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Role of Limited Hand Joint Mobility in Diabetic Type 1 Patients in Primary Health Care

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Abstract

Objective: Our study aims to:

1. To assess limited joint hand mobility in patients with diabetes type I
2. To determine whether the association of LJM differs between gender and the duration of diabetes

Study design: Cross sectional prospective study.

Settings: Departments of Family medicine and internal medicine outpatient's clinics of Mansoura Hospital, Egypt, (From December 2018 to December 2019).

Subjects: The research involved 200 diabetics (aged 14-40 years) were divided into two groups according to the presence of LJM. Standard laboratory tests were performed.

Results: This is a cross-sectional analysis. The frequency of LJM was 33.7% (29.8% in women and 38.9% in men). Subjects with LJM showed longer diabetes duration (P<0.001) than those without (women 16.7 ± 9.1 vs. 10.3 ± 6.0 years; men 15.0 ± 9.0 vs. 9.4 ± 6.3 years).

Age and HbA1c were not different between men and women with or without LJM. In a multiple logistic regression analysis, adjusted for age and diabetes duration, male sex independently predicted the presence of LJM. Females predominates in having LJM rather than males. Ultrasound can be used to assess LJM by assessing flexor tendon sheath thickening.

Conclusion: Limited Joint Mobility (LJM) is a common complication of Diabetes Mellitus (DM). LJM often is characterized by hand stiffness, but other joints may be involved. The prayer and tabletop signs may be used to detect limitation of joint mobility in the hands. Range of motion should be checked in the large joints as well as in the hand and finger joints. LJM should be distinguished from other musculoskeletal conditions that also are seen frequently in the hands of patients with DM. LJM may be associated with the duration of DM.

This condition is predictive of other diabetic complication like retinopathy, nephropathy, neuropathy and hypertension. Ultrasound can be used to assess LJM by assessing flexor tendon sheath thickening.

Keywords: Limited joint mobility; LJM; Ultrasonography; Diabetes type 1; Diabetic cheiroarthropathy; DCA

Abbreviations: BMI: Body Mass Index; DCA: Diabetic Cheiroarthropathy; DIP: Distal Interpharyngeal Joint; LJM: Limited Joint Mobility; LJMS: Limited Joint Mobility Syndrome; MCP: Metacarpophalangeal Joint; PIP: Proximal Interpharyngeal Joint; T1DM: Type 1 Diabetes Mellitus; T2DM: Type 2 Diabetes Mellitus

Introduction

Limited Joint Mobility (LJM), or diabetic cheiroarthropathy, is considered the earliest clinically apparent complication of diabetes and can be found in ~30-50% of type 1 diabetes. It begins with an extension deficit at the 5th finger on each hand and spreads radially, affecting interphalangeal and metacarpophalangeal joints. The inability of digital extension, is usually painless, not disabling and occurs secondary to thickening of the subcutaneous tissue, the flexor tendon sheaths, and sometimes the periarticular skin [1].

Frozen shoulder and carpal-tunnel syndrome, collectively known as "cheiroarthropathy," is extremely common in chronic type 1 diabetes, due to an accumulation of advanced glycosylation end products [2].

LJM has insidious onset and may predate the recognition of overt DM. Limited joint mobility, it not painful or disabling. It is linked to poor glycemic control and other complications of DM, but whether it predates the appearance of renal or ophthalmic disease and whether careful blood glucose control with insulin therapy can reduce the rate of its development has not been conclusively determined. However, easy diagnosis of LJM should be a part of the routine assessment of patients with DM, and its presence is a predictor to the presence of microvascular or macrovascular disease or both [3].

It occurs in both sexes equally; and common in patients on insulin, with juvenile onset, or longer duration of the diabetes. It begins as contractures in the distal interphalangeal and proximal interphalangeal joints. Gradually, increases to involve metacarpophalangeal joints, wrists, and other peripheral joints of both upper and lower limbs. It is usually asymptomatic, but later in the course of illness, the patients complain of stiffness, weakness of grip, clumsiness, and decreased dexterity due to reduced ability to perform fine movements. Typically, LJM is painless; however, patients with coexisting neuropathy may report pain [3]. This condition is predictive of other diabetic complication like retinopathy, nephropathy, neuropathy and hypertension [4].

It is clinically, detected by what is called the "prayer sign", which is assessed by asking the patient to put his or her hands together in a praying position with the fingers fanned and to press together the palmar surfaces of the interphalangeal joints and the palms. Normally, an individual is able to oppose both hands together, but a patient with LJM fails to do so Prayer sign correlates well with goniometer in detection of LJM [5].

Another test to detect LJM is the "tabletop test" which is conducted by asking the patient to place his hands palms-down on a tabletop with the fingers spread. A normal individual should be able to make contact of palmer surface of hand; however, a patient with LJM will not be able to do so. In case of positive test, the examiner may confirm limitation of joint motion with passive extension of the fingers. Differential diagnosis includes Dupuytren contracture, tenosynovitis of the finger flexor tendons, reflex sympathetic dystrophy, palmar fasciitis, and scleroderma [3].

Laboratory investigations includes (erythrocyte sedimentation rate, antinuclear antibodies and rheumatoid factor), radiographic evaluation, and nail fold capillaroscopy are usually unremarkable [5].

Patients with LJM had a tendon sheath thickness of more than 1 mm, compared with a thickness of less than 1 mm in unaffected patients with DM and controls [6].

Ultrasonography shows increased the skin thickness which increases with the duration of DM and is closely related to the presence of LJM [7]. There is significantly more sonographic "major lesions" or degenerative changes in the supraspinatus and Achilles tendons of patients with DM [8].

The purpose of this study is 1) to evaluate the role of ultrasonography in assessing of LJM and 2) to determine whether the association of LJM differs between gender and the duration of diabetes.

Research question

The research question for the purpose of this study is: 'What is the role of ultrasonography in assessing of LJM?'

Objective

The objective of the study is:

1. To assess limited joint hand mobility in patients with diabetes type I and
2. To determine whether the association of LJM differs between gender and the duration of diabetes.

Materials and Methods

Research method and design

This is a cross sectional study carried out at Department of Family medicine in corporation with internal medicine and Endocrinology Department at out patient's clinics of …… Hospital, Qatar as inpatients or outpatients, and the work started since December 2018 till December 2019.

The study population comprised involved 100 diabetics (type 1 diabetic subjects) (IDD M) (aged 15-65 years) who were investigated for the presence of LJM and an age-matched control group of 100 non-diabetic subjects were selected from the relatives of the patients was also included. All control subjects were tested with a standard OGTT and diagnosis was made based on the WHO criteria [9]. All patients received adequate information about the study and written consents were obtained before enrollment. The protocol was approved by the ethics committee of the hospital.

Study sample

The study participants included involved 200 subjects (aged 15-65 years):

- Group 1(LJM): 100 diabetics type 1 with LJM.
- Group II (NLJM): an age-matched control group of 100 non-diabetic subjects

The sampling method was convenient, and participants were consented to participate in the study.

The eligibility criteria are as follows:

1. aged 15-65 years
2. Patients of type 1 diabetes duration of >2 years,
3. and were treated with at least four daily insulin injections,
4. Age and sex matched non-diabetics who consented to participate in the study were selected for the study provided they did not have any obvious previous hand pathology.

Exclusion criteria

1. Patients who had hand diseases due to rheumatoid arthritis, osteoarthritis, infective arthritis, traumatic arthritis, gouty arthritis, end-stage renal disease, and thyroid disorders were excluded.
2. Patients who had no history of arthritis or primary joint disease.
3. Patients using special medications such as glucocorticoid, hormones, thyroid hormones, or anticonvulsive drugs.
4. Patients with secondary osteoporosis caused by systemic diseases and who took drugs influence the bone metabolism with exclusions of all other causes of osteoporosis.

Procedure

A full medical history including the duration and age of onset of diabetes was obtained. All participants underwent a thorough baseline evaluation including a detailed review of their medical history and physical examination. Patients' demographic characteristics including [age, gender and Body Mass Index (BMI)] were noted of each subject during face-to-face interviews.

Body weight was measured, body height was obtained measuring the supine length, and Body Mass Index (BMI) was calculated as body weight (in kilograms) divided by height (in meters) squared. All subjects were subjected to a thorough clinical examination.

Laboratory Measurements

Blood samples were collected and fasting plasma glucose, 2-h postprandial glucose and glycosylated hemoglobin were evaluated. Glycemic control was assessed by calculating the average of previous 12 months readings of fasting blood glucose (obtained from computerized archive for each patient).

Assessment of LJM

All diabetic patients and non-diabetic controls were examined for the presence of cheiroarthropathy by:

Prayer sign

The prayer sign was used for qualitative assessment of limited joint mobility. The prayer sign is described as the inability to fully flatten the two palms when opposed and clasped together. B) If this test is positive, the examiner, confirm the limitation of joint motion with passive extension of the fingers.

Assessment of LJM via Ultrasonography

High-frequency ultrasonography with a 7.5 MHz, and subsequently a 10 MHz, a probe was used to examine the volar aspects of both hands. The examination was performed in the transverse plane with special attention paid to the evaluation of all flexor tendons and tendon sheaths in the hand, but only the tendon sheaths with the greatest thickness were used for measurements used in the analysis. First, all the ultrasound scans were done by a consultant radiologist (ABT) and the measurements of the tendon sheaths performed using the facilities on the ultrasound scanner.

Assessment of Retinopathy

All the diabetic patients were examined by an ophthalmologist for the presence of diabetic retinopathy after pupillary dilatation in a dark room.

Statistical analysis

The data of this study were analyzed using descriptive data, release 17.0 for Windows (SPSS version 17.0., Chicago: SPSS Inc). Means and standard deviations were calculated; Student t-test and Chi-square (χ^2) test were used as appropriate. A significant difference was reported when the P value is < 0.05.

Ethical Aspects

The protocol for the study was approved by the Ethical and Research Committee of the Hospital. Data were collected only after the informed consent had been signed by all patients.

Results

The study population comprised 200 subjects (aged 14-40 years), divided into two groups; group 1 (LJM): 100 diabetics type 1 with LJM and group II (NLJM): an age-matched control group of 100 non-diabetic subjects. Our results showed association between the patient's age, weight and BMI and the development of LJM being statistically significant (Table 1).

	Study Group	Min	Max	Mean	SD	P value
Age	**Control**	32	59	46.2	6.2	**<0.001**
	T1DM	15	65	35.8	13.5	
Height (cm)	**Control**	135	185	165.1	7.6	**0.023**
	T1DM	100	182	160.9	12.4	
Weight (kg)	**Control**	50	120	76.0	11.3	**<0.001**
	T1DM	22	90	64.1	15.1	
BMI (kg/cm^2)	**Control**	19.8	37.0	27.8	3.1	**<0.001**
	T1DM	16.4	34.3	24.5	4.4	

Table 1: Sociodemographic characteristics of our patients.

The prevalence in T1DM is 55.00% which is slightly high. 20.00% of T1DM have LJM with the involvement of DIP joint and 10.7% MCP joint which is high. Involvement of the wrist was 6.1%, whereas PIP joint, MCP joint and wrist (large joint) is found in 63.00% of T1DM patients, indicating a more severe involvement of joints in T1DM (Tables 2 and 3).

	Prevalence of Cheiroarthropathy		95% Confidence Interval
	Lower		**Upper**
Control	5% (5 /100)	1.7%	10.7%
T1DM	55.00 % (55 /100)	40.2%	70.1%
All Sample	30.0% (60 /200)	24.1%	36.6%

Table 2: Prevalence of Cheiroarthropathy among study group.

Joint Type		P Value
DIP	13	0.378
MCP wrist	7 4	0.459 0.106
PIP, MCP and wrist (large joint)	41	<0.005*

Table 3: Distribution of patients according to joints affected by Cheiroarthropathy in T1DM.

In T1DM 14 of 23 male patients, and 21 of 32 female patients have cheiroarthropathy. Among all study groups; females predominate in having cheiroarthropathy rather than males; (P<0.05) (Table 4).

Study Group	Cheiroarthropathy		Total		P value	
	Present		Not			
N	**%**	**N**	**%**	**N**	**%**	
Control						
Male	2	40.0	48	45.7	40	45.5	
Female	3	60.0	57	54.3	60	54.5	0.802
Total	5	100.0	105	100.0	100	100.0	
T1DM							
Male	14	36.0	14	55.0	23	60.0	Male
Female	21	64.0	11	55.0	32	60.0	0.540
Total	35	100.0	25	100.0	45	100.0	

Table 4: Distribution of Cheiroarthropathy in the study group according to sex.

There was no significant association between average fasting blood sugar (12 months) and the development of diabetic LJM (P value>0.05). Also, there was no significant association between HbA1c and the development of diabetic LJM (Table 5).

Study Group		LJM	N	Mean	SD	P value
T1DM	FBS (mmol/L)	Cheiroarthropathy	25	15.2	6.0	0.586
			20	14.2	5.4	
	HbA1C (%)	Cheiroarthropathy	25	7.9	2.6	0.393
			20	7.3	2.2	

Table 5: Relation of LJM with glycemic control.

We also, found that retinopathy was significantly associated with LJM in T1DM patients (P<0.05) (Table 6). Our results showed that the age of diabetes onset has no significant effects on the development or absence of LJM (P>0.05). Longer disease duration in both types of diabetes is significantly associated with the development of LJM (P>0.05) (Table 7).

Study Group		% of Retinopathy	P value
T1DM	LJM	42.9	0.001
	No LJM	57.1	

Table 6: Distribution of diabetic patients according to presence of retinopathy, and LJM.

Study Group		LJM	No.	Mean	SD	P value
T1DM	Age at Onset (year)	Yes	25	20.4	11.4	0.646
		No	20	21.9	9.8	
	Disease Duration (years)	Yes	25	17.6	8.3	0.009*
		No	20	12.0	4.4	

Table 7: Disease factors (age at onset and disease duration).

Ultrasound scans of a patient with diabetic cheiroarthropathy and an unaffected diabetic control showing hypoechoic thickening of the flexor tendon sheath (shown by the two crosses) in diabetic cheiroarthropathy (thickness 2.3 mm) compared to the control (thickness 0.6 mm).

Ultrasound scans from all patients with LJM showed a hypoechoic thickening of the flexor tendon sheaths. Quantitative analysis of the tendon sheath thickness revealed measurements > 1 mm (median 1.8 mm, range 1.0-2.3 mm), compared to diabetic patients without DCA and healthy controls (<mm, medians 0.6 and 0.5 mm, respectively, range 0.3-1 mm). The medians and 95% confidence intervals of tendon sheath measurements in both groups (Kruskal-Wallis test, P < 0.001).

Discussion

Limited Joint Mobility Syndrome (LJMS) or diabetic cheiroarthropathy is a long-term complication of diabetes mellitus [10]. LJMS may pass underdiagnosed when compared to the micro- and macrovascular complications of diabetes, as more attention is paid towards the complications of diabetes such as nephropathy, neuropathy and cardiovascular disease, although it is associated with neuropathy and other microvascular complications and it can influence patients' health-related quality of life quite dramatically [11].

According to our study, the results showed that the prevalence in T1DM is 55.00 % which is slightly high. A study by Lawson, et al. [11] have similar results regarding T1DM and its association with LJM being 51%, yet inT2DM was 39%.

Females predominates in having LJM rather than males. The higher prevalence of LJM in women than in men can be explained by the fact that most males are employed in manual work, while most women are housewives in our community and not involved in physical activities, the manual hand activity acts as a good physical exercise decreasing the incidence of LJM [10].

Our results showed association between the patient's age, weight and BMI and the development of LJM being statistically significant, which differs from that of Guillot B, et al. [12] who showed that diabetic LJM are unrelated to patient age.

There is no significant association between average fasting blood sugar (12 months) and the development of diabetic LJM. Also, there is no significant association between HbA1c and the

development of diabetic LJM and this result is similar to that obtained by Fitz Charles, et al. [13].

According to our study, it revealed that retinopathy is significantly associated with cheiroarthropathy in T1DM patients, this result is similar to that obtained by Rosenbloom [14].

The association with the duration of diabetes is significant and the longer the duration of diabetes the greater the possibility to develop LJM, this result is similar to that of Arkkila, et al. and Renard [15,16], they found great correlation between LJM and diabetes duration.

Using ultrasound, in assessment of LJM in T1DM appears to be significantly more profound when compared with T1DM patients without LJM and non-diabetic controls. This suggests that flexor tendon sheath thickening is an integral part of LJM. The pathogenesis of LJM is still not known, but increased skin thickness has been demonstrated both histologically and using ultrasound. Glycosylation of collagen is thought to be important in the pathogenesis of increased skin thickness in LJM. Real-time high-frequency ultrasound has not been used to evaluate the tendons and tendon sheath in LJM, being easy and quick and effectively demonstrate the tendon sheath thickening [17].

Study limitations

One of the limitations of our study is possibility of a selection bias could limit the generalizability of the findings of the study.

Conclusions

In summary, we have found that results suggest type 1 diabetic subjects had limited joint mobility in high prevalence. An association between LJM with increasing duration of diabetes. Diabetic cheiroarthropathy is associated with the presence of diabetic retinopathy in T1DM. LJM in type 1 diabetic subjects is related to flexor tendon sheath thickening and is easily demonstrated on ultrasound.

Recommendations

- Mobilization techniques are recommended to prevent some of the pathomechanical changes occurring due to LJM.
- Longitudinal studies are needed to examine the potential benefits of mobilization on LJM and to ascertain whether these joint limitations persist among type 1 diabetic subjects.
- Further work is needed to determine whether hand ultrasound could provide an easy, early test for microvascular disease which may complement conventional screening methods, e.g. retinal screening.

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