Assessment of Upper limb musculoskeletal complications of diabetes mellitus by Ultrasonography and nerve conduction study: Correlation with duration and severity of diabetes mellitus

Saad M. Alzokm[1], Abdullah Hussein[2] and Sherief M. Al Shazely [3]

Department of Rheumatology[1], Department of Diagnostic Radiology[2], Department of Neurology[3], University of Al-Azhar, Faculty of Medicine, Damietta, Egypt
saadalzokm@yahoo.com

Abstract: Introduction& purpose: Diabetes mellitus (DM) is a chronic metabolic disease of high morbidity and mortality. It is associated with musculoskeletal (MSK) disorders of the hand and shoulder that can be very incapacitating and significantly compromise their quality of life. The aim of this study was to evaluate the upper limb MSK abnormalities found in diabetic patients and correlation of these abnormalities with duration and severity of DM. **Methods:** The study comprised 60 diabetic patients and another 20 non diabetic subject act as control group. All subjects evaluated by history taking & MSK examination, fasting, post prandial blood sugar and HbA1c. High resolution Ultrasonography (shoulder & wrist) and nerve conduction studies were done. **Results:** among our patients 45 (75%) had upper limb MSK manifestation, 32 (53.3%) had trigger finger, 27 (45%) had frozen shoulder, 26 (43.3%) had carpal tunnel syndrome, 7 (11.7%) had Dupuytren contracture, one (1.7%) had diabetic cheiroarthropathy, and one (1.7%) patient had shoulder hand syndrome. These differences between patients and control were significant ($p<0.05$).Patients who had upper limb MSK manifestations had significantly longer DM duration than those without DM (6.5 ±4.2 years versus 3.5 ±1.2 years respectively ($p=0.007$). Also patients who had upper limb musculoskeletal manifestations had significantly higher HBA1c than those normal (7.3 ±1.6 versus 4.9 ±0.4 respectively ($p<0.001$). **Conclusions**: there are significant associations of hand and shoulder abnormalities in diabetic patients. We found a strong relationship between duration and degree of hyperglycemia of DM with upper limp MSK complications.

[Saad M. Alzokm, Abdullah Hussein and Sherief M. Al Shazely. **Assessment of Upper limb musculoskeletal complications of diabetes mellitus by Ultrasonography and nerve conduction study: Correlation with duration and severity of diabetes mellitus.** *J Am Sci* 2015;11(4):165-175]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 19

Keywords: Upper limb, Musculoskeletal complications, Diabetes mellitus, Ultrasonography, Nerve conduction study.

1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disease of high morbidity and mortality **[1].**

Type 1 DM results from a complete deficiency of insulin due to the autoimmune-mediated destruction of insulin-producing β cells in the pancreas; in type 2 DM, which represents most of the DM cases (around 95%), there is insulin resistance, excessive hepatic production of glucose, and abnormal fat metabolism, resulting in a relative deficiency of that hormone **[2].**

The prevalence of type 2 DM are increases more than that of type 1 DM because of the increase in obesity and the reduction in physical activities as countries become more industrialized **[3].**

According to international diabetes federation, 2006, DM affects 240 million people worldwide and this number is projected to increase to 380 million by 2025. Alarmingly, 80% of this burden will affect the low and middle income countries **[4].**

DM is considered as an epidemic in the modern world and much of its morbidity and mortality is related to micro and macro vascular complications. However, it is also associated with musculoskeletal disorders of the hand and shoulder that can be very incapacitating and significantly compromise their quality of life **[5, 6].**

The manifestations of DM in the hand have been widely discussed in the last two decades, but the exact prevalence is still unknown. There is evidence that these entities are not only more frequent in patients with DM but may also be associated with its duration, poor metabolic control and presence of micro vascular complications **[7, 8].**

The exact pathophysiology of most of these musculoskeletal disorders remains obscure; however, connective tissue disorders, neuropathy or vasculopathy may have a synergistic effect on the increased incidence of musculoskeletal disorders in DM **[9].**

Prolonged hyperglycemia in uncontrolled diabetic patients results in collagen glycosylation. Glycosylated collagen is less soluble, offers increased resistance to collagenases and accumulate in connective tissue, which not only alters the extra

cellular matrix structure and function but also affects cell viability **[7].**

Diabetes has a prevalence increasing with age, approximately 20% of population 65 years and older are diabetic. In diabetics, among various musculoskeletal disorders hand and shoulder pathologies are much more commonly seen **[9].**

Most published studies reported that capsulitis and tendonitis in the shoulder are the most common conditions, whereas carpal tunnel syndrome (CTS), Dupuytren's contracture and trigger finger are the commonest abnormalities of the hand observed in the diabetic patients **[10].**

Musculoskeletal ultrasound (US) is an imaging tool with a wide set of advantages over other imaging modalities, being safe, easily accessible, relatively cheap, not invasive and lacking of any contraindications **[11].**

Joint US is a simple and effective method for assessment of degenerative changes of the joint and joint effusion, it allowing a reliable differential diagnosis for causes of soft tissue swelling. The application of Doppler US is useful in evaluation of early inflammatory changes and vascular abnormality **[12].**

Aim of work:

The aim of this work was to evaluate the upper limb musculoskeletal abnormalities found in diabetic patients and correlation of these abnormalities with duration and severity of DM.

2. Subjects and methods:

I-Subjects:

The case-control observational study was conducted at Rheumatology, Neurology & Radiology Departments, Al-Azhar University Hospital, Damietta, Egypt, from February 2013 to April 2014. It comprised 60 adult diabetic patients (type 1 and 2). Another 20 healthy non diabetic subjects were employed to act as the control group. The patients and control group were adult subjects of either gender, aged less than 50 years. Informed consent was obtained from all of them. Patients and control groups were selected so that age, body weight and height were matching. All subjects having morbid obesity, connective tissue disease e.g. SLE & rheumatoid arthritis, history of alcoholism and other endocrine disease (hypothyroidism, hyperthyroidism, hyperparathyroidism, and Cushing syndrome), were excluded from this study.

II-Methods: All patients and controls were subjected to;

1-History taking & musculoskeletal examination,

2-Laboratory investigation including: fasting, post prandial blood sugar and HbA1c.

3-Immaging including: plain X ray (shoulder, elbow & hand joints) and high resolution ultrasonography (US) (shoulder & wrist),

4-**Nerve conduction studies for median nerve.**

Technique of US of shoulder joint:

US for the shoulder examination, done by using Toshiba xario linear array probe**,** high-frequency linear probes range from 5 to 15 MHz, with frequencies between 7 and 10 MHz.

Position No. 1: Long Head of Biceps:

The patient place the hand palm up in supination on his or her leg The transducer is placed in the transverse plane on the patient, and the long head of the biceps brachii tendon is seen within the bicipital groove in short axis**.**

Position No. 2: Subscapularis

Patient is seated arm at side, elbow flexed, arm externally rotated palm up.

Position No. 3: Supraspinatus

Patient facing direction of shoulder being studied, 90° to the examiner with hand on "back pocket" and elbow tucked in.

Position No. 4: Posterior Glenoid Labrum

Patient is seated, back toward examiner, arm at side, elbow relaxed; probe place longitudinally of posterior glenohumeral joint.

Technique of US of carpal tunnel

The patients were seated facing the examiner with their forearms extended on a flat surface in the supine position with their fingers semi extended. The median nerve was examined axially and longitudinally along the carpal tunnel. We avoid excess pressure by the transducer over the wrist to minimize sampling errors.

The cross-sectional area of the median nerve was determined by outlining the nerve contour using continuous boundary tracer.

High-resolution US grading of CTS according to the cross sectional area of the median nerve was as the following:

Normal: cross-sectional area (CSA) < 10 mm^2

Mild: cross-sectional area 10.0 – 13.0mm^2

Moderate: cross-sectional area 13.0- 15.0 mm^2,

Sever: cross-sectional area > 15.0 mm^2 **[13].**

Nerve conduction studies;

Is done by using basic system includes a 2 or 4 channel amplifier with EMG, NCV, F Wave, H-Reflex, RNS, Blink, somato-sensory evoked potentials, autonomic studies, and customizable report generation utilizing microsoft word

Motor median conduction studies were performed by using the standard techniques of supramaximal stimulation. The distal motor nerve latency (DML) was measured with an active electrode placed over the muscle belly of the M. APB, and the nerve was stimulated used bipolar

stimulation electrodes with the cathode positioned 2 cm proximal to the wrist crease. The cathode was placed closest to the recording electrode. If necessary, the skin temperature was raised to >32°C using hot packing. The averaged antidromic median sensory nerve action potential (SNAP) response over digit 4 was recorded using ring electrodes. Percutaneous stimulation of the median nerve at the wrist was performed using a difference of 12–14 cm from the stimulation site to the electrodes. The averaged distal sensory latency (DSL) was measured from the stimulus to the initial negative deflection for biphasic SNAPs or to the initial positive peak for triphasic SNAPs.

NCS severity was classified as follows:

(1) Minimal to mild abnormality, i.e., abnormal comparative tests or prolonged median distal sensory latency (DSL > 3.5 ms) but normal median distal motor latency (DML);

(2) Moderate abnormality, i.e., prolonged median DSL and DML (≥4.2 ms);

(3) Severe abnormality, i.e., absence of median sensory nerve action potential and prolonged median DML or absent compound muscle action potentials **[14, 15, 16].**

III-Statistical analysis:

The collected data were organized tabulate and statistically analyzed using SPSS (Statistical Package for Social Science) software compute program version 12 (SPSS Inc, USA). The results were represented in tabular forms then interpreted. Mean, standard deviation, range, frequency and percentage were used as descriptive, chi square and Fisher exact test was used for testing significance of observed differences between studied patients. The level of significance was adopted at $p < 0.05$.

3. Results:

Table (1): Showing that 60 patients with DM of which 33 (55%) were females and 27 (45%) were males and 20 controls of which 10 (50%) were females and 10 (50%) were males.The average duration of DM in the patients was 5.8 ±3.9 years (range = 1 – 20 years). The average fasting blood sugar in the patients was 164.4 ±45.7 mg/dl and controls was 86.9 ±12.2 mg/dl. The average post prandial blood sugar in the patients was 263.3 ±77.8 mg/dl and controls was 132.4 ±6.1 mg/dl. The average HBA1c% in the patients was 6.7 ±1.8 % and controls 4.9 ±0.6 %. As regard type of diabetes of which 7 (11.7%) were type 1 and 53 (88.3%) were type 2.

Table (2): Showing that among our DM patients 45 (75%) patients have upper limb musculoskeletal manifestation, 32 (53.3%) patients had trigger finger, 27 (45%) patients had frozen shoulder, 26 (43.3%) patients had carpal tunnel syndrome, 7 (11.7%) patients had Dupuytren contracture, one (1.7%) patient had diabetic cheiroarthropathy, and one (1.7%) patient had shoulder hand syndrome.

Table (1): demographic data of the cases

	Patients with DM (n=60)	Controls (n=20)
Age (years)		
Range	20 – 49	22 – 49
Mean ±D	41.5 ±7.1	40.5 ±8.4
Sex (n, %)		
Female	33 (55%)	10 (50%)
Male	27 (45%)	10 (50%)
Duration of DM (years)		
Range	1 – 20	-
Mean ±D	5.8 ±3.9	-
Blood Sugar Parameters		
Fasting blood sugar		
Range	89 – 304	70 – 105
Mean ±D	164.4 ±45.7	86.9 ±12.2
Post prandial blood sugar		
Range	135 – 420	123 – 140
Mean ±D	263.3 ±77.8	132.4 ±6.1
HBA1c%		
Range	4.5 – 10.3	4.2 – 6.0
Mean ±D	6.7 ±1.8	4.9 ±0.6
Type of DM		
Type I	7 (11.7%)	-
Type II	53 (88.3%)	-

Table (3): Showing comparison between patients and control as regard MSK complications, where frozen shoulder (45% versus 10%, p=0.036), trigger finger (53.3% versus 10% p=0.011), carpal tunnel syndrome (43.3% versus 10%, p= 0.045). Dupuytren contracture (11.7 % versus 0.00 %), shoulder hand syndrome (1.7% versus 0.00%) and diabetic cheiroarthropathy (1.7% versus 0.00%). These differences were significant ($p < 0.05$).

Table (4): showing that the duration of DM was significantly longer in patients with frozen shoulder than DM patients without frozen shoulder (6.9 ±4.2 years versus 4.8 ±3.4 years respectively, p=0.037). The duration of DM was 6.9 ±4.7 years in the DM patients with trigger finger compared to 4.4 ±2.2 years in the DM patients without trigger finger. This difference was significant (p=0.012). DM patients with carpal tunnel syndrome had a significantly higher disease duration than those without carpal

tunnel syndrome (7.4 ±4.5 years versus 4.5 ±2.9 years respectively, p=0.004). DM duration was also significantly longer in the DM patients with diabetic cheiroarthropathy than patients without (12.7 ±4.8 years versus 4.8 ±2.7 years, respectively, p<0.001). Diabetic patients who had upper limb musculoskeletal manifestations had significantly longer DM duration than those without MSK complications (6.5 ±4.2 years versus 3.5 ±1.2 years respectively (p=0.007).

Table (5): showing that the HBA1c was significantly higher in patients with frozen shoulder than DM patients without frozen shoulder (7.8 ±1.5 versus 5.8 ±1.5 respectively, p<0.001). The HBA1c was 7.5 ±1.7 in the DM patients with trigger finger compared to 5.7 ±1.4 in the DM patients without trigger finger. This difference was significant (p<0.001). DM patients with carpal tunnel syndrome had a significantly higher HBA1c than those without carpal tunnel syndrome (8.1 ±1.5 versus 5.6 ±1.1 respectively, p<0.001). HBA1c was also significantly longer in the DM patients with diabetic cheiroarthropathy than patients without (8.7 ±0.9 versus 6.4 ±1.7, respectively, p<0.001). Diabetic patients who had upper limb musculoskeletal manifestations had significantly higher HBA1c than those without (7.3 ±1.6 versus 4.9 ±0.4 respectively (p<0.001).

Table (6): showing that US examination of the shoulder revealed that biceps edema was more frequent in the DM patients than in controls (43.3% versus 10% respectively, p=0.045).The restricted movement of the Subscapularis muscle was more frequent in the DM patients than in controls (56.7% versus 20% respectively, p=0.032) and Supraspinatus bulging was more frequent in the DM patients than in controls (55% versus 20% respectively, p=0.040). The average coraco-humeral ligament (CHL) thickness was 1.9 ±1 mm in the DM patients compared to 1.2 ±0.4 in the controls. This difference was significant (p=0.047).

Table (7): the average cross sectional area of the carpal tunnel when measured by the US in the DM patients was 9.8 ±1.9 compared to 9.7 ±1.3 in the controls. This difference was insignificant. The average distal motor latency(DML) of the median nerve of the DM patients was significantly longer than the controls (4.1 ±0.9 msec and 3.4 ±0.8 msec respectively, p=0.017). Also the average distal sensory latency(DSL) of the median nerve was significantly longer in the DM group than in the controls (2.3 ±0.6 msec and 2 ±0.6 respectively, p=0.037).

Table (2) Frequency of the upper limb MSK complications in DM patients

	n	%
Upper limb MSK complications	45	75
Trigger finger	32	53.3
Frozen shoulder	27	45
Carpal tunnel syndrome	26	43.3
Dupuytren contracture	7	11.7
Shoulder hand syndrome	1	1.7
Diabetic cheiroarthropathy	1	1.7

Table(3): Comparison of the frequency of the upper limb MSK complications between the DM group and the controls

	Patients with DM (n=60)		Controls (n=20)		Chi square t test	
	n	%	n	%	X^2	p
Frozen shoulder						
Absent	33	55	18	90	4.375	0.036
Present	27	45	2	10		
Shoulder hand syndrome						
Absent	59	98.3	20	100	0.169	0.681
Present	1	1.7	0	0		
Trigger finger						
Absent	28	46.7	18	90	6.459	0.011
Present	32	53.3	2	10		
Diabetic cheiroarthropathy						
Absent	59	98.3	20	100	0.169	0.681
Present	1	1.7	0	0		
Carpal tunnel syndrome						
Absent	34	56.7	18	90	4.020	0.045
Present	26	43.3	2	10		
Dupuytren contracture						
Absent	53	63.3	20	100	1.296	0.255
Present	7	11.7	0	0		

Table(4): The association of duration of DM with the upper limb MSK complications in the DM patients

	Duration of DM patients (years)		Student's t test	
	range	Mean ±SD	t	p
Frozen shoulder				
present	1 – 20	6.9 ±4.2		
absent	1 – 16	4.8 ±3.4	2.138	0.037
Trigger finger				
present	1 – 20	6.9 ±4.7		
absent	1-10	4.4 ±2.2	2.596	0.012
Carpal tunnel syndrome				
present	1 – 20	7.4 ±4.5		
absent	1-15	4.5 ±2.9	2.983	0.004
Dupuytren contracture				
present	2 – 20	12.7 ±4.8		
absent	1-13	4.8 ±2.7	6.530	<0.001
Upper limb musculoskeletal manifestations				
present	1 – 20	6.5 ±4.2		
absent	1-6	3.5 ±1.2	2.775	0.007

Table (5):The association of HBA1c with the upper limb MSK complications in DM patients

	HBA1c of DM patients		Student's t test	
	Range	Mean ±SD	t	p
Frozen shoulder				
present	5.1 – 10.2	7.8 ±1.5		
absent	4.5 – 10.3	5.8 ±1.5	5.173	<0.001
Trigger finger				
present	4.5 – 10.3	7.5 ±1.7		
absent	4.5 – 10.1	5.7 ±1.4	4.494	<0.001
Carpal tunnel syndrome				
present	5.1 – 10.3	8.1 ±1.5		
absent	4.5 – 9	5.6 ±1.1	7.203	<0.001
Dupuytren contracture				
present	7.5 – 10.3	8.7 ±0.9		
absent	4.5 – 10.2	6.4 ±1.7	3.462	<0.001
upper limb musculoskeletal complications				
present	4.5 – 10.3	7.3 ±1.6		
absent	4.5 – 6.3	4.9 ±0.4	5.617	<0.001

Table(6):Comparison of the findings of the US examination of the shoulder between the DM group and the controls

	Patients with DM (n=60)		Controls (n=20)		Chi square test	
	n	%	n	%	X^2	p
Biceps edema						
Absent	34	56.7	18	90	4.020	0.045
Present	26	43.3	2	10		
Subscapularis restricted movement						
Absent	26	43.3	16	80	4.613	0.032
Present	34	56.7	4	20		
Supraspinatus bulging						
Absent	27	45	16	80	4.200	0.040
Present	33	55	4	20		
Coraco humeral ligament(CHL)thickness (mm)						
Mean ±SD	1.9	±1	1.2	±0.4	2.019*	0.047

** Independent student's t test*

Table (7):Comparison of the findings of the US examination and the electrophysiological examination of the carpal tunnel between the DM group and the controls

	Patients with DM (n=60)	Controls (n=20)	Chi square test	
	Mean ±SD	Mean ±SD	*t*	p
Cross sectional area of the carpal tunnel(CSA)	9.8 ±1.9	9.7 ±1.3	0.248	0.805
Distal motor latency(DML) of the median nerve	4.1 ±0.9	3.4 ±0.8	2.441	0.017
Distal sensory latency(DSL) of the median nerve	2.3 ±0.4	2 ±0.6	2.132	0.037

** Independent student's t test*

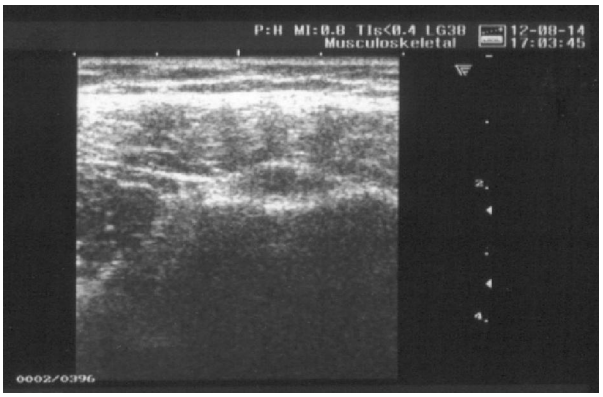

Figure (1): Transverse view US of left biceps showing effusion

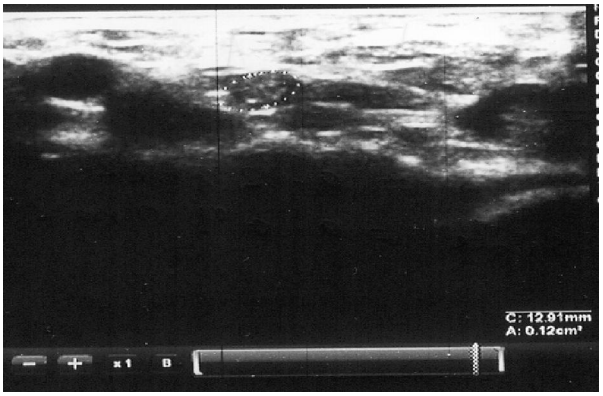

Figure (2): CSA of median nerve US.

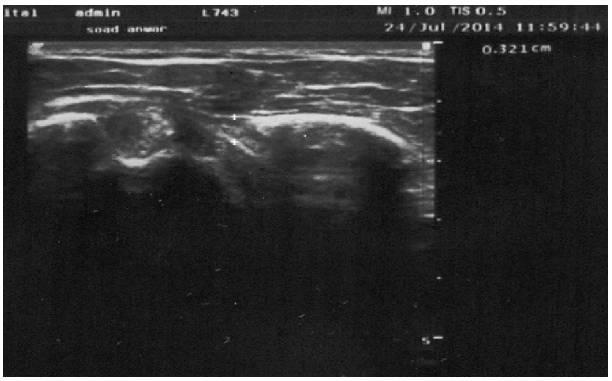

Figure (3): Coraco humeral ligament (CHL) thickness of left shoulder

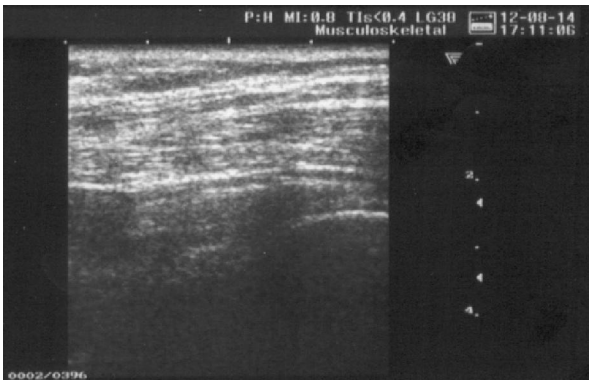

Figure (4): Transverse US view of left glenohumeral joint

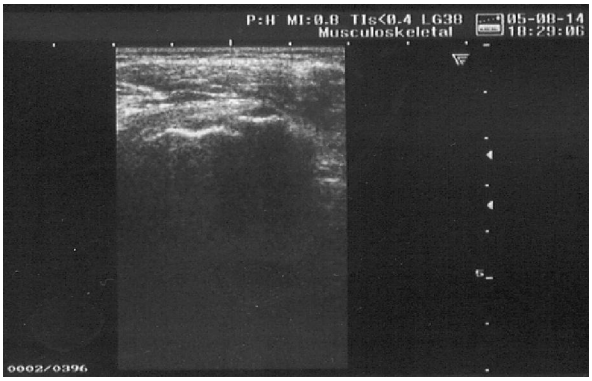

Figure (5): Transverse view US of Supraspinatus.

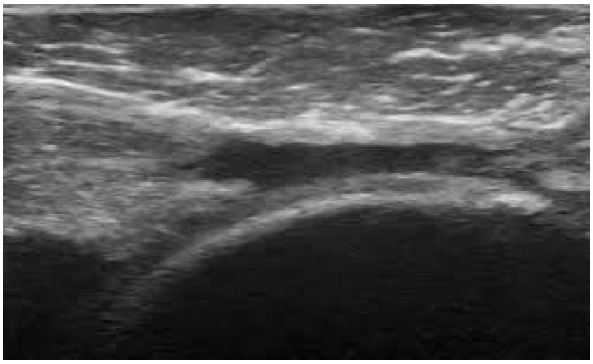

Figure (6): Longitudinal B-mode us scan shows relative large full thickness hypoechoic longitudinal arranged Supraspinatus collection, displays about 33 x 12-mm in longitudinal and transverse dimensions in largest span.

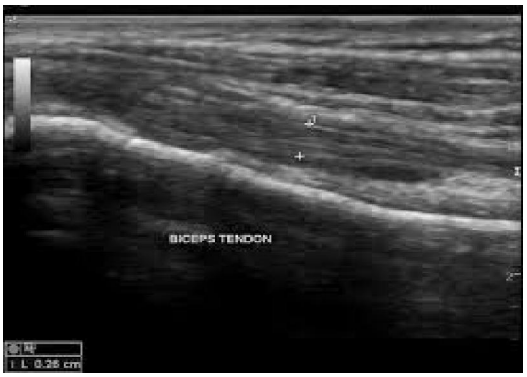

Figure (7): B-Mode Ultrasound longitudinal scan of biceps tendon, displays about 12-mm in thickness.

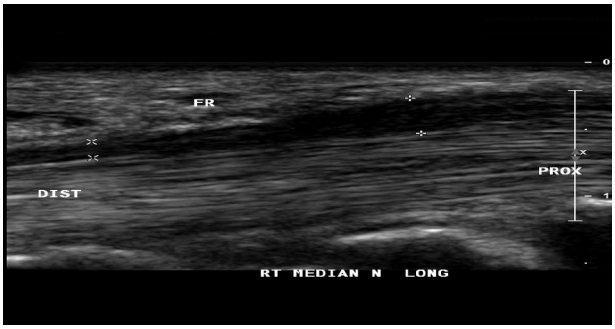

Figure (8): Normal longitudinal median nerve-hypo echoic interior echo and peripheral hyper echoic nerve sheath.

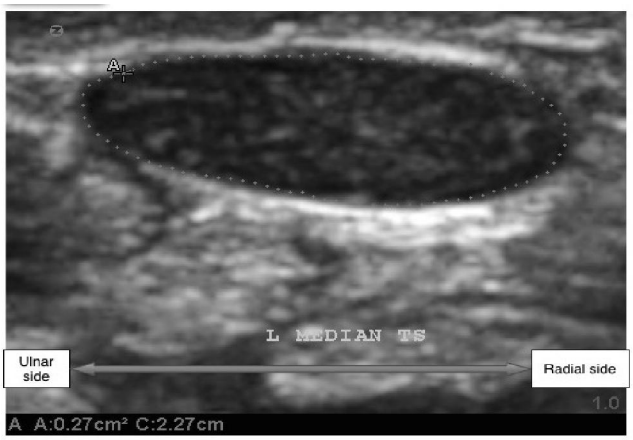

Figure (9): Flattening of the median nerve in CTS.

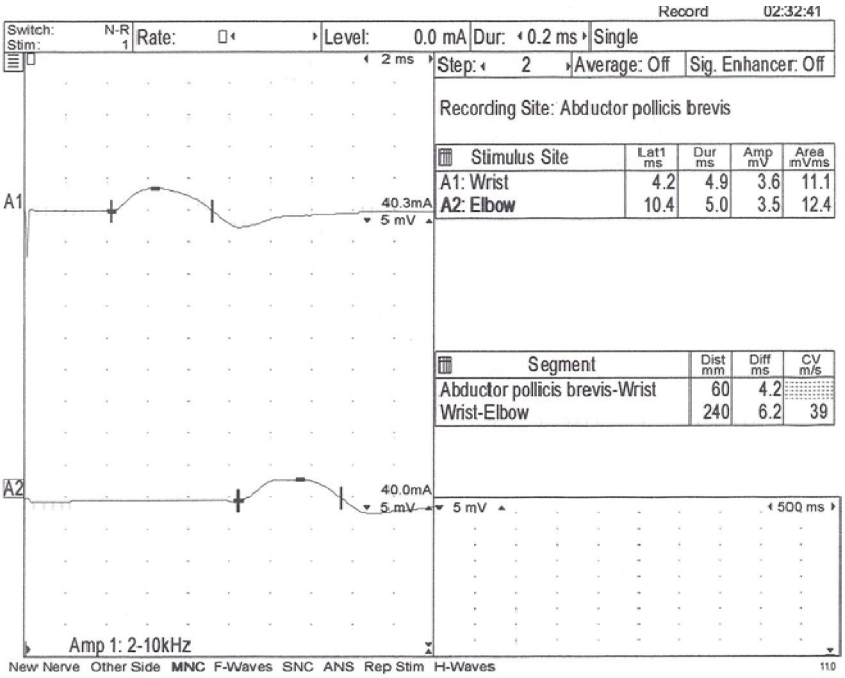

Figure (10): Median nerve conduction study, showing sensorimotor demylanating median neuropathy at the wrist (CTS) moderate degree

4. Discussion

This study was designed to evaluate the frequency of MSK complications in diabetic patients and its correlations with duration, and severity of DM.

The study included 60 patients with DM mean age (41.5 ±7.1) of which 33 (55%) were females and 27 (45%) were males and 20 controls, mean age (40.5 ±8.4) of which 10 (50%) were females and 10 (50%) were males, who served as a control group (table 1).

As showing in (table 2), the frequency of upper limb MSK complications in our diabetic patients was (75%), this was in accordance to **Ramchurn, [17],** that reported (75%) of diabetic patients had MSK complications, However **Kidwai et al., [18]**, reported that **(**32.9%) of the diabetic patients had MSK manifestations, which can be explained by the duration of DM, which was less than ten years in most of their patients.

In our study, the frequency of patients that had trigger finger was (53.3%), while **Ramchurn et al., [17],** reported that trigger finger in their study was (29%) and it is the commonest abnormalities in the hands, On the other hand, **Halesha B. R, and Krishnamurthy V. R, [19],** reported that trigger finger was (6.5%). **Abourazzak et al., [20]** also reported in their study that trigger finger was (7%). This discrepancy can be attributed to the nature of occupation in our diabetic patients as they were mainly manual workers (e.g. carpenters, tailors).

The frequency of our patients that had frozen shoulder was (45%) and this result in agreement with **Barki S, et al., [21]**, that reported frozen shoulder was (46.9%)**,** however, **Halesha B. R, and Krishnamurthy V. R, [19],** reported that frozen shoulder was (18 %), and it was the most common musculoskeletal complications seen in their diabetic group. it may be attributed to their Male/Female participal that was 225/175, but in our study the Male /Female participial was 27/33 and frozen shoulder is predominant in females **(Cagliero E., et al., [22].**

It is a well-established fact that CTS is the commonest entrapment neuropathy involving one third of the diabetic population, however, this may be an underestimate since only one-sixth of the patients suffering from it report symptoms. Furthermore, genotype, environmental factors, lifestyle and occupation also play a role (**Dyck PJ, [23]**; this explains the more frequent CTS in our study (43.3%). **Abourazzak et al., [20],** reported that (29%) of their diabetic patients had CTS; and it was the most frequent manifestation involving the hands. Many of the patients with CTS in our study belong to the obese category, which is a well-recognized predisposing factor along with diabetes (**Aroori S, Spence RAJ, [24],** and this may explaining this discrepancy.

Risk factors for the development of limited joint mobility in patients with diabetes include older age, disease duration and cigarette smoking **(Silverstein JH, et al., [25].** We had encountered a low frequency of patients with diabetic cheiroarthropathy (1.7%); this was disagreeing with **Halesha B. R, and Krishnamurthy V. R, [19],** that reported diabetic cheiroarthropathy in (13.5%). **Abourazzak et al., [20],** also reported 19% of their diabetic patients had diabetic cheiroarthropathy**.** It may be attributed to the age of our patients which is less than 50 years.

The frequency of our patients that had Dupuytren contracture was (11.7%); this was in accordance to **Halesha B. R, and Krishnamurthy V. R, [19],** that reported Dupuytren contracture in (17.5%),while highly variable with **Kidwai et al., [18]** that reported it in only (1.0%). This discrepancy can be attributed to the nature of occupation in our diabetic patients as they were mainly manual workers (e.g. carpenters, tailors).

As regards shoulder hand syndrome the frequency in our study was (1.7%) that was in accordance to **Halesha B. R, and Krishnamurthy V. R, [19]** that reported it in (1.5%).

In our study we compared frequency of the upper limb musculoskeletal complications between DM and control groups (table 3), and we found more frequent frozen shoulder in our diabetic patients than control (45% versus 10%, p=0.036). A study done by **Tighe CB, Oakley WS., [26],** confirmed the incidence of adhesive capsulitis being two to four times higher in diabetics than in the general population and the prevalence of diabetes in patients with adhesive capsulitis was shown at 38.6%. Also **Halesha B. R, and Krishnamurthy V. R, [19],** revealed more frequent frozen shoulder in their diabetic patients (18% versus 3%, P <0.005), and **Kidwai et al., [18]** that was reported (11.0% versus 2.5%, P= 0.001).

One of our patient had shoulder hand syndrome, while none of the controls had (1.7% versus 0%, p = 0.681), this was in agreement with **Halesha B. R, and Krishnamurthy V. R, [19],**that was reported (1.5% versus 0.75 %, P >0.05).

More frequent trigger finger (53.3% versus 10%, P=0.011) was seen in our diabetic patients than controls, thus became in agreement with **Halesha B. R, and Krishnamurthy V. R, [19]** that was reported (6.5% versus 0.5%, P >0.05), and **Kidwai et al., [18]** that was reported (3.8% versus 0.5%, P=0.037).

Also more frequent carpal tunnel syndrome (43.3% versus 10%, p= 0.045) than control, this was close to **Kidwai et al., [18]** (9.0% versus 2.0%, p=0.002), and **Halesha B. R, and Krishnamurthy**

V. R, [19], that reported (11% versus 1.5%, p. <0.05).

As regards to diabetic cheiroarthropathy, one of our diabetic patients had it, while none of the controls had (1.7% versus 0%), and this in disagreement with **Kidwai et al., [18]**, that reported (9.5% versus 2.5%, p. 0.003) and (**Halesha B. R, and Krishnamurthy V. R), [19],**that reported (13.5% versus 0.5%, p <0.05).

Finally, Dupuytren contracture it was more frequent in our diabetic patients, while none of the controls had, (11.7% versus 0%, p= 0.255), that was in accordance with (**Halesha B. R, and Krishnamurthy V. R), [19],** that reported (17.5% versus 2.5%, p. <0.02), but disagreement with **Kidwai et al., [18],** that reported (1.0% versus 0%).

As showing in table (4) The duration of DM was correlated with different upper limb MSK complications, that was significantly longer in patients with frozen shoulder than DM patients without frozen shoulder (6.9 ±4.2 years versus 4.8 ±3.4 years respectively, p=0.037), made it in close to **Arkkila, et al., [27]** (28.7 ± 8.2 with range from 11 to 48 years versus 17.1±9.1 ranging from1 to 47years in diabetic patients without frozen shoulder (p< 0.01).

The duration of DM was 6.9 ±4.7 years in the DM patients with trigger finger compared to 4.4 ±2.2 years in the DM patients without trigger finger. This difference was significant (p=0.012), that was in accordance to **S. KOH., et al., [28],** that reported (22 ± 10.3 versus 13± 9.7 years in their diabetic patients without trigger finger P<0.01).

DM patients with carpal tunnel syndrome had a significantly higher disease duration than those without carpal tunnel syndrome (7.4 ± 4.5 years versus 4.5 ± 2.9 years respectively, p=0.004), that was in accordance to **Basim Athaib, [32]** that reported the number of diabetic patients found to had CTS with duration of diabetes as follows < 5 years= 2 patients, 5-10 years=7, > 10 years= 11 patients by Fisher exact test P value < 0.005,so significant correlation with disease duration.

DM duration was also significantly longer in the DM patients with diabetic cheiroarthropathy than patients without (12.7 ±4.8 years versus 4.8 ±2.7 years, respectively, p<0.001). That was in accordance to **Fernando and Vernidharan, [30],** that reported (12 ± 6.5 years 7.5 ± 6.1 in their diabetic patients without diabetic cheiroarthropathy).

Finally diabetic patients who had upper limb musculoskeletal manifestations had significantly longer DM duration than those without (6.5 ±4.2 years versus 3.5 ±1.2 years respectively, p=0.007), that was in accordance to **Cagliero, et al., [22]**, that reported (22 ± 10 versus 14 ± 10years in their diabetic patients without upper limb MSK manifestations, p. <0.01).

Also the study included the correlation of different MSK manifestations in the upper limb of our diabetic patients with the mean of the most recent HBA1c (table 5), that was significantly higher in patients with frozen shoulder than DM patients without frozen shoulder (7.8 ±1.5 % versus 5.8 ±1.5% respectively, p<0.001), that was in accordance to **Arkkila, et al., [27],** that reported (9.1 ± 2.0 % versus 8.5 ± 1.7% in their diabetic patients without frozen shoulder p < 0.05).

The mean HBA1c was 7.5 ± 1.7% in the DM patients with trigger finger compared to 5.7 ± 1.4 % in the DM patients without trigger finger. This difference was significant (p<0.001). Also, **Vance MC, [33]** reported that development of trigger finger appears to be associated with higher HbA1c levels in their diabetic patients while they did not use the mean HBA1c but they used an average of HbA1c measurements during the same time period and performed subgroup analysis based on specified HbA1c levels (group A, HbA1c level < 7.0%; group B, HbA1c 7.0% to 7.9%; group C, HbA1c 8.0% to 8.9%; group D, HbA1c ≥ 9.0%).

DM patients with carpal tunnel syndrome had a significantly higher mean HBA1c than those without carpal tunnel syndrome (8.1 ± 1.5% versus 5.6 ± 1.1% respectively, p<0.001), that disagree with **Hendriks et al., [29],** that was reported (7.1 ± 3.2%versus 7.3 ± 3.2% in their diabetic patients without carpal tunnel syndrome p = 0.567). It may be attributed to their cases and controls that were only enrolled in a secondary care setting and thereby mostly severe cases were included. Thus, less severe CTS patients treated with conservative treatment by general practitioners did not participate in the study.

Mean HBA1c was also significantly higher in the DM patients with diabetic cheiroarthropathy than patients without (8.7 ± 0.9% versus 6.4 ± 1.7%, respectively, p<0.001). In conclusion diabetic patients, who had upper limb musculoskeletal manifestations had significantly higher mean HBA1c than those without (7.3 ± 1.6% versus 4.9 ± 0.4% respectively, p<0.001). **Cagliero, et al., [22],** reported Mean HbA1C levels were somewhat higher in patients with hand or shoulder syndromes than in those without them (8.3 ± 1.6% versus 8.0 ± 1.5%, p=0.22).

As showing in table (6), US examination of the shoulder revealed that biceps edema was more frequent in the DM patients than in controls (43.3% versus 10% respectively, p=0.045). The restricted movement of the Subscapularis muscle was more frequent in the DM patients than in controls (56.7% versus 20% respectively, p=0.032) and Supraspinatus

bulging was more frequent in the DM patients than in controls (55% versus 20% respectively, p=0.040). The average Coraco-humeral ligament thickness was 1.9 ±1 mm in the DM patients compared to 1.2 ±0.4 in the controls. This difference was significant (p=0.047). That was in accordance to **Carlos Homsi, et al., [35]**, as they observed patients with adhesive capsulitis had a significantly thicker Coraco humeral ligament (CHL) than did control subjects (average 4.1 mm versus 2.7 mm).

In table (7), the average cross sectional area of the carpal tunnel when measured by the US in our DM patients was 9.8 ±1.9 compared to 9.7 ±1.3 in the controls. This difference was insignificant. The average distal motor latency (DML) of the median nerve of our diabetic patients was significantly longer than the controls (4.1 ±0.9 msec and 3.4 ±0.8 msec respectively, p=0.017). Also the average distal sensory latency (DSL) of the median nerve was significantly longer in the DM group than in the controls (2.3 ±0.6 msec and 2 ±0.6 respectively, p=0.037). **Tsai et al., [36],** reported that, there is no difference in the CSA of the median nerve at the wrist crease or tunnel outlet in CTS patients either diabetic or non-diabetic(15.3±3.7 versus 15.5±4.8), also as regard DML in CTS patients, there was no significant difference between diabetic patients as compared with non-diabetic (5.3 ± 1.2 versus 5.2 ± 1.3, p= 0.35), but as regard DSL in CTS patients was higher in diabetic patients than non-diabetics (3.8 ± 1.0 versus 3.8 ± 1.0, p= 0.014). So our result in accordance with Tsai et al in CSA and DSL but not agree with them in DML, and this difference explained by that he compared between patients with CTS either diabetic or non-diabetic, but we compared between diabetic patient with CTS and non-diabetic persons hadn't CTS.

Conclusion

- We had observed a significant association of hand and shoulder abnormalities with DM.
- We found a strong relationship between duration and degree of hyperglycemia of DM with upper limb MSK complications.
- Another important observation was that the frequencies of upper limb musculoskeletal abnormalities in our diabetic subjects were found to be significantly higher than the international data. It may depend on the degree of hyperglycemia, which was higher in most of our patients, also low socioeconomic standard.
- Furthermore, the most frequently found abnormality in the upper limb was trigger finger.
- Ultrasound was a satisfactory method for diagnosis of adhesive capsulitis either dynamically (detection of Subscapularis restricted movement during external rotation and Supraspinatus bulging during abduction of shoulder), or by measuring CHL thickness. Also it was a useful tool in screening for median nerve in addition to nerve conduction study in diagnosis of CTS.
- It is recommended that diabetic patients should always be screened for the presence of rheumatic complications since early recognition lessens the chances of irreversible damage

Table (8): List of abbreviations:

Abbreviation	meaning
DM	Diabetes mellitus
MSK	musculoskeletal
HbA1c	Glycosated hemoglobin A1C
CTS	carpal tunnel syndrome
US	ultrasonography
CSA	cross-sectional area
SD	standard deviations
DCT	Dupuytren contracture
CHL	Coraco humeral ligament
DML	Distal motor latency
DSL	Distal sensory latency

References:

1. Smith LL, Burnet SP, and McNeil JD: Musculoskeletal manifestations of diabetes mellitus. Br J Sports Med; 37(1): 30–5, 2003.
2. Lebiedz-Odrobina D and Kay J: Rheumatic manifestation of diabetes mellitus. Rheum Dis Clin N Am; 36(4):681–99, 2010.
3. Alvin C Power, Kasper DL, Braunwald E, *et al.*: Diabetes and rheumatic diseases. Harrison's Principle of Internal Medicine. 16. ed. McGraw-Hill; pp. 3779–829, 2004.
4. International Diabetes Federation: Diabetes Atlas. 3rd edition. Brussels, Belgium: International Diabetes Federation, 2006.
5. Schiavon F, Circhetta C, and Dani L: The diabetic hand. Reumatismo, 56:139–142, 2004.
6. Qidwai W and Ashfaq T: Imminent Epidemic of Diabetes Mellitus in Pakistan: Issues and challenges for Health Care Providers. JLUMH, 09:112, 2010.
7. Crispin JC and Alcocer VJ: Rheumatic manifestations of diabetes mellitus. Am J Med 14:753–757, 2003.
8. Arkkila PE, and Gautier JF: Musculoskeletal disorders in diabetes mellitus: an update. Best Pract Res Clin Rheumatol, 17:945–970, 2003.
9. Tasoglu O, Dogan-Aslan M, Yenigun D, *et al.*: challenging case of diffuse diabetic musculoskeletal system involvement: diagnostic confusion with rheumatoid Arthritis. Reumatol Port., 2014.
10. Del Rosso A, Cerinic MM, De Giorgio F, *et al*: Rheumatological manifestations in diabetes mellitus. Curr Diabetes Rev 4:455–466, 2006.
11. Filippucci E, Iagnocco A, Meenagh G *et al*: Ultrasound imaging for the rheumatologist VII. Ultrasound imaging in rheumatoid arthritis. Clin Exp Rheumatol; 25:5_10, 2007.

12. Moller B, Banel H. And Rotzetter M: Measuring Joint Cartilage by ultrasound as Promising alternative to conventional radiograph imaging. Arthritis Rheum. 61: 435 – 41, 2009.
13. El Miedany YM, Aty SA, and Ashour S: Ultrasonography versus nerve conduction study in patients with carpal tunnel syndrome: substantive or complementary tests? Rheumatology (Oxford); 43(7):887-95, 2004.
14. Pertson DC and Shapiro BE: Common mononeuropathy: Median neuropathy. In: Pertson D, Shapiro B, ed. Electromyography and neuromuscular disorder: clinical-electrophysiologic correlations 2nd edition. Boston:butterworth-Heinemann ;261-71, 2005.
15. Jablecki CK, Andary MT, Floeter MK, *et al:* Practice parameter: Electrodiagnostic studies in carpal tunnel syndrome. Report of the American Association of Electrodiagnostic Medicine, American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation..Neurology; 58: 1589 – 1592, 2002.
16. Cherian A and Kuruvilla A: Electrodiagnostic approach to carpal tunnel syndrome. Ann Indian Acad.Neurol; 9:177-82, 2006.
17. Ramchurn, Chiedza Mashamba, Elizabeth Leitch, *et al*: Upper limb musculoskeletal abnormalities and poor metabolic control in diabetes. European Journal of Internal Medicine 20: 718–721, 2009.
18. Kidwai, Lubna Wahid, Shaista A Siddiqi, *et al*: Upper limb musculoskeletal abnormalities in type 2 diabetic patients in low socioeconomic strata in Pakistan. BMC Research Notes, 6:16, 2013.
19. Halesha B. R and Krishnamurthy V. R: "A Study of Rheumatological Manifestations of Diabetes Mellitus in a Tertiary Care Centre of Southern India". Journal of Evolution of Medical and Dental Sciences; Vol. 3, Issue 51, P. 11881-11886, 2014.
20. Abourazzak, Fatima Ezzahra, Nessrine Akasbi, et al: Articular and abarticular manifestations in type 2 diabetes mellitus Eur J Rheumatol 4: 132-4, 2014.
21. Barki S, Khan HM, Jilani SM, *et al*:Common Musculosekeltal Disorders in Diabetes Mellitus Patients. Pak. j. rehabil; 2(1):53-62, 2013.
22. Cagliero E: Rheumatic manifestations of diabetes mellitus. Curr Rheumatol Rep.; 5: 189-94, 2003.
23. Dyck PJ, Kratz KM, Karnes JL, *et al*: The prevalence by staged severity of various types of diabetic neuropathy, retinopathy, and nephropathy in a population-based cohort: the Rochester Diabetic Neuropathy Study. Neurology, 43:817–824, 1993.
24. Aroori S and Spence RAJ: Carpal tunnel syndrome: Ulster Med J, 77:6–17, 2008.
25. Silverstein JH, Gordon G, Pollock BH, *et al*:Long-term glycemic control influences the onset of limited joint mobility in type 1 diabetes. J Pediatr; 132: 944 – 947, 1998.
26. Tighe CB and Oakley WS: The prevalence of a diabetic condition and adhesive capsulitis of the shoulder. South Med J, 101:591–595, 2008.
27. Arkkila, Ilkka M Kantola, Jorma S A Viikari, *et al*: Shoulder capsulitis in type I and II diabetic: association with diabetic complications and related diseases; Ann Rheum Dis 55:907-914, 1996.
28. S. KOH, S. NAKAMURA, T. HATTORI, *et al*: The Journal of Hand Surgery (European Volume) 35E: 4: 302–305, 2010.
29. Hendriks, Peter R van Dijk, Klaas H Groenier, *et al*: Type 2 diabetes seems not to be a risk factor for the carpal tunnel syndrome: a case control study. BMC Musculoskeletal Disorders, 15:346, 2014
30. Fernando and Vernidharan: Limited Joint Mobility In SRI Lankan Patients With Non-insulin dependent DM. British Journal of Rheumatology 36: 263_265, 1997.
31. Aghaei M, Bazrafshan HR, Sedighi S, *et al*: Frequency of Rheumatologic Manifestations in Diabetic Patients in Gorgan, North of Iran. Int. J. Med Health Sci. January, Vol-2; Issue-1, 2013.
32. Basim Athaib: The Prevlance of Hand Abnormalities In Diabetic Patients In Al.Nassiyria City And Its Association With Diabetic Variables. Thi-Qar Medical Journal (TQMJ): Vol(5) No(3): (28-34), 2011.
33. Vance MC, Tucker JJ, Harness NG, *et al*: The association of hemoglobin A1C with the prevalence of stenosing flexor tenosynovitis. PubMed. Sep; 37(9):1765-9, 2012.
34. Uqba N. Yousif :Study of hand syndromes in diabetic patients attending Al Kadhemiya teaching hospital, BaghdadTikrit Medical Journal; 15(1):147-152, 2009.
35. Carlos Homsi, Marcelo Bordalo-Rodrigues et al:Ultrasound in adhesive capsulitis of the shoulder: is assessment of the coracohumeral ligament a valuable diagnostic tool? Skeletal Radiol.; 35: 673–678, 2006.
36. Tsai Nai-Wen, Lian-Hui Lee, Chi-Ren Huang, et al: The diagnostic value of ultrasonography in carpal tunnel syndrome: a comparison between diabetic and non-diabetic patients BMC Neurology, 13:65 http://www.biomedcentral.com/1471-2377/13/65,2013.

3/31/2015