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Research Paper

Assessment of the Carpal Tunnel Syndrome in Female Patients With Hypothyroidism

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ABSTRACT

Introduction: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy. There are several factors that influence the severity of CTS. The purpose of this study was to explore the severity of CTS in hypothyroid patients.

Methods: This cross-sectional study was conducted in the university clinic. Seventy-six participants with a clinically and electrophysiological confirmed diagnosis of CTS were included in the study. The demographic data and severity of CTS were analyzed based on the presence (n=38) or the absence (n=38) of primary hypothyroid disease. Thirty-eight hypothyroid patients who were being treated were included in this study. For the assessment of the severity of CTS, the Boston questionnaire (BCTQ) and electrodiagnostic tests were used. For data analysis, an independent sample t-test and chi-squared test were carried out. A $P<0.05$ was considered significant.

Results: The mean age of hypothyroid and non-hypothyroid CTS patients was 46.21±7.22 and 44.24±8.02 years, respectively. Body mass index (BMI) was >30 kg/m^2 in both groups. There was no significant difference in demographic data among the two groups. The mean score of symptom severity in hypothyroid and non-hypothyroid-CTS patients were 30.37±10.84 and 35.89±7.19, and also functional status was 21.71±9.04 and 25.92±6.62, respectively. There was a significant difference between the two groups, in terms of symptom severity scale (P=0.017, 95% CI, 31.14%, 35.48%) and functional status scale (P=0.023, 95% CI, 21.95%, 25.67%). In terms of electrophysiological findings, there was no statistically significant difference between these two groups.

Conclusion: The results of this study indicated that, contrary to expectation, the severity of CTS is higher in non-hypothyroid patients than in hypothyroid patients.

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Highlights

• There is a significant difference between hypothyroid and non-hypothyroid patients with carpal tunnel syndrome (CTS) in terms of symptom severity and functional status.

• The severity of CTS is higher in non-hypothyroid patients than in hypothyroid patients.

• There is no significant difference between hypothyroid and non-hypothyroid patients with CTS in terms of electrophysiological parameters.

Plain Language Summary

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, which is caused by median nerve compression in the wrist. The syndrome is diagnosed according to clinical symptoms, physical examination, and electrodiagnostic tests. There are several risk factors involved in causing this syndrome that comprises age, obesity, Diabetic Mellitus, rheumatoid arthritis, smoking, pregnancy, hypothyroidism, congenital anomalies and wrist injury. Evidence suggests that hypothyroidism is a significant predisposing factor for CTS. The purpose of this study was the assessment of the severity of CTS in hypothyroid patients. Overall, 76 female patients who were clinically and electrophysiologically confirmed to have CTS were included in the study. All participants filled out the Boston carpal tunnel questionnaire (BCTQ) to assess symptom severity and functional status for daily activities. Electrophysiological study was performed in bilateral hands. Of 76 patients, 38 patients had hypothyroidism and 38 participants were idiopathic CTS (without hypothyroidism). There was no significant difference between hypothyroid and non-hypothyroid-CTS patients in terms of age, duration of CTS, and BMI. The mean score of symptom severity scale and functional status scale was higher in non-hypothyroid-CTS than in hypothyroid-CTS patients. There was no significant difference in respect to electrophysiological parameter results in two groups. A possible explanation for unrelated clinical symptoms with electrodiagnostic grading in hypothyroidism patients may be the role of thyroid replacement therapy in reducing symptoms, regardless of its effect on electrodiagnostic parameters.

1. Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, caused by compression of the median nerve in the wrist (Nazish et al., 2019). King Fahd Hospital of University, Al-Khobar, Kingdom of Saudi Arabia from April 2017 to March 2018 and included 200 patients with CTS. Body parameters, such as blood pressure (BP). The prevalence of CTS varies among different populations. A recent study in Iran reported a prevalence of 1.82% for CTS in the general population (2.23% among females and 0.58% among males) (Moosazadeh et al., 2018). A hallmark of this disorder is pain, paresthesia, and burning along the pathway of the median nerve. In advanced stages, weakness and atrophy of the muscles in the thenar region develop, leading to difficulty in performing activities (Stevens et al., 1992). Diagnosis of the syndrome is based on clinical symptoms, physical examination, and electrodiagnostic tests (Karimi et al., 2021; Razavi et al., 2021). Several risk factors contribute to the development of CTS, including age, obesity, diabetic mellitus, rheumatoid arthritis, smoking, pregnancy, hypothyroidism, congenital anomalies, and wrist injury (Karimi et al., 2017; Moghtaderi et al., 2005). Evidence suggests that hypothyroidism is a significant predisposing factor for CTS, with reported prevalence rates ranging from 8.7% (Karimi et al., 2017) to 38.2% among CTS patients with subclinical hypothyroidism (Roshanzamir et al., 2016). Studies have indicated that most hypothyroid patients with CTS have mild forms of the syndrome, with none experiencing severe CTS (Asadi & Roshanzamir, 2017; Beghi et al., 1989; Karne & Bhalerao, 2016).

There are several theories regarding the pathogenesis of CTS, including alterations in fluid balance, dermal edema, excess deposition of glycosaminoglycans, hyaluronic, acid, and mucopolysaccharides in subcutaneous tissues, and dysfunction of myelin and axonal processes (Beghi et al., 1989; Karne & Bhalerao, 2016). Hypothyroidism is known to increase body mass index (BMI) and obesity and has been identified as an independent risk factor for CTS. However, the extent of CTS severity in hypothyroid patients remains unclear. To date, only a few studies have investigated the role of hypothyroidism

in CTS severity. Considering that the severity of clinical symptoms affects treatment outcomes, the aim of this study was to assess the severity of CTS in hypothyroid patients.

2. Materials and Methods

Study design

This retrospective cross-sectional study was conducted at the University Clinic Bagheban in Sari City, Mazandaran Province, Iran, from December 2018 to February 2020.

Setting and participants

All female patients who were referred to our electrophysiology clinic with clinical symptoms of CTS containing numbness, tingling, paresthesia, pain, burning feeling, and weakness in unilateral or bilateral hand or wrist, were examined (AANEM et al., 2002). After a physical examination, the electrodiagnostic test was done for confirmation of CTS. Due to the effect of occupation and gender on CTS, all contributors in this research were housewives and females. CTS patients ≥18 years old who had hypothyroid and were being treated with thyroxine were included in the study, along with patients with idiopathic CTS. Exclusion criteria included pregnancy, hyperthyroidism, diabetes mellitus, other endocrinal diseases, connective tissue diseases, arthritis, wrist fractures, renal and liver diseases, acromegaly, neuropathy, radiculopathy, and aforementioned CTS surgery.

Overall, 76 patients who had a clinically and electrophysiologically confirmed diagnosis of CTS were included in the study. All female patients presenting with clinical symptoms of CTS, including numbness, tingling, paresthesia, pain, burning sensation, and weakness in one or both hands or wrists, were evaluated at our electrophysiology clinic (AANEM et al., 2002). Following a physical examination, electrodiagnostic testing was performed to confirm the diagnosis of CTS. Given the influence of occupation and gender on CTS, all participants in this study were female housewives.

The study included CTS patients aged 18 years and older who had hypothyroidism and were undergoing treatment with thyroxine, as well as patients with idiopathic CTS. Exclusion criteria comprised pregnancy, hyperthyroidism, diabetes mellitus, other endocrine disorders, connective tissue diseases, arthritis, wrist fractures, renal and liver diseases, acromegaly, neuropathy, radiculopathy, and previous CTS surgery.

A total of 76 patients with clinically and electrophysiologically confirmed CTS were enrolled in the study.

Data sources and measurement

All participants completed the Boston carpal tunnel questionnaire (BCTQ) and provided demographic data including, age, educational level, affected hand, duration of the disease, weight, height, and BMI. BCTQ investigates the severity of patient's symptoms and their ability to perform daily tasks. It contains 19 questions (11 items related to the severity of symptoms and 8 items allied to functional ability). Each question is scored on a scale of five, ranging from no symptoms to very severe. The scores are totaled for each individual, with higher scores indicating more intense symptoms and disability (Levine et al., 1993). CTS severity was evaluated according to BCTQ and electrophysiological parameters. The electrodiagnostic test was conducted by a neurologist following the guidelines of the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM), using a Micromed MYOQUICK model electromyography apparatus (Jablecki et al., 2002). Electrophysiological findings were categorized into six grades, ranging from normal to extremely severe CTS, in accordance with the Bland neurophysiological grading scale (Bland, 2000). The parameters measured included peak latency, amplitude, and conduction velocity of the sensory median nerve, and distal latency, amplitude, and conduction velocity of the motor median nerve. Needle electromyography was performed on the abductor pollicis brevis muscle and other muscles in the upper limb to assess the severity of CTS and exclude brachial plexopathy or radiculopathy. electrodiagnostic results were considered abnormal if peak latency was >3.5 ms, base-to-peak amplitude was <20.0 μV, conduction velocity was <50 m/s studies, distal motor latency was >4.4 ms, base-to-peak amplitude was <4.0 mV, and nerve conduction velocity (NCV) was <49 m/s (Ali et al., 2012; Basiri & Katirji, 2015). Electrophysiological studies were performed on both hands, and the hand with the most severe electrophysiological findings was evaluated.

Statistical analysis

All analyses were performed using SPSS software, version 24. The one-sample Kolmogorov-Smirnov-test was used to test for normality; the results of this test indicated that parametric tests should be performed. Quantitative data were presented as Mean±SD, while qualitative data

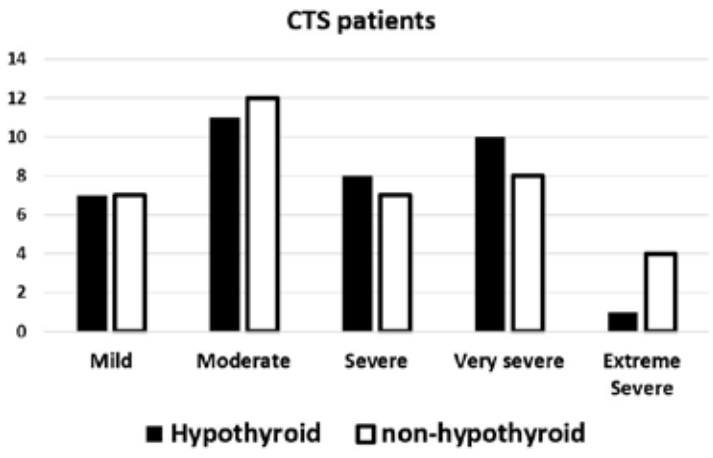

Figure 1. Electrodiagnostic grading according to Bland study in hypothyroid and non-hypothyroid CTS patients

were described in terms of frequency and percentage. An independent sample t-test was conducted to assess quantitative data between the two groups (electrodiagnostic parameter findings and severity of CTS according to Boston score in hypothyroid and non-hypothyroid patients). A chi-squared test was applied to assess the relationship between categorical variables and qualitative data. A $P<0.05$ was considered significant.

3. Results

Seventy-six patients with clinical and electrodiagnostic evidence of CTS were included in this study between December 2018 to February 2020, of whom 38 patients had hypothyroidism and 38 participants had idiopathic CTS (without hypothyroidism). The mean age of all patients was 45.02±7.74 years. Unilateral and bilateral CTS were in 26(34.2%) and 50(65.8%) patients, respectively. The patients had a BMI of 31.47±5.26 kg/m^2, with a minimum of 21.5 to a maximum of 45 kg/m^2. The mean durations of CTS and hypothyroidism were 29.61±32.29 and 98.93±64.19 months, respectively.

Comparison of CTS patients with and without hypothyroid disease

Thirty-eight of the CTS patients had hypothyroidism and 38 did not. There was no significant difference between hypothyroid and non-hypothyroid CTS patients in terms of age (46.21±7.22 years vs. 44.24±8.02 years, P=0.225), duration of CTS (31.89±32.13 and 28.24±32.60 months, P=0.609), and BMI (30.78±5.29 and 31.89±5.29 kg/m^2, P=0.326). Bilateral CTS was present in 24(63.2%) of the 38 patients with hypothyroidism and in 26(68.4%) of the 38 patients without hypothyroidism (P=0.22). The demographic and clinical characteristics of the study participants are presented in Table 1.

Comparison of the Boston questionnaire score in hypothyroid and non-hypothyroid-CTS patients

The mean score of the symptom severity scale (SSS) in hypothyroid CTS patients and non-hypothyroid CTS patients was 30.37±10.84 and 35.89±7.19, respectively. Similarly, the mean score of the functional status scale (FSS) was 21.71±9.04 and 25.92±6.62, respectively. There was a significant difference between the two groups in terms of SSS (P=0.017; 95% CI, 31.14%, 35.48%) and FSS (P=0.023; 95% CI, 21.95%, 25.67%) scores.

Comparison of the electrophysiological parameters in hypothyroid and non-hypothyroid CTS patients

The electrodiagnostic findings, such as median nerve sensory onset latency, peak latency, amplitude, and conduction velocity, as well as median nerve motor distal latency, amplitude, and conduction velocity, were measured in the involved hands of all participants. There was no significant difference in respect to electrophysiological parameter results between the two groups. The majority of participants in hypothyroid CTS and non-hypothyroid CTS had moderate CTS (29.70% and 34.51%, respectively). The chi-square test found no significant differences between the two groups according to Bland's grading of electrodiagnostic findings (Figure 1). The mean score was obtained for each electrophysiological parameter in hypothyroid and non-hypothyroid CTS

Table 1. Demographic characteristics of participants

Variables		Mean±SD/ No. (%)		P*
		Hypothyroid -CTS	Non-hypothyroid -CTS	
Age		46.21±7.2	44.24±8.1	0.225
Age group	18-29	0(0)	2(3.4)	
	30-39	6(15.7)	13(22.4)	
	40-49	15(39.4)	24(41.3)	
	50-59	17(44.73)	17(29.3)	
	≥60	0(0)	2(3.4)	0.160
Body parameters	Wight	78.97±14.1	82.72±14.4	0.225
	Height	160.0±0.4	161.0±0.5	0.127
	BMI	30.78±5.2	31.89±5.2	0.326
CTS sites	Bilateral	24(63.2)	26 (68.4)	
	Unilateral	14 (36.8)	12 (31.6)	0.220
Duration of CTS to month;		31.89±32.13	28.24±32.60	0.609

*p-value <0.05 is significant. SD= standard deviation; CTS=carpal tunnel syndrome

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patients (Table 2). No statistically significant difference was observed between these two groups.

The relationship between the electrodiagnostic grading and Boston score

To evaluate the relationship between electrodiagnostic grading and clinical symptoms, mild to moderate CTS cases were grouped separately from severe to extremely severe CTS cases. Independent t-test analysis revealed no statistically significant association between electrodiagnostic grading and SSS and FSS scores in the hypothyroidism group (Table 3). Conversely, there was a significant positive association between electrodiagnostic grading and clinical symptoms (P=0.01; 95% CI, 33.52%, 38.26%) as well as FSS (P=0.002; 95% CI, 23.74%, 28.09%) in non-hypothyroidism CTS patients. The results of this analysis are presented in Table 3.

Table 2. Electrophysiological parameters of the median nerve in hypothyroid and Non-hypothyroid-CTS patients

Median nerve Parameters	Mean±SD		P*
	Hypothyroid-CTS	Non-Hypothyroid-CTS	
Sensory peak Latency(ms)	3.75±2.33	3.07±2.19	0.322
Sensory amplitude (µv)	25.36±15.17	28.61±11.31	0.373
Sensory conduction velocity(m/s)	34.23±11.25	38.04±6.13	0.141
Motor distal latency(ms)	6.16±2.06	5.90±1.66	0.553
Motor amplitude (mv)	10.73±4.08	11.43±5.94	0.550
Motor conduction velocity (m/s)	55.67±4.97	55.98±6.26	0.

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* p-value <0.05 is significant. SD=standard deviation; CTS= carpal tunnel syndrome; ms=millisecond; µv=microvolt; m/s= meter/ second; mv= millivolt.

Table 3. Association between electrodiagnostic grading and clinical symptoms according to BCTQ

BCTQ	Hypothyroid-CTS			Non-Hypothyroid-CTS		
	Mild to moderate	Severe	P*	Mild to moderate	Severe	P*
SSS (SD)	28.27 (10.43)	33.47 (11.04)	0.15	33.05 (5.05)	38.73 (7.42)	0.01
FSS (SD)	19.32 (8.11)	24.42 (9.40)	0.08	22.21 (4.93)	29.63 (6.05)	0.002

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* P<0.05 is significant. SSS: symptom severity scale; FSS: functional status scale. BCTQ= Boston carpal tunnel questionnaire; CTS= carpal tunnel syndrome; SD=standard deviation

4. Discussion

Hypothyroidism is considered a risk factor for the development of CTS (Karimi et al., 2017; Farzan et al., 2012; Shiri, 2014) but the severity of CTS in hypothyroid patients undergoing treatment remains unclear. The aim of this study was to compare the severity of CTS between treated hypothyroid and non-hypothyroid patients. This study specifically targeted housewives to mitigate the confounding effect of gender and occupation on CTS. The mean age of hypothyroid and non-hypothyroid CTS patients was similar. Additionally, the mean BMI was above 30 kg/m^2 in both groups, consistent with previous research (Becker et al., 2002). Regarding demographic data, hypothyroid patients were comparable to non-hypothyroid patients. The study findings revealed that the clinical symptoms of CTS were more severe in non-hypothyroid patients compared to treated hypothyroid patients. This contradicts the findings of Asadi and Roshanzamir, who reported that the clinical symptoms of hypothyroid patients were more severe than those of non-hypothyroid patients (Asadi & Roshanzamir, 2017).

In our study, all of the hypothyroid patients were undergoing hormone replacement therapy. Therefore, treatment may effectively reduce the severity of patients' clinical symptoms. Kasem et al.'s study demonstrated the effectiveness of hormone replacement therapy in alleviating CTS symptoms (Kasem et al., 2014). In the present study, age and BMI in the hypothyroid and non-hypothyroid patients were comparable. Therefore, we believe that thyroxine replacement therapy may contribute to alleviating the severity of patients' clinical symptoms. Additionally, our study found no association between the severity of CTS based on electrophysiological findings in hypothyroid and non-hypothyroid CTS patients. These findings align with those of Asadi and Roshanzamir's study (Asadi & Roshanzamir, 2017).

This study showed that although hypothyroidism is considered a possible risk factor for CTS in previous research (Cruz et al., 1999; El-Salem & Ammari, 2006), there is no evidence to suggest that hypothyroidism influences the severity of electrophysiological parameters. Regarding the correlation between clinical symptoms and electrodiagnostic grading in CTS, our findings indicated that the severity of clinical symptoms and functional impairment, as assessed by the Boston score, is more closely associated with the grading of the electrodiagnostic test in non-hypothyroid CTS patients. Surprisingly, this relationship was not observed in hypothyroidism patients. This finding aligns with that of Asadi and Roshanzamir who found no relationship between clinical symptoms and electrodiagnostic findings in patients with hypothyroidism (Asadi & Roshanzamir, 2017). These results could be explained by the possibility that the severity of clinical symptoms is directly related to median nerve damage. Furthermore, the lack of correlation between clinical symptoms and electrodiagnostic grading in hypothyroid patients may be attributed to the role of thyroid replacement therapy in symptom reduction, regardless of its impact on electrodiagnostic parameters. Aldaghri et al. reported that more than two-thirds of individuals with hypothyroidism were asymptomatic, and the presence of thyroid abnormality did not affect the duration of CTS (Aldaghri et al., 2020).

5. Conclusion

The results of this study suggest that the severity of CTS may be higher in non-hypothyroid patients compared to hypothyroid patients. Thus, it can be inferred that thyroid replacement therapy plays a role in reducing clinical symptoms. This warrants further investigation in future research.

Ethical Considerations

Compliance with ethical guidelines

The present study was approved by the Ethics Committee of Mazandaran University of Medical Sciences (Code: 5.7.96).

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Authors' contributions

Conceptualization and supervision: Narges Karimi, Ozra Akha and Javad Rezaeifard; Methodology: Narges Karimii; Data collection: Narges Karimi and Ozra Akha; Data analysis: Narges Karimi and Javad Rezaeifard; Funding acquisition and resources: Narges Karimi; Investigation and writing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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