RANGE OF MOTION IN SELECTED JOINTS OF DIABETIC AND NON-DIABETIC SUBJECTS

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SUMMARY
The purpose of the study was to compare the mobility of selected joints of the limbs in diabetic and non-diabetic subjects. One hundred volunteer subjects comprising 50 diabetic and 50 non-diabetic subjects participated in this study. The range of motion of the shoulder, elbow, wrist, fingers, hip and knee joints were measured. The occurrence of finger deformities was also studied. The range of motion was measured using a double-armed simple goniometer and recorded in degrees.

The outcome of this study revealed that there was a significant difference between joint mobility in the diabetic and non-diabetic subjects for all the joints ($p < 0.05$), except the knee and elbow joints ($p > 0.05$). There was also a low and positive correlation between the duration of diabetes and the frequency of finger deformities. No significant difference was found between joint mobility of male and female diabetic subjects ($p > 0.05$).

It was concluded that the reduced range of motion of some joints especially, the wrist and the hands, could occur as a complication from diabetes mellitus.

Key words: diabetes, joint motion

INTRODUCTION

Diabetes mellitus (DM) may be defined as a chronic hereditary disease characterized by an abnormally high level of glucose in the blood and the excretion of glucose in the urine.[1] The World Health Organization (WHO)[2] classified diabetes mellitus into two clinical categories namely, insulin dependent diabetes mellitus (IDDM) and non insulin dependent diabetes mellitus (NIDDM). Diabetes mellitus is believed to lead to metabolic and associated functional changes in the body, which could give rise to complications, including those of the vascular system. A study by Starker et al.[3] reported limited joint mobility of the hands as a clinical finding in approximately 30% of children and adolescent insulin-dependent diabetes mellitus patients.

Flexion contractures in the diabetic hand were found to be associated with peripheral neuropathy. The clinical progression of frozen shoulder in diabetics was studied by researchers[4] who discovered that a triad of conditions commonly occurred together. The triad is made up of painful shoulder (with subdivisions of tendinitis and acute or non acute painful shoulder with restricted mobility), hand syndromes (including limited joint mobility, finger deformities, stiff hands, flexor tenosynovitis, carpal tunnel syndrome and Dupuytrens contractor), and restricted hip mobility. The presence of the described triad was strongly associated with the duration of diabetes and with diabetic neuropathy.[4] Skin disorders are especially common in the extremities of diabetics. They result from an increased cross-linkage of collagen fibers and are believed to account for the decreased elasticity and toughening of the connective tissues. Proliferation of the endothelial cells is observed and the skin becomes thick, tight and waxy.[5] Past studies have established limited joint mobility and contractures as part of the diabetic syndrome.[3, 6]

The cited studies, however, did not establish the extent to which diabetes affects joint motion. There is a need to find the relationship between general joint mobility and finger joint motion. There is also a need to find the relationship between joint mobility and finger joint contractures in diabetics on the one hand and the age of onset, duration of onset and types of diabetes, especially in black diabetics, on the other hand.

This study was carried out to evaluate the relationship between the range of motion in selected joints and finger deformities in some Nigerian diabetic and non-diabetic subjects.

MATERIALS AND METHODS

Subjects

One hundred subjects comprising 50 diabetic and 50 non-diabetic (control) subjects participated in this study. The diabetic subjects were volunteer diabetic patients attending the diabetes clinics of the University College Hospital (UCH), Ibadan, Nigeria. The 50 non-diabetic subjects were apparently healthy, age-matched volunteers from the staff and relatives of patients at the University College Hospital, Ibadan. The classification of the subjects into different age groups is shown in table 1. Informed consent was sought and obtained from the diabetic subjects while ethical consent was also obtained from the attending physicians.

Materials

The materials used in this study were:

1. A simple double-armed goniometer
2. A 'Vygon' 16.5 ruler
3. A firm plinth

PROCEDURE

Before measurements were taken, other factors apart from diabetes mellitus that could result in limitation of joint mobility (such as trauma, stroke, arthritis) were excluded. Questions were asked to ascertain the following:

- history of oedema around the joints to be measured
- history of trauma of any joint
- history of joint pain
- history of joint diseases like osteo-arthritis, rheumatoid arthritis
- history of any neuropathy (paraesthesia or nimbleness)

To carry out the joints' range of motion, the subjects were requested to adequately undress for effective access to the joint. The following ranges of joint motion (ROM) were measured and recorded in degrees.

Knee Joint. The movements assessed in this joint were flexion and extension. The patient was in prone-lying position and with the lateral condyle of the femur as fulcrum, the stationary arm of the goniometer was placed on the lateral midline of the femur, towards the greater trochanter and the moveable arm placed on the lateral border of the fibula. The subject was instructed to bend his knee (flexion) as much as he could and the range moved was recorded. The subject was then asked to fully straighten (extension) his knee as much as possible and this range was recorded.

Hip Joint. The ROM at the hip joint was measured with the subject in supine position. The greater trochanter of the femur was the fulcrum, the stationary arm of the goniometer was placed along the greater trochanter and lateral superior crest of the ilium, while the moveable arm was in line with the lateral midline of the femur towards the lateral condyle. The subject was instructed to bend his hip (flexion) as much as possible keeping the knee flexed while ensuring that the contra-lateral lower limb was flat on the plinth. To measure hip extension, the subject lay in prone position and the goniometer was placed as in the flexion test. The subject was instructed to keep his knee straight, waist in contact with the plinth and then lift the whole limb up, the angle subtended was measured and recorded as hip extension.

Shoulder Joint. Shoulder flexion was measured with subject in supine position. The lateral tip of acromium was used as the fulcrum, the moveable arm of the goniometer was on the lateral midline of the humerus to the epicondyle while the stationary arm was placed along the mid-axillary line of the trunk. The subject was instructed to raise the arm up while keeping the elbow straight (shoulder flexion). Shoulder extension was measured with the subject in prone-lying and the goniometer placed as in shoulder flexion measurement. The subject was instructed to raise the whole upper limb straight up keeping the elbow straight and without lifting the shoulder joint off the plinth while the measurement was taken.

Elbow Joint. Flexion of the elbow was measured with the subject in supine position. The fulcrum of the measurement was the lateral epicondyle of the humerus. The movable arm of the goniometer was placed on the lateral midline of the forearm, between the styloid processes, while the stationary arm was placed on the lateral midline of the humerus. The subject was asked to bend the elbow (flexion) and stretch out (extension) the elbow fully from the bent position.

Wrist Joint. Wrist joint range of motion was measured using a point midway between the two styloid processes as the pivot. The stationary arm of the goniometer was placed on the dorsum of the forearm, while the moveable arm was on the dorsum of the third metacarpal. The subject was asked to bend the wrist (flexion) from neutral position to the fullest extent possible. Wrist extension was measured using the styloid process of the ulnar as the fulcrum. The stationary arm of the goniometer was on the lateral midline of the ulna towards the olecranon process, the movable arm was on the lateral midline of the fifth finger. The subject was asked to move the wrist dorsally (extension) from neutral position to full extension.

Joints of the Hand. The motion of the metacarpo-phalangeal joint and the distal and proximal interphalangeal joints were measured without the goniometer. The procedures used to assess the joints were as follows:

1. The subject was asked to place both hands flat on the surface of a powdered table. Any finger that did not make full contact with the table surface was noted as having a deformity. The number of such deformities present on each hand was recorded.

2. The subject was asked to make the prayer sign by placing both palms and fingers such that they oppose each other fully. It was regarded as a deformity in either or both fingers if the palms and fingers did not make good contact.

3. The subjects were asked to put the hands in prayer form as described above. A ruler was then used to measure the distance between the midline of the lateral surface of each of the opposing fingers at the proximal interphalangeal joints. In the case of the thumb, the distance was measured from between the mainlines of the dorsum of both opposing thumbs at the proximal interphalangeal joints. The distance was measured in centimeters.

TREATMENT OF DATA

Descriptive statistics of mean and standard deviation were calculated for the range of motions measured. Student's t-test was conducted to study the difference in the range of motion of the joints between non-insulin dependent and insulin dependent diabetic subjects. The range of motion between the diabetic and the non-diabetic subjects was also compared. Pearson's moment correlation coefficient was used to find the correlation between occurrence of finger deformity and the duration of onset of diabetes.

RESULTS

Fifty male and female diabetics participated in this study, they served as the diabetics group. Fifty male and female apparently healthy non-diabetic subjects served as the control group. The subjects were further subdivided into 6 age groups as shown in table 1. The mean range of motions for the diabetics and normal group subjects are shown in table 2. Significant differences were observed in the range of motion of the hip, shoulder, wrist and fingers between the diabetics and normal subjects ($P < 0.05$). No significant difference was observed in the range of motion of the knees and elbows between the diabetics and non-diabetics ($P > 0.05$) as shown in table 2.

The range of joint motion between the non-insulin and insulin dependent diabetic patients was compared (table 3). The flexion and extension motions of the hip joints were not significantly different for the NIDDM and IDDM subjects ($P > 0.05$). The knee extension and flexion as well as wrist flexion were significantly different between the NIDDM and IDDM subjects ($P < 0.05$). No significant differences were seen in the shoulder flexion and extension; elbow flexion and extension, wrist extension and the motion of the thumb, middle and 4th fingers. There were also no significant differences between the ROM in the male and female subjects for the different age groups ($P > 0.05$) A low but positive correlation was observed for the duration of diabetes and presence of finger deformities in both the left and right hands of the IDDM and NIDDM patients (table 4).

Table 1. Classification of the Subject into Age Groups

	21-30 year (n=3)	31-40 year (n=5)	41-50 year (n=11)	51-60 year (n=20)	61-70 year (n=9)	71-80 year (n=2)	Total (N=50)
Diabetics							
Male	2	3	6	7	5	1	24
Female	1	2	5	13	4	1	26
Total	3	5	11	20	9	2	50
Mean Age	25.7	36.2	47.2	55.4	64.6	73.0	52.2
Standard deviation	4.04	3.11	2.70	2.90	3.60	0.00	11.5
Control							
Male	2	6	4	8	2	1	23
Female	4	4	6	11	2	-	27
Total	6	10	10	19	4	1	50
Mean Age	24.3	34.9	45.7	54.3	62.5	71.0	46.1
Standard deviation	0.82	2.60	3.10	2.70	1.29	0.00	12.3

Table 2. Range of Motion of Diabetic and Control Subjects

Joint			Diabetic (n=50)	Control (n=50)	t-value	p-level
Hip	(Rt)	Flexion	92.1±14.6	110.4±7.9	9.026	<0.05
		Extension	12.6±3.6	15.3±1.3	4.373	<0.05
	(Lt)	Flexion	91.7±12.6	110.9±8.1	7.795	<0.05
		Extension	13.1±3.1	15.1±1.1	5.072	<0.05
Knee	(Rt)	Flexion Extension	132.4±5.4	132.8±5.3	0.275	<0.05
	(Lt)	Flexion Extension	132.6±5.9	132.9±4.9	0.408	<0.05
Shoulder	(Rt)	Flexion	174.4±11.8	174.4±11.8	79.8±0.8	<0.05
		Extension	57.0±9.0	63.2±4.8	4.492	<0.05
	(Lt)	Flexion	174.0±11.5	179.9±0.4	3.238	<0.05
		Extension	55.9±9.9	63.0±5.0	4.268	<0.05
Elbow	(Rt)	Flexion Extension	137.9±4.0	137.9±4.0	137.9±4.0	<0.05
	(Lt)	Flexion Extension	137.8±3.9	137.6±4.1	0.124	<0.05
Wrist	(Rt)	Flexion	81.7±10.4	89.4±2.9	5.395	<0.05
		Extension	79.2±8.9	87.6±3.4	7.280	<0.05
	(Lt)	Flexion	83.0±8.6	89.7±1.5	5.016	<0.05
		Extension	75.0±11.1	87.2±4.1	6.253	<0.05
Finger		Thumb	3.1±0.2	2.8±0.3	5.996	<0.05
		Index	1.8±0.2	2.3±0.4	7.638	<0.05
		Middle	1.9±0.2	2.4±0.5	6.166	<0.05
		Ring	1.8±0.2	2.2±0.4	5.887	<0.05
		Little	1.7±0.2	2.2±0.6	5.764	<0.05

Table 3. Range of Motion of Non-insulin and Insulin Dependent Diabetic Subjects

Joint			NIDDM (n=35)	IDDM (n=15)	t-value	p-level
Hip	(Rt)	Flexion	88.8±14.2	100±12.7	2.756	<0.05
		Extension	12.1±3.4	13.7±4.1	1.328	<0.05
	(Lt)	Flexion	88.2±11.1	99.9±12.6	3.115	<0.05
		Extension	12.7±2.7	13.9±3.9	1.085	<0.05
Knee	(Rt)	Flexion Extension	131.4±5.7	134.6±4.1	2.236	<0.05
	(Lt)	Flexion Extension	131.4±5.7	135.3±5.7	2.217	<0.05
Shoulder	(Rt)	Flexion	173.6±12.2	176.3±10.8	0.778	<0.05
		Extension	56.8±9.6	57.7±7.9	0.345	<0.05
	(Lt)	Flexion	173.0±12.3	175.0±9.4	0.501	<0.05
		Extension	55.7±103	56.3±9.5	0.199	<0.05
Elbow	(Rt)	Flexion Extension	137.5±4.4	139.1±2.9	1.517	<0.05
	(Lt)	Flexion Extension	137.4±4.1	138.6±3.7	1.083	<0.05
Wrist	(Rt)	Flexion	80.2±116	85.4±5.4	2.162	<0.05
		Extension	79.1±9.8	79.4±6.6	0.126	<0.05
	(Lt)	Flexion	81.7±9.2	86.0±6.2	1.927	<0.05
		Extension	73.2±12.5	79.2±5.0	2.423	<0.05
Finger		Thumb	2.8±0.2	2.9±0.4	0.900	<0.05
		Index	2.4±0.4	2.2±0.3	1.942	<0.05
		Middle	2.4±0.5	2.3±0.4	0.750	<0.05
		Ring	2.3±0.4	2.1±0.4	1.626	<0.05
		Little	2.3±0.6	2.0±0.4	2.069	<0.05

Table 4. Correlation between Duration of Onset and Finger Deformities

	Finger Deformities			
	Right Hand		Left Hand	
	(n=15) IDDM	(n=35) NIDDM	(n=15) IDDM	(n=35) NIDDM
Duration of onset of diabetes mellitus	0.099	0.139	0.182	0.323

DISCUSSION

This study has shown that there is a reduction in the ROM of the joints and the presence of finger deformities in subjects with diabetes mellitus. For each joint evaluated, there was no significant difference between the males and females in a particular age group. This confirms the submission of Knowles[7] that the presence of diabetic lesion could not be related to race, sex, dose of insulin or estimated control of diabetes.

In this study, there was a significant difference in the ROM of the shoulder, wrist and hip joints and the fingers between diabetic and normal subjects. Several studies have found that individuals with diabetes mellitus have reduced range of motion at the wrist and fingers. The limitation in the ROM of the joints was suggested to be a result of the non-enzymatic glycosylation which might alter packing, cross-linking and turnover of the collagen fibers.[3,7,8,9]

The ROM of the knee, wrist, 2nd and 5th fingers was significantly different between the insulin dependent and non-insulin dependent subjects. This trend agrees with the observation of Starkman et al.[3] This study also revealed a link between the onset of diabetes and the presence of finger deformity. It is implied that a period of metabolic derangement is associated with joint mobility in diabetic patients.[9,10]

Joint motion limitation was also observed to be more common in the fingers than in the other joints evaluated in this study. Campbell et al.[9] reported that hand and finger deformities or contractures were more frequently observed than in other joints such as the elbow, shoulder and ankle.

CONCLUSION

Based on the findings of this study, it can be concluded that limitations in joint mobility occur in diabetic subjects when compared with non-diabetic subjects. Individuals with NIDDM also had more significantly reduced range of joint motion than the IDDM subjects. Joint deformities and reduced ROM have low but positive correlations with the duration of the onset of diabetes.

RECOMMENDATIONS

Based on the clinical implication of this study, it is recommended that the physiotherapist in charge of the physical management of the diabetic should, as a routine, pay attention to joint mobility in this group of patients, irrespective of the pathology when the patient was referred for physiotherapy. Joint mobility in the upper and lower limbs affects, to a large extent, the ease of performance of activities of daily living and may have a bearing on the dependency level of the diabetic patient. Regular joint mobilization exercises should be included in the treatment regime of the diabetic patient, irrespective of whether joint limitation is the presenting complaint or not.

Also, based on the findings of this study, it is recommended that physicians handling diabetic patients should refer them for routine physiotherapy to ensure the attainment and maintenance of adequate range of joint motion. Active and passive therapeutic exercises are the major physiotherapy modality needed to prevent limitation of range of joint motion. When therapeutic exercises are administered by qualified physiotherapists, they will not have any negative effect on the pathology or the treatment of diabetes mellitus. Utilization of physiotherapy services in the total management of diabetes mellitus should not be left to the rehabilitation of the diabetic amputee or diabetic hemiplegic subjects.

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