ASSESSMENT OF RANGE OF MOTION IN SELECTED UPPER LIMB JOINTS OF PATIENTS WITH TYPE 2 DIABETES MELLITUS: A CASE-CONTROL STUDY

Odunayo Theresa Akinola[*,1], **Faderera Ajibola Adepoju**[*], **Adesola Ojo Ojoawo**[**], **Chidi Enemmo**[**] and **Babatunde Elijah Arayombo**[□]

[*]Physiotherapy Department, Faculty of Basic and Health Sciences, College of Health Sciences, Bowen University, Iwo, Nigeria., [**]Department of Medical Rehabilitation, Faculty of Basic Medical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile Ife, Nigeria., [□]Department of Anatomy and Cell Biology, Faculty of Basic Medical Sciences, College of Health Sciences, Obafemi Awolowo University, Ile Ife, Nigeria.

ABSTRACT Limitation in joint mobility was recognized as the most common and earliest long-term complication of patients with type 2 diabetes mellitus. The study assessed the range of motion in selected joints of patients with type 2 diabetes mellitus and compared it with aged-matched healthy individuals

Fifty subjects volunteered to participate in the study this comprised of 25 patients with type 2 diabetic mellitus and 25 age and sex matched healthy individuals.

The range of motion of the joints of the shoulder, wrist thumb, index and the middle fingers of diabetics and normal subjects were measured with a full circle universal goniometer using a standard protocol. Data were analyzed using descriptive and inferential statistics. Alpha level was set at 0.05

The result showed that there was a significant difference between the range of motion of the measured joints; shoulder (t=-23, p=0.000), metacarpophalangeal joints of the index finger in flexion (t=7.056, p=0.000) and extension (t=-13.548, p=0.000) in diabetics when compared with non-diabetic subjects ($p<0.005$).

In conclusion, limited joint mobility occurs in subjects with type 2 diabetics as one of the complications of the disease.

KEYWORDS range of motion, shoulder joints, elbow joint upper limb joints, type 2 diabetes mellitus

Introduction

Diabetes Mellitus (DM) is a significant health problem with a report by the World Health Organization that about 422 million people have diabetes mellitus in the world[1]. The prevalence of diabetes mellitus is increasing rapidly; by 2025 it's suggested that the number of people with diabetes mellitus will be doubled[1]. According to International Diabetes Foundation[2] it was estimated that about 415 million adults have diabetes, it's expected to rise to 642 million by 2040. Seventy-five percent of adults with diabetes are found in low and middle-income countries, and about 5 million people died of diabetes in 2015 [2]. The prevalence of diabetes in Africa is 1% in rural areas, and it ranges from 5%-7% in urban sub-Saharan African [3]. Past studies in Nigeria have shown the prevalence of the condition among the citizens in which the prevalence was at 0.8% to 2.8%[4],[5]. However, the current prevalence of DM in Nigeria is not known but maybe around 8% to 10%. [6].

Diabetes mellitus is a chronic disease that occurs when the pancreas fails to produce insulin or when the body cannot utilize the insulin produced[2]. The world health organization classified diabetes mellitus into two principal forms, type 1 diabetes also known as insulin-dependent diabetes mellitus(IDDM) and typed 2 diabetes known as non-insulin dependent diabetes

DOI:10.5455/IJMRCR.Type2-Diabetes-Mellitus
First Received: December 07, 2018
Accepted: January 02, 2019
Manuscript Associate Editor: Ivon Ribarova (BG)
Reviews: Sharan Badiger (IN), Rashmi Aggarwal (IN)
[1]Plastic and reconstructive surgery department, Ibn Sina teaching Hospital. Rabat, Morocco; E-mail: aoojoawo@yahoo.com
Phone: +212628504474

(NIDDM) [1]. In type 1 diabetes, the pancreas fails to produce insulin, and in type 2 diabetes is as a result of ineffective use of the insulin produced by the pancreas1. Fisman et al. reported that the prolong hyperglycemia was due to increased protein glycation among diabetes patients and the resultant generation of free radicals which leads to glycation of extracellular matrix and increased tissue stiffness[7].

Diabetes mellitus is one of the leading cause of neuropathy, and the most prevalent clinical form of diabetic neuropathy is distal symmetrical polyneuropathy affecting about 90 percent of the patients [8],[9]. Limitation in joint mobility was recognized as the most common and earliest long-term complication of type 1 DM and also in type 2 DM[10]. Musculoskeletal disorders, Achilles tendon pathology, trigger finger, Dupuytren limited joint mobility syndrome, carpal tunnel syndrome, frozen shoulder and plantar fasciitis have been found to occur more often in subjects with diabetes compared to non-diabetics [11]. Reduced joint mobility is frequent but not widely recognized musculoskeletal complication of diabetes [12]. Ikem et al documented some of the characteristics of diabetic foot disease, another study on the association between the hand abnormality and the duration of diabetes but not age or sex was carried out by Gamstedtit are appropriate to evaluate the effects of diabetes on a range of motion of hand and shoulder joints [12],[13]. Hence, this study therefore, assessed the quantitative effects of type 2 diabetes mellitus in these joints especially among blacks.

Materials and Methods

Subjects

Subjects for this study were individuals with type 2 diabetes mellitus attending the diabetes clinics of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Osun State and healthy individuals of the same age and sex.

Inclusion Criteria

The study involved both male and female individuals with type 2 diabetes mellitus attending the diabetes clinics of Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Osun State for at least one year and healthy individuals of the same age and sex.

Exclusion Criteria

1. Patients with limited joint mobility due to trauma
2. Patients with stroke
3. Patients with joint disease like osteoarthritis

Sampling Technique

Patients were selected using purposive sampling technique while healthy individuals were randomly selected.

Sample size determination

For a study comparing two means according to Eng, the equation for sample size is: [14]

$$N=\frac{4\sigma^2\left(Z_{crit}+Z_{pwr}\right)^2}{D^2}$$

Where N is the total sample size (the sum of the sizes of both groups), σ Is the assumed SD of each group (assumed to be equal for both groups) and this is assumed to be 6. Z_crit is the standard normal deviate corresponding to the selected significance criterion (i.e. 0.05(95% = 1.960).

Z_pwr is the standard normal deviate corresponding to selected statistical power (i.e 0.80 = 0.842).

D is the minimum expected difference between the two means and D = 5

Therefore;

$N=4 \times 6^2\ (1.96 + 0.842)^2 \div 5^2$

$N=45.22\sim 45$

This was increased to 50 because of attrition.

Therefore a total number of 50 participants were enrolled for this study (25 diabetic patients and 25 non-diabetics).

Instruments

The following materials were used:

1. A full circle universal goniometer(MultiCare Surgical Product Corporation, New Delhi, India. 2016)
2. Butterfly tape rule
3. Hanson bathroom weighing scale
4. A firm plinth

Procedure:

The ethical approval was obtained from the Health Research and Ethics Committee, Institute of Public Health, Obafemi Awolowo University, Ile-Ife, Osun State, for the study. The purpose and procedures of the research were explained to each subject, and their informed consent was obtained as well. Participants were also screened for history of trauma of the joint, joints disease (osteoarthritis) and joint pain. The joints' range of motion was measured and recorded in degrees.

The range of motion of the following joint was measured Shoulder joint.

The subject was in supine position, with the knee flexed to flatten the lumbar spine. The shoulder is positioned in 0 degrees of abduction, adduction, and rotation. The forearm is positioned in 0 degrees of supination and pronation so that the palm faces the body. The fulcrum of the goniometer was placed close to the acromial process; the two arms were aligned along the lateral midline of the humerus and extend over the lateral epicondyle of the humerus. The subject was instructed to flex the shoulder, and the angle was measured with the movable arm. For shoulder extension the subject was in prone position, with the goniometer at the same position as flexion, the subject was instructed to move the hand backwards, the angle measured[15]

Wrist joint

The patient was in sitting position, the forearm resting on a table for both wrist flexion and extension. The fulcrum of the goniometer was placed at the level of the triquetrum. The stationary arm was aligned along the ulna in line with the olecranon process and the ulnar styloid process. The movable arm was aligned along the fifth metacarpal. For wrist flexion, the subject was instructed to move the hand down and the angle measured. Wrist extension was measured with the goniometer at the same position, the subject was instructed to move the hand upward, and the angle measured [15].

Table 1 Comparison between physical characteristics of subjects and control N=50

Variables	Subjects n=25 Mean ±SD	Control n=25 Mean ±SD	Total n=50 Mean ±SD	t-value	p-value
AGE (YEARS)	67.40 ±6.30	67.40 ±6.30	44.74 ±23.42	0.077	0.940
WEIGHT (KG)	70.12 ±5.96	70.12 ±5.96	66.40 ±8.43	0.432	0.669
HEIGHT (M)	1.67 ±0.07	1.68 ±0.07	11.80 ±10.39	0.538	.670
BMI (KG/M2)	25.10 ±2.63	25.10 ±2.63	39.87 ±15.67	0.260	.798

Joints of the hand

The axis was positioned laterally on the joint axis while the fixed arm was aligned to the proximal bone (proximal phalange for the interphalangeal joint and metacarpal for metacarpophalangeal joint). In each case, the movable arm of the goniometer was aligned to the distal bone of the joint at the neutral position. The subject was asked to bend the respective distal part as fully as possible. The final angle movement was measured[15].

Data analysis

The data was analyzed using Statistical Package for Social Sciences version 17. Descriptive and inferential statistics were used to summarize the data. Independent t-test was used to compare a range of motion of diabetes mellitus patients and the control.

Results

Presented in table 1 is the comparison of the physical characteristics of patients with type 2 diabetes mellitus and healthy individuals. There was no significant difference ($p > 0.05$) between the physical parameters of patients with type 2 diabetes mellitus and age match control.

Shown in table 2 is the sex distribution of the subjects and control. It was observed that the number of male with diabetes were more than that of female.

Shown in table 3 is the comparison between the range of motion of subjects with diabetes and age matched control. It was observed that significance differences were observed in the range of motions of shoulder (t = 20.006, p = 0.00), wrist flexion (t = 4.234, p = 0.000), extension (t = -23.356, p = 0.000) and joints of the fingers; metacarpophalangeal joints of the thumb flexion (t = -14.920, p = 0.000) and extension (t = -41.302, p = 0.000), index finger flexion (t = 7.056, p = 0.000) and extension (t = -13.548, p = 0.000), between the patients and the control except the distal interphalangeal joints of index and middle fingers ($p>0.05$).

Table 2 Sex Distribution of Subjects and Controls

Variables	Frequency	Percentage
Subjects	N=25	
Male	14	56
Female	11	44
Control		
Male	14	56
Female	11	44
Total		
Male	28	43.10
Female	22	33.80

COMPARISON OF RANGE OF MOTION BETWEEN MALE AND FEMALE SUBJECTS

The range of joints motion between males and females subjects were compared in table 4. No significant differences were seen in the shoulder flexion (t = 0.228, p = 0.822) and extension (t = 0.850, p = 0.404), wrist flexion (t = -1.489, p = 0.150) and extension (t =0.432, p = 0.163), metacarpophalangeal joints of the thumb flexion (t = -0.770, p = 0.940) and extension (t = 0.432, p = 0.669), of both male and female subjects.

Discussion

This study was carried out to assess the range of motion in selected joints of patients with type 2 diabetes mellitus and age and sex match control. The study observed no significant difference in ages, weight, height and body mass index (BMI) between the patients and the controls. This indicates the homogeneity of the two groups and that any variation observed in the measurement were as a result of the disease not based on anthropometric differences.

The study showed a significant reduction in the range of motion of the shoulder, wrist and the joints of fingers between type 2 diabetic and normal subjects. Our finding was in support of the study of Cagliero and Aprizzesse [16]. They found limitation in joints range of motion of patients with type 2 diabetes. What is responsible for the reduction, Cagliero and Aprizzesse[16] then explained that it was as a result of the non-enzymatic glycosylation which might alter packing cross-linking and turnover of the collagen fibres. This was in line with the conclusion by Kameyama et al., [17] which says the proliferation of the endothelia cells and thickness, tightness of the skin occurs in diabetic patients. Finger joints are frequently affected in patients with type 2 diabetes mellitus; this is supported in a study conducted by Rajendran et al. [18].

The study also showed that for each joint evaluated there was no significant difference between the males and females joints' range of motion of patient with type 2 diabetics. However, Schulte et al. reported a contrary view that limited joint mobility worsens in association with male sex and study by Khader et al., showed that hand deformity occurs more in female gender than in male [19],[20] The study also showed that most of the diabetic patients are overweight with mean BMI of 25.10 kg/m2, this means overweight is one of the risk factors for type 2 diabetes mellitus. This was supported by a study conducted by Hart et

Table 3 Comparison of Range of Motion of subjects and Control in Selected Joints N=50

JOINTS			N=25 MEAN±SD	N=25 MEAN±SD	t-value	p-value
Thumb	MCP	Flexion	48.16±6.34	80.48±8.75	-14.920	0.000**
		Extension	8.72±0.84	82.08±8.84	-14.302	0.000**
	IP	Flexion	54.64±6.30	100.64±12.19	-16.757	0.000**
Index	MCP	Flexion	60.08±10.14	65.64±11.06	7.056	0.000**
		Extension	22.08±3.23	43.64±7.27	-13.548	0.000**
	PIP	Flexion	80.48±8.75	82.68±8.93	16.187	0.000**
	DIP	Flexion	42.64±7.06	43.64±7.27	-0.493	0.000**
Middle Finger	MCP	Flexion	62.68±8.98	68.24±9.97	6.473	0.000**
		Extension	21.92±2.64	37.08±6.04	-11.495	0.000**
	PIP	Flexion	82.08±8.84	86.64±9.06	17.431	0.000**
	DIP	Flexion	43.64±7.27	46.24±8.97	-1.125	0.000**
Wrist		Flexion	46.24±8.97	48.08±9.04	4.234	0.000**
		Extension	37.08±6.04	100.64±12.19	-23.356	0.000**
Shoulder		Flexion	100.64±12.19	101.68±12.47	20.006	0.000**
Key: MCP= Metacarpophalangeal Joint, IP = Interphalangeal Joint, PIP = Proximal Interphalangeal Joint, DIP = Distal Interphalangeal Joint ** = Significant level at p<0.001						

Table 4 Comparison of Range of Motion between Male and Female subjects N=25

JOINTS			MALE n=14 MEAN±SD	FEMALE n=11 MEAN±SD	t-value	p-value
Thumb	MCP	Flexion	48.07±6.39	48.27±6.69	-0.770	0.940
		Extension	8.79±0.97	8.64±0.67	0.432	0.669
	IP	Flexion	54.78±5.02	54.45±7.90	0.128	0.900
Index	MCP	Flexion	59.07±9.03	61.36±11.73	-0.553	0.586
		Extension	21.93±1.90	22.27±4.50	-0.260	0.798
	PIP	Flexion	83.43±8.79	76.72±7.46	2.020	0.550
	DIP	Flexion	41.93±5.33	43.54±9.00	-0.560	0.581
Middle Finger	MCP	Flexion	61.21±8.51	64.54±9.63	-0.917	0.369
		Extension	22.36±1.82	21.36±3.44	0.930	0.362
	PIP	Flexion	83.93±8.76	79.73±8.76	1.190	0.246
	DIP	Flexion	43.28±4.92	44.09±9.75	-0.269	0.790
Wrist		Flexion	43.93±6.64	49.18±10.91	-1.489	0.150
		Extension	35.57±5.02	39.00±6.90	-1.440	0.163
Shoulder		Flexion	101.14±11.17	100.00±13.92	0.228	0.822
		Extension	49.36±3.75	47.82±5.31	0.850	0.404

Key: MCP = Metacarpophalangeal Joint,
IP = Interphalangeal Joint,
PIP = Proximal Interphalangeal Joint,
DIP = Distal Interphalangeal Joint

al. that increased BMI was the dominant risk factor for type 2 diabetes[21].

Conclusion

The results of this study show that there is a reduced range of motion between patients with type two diabetes when compared with non-diabetics of the same age and sex. Reduced range of motion of joints occurs in diabetic patients irrespective of gender.

References

1. World Health Organization. Global Report on Diabetes, Geneva. 2016. Downloaded Nov 12, 2018

2. IDF. International Diabetes Federation. IDF Diabetes Atlas 6th ed. Brussels. International Diabetic Federation, Diabetes Mellitus, 2015. Downloaded Nov 11, 2018

3. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in Sub-Saharan Africa. Circulation, 2005:112; 3592-3601.

4. Olatunbosun ST, Ojo PO, Fineberg NS, Bella AF, Prevalence of diabetics mellitus and impaired glucose tolerance in a group of urban adults in Nigeria. J Natl Med Assoc. 1998; 90:293-301.

5. Akinkugbe OO. Non-communicable diseases in Nigeria-final report of a national survey. Lagos: Federal Ministry of Health-National Expert Committee on Non-Communicable Diseases, 1997; 65-68.

6. Ogbera AO, Ekpebegh C. Diabetes mellitus in Nigeria: The past, present and future. World J Diabetes. 2014;5 (6):905-11.

7. Fisman EZ, Tenenbaum A (eds): Cardiovascular Diabetology: Clinical, Metabolic and Inflammatory Facets. Adv Cardiol. Basel, Karger, 2008, vol 45, pp 1-16

8. Boulton AJ, Vinik AI, Arezzo JC, Bril V, Feldman EL, Freeman R, Malik RA, Maser RE, Sosenko JM, Ziegler D, Diabetic neuropathies: a statement by the American Diabetes Association. Diabetes Care, 2005; 28:956-962.

9. Tesfaye S, Boulton AJ, Dickenson AH. Mechanisms and management of diabetic painful distal symmetrical polyneuropathy. Diabetes Care; 2013; 36:2456-2465.

10. Fitzcharles MA, Duby S, Waddell RW, Banks E. Limitation of joint mobility (cheiroparthropathy) in adult non-insulin-dependent diabetic patients. Ann Rheum. 1984; 43: 251-7.

11. Smith LL, S P Burnet, J D McNeil. Musculoskeletal manifestation of diabetes mellitus. J Sports Med; 2003; 37: 30-35.

12. Ikem RT, Kolawole BA, Olasode O. A descriptive study of foot complications in diabetic patients with symptomatic peripheral neuropathy. Afr J Neurol Sci. 2005; 24: 7- 12

13. Gamstedt A. Hand abnormalities in patients with NIDDM. Prog Diabetes; 199; 4:16

14. Eng J. Sample size estimation: How many individuals should be studied. Radiology and radiologists, research statistical analysis. 2003; 227: 309-313.

15. Cynthia C.N, D. Joyce White, Measurement of joint Motion: A Guide to Goniometry. F.A Davis Company Philadelphia 2nd edition. 1995

16. Cagliero Enrico, and , William Apruzzese, 2002 Musculoskeletal Disorders of the Hand and Shoulder, in Patients with Diabetes Mellitus. April 15, 2002, THE AMERICAN Journal of Medicine. Volume 112 487-490

17. Kameyama M, Meguro S, Funae O, Atsumi Y, Ikegami H. The presence of limited joint mobility is significantly associated with multiple digit involvement by stenosing flexor tenosynovitis in diabetics. J Rheumatol 2009;36(8):1686-90.

18. Rajendran S. R, Bhansali A, Walia R, Dutta P, Bansal V, Shanmugasundar G (2011) Prevalence and pattern of hand soft-tissue changes in type 2 diabetes mellitus, 37: 312-317

19. Schulte L, Roberts M. S, Zimmerman C, Ketler J, Simon L.S. A quantitative assessment of limited joint mobility in patients with diabetes 1993; 36:1429-1443.

20. Khader N. Mustafa, Yousef S. Khader, Amal K. Bsoul, Kamel Ajlouni. (2015) Musculoskeletal disorders of the hand in type 2 diabetes mellitus: prevalence and its associated factors.

21. Hart CL, Hole DJ, Lawlor DA, Davey SG. How many cases of type 2 diabetes mellitus are due to being overweight in middle age? Evidence from the Midspan prospective cohort studies using mention of diabetes mellitus on hospital discharge or death records. Diabet Med. 2007; 24:73–80