valgus in 19 (33.33%) participants, pes planus in 13(22.81%) participants, followed by genu valgum, genu varum and hallux valgus which was 7.02% respectively. Upper limb deformities included salaam deformity which was observed in 21 (36.84%) participants. The most frequent deformity observed was pes cavus. Other manifestations such as cross-over toes, tingling in hands at night, wasting of hypothenar muscles, etc. were also commonly seen with a total prevalence of 40.35% (Table 3).

The chippaux index was analysed for 94 participants as 1 could not be assessed due to open wound injury over foot. According to Chippaux index, 26 (27.37%) participants in the sample presented with tendency to cavus foot and 14(14.74%) with tendency to flatness or pronated foot. The remaining 56.84% participants showed chippaux index within normal ranges. The medial weight bearing of foot was observed in 17(17.89%) participants, whereas lateral weight bearing was seen in 27 (28.42%) participants (Table 4).

Using chi square test with simulation it was concluded that ROM and deformity are significantly associated (p=0.012) (Table 5). Age (p=0.288) and gender (p=0.705) of the participants did not have a significant association with deformities. Musculoskeletal deformities were more commonly seen in males (62.75%) than females (56.82%). The duration of diabetes did not have any significant relation with deformities (p=0.119). Other parameters such as pain (p=0.311), muscle weakness (p=1) and activity limitation (p=1) did not show any significant association with musculoskeletal deformities in patients with DM type 1.

Table 3: Prevalence of musculoskeletal deformities in participants with DM type 1.

Deformity	Present	57 (60%)
	Absent	38 (40%)
Type	Hallux Valgus	19 (33.33%)
	Hallux Varus	4 (7.02%)
	Pes Planus	13 (22.81%)
	Pes Cavus	25 (43.86%)
	Genu Valgum	4 (7.02%)
	Genu Varus	4 (7.02%)
	Salaam Deformity	21 (36.84%)
	Others*	23 (40.35%)
*Indicates pain in calf, pain in thigh, knee pain, etc.		

Table 4: Scores on Chippaux Index and weight bearing of foot in participants with DM type 1.

Chippaux Index	Tendency to cavus foot	26 (27.37%)
	Normality range	54 (56.84%)
	Tendency to flatness and/or pronation	14 (14.74%)
Weight Bearing	Lateral	27 (28.42%)
	Medial	17 (17.89%)
	Normal	50 (52.63%)

Table 5: Association of different factors with deformity.

Factor	Sub-category	Deformity		P-value
		Present	Absent	
Age Group*	≤16	30 (54.55%)	25 (45.45%)	0.2889
	>16	27 (67.5%)	13 (32.5%)	
Gender	Male	32 (62.75%)	19 (37.25%)	0.7054
	Female	25 (56.82%)	19 (43.18%)	
Occupation	student	39 (56.52%)	30 (43.48%)	0.3721
	Non-Student	18 (69.23%)	8 (30.77%)	
Duration of DM*	≤4	27 (51.92%)	25 (48.08%)	0.1195
	>4	30 (69.77%)	13 (30.23%)	
ROM	Full and Pain Free	43 (53.75%)	37 (46.25%)	0.012 MC
	Restricted and Pain Free A	14 (93.33%)	1 (6.67%)	
Pain	Present	49 (57.65%)	36 (42.35%)	0.3113 MC
	Absent	8 (80%)	2 (20%)	
Weakness	Present	56 (59.57%)	38 (40.43%)	1MC
	Absent	1 (100%)	0 (0%)	
Activity Limitation	Present	1 (100%)	0 (0%)	1 MC
	Absent	-59.57%	38 (40.43%)	

DISCUSSION

The purpose of this study was to determine the prevalence of musculoskeletal manifestations in DM type 1. Studies have specified that limited joint mobility due to DM type 1, is reversible in early stages but becomes irreversible in time [11]. Hence age plays an important role. Longer diabetes duration has been considered as a risk factor for both limited joint mobility and microvascular complications [12]. Literature also shows that longer duration of diabetes is also considered as a predictor of foot abnormalities. However, the duration of diabetes (5.65 ± 4.9 years) in the current study was not associated with musculoskeletal deformities (p=0.119) [13]. A research conducted on effect of diabetes mellitus on osteoarthritis of knee states that the mechanism of diabetes mellitus on pain is unclear, however, diabetes mellitus type 1 may cause pain, in most cases by inducing a symmetrical sensory polyneuropathy in the distal part of the extremities, with prevalent loss of small fibers. Also, higher pain intensities were recorded during activities which put load on the joint as well as under resting conditions without load [14]. Pain was experienced by majority of the patients in our study (89.47%).

The exact etiology of limited joint mobility is unknown, although there is evidence of soft tissue accumulation of advanced glycation end products in tissues, which may cause stiffening [15,16]. Our study showed that ROM was

associated with the presence of deformities in patients with DM type 1. Studies show that there is inability to fully flex or extend the fingers and sclerosis of tendon sheaths. The underlying cause is thought to be multifactorial. Increased glycosylation of collagen in the skin and periarticular tissue, decreased collagen degradation, diabetic microangiopathy, and possibly diabetic neuropathy are thought to be some of the contributing factors. The joints commonly affected in our study were the PIP and DIP joints. Flexion contractures of the fingers may develop at advanced stages. One indication of the presence of this condition is known as the "prayer sign" also known as the salaam deformity, which was observed as a common deformity in the upper extremities (36.84%) in the current study. This is seen when the patient is unable to press their palms together completely without a gap remaining between opposed palms and fingers [4]. The prevalence of musculoskeletal deformities in our study was found to be 60%. Our present findings considered together with those results of the literature show that foot abnormalities are more common in patients with DM type 1 [17,12]. Foot deformities are important contributory risk factors and predictive of foot ulceration, possibly by predisposing the skin to high pressure at the site of the foot deformity [18]. Hence, ankle and foot joint mobility must be evaluated and prevented to avoid further foot problems in adolescents with DM type 1 from early stages. Some studies have indicated a significant relationship between hallux valgus and pes planus feet when contrasted with the neutrally aligned foot. The feet may possibly share a similar etiology in most cases, such as a tight gastrocnemius or heel cord [16].

Studies have indicated that Chippaux Index values are lower in individuals with DM type 1, which means that they trend toward pes cavus [19,20]. Our results which show a foot structure deviation toward pes cavus are consistent with this knowledge. Individuals with DM type 1 are known to have a significantly lower ankle and foot range of motion, a lower ankle muscle strength, and a tendency to high medial longitudinal arch. Furthermore, muscle weakness progresses from distal to proximal in consequence of motor neuropathy leading to atrophy in the intrinsic muscles before the extrinsic muscles. This condition is known to cause muscle imbalance which may result in hammer toes, claw toes, and pes cavus [21]. Studies suggest that diabetic neuropathy may lead to disturbance of foot mechanics. A study examining gait abnormalities in diabetic neuropathy showed that there was there was more lateral position of the centre of pressure on the sole of the foot [22]. Majority of the patients from our study also show the presence of lateral weight bearing (28.42%) compared to medial weight bearing (17.89%).

Absence of a control group and small sample size were the limitations of this study. Also, there was no follow-up done to comment on the severity of musculoskeletal manifestations occurring with increase in duration of diabetes.

CONCLUSION

The present study concludes that, musculoskeletal manifestations occur with a greater frequency in patients with Diabetes Mellitus type 1. The prevalence of musculoskeletal deformities in patients with DM type 1 was 60%. Also, ROM and musculoskeletal deformities were significantly associated. We suggest that further studies should be conducted evaluating the association of a single parameter with musculoskeletal deformities in patients with diabetes.

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