Original Article

DOI: 10.7860/JCDR/2015/13149.6101

Assessment of the Presence of Carpal Tunnel Syndrome in Patients with Diabetes Mellitus, Hypothyroidism and Acromegaly

Internal Medicine Section

PELIN OKTAYOGLU[1], KEMAL NAS[2], FARUK KILINÇ[3], NEBAHAT TASDEMIR[4], MEHTAP BOZKURT[5], ISMAIL YILDIZ[6]

ABSTRACT

Introduction: Carpal tunnel syndrome (CTS) is one of the most common entrapment neuropathies of the upper limbs. It results from compromised median nerve function of the wrist that is caused by increased pressure in the carpal tunnel. Repetitive use of the hand and wrist, obesity, pregnancy, rheumatoid diseases, trauma and endocrinopathies are some of the risk factors for CTS.

Aim: The purpose of this study was to find out whether patients with diabetes mellitus (DM), hypothyroidism and acromegaly have an increased incidence of carpal tunnel syndrome compared to each other and normal population.

Materials and Methods: Patients were assigned into three groups as follows: patients with type II DM n: 100, patients with hypothyroidism n:48 and patients with acromegaly n:36. In addition, 50 healthy individuals were included in the study as control subjects. Patients were asked if they had any pain, symptoms of paraesthesia and numbness. Patients with peripheral neuropathy were excluded from the study. Boston Symptom Severity Scale and Functional Capacity Scale were used to assess symptom severity and functional capacity. CTS was investigated by performing electrophysiological study for both hands.

Results: The incidence of CTS was significantly higher in all three groups compared to the control group ($p>0.05$). In addition, the incidence of CTS was significantly higher in the DM group compared to the hypothyroid and acromegaly groups ($p<0.001$). The incidence of bilateral CTS in the DM group was significantly higher compared to both hypothyroid and acromegaly groups and the control group ($p<0.001$).

Conclusion: CTS has a higher incidence in DM, hypothyroid and acromegaly patients compared to healthy individuals. Clinicians should be careful about development of CTS in DM, hypothyroidism and acromegaly. They should adopt a multidisciplinary approach and co-operate with the psychiatrist.

Keywords: Endocrinopathies, Electropysiologic study, Median nerve

INTRODUCTION

Carpal tunnel syndrome (CTS), which is one of the most common entrapment neuropathies of the upper limbs, is the focal neuropathy of the median nerve around the wrist arising particularly from repetitive use of the hand [1]. The prevalence of CTS in general population varies from 3.7% to 5.8% [2]. A previous study screening a large population reported 4% prevalence for CTS [3]. The risk factors for CTS include repetitive use of hand and wrist, advanced age, obesity, pregnancy, acromegaly, amyloidosis, diabetes mellitus (DM), renal diseases, thyroid diseases, trauma and osteoarthritis [4]. Increased pressure in the carpal tunnel is the most important factor in the aetiology of the disease. High pressure in the carpal tunnel disrupts the blood flow in the median nerve and does harm to the nerve [5].

Although it is known that the main conditions associated with CTS are diabetes and some systemic diseases, the origin of CTS is often unknown in many cases [6]. Symptoms of CTS include pain, paraesthesia and weakness in the hand, especially in the first three fingers at nights. Pain may travel up the arm toward the shoulder [7]. Diabetic neuropathy is a clinical condition characterized by nerve damage that presents with symptoms such as pain and paraesthesia or problems caused by neurologic deficit. The prevalence of CTS varies in different studies; however it is reported to be more prevalent in DM patients compared to the normal population [6,8-10].

Carpal tunnel syndrome is very common among acromegaly patients and often accounts for the initial symptom. It is claimed that the incidence of CTS ranges from 25% to 64% in the presence of acromegaly. However, the actual incidence is deemed to be underestimated [11,12].

The pathological mechanisms of peripheral nerve abnormalities in patients with thyroid dysfunction remain unclear. The proposed etiology is a mononeuropathy, secondary to compression that is caused by mucinous deposits present in the soft tissues around the peripheral nerves and a polyneuropathy that is caused by a demyelinating process or primary axonal degeneration [13]. It has also been suggested that almost 29% of hypothyroid patients might have evidence of CTS on nerve conduction studies [14]. In this study, we aimed to find out whether DM, hypothyroid and acromegaly patients had an increased incidence of CTS compared to each other and the healthy individuals by evaluating the electroneuromyography (ENMG) findings.

MATERIALS AND METHODS

Patient selection: One hundred patients with Type II DM, 48 patients with hypothyroidism, 36 patients with acromegaly who presented to Dicle University, Faculty of Medicine, Endocrinology and Metabolic Diseases and Physical Therapy and Rehabilitation Clinic and 50 healthy control subjects who were selected from among the staff members of Dicle University Hospital were included in this study. All the patients were under medical treatment. Musculoskeletal system examination was performed for all patients. Pain, symptoms of paraesthesia and numbness were questioned in the form of present/absent. Presence of thenar atrophy was noted. Patients with a previous diagnosis of CTS, patients operated for CTS, patients with a history of Colles fracture, patients with the diagnoses of two or all of DM, hypothyroidism and acromegaly, patients with a history of peripheral nerve damage in the upper limbs and patients with conditions that might constitute a contraindication for the electrophysiological study were excluded from the study. In addition, 13 DM patients and 5 hypothyroid patients who were found to have polyneuropathy as a result of the electrophysiological study were also excluded from the study.

Symptomatic and functional evaluation of the patients: Boston Questionnaire was used for symptomatic and functional evaluation

[15]. Boston Symptom Severity Scale consists of 11 items. Each item has 5 choices from 1 to 5. Average score is obtained by dividing total points to the number of questions and ranges from 1 to 5. A higher score indicates a severe symptom. Boston Functional Capacity Scale consists of 8 items. Average score is calculated in the same manner. A higher score indicates a declining functional capacity. The average score in Boston scale is calculated separately for symptom severity and functional capacity [15].

Electrophysiological study and CTS grading: Electrophysiological study was performed using Synergy Version 15.0 (Viasys Healthcare UK Ltd). Attention was paid to maintain the skin temperature of the patients above 32°C during the study [16].

Sensory and motor nerve conduction studies were performed using surface disc electrodes. Sensory nerve action potentials were recorded orthodromically by these electrodes. In the median nerve sensorial conduction studies, the stimulation were applied to the index finger and sensory nerve action potential (SNAP) was recorded in the wrist. Furthermore, stimulation of the wrist was recorded below the elbow. For median nerve motor conduction, stimulation was performed in the wrist and elbow, and the compound muscle action potential (CMAP) was recorded from the thenar eminence, with the active recording electrode placed over the belly of the abductor pollicis brevis and the reference electrode over the abductor pollicis brevis tendon. In addition, the ulnar motor conduction was recorded in the hypothenar region by performing stimulation in the wrist and below and above the elbow. Ulnar sensorial conduction recording was performed while stimulating the nerve to the fifth finger and recording SNAP in the wrist. The findings were compared with the normal values of the Turkish population [17]. The electrophysiological findings were assessed according to the grading system developed by Padua. The electrophysiological grading criteria proposed by Padua are as follows [18]:

1. Extreme CTS: Motor and sensory potentials effectively unrecordable.

2. Severe CTS: Sensory response absent and abnormal distal response present.

3. Moderate CTS: Sensorial conduction abnormalities in the finger-wrist segment combined with distal motor abnormalities.

4. Mild CTS: Sensorial conduction velocity abnormalities in the finger-wrist segment with normal distal motor latency.

5. Minimal CTS: Abnormal results found in the comparative study on the finger-wrist segment.

6. Normal: Electrophysiological findings in the normal range [18].

Each patient was assigned into one of the following four categories according to the electrophysiological findings:

0 (normal): Grade 6 in Padua's system.

1 (mild): Grades 4 and 5 in Padua's system.

2 (moderate): Grade 3 in Padua's system.

3 (severe): Grades 1 and 2 in Padua's system.

STATISTICAL ANALYSIS

SPSS (Statistical Package for the Social Sciences) 16.0 software was used for statistical analysis. The results were expressed as median values, unless otherwise stated. Parametric continuous variables were compared using Student's t-test or analysis of variance (ANOVA). On the other hand, nonparametric continuous variables were compared using Mann-Whitney U-test or Kruskal-Wallis test. Categorical variables were compared using Chi-square test. A p-value -smaller than 0.05 was considered statistically significant.

RESULTS

Demographic profiles of the patients were demonstrated in [Table/Fig-1]. No significant difference was found between the groups in age, gender, dominant hand, height and weight (p>0.05). The median duration of disease was 7, 5, 3 years, respectively in DM, hypothyroid and acromegaly groups.

	Diabetes mellitus n=87	Hypothyroidism n=43	Acromegaly n=36	Control n=50	p
Gender M/F	37/50	16/27	13/23	27/23	*
Dominant hand Left/Right	5/82	0/43	1/35	2/48	*
Age (mean±SD)	49±11	43±11	42±12	46±13	*
Height (mean±SD)	164±6	162±6	166±8	77±14	*
Weight (mean±SD)	71±11	74±13	77±14	73±14	*

[Table/Fig-1]: Demographic profile of the groups
* Not significant according to the significance tests p>0.05

Evaluation of clinical symptoms in the groups

The percentages of DM, hypothyroid and acromegaly patients and the control subjects who complained about clinical symptoms such as pain, paraesthesia, weakness and numbness were demonstrated in [Table/Fig-2]. No significant difference was found between the three groups in symptoms of paraesthesia, weakness and numbness (p>0.05). On the other hand, a significant difference was found in pain between the three groups [Table/Fig-2].

Comparison of clinical symptoms between the patient groups

Patient groups were compared with respect to pain, paraesthesia, weakness and numbness in the wrist, and significant differences were found in many parameters. The percentages of the DM, hypothyroidism and acromegaly patients who had pain were significantly higher compared to that of the control subjects. The percentages of the patients who described pain, paraesthesia symptoms, weakness and numbness in the wrist were demonstrated [Table/Fig-2].

Comparison of electrophysiological findings between the groups

The data showing the electrophysiological comparisons between the groups were demonstrated in [Table/Fig-3]. According to these comparisons, there were statistically significant differences in the values of right median nerve motor distal latency, right median nerve

	DM n=87	Hypothyroidism n=43	Acromegaly n=36	Control n=50
Pain n (%)	66 (75.9)$^{\beta,\delta}$	23 (53.5)$^{\beta}$	26 (72)$^{\kappa}$	8 (16)$^{\beta,\delta,\kappa}$
Paraesthesia * n (%)	69 (79.3)$^{\alpha}$	30 (69.8)$^{\pi}$	29 (80.6)$^{\mu}$	16 (32)$^{\alpha,,\mu}$
Weakness * n (%)	40 (46) $^{\varphi}$	12 (27.9)$^{\alpha}$	17 (47.2)$^{\delta}$	5 (10)$^{\varphi,a,d}$
Numbness * n (%)	45 (51.7)$^{\gamma}$	21 (48.8)$^{\beta}$	22 (61.1)$^{\varepsilon}$	8 (16)$^{\gamma,b,e}$
Tinnel* n (%)	35 (40.2)$^{\lambda}$	21 (48.8)$^{\chi}$	19 (52.8)$^{\phi}$	8 (16)$^{\lambda,c,f}$

[Table/Fig-2]: Proportion of clinical complaints and symptoms within each group

* According to the assessment between three groups in chi-square test p>0.05
$^{\beta}$significant difference between groups marked with β p=0.01, χ^2=6.672
$^{\delta}$significant difference between groups marked with δp=0.001, χ^2=21.2
$^{\kappa}$significant difference between groups marked with κp=0.001, χ^2=10.33
$^{\alpha}$significant difference between groups marked with αp=0.001, χ^2=30.17
$^{\pi}$ significant difference between groups marked with p=0.001, χ^2=13,19
$^{\mu}$significant difference between groups marked with μp=0.001, χ^2=18,9
$^{\varphi}$significant difference between groups marked withφp=0.001, χ^2=18.6
$^{\gamma}$significant difference between groups marked with γp=0.001, χ^2=17.08
$^{\lambda}$significant difference between groups marked with λ p=0.001, χ^2=8.65
^{a}significant difference between groups marked with a p=0.02, χ^2=4.96
^{b}significant difference between groups marked with bp=0.001, χ^2=11.6
^{c} significant difference between groups marked withc p=0.001, χ^2=11.6
^{d}significant difference between groups marked with d p=0.001, χ^2=17.2
^{e}significant difference between groups marked with ep=0.001, χ^2=18.75
^{f}significant difference between groups marked with fp=0.001, χ^2=13.14

	Diabetes mellitus n=87 Median (min-max)	Hypothyroidism n=43 Median (min-max)	Acromegaly n=36 Median (min-max)	Control n=50 Median (min-max)
Functional scale	1.5 (1-4.5)□	1.4 (1-3.5)	2 (1-3.2)μ	1 (1-3.8)□, μ
Symptom severity scale	2.3 (1-5)□	2 (1-5)γ	2 (1-4.5)	1.2 (1-4)□, γ
HbA1c	7.95 (4.5-14.5)	-	-	-
Duration of disease (year)	7 (0.1-27)	5 (0.2-20)	3 (0.25-10)	-
Left median motor distal latency	3.45 (2.6-9.65)□	3.02 (2.6-4.9)	3.6 (2.45-5.45)	3 (2.05-10.3)□
Right median motor distal latency	3.5 (2.6-7.50)*,□	3.12 (2.3-5.2)*	3.22 (1.6-9.1)	3 (2.05-10.3)□
Left median CMAP (wrist) amplitude	7200 (4000-13600)□	8350 (2200-11500)	7100 (300-9600)	8650 (2000-14700)□
Right median CMAP (wrist) amplitude	7000 (2000-12900)□	7900 (2700-10900)	7300 (400-11600)	8000 (1000-15000)□
Left median motor conduction velocity (wrist-elbow)	53.75 (33.6-61.7)□	53.25 (32.8-67.6)	54.7 (40.8-65.6)	56.4 (40.8-65.7)□
Right median motor conduction velocity (wrist-elbow)	53.7 (36.4-66.7)	54.3 (44.2-66.1)	54.25 (41.4-66.7)	55.4 (40.8-66.7)
Left median sensory latency (index finger)	3.1 (1.85-4.65)*,□	2.6 (1.8-3.8) *, γ	2.35 (1.7-13)	2.3 (1.7-3)□, γ
Right median sensory latency (index finger)	3.15 (1.95-10.7)*,κ, □, γ	2.8 (1.7-9.4) *	2.35 (1.6-6.4)κ	2.15 (1.65-2.95)□, γ
Left median SNAP (index finger- wrist) amplitude	15 (0.5-38)□, γ	13 (6-30)	11 (2.7-23)δ	17 (9.7-30)□, γ, δ
Right median SNAP (index finger-wrist)	11 (3-26)□, γ	12.7 (2-25)	12.1 (3-26) δ	15 (2.8-47.7)□, γ, δ
Left median sensoryl conduction velocity (index finger - wrist)	38.6 (25.8-75.7) *,β, □, γ	44.4 (31.6-66.7)*	48.3 (15.8-67.7)β	51.2 (40-75.7)□, γ
Right median sensory conduction velocity (index finger - wrist)	36.5 (8.4-65.1) *,κ, □, γ	44.0 (14.8-80)*	48.4 (17.2-81.3)κ	51.2 (39-73.7)□, γ

[Table/Fig-3]: Assessment of groups regarding the clinical and electrophysiological parameters
CMAP compound muscle action potential, SNAP sensory nerve action potential
*significant difference between groups marked with *p=0.001
βsignificant difference between groups marked with βp= 0.007
κsignificant difference between groups marked with κp=0.001
osignificant difference between groups marked with op=0.001
γsignificant difference between groups marked with γp=0.001
μsignificant difference between groups marked with μp=0.003
δsignificant difference between groups marked with δp=0.001

	Diabetes mellitus n=87	Hypothyroidism n=43	Acromegaly n=36	Control n=50
Number of patients with positive Carpal Tunnel Syndrome (%)	62 (71.2)δ, μ, γ	14 (32.5)δ, □	18 (50)μ, β	2 (4)γ, β, □
Number of patients with negative Carpal Tunnel Syndrome (%)	25 (28.7)	29 (67.4)	18 (50)	48 (96)
Number of patients with positive bilateral carpal tunnel syndrome (%)	44 (50.5)a,b	10 (23.2)a	12 (33.3)b	1 (2)

[Table/Fig-4]: Number and proportion of patients with carpal tunnel syndrome in each group

δsignificant difference between groups marked with δ p=0.001, χ^2=17.75
μsignificant difference between groups marked with μ p=0.024, χ^2=5.06
γsignificant difference between groups marked with γp= 0.001, χ^2=57.71
βsignificant difference between groups marked with β p=0.001, χ^2=24,81
□significant difference between groups marked with p=0.001, χ^2=13.23
asignificant difference between groups marked with a p=0.002, χ^2=9.516
bsignificant difference between groups marked with bp=0.041, χ^2=3.456

(index finger-wrist) sensory distal latency, right median nerve sensory (index finger-wrist) conduction velocity, left median nerve (index finger-wrist) sensory conduction velocity and left median sensory nerve distal latency (index finger-wrist) between the DM group and the hypothyroid group (p=0.001). As to the comparison between the DM group and the acromegaly group, right and left median nerve sensory (index finger-wrist) conduction velocity decreased significantly (p=0.001) while the right median sensory nerve (index finger-wrist) distal latency increased significantly (p=0.007) the DM group compared to the acromegaly group. No significant difference was found between hypothyroid and acromegaly groups in electrophysiological findings (p>0.05). Comparison of electrophysiological findings between the patient groups and the control group was demonstrated in [Table/Fig-3].

Comparison of the presence of CTS between the groups

The incidence of CTS was higher in all three patient groups compared to the control group (p=0.001). In addition, the incidence of CTS was significantly higher in the DM group compared to the hypothyroid and acromegaly groups according to the paired comparison results (p=0.001 versus p=0.024, respectively). The statistical analysis of incidence did not show any significant difference between hypothyroid and acromegaly groups (p>0.05) [Table/Fig-4]. There was no significant difference in the incidence of bilateral CTS between the acromegaly and hypothyroid groups. However, the incidence of bilateral CTS was significantly higher in the DM group compared to the hypothyroid (p=0.002) and acromegaly groups (p=0.048). The incidence of bilateral CTS was significantly higher in all three groups compared to the control group (p=0.001).

Comparison of the disease duration between the groups

Duration of disease was longer in the DM group (mean 8.24±5.84 years) compared to the acromegaly (mean 3.89±2.80 years) and hypothyroid (mean 5.26±3.73 years) groups (p=0.001). There was no significant difference between acromegaly and hypothyroid groups in duration of disease (p=0.075). In addition, patients with CTS either in the right or left hand had longer duration of disease (mean 9.24±6.22 years) compared to those without CTS (mean 5.65±3.96 years) in the DM group (p=0.012). On the other hand, there was no significant difference in duration of disease between patients with CTS and without CTS in acromegaly (p=0.207) and hypothyroid groups (p=0.473).

DISCUSSION

CTS is one of the most common musculoskeletal system disorders. It is characterized by the compression of a nerve originating from the back of the elbow and anterior aspect of the wrist to the hand under a ligament at the wrist level [4]. It usually causes numbness

and tingling radiating to fingers. Numbness and tingling are accompanied by pain and loss of strength in time [5]. Symptoms and findings of the patient are important for diagnosis of CTS. These findings should be confirmed by electrophysiological studies. Nerve conduction study is the most precise diagnostic test for CTS; however, nerve conduction studies were reported to be normal in 22% of the patients who were definitely diagnosed with CTS in the clinic setting [19].

Neuropathies account for the most common late-term complications of diabetes and affect 50% of the diabetic patients [20,21]. Diabetic neuropathy is defined as a finding of peripheral nerve dysfunction in a diabetic patient without any other causes that can explain the neural involvement [21]. Minimum two of peripheral nerve dysfunction symptoms, pathologic electrophysiological findings, pathological quantitative sensorial tests or pathological quantitative autonomic tests should be present for diagnosis of diabetic polyneuropathy. One of the two studies must be either an electrophysiological study or a quantitative test [21,22]. Patients with polyneuropathies were excluded from the present study.

In this study, the electrophysiological study of the DM group showed that right and left median motor distal latency increased significantly compared to the control group while the left median motor conduction velocity (wrist-elbow) decreased significantly compared to the control group. In addition, right and left median nerve CMAP amplitude values were lower in the DM group compared to the control group. Furthermore, as to the comparison of median nerve sensory conduction between the groups, right and left median nerve (index finger-wrist) sensory conduction velocity decreased whereas right and left median sensory nerve (index finger-wrist) distal latency increased and right and left median nerve (index finger-wrist) SNAP amplitude decreased significantly in the DM group compared to the control group. In addition, CTS was positive in 71.2% of the DM patients. In their study, Pandey et al., reported 14% CTS rate in DM patients [23]. Chammas et al., on the other hand, reported 15% to 25% CTS rate in their study in which they included Type 1 and Type 2 DM patients [9]. It was claimed in the previous studies that this rate might positively correlate with the duration of disease and age [9]. The relatively high CTS rate found in the present study might be explained by the prolonged duration of disease and age. Moreover, occupational factors and the fact that majority of people in this area were engaged with agriculture and horticulture might have caused CTS rate to rise.

Hypothyroidism is usually an important risk factor for CTS [24]. The most common nerve conduction abnormality among patients with newly diagnosed hypothyroidism occurs mainly in the sensorial nerves including primarily the sural nerves [25,26]. In their study, Yuksel et al., demonstrated that the median motor and sensory nerves were affected the most compared to other nerves among 22 hypothyroid patients according to the electrophysiological study findings [27]. In another study, Somay et al., found that sensory nerves were mostly affected among 19 hypothyroid patients according to the nerve conduction studies [28]. In the present study, paired comparison of hypothyroidism group with the control group revealed that right and left median sensory nerve conduction velocity decreased, distal latency increased and SNAP values decreased significantly in the hypothyroid group compared to the control group. Therefore, we are of the opinion that entrapment neuropathies can be detected at an early stage by means of electrophysiological studies even if the patient does not present with any neurological or clinical symptom because entrapment neuropathies usually involve upper limbs in hypothyroid patients [29]. Kececi et al., demonstrated CTS in 37,5% of 44 patients who were newly diagnosed with hypothyroidism and were not on hormone replacement therapy [29]. In this study, we found CTS in 32,5% of the hypothyroid patients, which was in agreement with the literature data and with the results of the study performed by Kececi et al.

Acromegaly is a condition caused by excessive secretion of growth hormone due to the pituitary adenoma. As a result, oedema or excessive growth occurs in the skeletal tissues or other tissues such as soft tissue, synovial membrane, ligaments, periosteum and cartilage [4,30]. Peripheral neuropathy develops due to the compression of a peripheral nerve around the growing muscle and skeletal system or due to oedema. Kameyama et al., demonstrated CTS findings in 81% of the asymptomatic acromegaly patients by means of electromyography studies [30]. In the present study, we found CTS in 50% of the acromegaly patients. Furthermore, we found that right and left median nerve (index finger-wrist) SNAP values decreased significantly in the acromegaly group compared to the control group.

In this study, CTS was more prevalent among the DM, hypothyroid and acromegaly groups compared to the control group, which might be explained by the metabolic and structural damage caused by these diseases. CTS incidence was higher in the DM group compared to the hypothyroid and acromegaly groups, which might have been caused by the increased osmotic pressure arising from intracellular sorbitol accumulation in the DM group, resulting in oedema and hydropic degeneration [31]. Indeed, high incidence of bilateral CTS among these patients reinforces this probability. Similarly, changes that took place in the vaso nervorum in the DM group might be important risk factors for CTS [32].

CONCLUSION

CTS can be detected at an early stage by means of electrophysiologicalstudies even if the patient does not present with any neurological or clinical symptom. It can occur bilaterally rather in DM patients than hypothyroid and acromegaly patients. Endocrinologists are advised to be mindful of the potential development of CTS in DM, hypothyroid and acromegaly and take necessary precautions against the risk of CTS together with the physiatrist even in patients without noteworthy symptoms that might lead to consideration of neuropathy.

REFERENCES

[1] Sung-Bom P, Woohyun S, Seung-Don Y. Slowed conduction velocity of the median sensory nerveacross the carpal tunnel in normal adults. *Am J Phys Med Rehabil*. 2005;84:598-603.

[2] Bagatur AE. Karpal Tünel Sendromu. *Ortopedi Travmatoloji Derg*. 2006;2:52-63.

[3] Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosen I. Prevalence for clinically proved carpal tunnel syndrome is 4 percent. *Lakartidningen*. 2000;97:1668-70.

[4] Stevens JC, Beard CM, O'Fallon WM, Kurland LT. Conditions associated with carpal tunnel syndrome. *Mayo Clin Proc*. 1992;67(6):541-48.

[5] Tunç T, Kutlu G, Coskun Ö, Okuyucu E, Çavdar L, Inan LE. Karpal tünel sendromunda klinik ve elektrofizyolojik karsılastırılması. *ADÜ Tıp Fakültesi Dergisi*. 2006;7(2):23-26.

[6] Dyck PJ, Kratz KM, Karnes JL, Litchy WJ, Klein R, Pach JM, et al. The prevalence by staged severity of various types of diabetic neuropathy in a population-based cohort: The Rochester Diabetic Neuropathy Study. *Neurology*. 1993;43:817.

[7] Heecheon Y, Zachary S, Andres F, Mılınd JKD, Sanjıv HN. Relationship between symptom severity scales and nerveconduction measures in carpal tunnel syndrome. *Muscle Nerve*. 1999;22497-501.

[8] Mondelli M, Giannini F, Giacchi M. Carpal tunnel syndrome incidence in a general population. *Neurology*. 2002;58:289-94.

[9] Chammas M, Bousquet P, Renard E, Poirier JL, Jaffiol C, Allieu Y. Dupuytren's disease, carpal tunnel syndrome, trigger finger and diabetes mellitus. *J Hand Surg*. 1995;20A:109-14.

[10] Alp R, Sargın H, Bulut G, Sargın M, Börü ÜT, Yayla A. Tip 1 diabetlilerde periferik nöropati ve semptomatik karpal tünel sendromu sıklıgı. *Kartal Egitim ve Arastırma Hastanesi Tıp Dergisi*. 2004;15(2):67-89.

[11] Baum Baum H, Ludecke DK, Herrmann HD. Carpal tunnel syndrome and acromegaly. *Acta Neurochir (Wien)*. 1986;83:54-55.

[12] Nabarro JDN. Acromegaly. *Clin Endocrinol (Oxf)*. 1987;26(4):481-512.

[13] Kasem AA, Fathy SM, Shahin DA, Fikry AA. Carpal tunnel syndrome in hypothyroid patients: The effect of hormone replacement therapy. *AJIM*. 2014;2(3):54-58.

[14] Duyff RF, Van den Bosch J, Laman DM, van Loon BJ, Linssen WH. Neuromuscular findings in thyroid dysfunction: a prospective clinical and electrodiagnostic study. *J Neurol Neurosurg Psych*. 2000;68:750–55.

[15] Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, Fossel AH, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg Am*. 1993;75:1585–92.

[16] Denys EH. AAEM minimonograph #14: The influence of temperature in clinical neurophysiology. *Muscle Nerve*. 1991;14:795–811.
[17] Baysal A, Kuruoglu R, Beyazova M, Babacan G, Bilir E, Tan J, et al. Normal populasyonda sinir iletimi degerleri. *Ege Norolojik Bilimler Dergisi*. 1989;6:9–15.
[18] Padua L, Lo Monaco M, Padua R, Gregori B, Tonali P. Neurophysiological classification of carpal tunnel syndrome: Assessmentof 600 symptomatic hands. *Ital Neurol Sci*. 1997;18:145-50.
[19] Witt JC, Hentz JG, Stevens JC. Carpal tunnel syndrome with normal nerve conduction studies. *Muscle Nerve*. 2004;29:515-22.
[20] Boulton AJM, Arezzo JC, Malik RA, Sosenko JM. Diabetic somatic neuropathies. *Diabetes Care*. 2004;27:1458-86.
[21] Çelik M, Barkut K, Pazarcı NK, Taspınar S. Karpal tünel sendromu klinik tanılı diabetic hastalarda elektrofizyolojik bulgular. *Istanbul Üniversitesi Istanbul Tıp Fakültesi Dergisi*. 2006;69(3):70-74.
[22] Dyck PJ. Severity and staging of diabetic polyneuropathy. In Gries FA, Cameron NE, Low PA, Ziegler D. (Eds.) *Diabetic Neuropathy*. Thieme, Stutgart, Germany. 2003; pp. 170-75.
[23] Pandey A, Usman K, Reddy H, Gutch M, Jain N, Qidwai S. Prevalence of hand disorders in type 2 diabetes mellitus and its correlation with microvascular complications. *Ann Med Health Sci Res*. 2013;3(3):349-54.
[24] Palumbo CF, Szabo RM, Olmsted SL. The effects of hypothyroidism and thyroid replacement on the development of carpal tunnel syndrome. *J Hand Surg Am*. 2000;25(4):734-39.
[25] Beghi E, Delodovici ML, Bogliun G, Crespi V, Paleari F, Gamba P, et al. Hypothyroidism and polyneuropathy. *J Neurol Neurosurg Psychiatry*. 1989;52:1420-23.
[26] Arıkanoglu A, Altun Y, Uzarı E, Acar A, Çevik MU Demircan F, et al. Klinik ve subklinik hipotiroidili hastalarda median ve ulnar sinirin elektrofizyolojik incelemeleri: olgu kontrol çalısması. *Nöropsikiyatri Arsivi*. 2012;49:304-07.
[27] Yuksel G, Karlıkaya G, Tanrıdag T, Us O, Akyuz G. Nerve conduction studies, SEP and Blink Reflex studies in recently diagnosed, untreated thyroid disease patients. *J Neurol Sci (Turkish)*. 2007;24:7-15.
[28] Somay G, Oflazoglu B, Us O, Surardamar A Neuromuscular status of thyroid diseases: a prospective clinical and electrodiagnostic study. *Electromyogr Clin Neurophysiol*. 2007;47:67-78.
[29] Kececi H, Degirmenci Y. Hormone replacement therapy in hypothyroidism and nerve conduction study. *Neurophysiol Clin*. 2006;36:79-83.
[30] Kameyama S, Tanaka R, Hasegawa A, Tamura T, Kuroki M. Subclinical carpal tunnel syndrome in acromegaly. *Neurol Med Chir*. 1993;33:547-51.
[31] Clements, R. A Diabetic neuropathy—new concepts of its etiology. *Diabetes* 1979;28:604-11.
[32] Kulick RG. Carpal tunnel syndrome. *Orthopedic Clinics Of North America*. 1996;27(2): 345-54.

PARTICULARS OF CONTRIBUTORS:
1. Faculty, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Dicle University, Diyarbakir, Turkey.
2. Faculty, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Sakarya University, Sakarya, Turkey.
3. Faculty, Department of Endocrinology, Faculty of Medicine, Dicle University, Diyarbakir, Turkey.
4. Faculty, Department of Neurology, Faculty of Medicine, Dicle University, Diyarbakir, Turkey.
5. Faculty, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Dicle University, Diyarbakir, Turkey.
6. Faculty, Department of Biostatistics, Faculty of Medicine, Dicle University, Diyarbakir, Turkey.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Pelin Oktayoglu,
Dicle University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Diyarbakir-21280, Turkey.
E-mail: plnftr@hotmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jan 21, 2015**
Date of Peer Review: **Apr 27, 2015**
Date of Acceptance: **May 12, 2015**
Date of Publishing: **Jun 01, 2015**