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"Assessment of Peripheral Nerve Conduction in Hypothyroid Patients versus Healthy Volunteers: A Comparative Analysis"

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ABSTRACT

Introduction: The central nervous system frequently experiences effects in patients with hypothyroidism, prompting the development of various assessment tools. Nerve conduction studies are among these tools. This study aimed to compare nerve conduction studies between patients with hypothyroidism and healthy volunteers.

Materials and Methods: This study included 54 patients with hypothyroidism (cases) and 54 healthy volunteers (controls). Motor and sensory nerve conduction studies were performed bilaterally on the median and ulnar nerves in the upper limbs. Motor nerve conduction studies involved assessing distal motor latencies, motor nerve conduction velocity (NCV), and compound muscle action potentials' amplitude. Sensory nerve conduction studies included determining sensory NCV and amplitude of sensory nerve action potentials.

Results: The average age of patients with hypothyroidism was 40.46 ± 6.21 years, while volunteers' average age was 38.16 ± 3.35 years. Independent Student's t-tests revealed

statistically significant differences in median nerve conduction velocities and amplitude between the two groups. The study's findings indicate significant impairments in nerve conduction in patients with hypothyroidism compared to healthy volunteers, with more pronounced effects observed in the median nerve than in the ulnar nerve.

Conclusion: In conclusion, our study affirms the existence of neuropathy in patients with hypothyroidism, highlighting the utility of nerve conduction studies as a reliable tool for its assessment. However, a more comprehensive study involving a larger sample size of patients with hypothyroidism is necessary to arrive at a definitive conclusion.

Key Words: Nerve Conduction, Hypothyroidism, Neuropathy, Ulnar nerve, Median nerve.

INTRODUCTION

The thyroid gland stands as one of the largest endocrine glands within our body, responsible for secreting two crucial hormones: thyroxine (T4) and triiodothyronine (T3). These hormones exert their effects through the thyroid hormone receptors α and ß, playing vital physiological roles across numerous organs and tissues. Hypothyroidism, a condition marked by insufficient synthesis and secretion of thyroid hormone, poses challenges in meeting the brain and peripheral tissues' hormone requirements. The estimated incidence of hypothyroidism is around 4–5 per 1000 population annually for women and 0.6–0.9 per 1000 population annually for men, with overt hypothyroidism prevalent in approximately 1–2% of women and 0.1% of men. Causes of hypothyroidism may include autoimmune disorders, thyroid surgery, radiation therapy, pituitary disorders, or iodine deficiency, with iodine deficiency being the most common cause [1,2].

Neurological complications associated with hypothyroidism encompass neuropathy, carpal tunnel syndrome, myopathy, dementia, psychosis, cerebellar syndrome, and even coma. Peripheral neuropathy stands as one manifestation of hypothyroidism, with its development being insidious and requiring a prolonged duration for clinical manifestations to become apparent [1,2].

Studies have reported both mononeuropathy and polyneuropathy in individuals with hypothyroidism [3]. Mononeuropathy involves mucinous deposits that compress nerves and cause nerve damage, often detectable through nerve conduction velocity (NCV) studies. Some studies have highlighted the primary involvement of the myelin sheath [4-6]. While hypothyroidism impacts all peripheral nerves, the median nerve is frequently affected, leading to carpal tunnel syndrome [1]. Sensory nerve conduction deficits are more prominent in the early stages of neuropathy, with clinical symptoms including pain, cramps, and paraesthesia in the fingers and limbs. Earlier research has established that thyroid hormone enhances peripheral nerve reflexes' speed and amplitude. This study aimed to compare nerve conduction studies between patients with hypothyroidism and healthy volunteers.

MATERIAL AND METHODS

The study involved 54 patients with hypothyroidism and 54 healthy volunteers. Exclusion criteria included pregnant females, individuals with past or family history of neuropathy or neuromuscular diseases, alcoholism history, kidney and liver diseases, diabetes mellitus (DM), use of drugs causing neuropathy or myopathy, and serious illnesses like cardiac failure or HIV infection.

Participants were thoroughly informed about the study's purpose, procedures, and potential benefits, and their informed written consent was obtained. Nerve conduction studies were conducted using the MEDICARE EMG recorder. Standardized protocols were followed for the electrodiagnostic procedure, including motor and sensory nerve conduction studies. Patients were positioned comfortably in a supine position, and skin preparation was conducted before electrode application for optimal contact.

Motor and sensory nerve conduction studies were performed bilaterally on the median and ulnar nerves in the upper limbs. Motor nerve conduction studies involved assessing distal motor latencies, motor nerve conduction velocity (NCV), and compound muscle action potentials' amplitude. Sensory nerve conduction studies included determining sensory NCV and amplitude of sensory nerve action potentials.

Data were collected as per the study protocol and entered into a Microsoft Office Excel database. Statistical analysis was conducted using SPSS software, employing unpaired t-tests and chi square test for various analyses. A significance level of $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 presents the demographic characteristics of the study population, illustrating that both cases and controls exhibited comparable features.

Table 2 displays a comparative analysis of conduction velocities (measured in milliseconds) between cases and controls. Hypothyroid cases showed significantly reduced sensory and motor conduction velocities compared to the healthy control group. However, there were no significant differences observed in sensory and motor conduction velocities in the ulnar nerve between the two groups.

Table 3 illustrates a comparison of distal latency between cases and controls, indicating no significant differences in these parameters between the groups.

Table 4 presents a comparison of nerve conduction amplitudes (measured in milliamperes) between cases and controls. Sensory and motor conduction amplitudes were significantly lower in hypothyroid cases compared to healthy controls. Nonetheless, there were no significant

differences observed in sensory and motor conduction amplitudes in the ulnar nerve between the groups.

Figure 1 visually represents the graphical comparison of significantly different parameters in median nerve conduction between hypothyroid cases and controls.

Table 1: Demographic details of study population

Variable	Hypothyroid cases (n=54)	Controls (n=54)	p value
Age	40.46 ± 6.21	38.16 ± 3.35	0.78
Gender			
Males	34 (62.97%)	31 (57.41%)	0.91
Females	20 (37.03)	23 (42.59%)	

Table 2: Comparison of conduction velocities (ms) in study groups

Parameter	Hypothyroid cases (n=54)	Controls (n=54)	p value
Median motor	48.45 ± 8.14	56.07 ± 4.86	<0.001
Median sensory	52.22 ± 5.58	62.64 ± 10.34	<0.001
Ulnar motor	56.02 ± 3.82	61.47 ± 6.79	0.31
Ulnar sensory	59.94 ± 8.64	61.45 ± 8.93	0.74

Table 3: Comparison of distal latency in study groups

Parameter	Hypothyroid cases (n=54)	Controls (n=54)	p value
Median motor	7.27 ± 1.22	7.41 ± 0.58	0.19
Ulnar motor	6.55 ± 0.75	6.92 ± 0.58	0.23

Table 4: Comparison of Amplitude (mA) in study groups

Parameter	Hypothyroid cases (n=54)	Controls (n=54)	p value
Median motor	7.10 ± 2.03	9.42 ± 1.87	<0.001
Median sensory	44.46 ± 24.54	58.65 ± 29.10	<0.05
Ulnar motor	11.18 ± 2.30	12.03 ± 3.37	0.35
Ulnar sensory	50.85 ± 26.71	53.11 ± 34.52	0.19

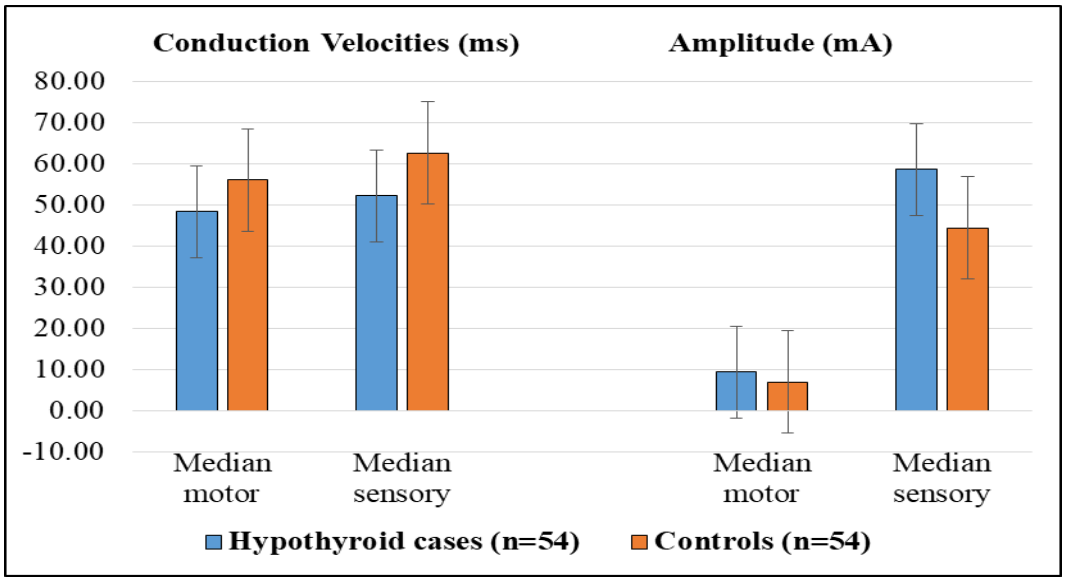

Figure 1: Graphical comparison of significant parameters

DISCUSSION

In our current investigation, patients diagnosed with hypothyroidism exhibited significantly reduced amplitudes and slowed conduction velocities in the median nerve. However, there were no notable increases in nerve latency for either the median or ulnar nerves. Notably, ulnar nerve conduction parameters, including velocity, amplitude, and latency, did not show statistically significant changes.

Musculoskeletal disorders are prevalent among individuals with hypothyroidism [7]. Yuksel et al. [8] reported that the most affected nerve was the median nerve, with impacts on both motor and sensory components, followed by the sural nerve. Our study corroborates these findings, highlighting the median nerve as the most affected, with impairments noted in both its sensory and motor components. Specifically, conduction velocity and amplitude of the median nerve were impacted in our study. In hypothyroidism, the accumulation of mucopolysaccharides, chondroitin sulfate, and hyaluronic acid in interstitial spaces can lead to water retention and subsequent weight gain [6]. These deposits surrounding nerves may compress them, resulting in swelling and degeneration [9]. Median nerve entrapment at the wrist due to mucinous material deposition is a common cause of peripheral nerve damage in hypothyroidism [5]. Dyck and Lambert [6] studied two cases morphologically and neurophysiologically, suggesting that metabolic alterations induced by endocrine disorders contribute to peripheral neuropathy. This dysfunction has been linked to morphological evidence of primary axonal degeneration, including axonal shrinkage, neurotubule and neurofilament disintegration, and active axonal breakdown [10].

The conduction velocity serves as a measure of the fastest conducting nerve fibers. Therefore, unless there is a selective pathological disturbance in the largest myelinated fibers, the loss will occur randomly. This means that even if 75% of the axonal population is reduced, many of the

fast-conducting fibers will still be functionally active, resulting in only mild alterations in conduction velocity. Demyelination refers to the loss of the myelin sheath surrounding the axon while leaving the axon tubule intact. This demyelination can occur paranodally or segmentally, with the former blocking conduction and the latter reducing conduction velocity [11].

Amplitude measurements are crucial in assessing sensory nerve conduction [12]. Nerve conduction velocity (NCV) primarily depends on faster-conducting nerve fibers. Even if the majority of nerve fibers are affected, the presence of a few faster-conducting fibers can sustain conduction, leading to results that may not accurately reflect the extent of fiber involvement [13]. Latency and conduction velocity rely on intact, myelinated nerve fibers, as myelin and nodes are essential for rapid action potential propagation. Conversely, waveform amplitude primarily reflects the number of functioning axons within the nerve. Slowed conduction velocity or prolonged latency typically indicates demyelinating injury, while amplitude loss correlates with axonal loss or dysfunction [14]. Another electrophysiological study reported abnormal nerve conduction studies with sensorimotor neuropathy of the axonal type [11].

It's important to note that our study did not include electromyography, autonomic function tests, or assessment of other peripheral nerves, representing limitations. However, our findings provide strong evidence of impaired median nerve conduction involving both sensory and motor components in hypothyroidism. A more comprehensive study with a larger sample size of hypothyroid patients is necessary to draw definitive conclusions.

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CONCLUSION

Our study conclusively demonstrates the presence of neuropathy in individuals diagnosed with hypothyroidism, emphasizing the value of incorporating nerve conduction studies into the diagnostic framework. While our findings underscore the significance of this assessment method, a thorough investigation encompassing a more extensive cohort of hypothyroid patients is imperative to establish a conclusive understanding of this association.

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