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Research Article

Nerve Conduction Studies and Measurement of Median Nerve Cross-Sectional Area in Patients Newly Diagnosed with Hypothyroidism

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Abstract

Aim: This study aimed to investigate the rate of carpal tunnel syndrome (CTS) and polyneuropathy in patients with new-diagnosed hypothyroidism and the relationship between median nerve conduction and the cross-sectional area of the median nerve by ultrasonography.

Material and Methods: It was a prospective, cross-sectional and case-control study. This study included thirty-five new-diagnosed hypothyroidism cases and thirty-five healthy controls. Bilateral sensory and motor nerve potentials were noted in the lower and upper extremities. The cross-sectional area of the median nerve was examined at the entrance of the CT with the axial plan by ultrasonography. The relationship between the cross-sectional areas of the median nerve and nerve conduction parameters was investigated.

Results: CTS was determined electrophysiologically in 8 (22.9%) patients. The control group had no CTS. There was no significant electrophysiological finding to support polyneuropathy in the patients. The cross-sectional areas of the median nerve were higher in the patient group but did not reach statistically significant ($p>0.05$). There was a positive correlation between the right and left cross-sectional area of median nerves and body mass index (BMI) ($p<0.05$).

Conclusion: The rate of CTS is high in patients with newly diagnosed hypothyroidism. There is a positive correlation between cross-sectional nerve areas and BMI. There was no significant correlation between nerve conductions and median nerve ultrasonographic cross-sectional areas.

Keywords: Nerve conduction, hypothyroidism, neuropathy, ultrasonography

INTRODUCTION

Hypothyroidism can cause a variety of neurological signs and symptoms. Hypothyroidism can involve both the central and peripheral nervous systems. In hypothyroid patients, proximal muscle weakness and peripheral neuropathy (numbness, paresthesia, and hypoesthesia) may develop. Some studies report carpal tunnel syndrome as the most common neuropathy associated with hypothyroidism (1). Again, some other studies suggest that primarily sensorimotor axonal polyneuropathy is the primary pathology (2-4). However, there are also studies speculating that there is a demyelinating affection rather than axonal neuropathy (5,6).

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Ultrasonography (US) can be used as a supportive method in diagnosing entrapment neuropathies, detecting the level of entrapment, and determining the etiology of entrapment. It may also contribute to the planning and follow-up of treatment (7).

Our study aimed to evaluate the degree of entrapment neuropathy or polyneuropathy (PNP) with nerve conduction studies (NCS) in newly diagnosed hypothyroid patients and to measure the median nerve cross-sectional areas by US in the carpal tunnel and to examine the correlation with electrophysiological parameters.

MATERIAL AND METHOD

This study was approved by the ethics committee of Selcuk University (No: 2019/04)

Participants and ethical procedure

Our study included 35 patients of both sexes, aged between 18-60, who applied to the endocrinology outpatient clinic of the Selcuk University Medical Faculty Hospital and were diagnosed with clinical hypothyroidism and had not yet been treated. As the control group, 35 healthy individuals who were similar in age and gender without any medical disease or drug use were included. Serum-free T4 (fT4) and thyroid-stimulating hormone (TSH) levels of the patients and control group were measured. Normal serum concentration ranges of TSH and fT4 were taken as 0.27–4.2 mU/L and 0.93–1.7 ng/dL, respectively. Healthy individuals with TSH and fT4 in this range were included in the control group. Patients with increased TSH and low fT4 levels were considered to have clinical hypothyroidism.

Sociodemographic data of the patients before the study were recorded in patient evaluation form as the weight, height, and body mass index (BMI). The backgrounds of the participants were questioned in detail, and the drugs they used, their history of operation, and known diseases were learned.

Pregnant women, those with vitamin B12 deficiency, kidney and liver disease, diabetes mellitus, alcoholism, use of drugs known to cause neuropathy or myopathy, malignancy, heart failure, and a personal or family history of neuropathy or neuromuscular disease were excluded from the study.

Nerve conduction studies and evaluations

Electrophysiological studies were performed by the same person with the Nihon Kohden Corporation Model MEB-9200K (Japan, 2005) EMG device according to the guidelines of the American Society for Electrodiagnostic Medicine (8). Motor-sensory nerve conduction and delayed responses of the cases and controls were recorded in the electrophysiology laboratory with a standard protocol. NCS bilateral median, ulnar sensory, and motor in the upper extremities; bilateral sural sensory, tibial, and peroneal nerve motor conduction studies were performed in the lower extremities. Recorded parameters: motor nerve-associated compound muscle action potential (CMAP) amplitude and areas, terminal and proximal latencies, and conduction velocities; sensory nerve action potential (SNAP) onset latency, amplitude, area, and conduction velocities were determined. Reflex responses: At least ten consecutive stimulations were given, and the right median F responses in the upper extremity and the left Tibialis F responses in the lower extremities were recorded. F responses minimum (Fmin) latencies were evaluated. Normative data were created prospectively from the lower and upper extremities of 35 healthy, age- and gender-matched individuals without any neurological or medical disease or drug use, using the same protocol, or adapted from similar literature3. Patients diagnosed with CTS electrophysiologically were grouped as mild, moderate, and severe according to their findings. Mild CTS: Reduced median sensory distal conduction velocity and/or decrease the sensory potential amplitude below normal. Moderate CTS: Extension of the distal latency of the median motor nerve in addition to the findings mentioned above. Severe CTS: It was often determined as the absence of sensory potential and a decrease in the normative values of motor response amplitude below 2 SD or prolongation of its latency (8-10).

The conduction velocity slows down more than 30% from the lower limit of the normal value in more than two motor and sensory nerves, except for the entrapment regions, distal latencies being above 150% of the normal upper limits, and acquired in significant conduction blocks was evaluated as demyelinating polyneuropathy; when there was a slight slowdown in conduction velocities, a slight prolongation of latencies, and a decrease in amplitudes in the foreground, it was evaluated as axonal polyneuropathy (11).

Ultrasonography examination

Nerve diameters were determined by US in terms of median nerve entrapment in both upper extremities by a person blinded to the results of NCS. The cross-sectional areas of the median nerve in the carpal tunnel were measured by the US and it was evaluated whether there was an increase in nerve thickness. Cross-sectional area measurement with median nerve US was performed as mentioned; while the patient was in the sitting position, the upper extremity arm on the measuring side was at semiflexion on the elbow, the forearm was positioned in supination, the fingers were semi-flexed, the wrist was on a flat surface, the probe was in the axial position at the entrance of the carpal tunnel. In order to increase the accuracy of the measurement, the hypoechoic inner border was measured by leaving the hyperechoic epineurium outside. During the measurement, care was taken not to apply pressure to the skin as much as possible with the probe, thus, not to measure the diameter of the nerve shorter (12). EsaoteMyLab Twice device 12 MHz linear probe was used for measurements, and area measurements were calculated by the device.

Statistical Analysis

The research data were analyzed using the SPSS (Statistical Package for Social Sciences v 22.0) software. Number, percentage, mean, and standard deviation were used as descriptive statistical methods. An independent sample t-test was conducted to compare continuous quantitative data between two independent groups. Categorical data were compared with Chi-square or Fisher's exact test. Relationship analyses between parameters were tested with Pearson correlation. $p<0.05$ was significant.

RESULTS

There were 30 (85.7%) females and 5 (14.3%) males in the patient and control groups. The mean age and height of the groups were similar ($p>0.05$). Although weight and BMI values were slightly higher in hypothyroid patients, this difference was not statistically significant ($p>0.05$) (Table 1).

Table 1. Patient and control group demographics, body mass index, and thyroid function tests mean and standard deviations

	Hypothyroid group (n = 35)	Control group (n = 35)	t	p
Age	37.40±10.88	37.80±10.35	0.16	0.88
Height	1.64±0.09	1.66±0.07	1.37	0.18
Weight	77.97±16.30	76.83±10.36	-0.35	0.73
BMI	29.11±6.04	27.75±3.46	-1.16	0.25
TSH	8.42±5.30	2.13±1.06	-6.89	**0.001**
T4	0.98±0.24	1.24±0.19	5.18	**0.001**
Female	30 (85.7%)	30 (85.7%)	X^2=0.00	p=0.63
Male	5 (14.3%)	5 (14.3%)		

TSH = Thyroid stimulating hormone, BMI=Body mass index, n=number, %=percent

Eight (22.9%) of 35 patients had CTS electrophysiologically, and 4 of them were bilateral. One of these patients had moderate CTS, and 7 had mild CTS. Severe CTS was not determined.

No significant electrophysiological abnormality was noted to support polyneuropathy. In general, the evaluation did not reach the level to confirm the definitive diagnosis of polyneuropathy, but there were isolated mild abnormalities in the subgroup analyses.

The cross-sectional area of the median nerve was higher in the hypothyroid group. Still, it did not reach a statistically significant difference ($p=0.06$ for the right median nerve, $p=0.26$ for the left median nerve) (Table 2).

Table 2. Comparison of ultrasonographic cross-sectional areas in the patient and control groups

	Control group (n = 35)	Hypothyroid group (n = 35)	t	p
Right median	7.66±1.60	8.33±1.34	-1.90	0.06
Left median	7.76±1.79	8.21±1.56	-1.14	0.26

A significant positive correlation was found between BMI and nerve cross-sectional areas. There was a significant positive correlation between BMI and right median ultrasonographic nerve cross-sectional area (UNCA) ($p=0.001$, $r=0.378$) and between BMI and left median UNCA ($p=0.002$, $r=0.363$).

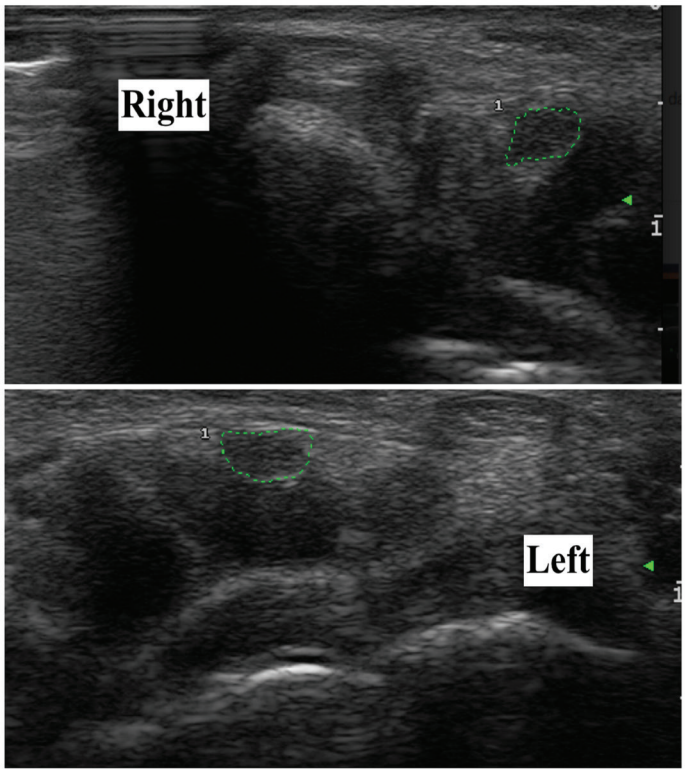

Figure 1. It shows a cross-section area of the right and left median nerve with wrist level gray scale ultrasound (dot lines indicate median nerve)

A slightly significant positive correlation was determined between left median sensory latency and left median UNCA ($p=0.008$, $r=0.314$) and between right median sensory latency and right median UNCA ($p=0.007$, $r=0.321$). There was also a slightly significant negative correlation between right median sensory conduction velocity and right median UNCA ($p=0.001$, $r=-0.380$) (Table 3).

Table 3. Correlation analyzes of nerve conduction and ultrasonographic cross-sectional areas

		Right median nerve	Left median nerve
sMLleft	r	0.335	0.314
	p	0.005	**0.008**
sMLright	r	0.321	0.290
	p	**0.007**	0.015
sMIHright	r	-0.380	-0.292
	p	**0.001**	0.014

sML = median sensory latency, sMIH = median sensory conduction velocity

No significant correlation was determined between TSH and T4 and NCS and other parameters.

DISCUSSION

The main result of our study is the presence of CTS with a high rate in newly diagnosed hypothyroid cases, but it supports that no significant PNP has developed, electrophysiologically. In studies on newly diagnosed hypothyroidism, CTS has been reported with a frequency of 16-55% (3,13). In the study of Asia et al., CTS was detected in 5 (19%) of 26 patients newly diagnosed with hypothyroidism. They suggested hypothyroidism predisposes to CTS via segmental demyelination by affecting Schwann cells (14). In our study, CTS was determined electrophysiologically in 8 (22.9%) of the patients. In 50% of these, the findings were compatible with bilateral CTS. The incidence of CTS in patients newly diagnosed with hypothyroidism varies. This may be related to the variable time elapsed between the onset of hypothyroidism and diagnosis. In addition, it may be caused by the differences in demographic characteristics such as age, gender, occupation and BMI of the cases in the study population. Study populations are small samples, large-scale studies are needed for clearer results. Moreover, CTS is a common medical condition, and its incidence increases in advanced age, independent of hypothyroidism. One of the factors limiting our study is the low number of cases.

US examination can be used as a supportive method in diagnosing entrapment neuropathies, determining the level of entrapment and the etiology of entrapment. It can contribute to the planning and follow-up of the treatment. Swelling of the nerve just proximal to the entrapment site can be demonstrated by US. The most commonly used ultrasonographic measurement method in carpal tunnel syndrome is nerve cross-sectional area measurement. Various studies have shown that the cross-sectional area of the median nerve is significantly higher in CTS patients than in the normal population (7). In our study, the cross-sectional area of the median nerve was higher in the hypothyroid group, but it did not reach a statistically significant level of difference. Slightly significant positive correlation between median sensory latencies and median UNCA in the correlation analyses of US and NCS; a slightly significant negative correlation was found with sensory conduction velocity. As Hamdy et al. reported (15), there was no high level of correlation. These findings suggest that US examination may contribute to the diagnosis of CTS in suspected cases of NCS.

USG evaluation in CTS may have some advantages over NCS. Other lesions, such as tenosynovitis, mass lesions and anatomical defects, which show similar symptoms to CTS, can be excluded by USG. Moreover, USG is inexpensive and includes a shorter examination time. There are authors recommending the use of USG as a first-line method in the diagnosis of CTS (16). Holovacova et al. showed that the increase in median nerve cross-sectional area caused by hypothyroidism and the clinical symptoms of CTS were completely reversible after TSH and T4 target levels were reached with thyroxine treatment. They speculated that monitoring the cross-sectional area of the median nerve with USG might prevent unnecessary surgery (7). There was a significant positive correlation between BMI and the right median ultrasonographic nerve cross-sectional area (UNCA) (p=0.001) and between BMI and the left median UNCA (p=0.002). The significant positive correlation between cross-sectional nerve areas and BMI is a distinguishing result of our study because there is no sufficient study in the literature. Our results can be speculated that the increase in BMI due to hypothyroidism may increase cross-sectional nerve areas, thus contributing to the development of entrapment neuropathy.

In studies of newly diagnosed hypothyroidism, electrophysiological findings of polyneuropathy were reported at a rate of 9-72% (3,13,17-19). Garget al. (18) detected electrophysiologically sensory-motor polyneuropathy in 10 (25%) of 40 patients with newly diagnosed hypothyroidism. Akarsu et al. (20) found no electrophysiological abnormality to support polyneuropathy in 31 patients with overt hypothyroidism and 139 patients with subclinical hypothyroidism. Similarly, no significant electrophysiological abnormality was found to support polyneuropathy in our study. Although a definitive diagnosis of polyneuropathy could not be carried out in the general evaluation, there were isolated mild abnormalities in the subgroup analyzes.

CONCLUSION

While our study reveals the presence of CTS with a high electrophysiological rate in newly diagnosed hypothyroid cases, it supports that no significant PNP has developed. The significant positive correlation between cross-sectional nerve areas and BMI can be speculated that the increase in BMI due to hypothyroidism may increase cross-sectional nerve areas, thus contributing to the development of entrapment neuropathy. In our study, the correlation between US cross-sectional areas and NCS suggests that it may contribute to and support the diagnosis of entrapment neuropathies.

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