

Ultrasonography of Median Nerve in Carpal Tunnel Syndrome in Patients with Hypothyroidism

M V Kameswar Rao¹, Seshdev Panigrahi²

¹Associate Professor, Department of Radiodiagnosis, M. K. C. G Medical College, Berhampur, Odisha, India.

²Assistant Professor, Department of Radiodiagnosis, M. K. C. G Medical College, Berhampur, Odisha, India.

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a common peripheral entrapment neuropathy in patients with hypothyroid. The diagnosis of CTS is usually clinical and confirmed by electrodiagnostic procedures. This study aimed to describe the diagnostic accuracy of high-resolution ultrasonography (US) as an alternative method to nerve conduction study for the diagnosis of subclinical CTS in patients with hypothyroidism before and after hormone replacement therapy. **Methods:** Sixty patients diagnosed with hypothyroidism were included in this study. Electrodiagnostic workup and ultrasonographic assessment of both right and left median nerves were done at the initial time of diagnosis and 3 months of euthyroid state after hormone replacement. **Results:** The comparison between right and left median nerves motor and sensory functions before and after treatment showed a significant change ($P < 0.001$). Right median nerve distal and proximal CSA were 13.5 ± 1.4 mm² and 10.6 ± 1.5 mm² respectively. On the left side CSA values were 13.1 ± 2.1 mm² and 9.9 ± 0.5 mm² respectively. After hormone replacement, values changed to 11.0 ± 1.4 mm² (distal) and 0.086 ± 0.003 mm² (proximal) on the right side and 11.0 ± 1.6 mm² (distal) and 8.2 ± 0.4 mm² (proximal) on the left side. 40 patients showed significant electrophysiological and radiological improvement with hormonal control. **Conclusions:** The US for median nerve cross sectional area can be used as a noninvasive diagnostic method which may be used for prognostication of CTS.

Keywords: Hypothyroidism, Carpal Tunnel Syndrome, Ultrasonography, Median Nerve.

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INTRODUCTION

Carpal tunnel syndrome (CTS) is a common entrapment neuropathy. The estimated prevalence is 1%–5% in the general population, with a higher prevalence among women and people older than 55 years.^[1] It has been shown that older age significantly affects some characteristics of peripheral nerves such as reduced expression of the major myelin proteins, demyelination, loss of myelinated and unmyelinated fibers, and delayed regeneration.^[2]

Early diagnosis is required to prevent permanent sequel. The diagnosis of CTS is usually suspected when clinical symptoms (such as numbness, nocturnal paresthesia, and pain in the median nerve territory) and signs (eg, Tinel, Phalen, and Reverse Phalen signs) are present.^[3] The diagnosis has to be confirmed by electrodiagnostic studies, which is the diagnostic reference standard test. It is also conducted to determine CTS severity, an essential factor affecting long-term outcome and treatment course, and to rule out other diagnoses.^[4]

Electrophysiological characteristics of nerves are changing with age, such as decrease conduction velocities comparing young and middle-aged groups. Consequently, EDX characteristics and normal values of nerve conduction studies (NCS) parameters are somewhat different in older ages. Since EDX is expensive and time-consuming and has significant false-positive and false-negative results, a growing trend regarding other diagnostic methods has been developed.^[5]

Several studies have shown the potential value of ultrasonography (US) in this disease. US is a feasible, simple, rapid, accurate, inexpensive, and noninvasive method, which has been increasingly used in CTS diagnosis.^[6-8]

The aim of this study is to evaluate the efficacy of ultrasound in newly diagnosed hypothyroid patients suffering from median nerve entrapment before and after hormone replacement therapy.

MATERIALS & METHODS

60 CTS patients with hypothyroidism were included in this study. This prospective study was carried out over a period of six months (Jan 2019 to June 2019) at the M. K. C. G Medical College & hospital. As they were newly diagnosed, none of these patients received any medical treatment for hypothyroidism. Patients showing other causes of neuropathy such as

Name & Address of Corresponding Author

Dr Seshdev Panigrahi,
Assistant Professor,
Department of Radiodiagnosis,
M. K. C. G Medical College,
Berhampur, Odisha, India

diabetes mellitus, alcoholism, liver and kidney disease, use of drugs known to cause neuropathy, malignancy or other serious illness and patients with a family history of neuropathy, patients with a history of wrist fracture or a previous surgery and injections in the wrist were excluded from the study. Laboratory investigations including complete blood count, urea, creatinine and random blood glucose, liver enzymes, electrolytes, vitamin B12 and folic acid were measured. Tests were performed at the onset of the study in order to eliminate other possible causes of neuropathy and all tests were normal. Free T3, free T4 and TSH level were evaluated. Patients with FT4 levels below 10.6 pmol/ml and TSH levels above 5.0 uIU/ml were accepted as hypothyroidism and underwent the initial electrodiagnostic evaluation according to standard techniques and median nerve ultrasonography. Thereafter, all patients received appropriate doses of thyroxine treatment for hypothyroidism and were monthly followed up for FT4, FT3 and TSH levels throughout a 3 month period after they have achieved euthyroid state. At the end of this period, patients underwent ultrasonographic evaluation. Patients were seated near the examiner with their arms stretched; hands in a supine position, wrists resting on a flat surface and fingers were semiflexed. To avoid causing any artificial nerve deformity no additional force was applied other than the weight of the probe. Cross-sectional area (CSA) of the median nerve was measured at the distal wrist (CSA-D), and proximal forearm (CSA-P). The CSA of median nerve was measured at the proximal inlet of carpal tunnel at level of the pisiform bone as a landmark and 12 cm proximal in the forearm by tracing a continuous line around the inner hyperechoic rim of the median nerve with electronic calipers 9. The CSA was measured 3 times, and the average value was used for analysis.

The examining radiologist was not permitted to ask the patients about symptoms. The only information provided to the examining radiologist was a written request from the referring neurologist that the patient will be examined for the presence of median nerve thickening. Ultrasonographic assessment was performed without knowledge of the clinical and electrodiagnostic test results.

Statistical analyses were performed by using SPSS Statistics 19. All data are reported as mean \pm standard deviations. The Paired $-$ Samples T Test was used to evaluate differences in the pre and post treatment values. Kruskal $-$ Wallis H was used to evaluate differences between more than two groups of nonparametric data.

RESULTS

There were 34 female patients with a mean age of 48 years (ranging from 28 to 64 years) and 26 female patients with a mean age of 49 years (ranging from 30 to 68 years).

Table 1: (Response of patients)

No of patients	Male (34)	Female (26)	Total (60)
Age	54.6 \pm 8.8	53.4 \pm 9.7	
Responded to treatment (No of patients)	30	10	40
Required medical treatment (No of patients)	4	6	10
Required surgical treatment (No of patients)	6	4	10

The ultrasonographic assessment revealed a statistically highly significant reduction in distal median nerve cross sectional area (CSA-d) after constitution of an euthyroid state. The mean CSA-d changed from 13.5 \pm 1.4 mm² to 10.6 \pm 1.5 mm² on the right side and from 13.1 \pm 2.1 mm² to 9.9.0 \pm 0.5 mm² on the left side. On the other hand, the change in proximal median nerve cross sectional area (CSA-p) was much less statistically significant. 40 patients had satisfactory ultrasonographic and clinical improvement after 3 months of restoration of an euthyroid state, while 20 patients failed to achieve such improvement. Out of these 20 patients, 10 patients of those with carpal tunnel syndrome were maintained on medical treatment for an extended period to get improved. On the contrary, 10 patients were referred for surgical release of the carpal tunnel [Table 1]. The patients who responded to hormonal replacement therapy (HRT) had smaller CSA-d ($p < .005$) on both sides than those who partially responded to therapy and who were referred for surgery.

DISCUSSION

Carpal tunnel syndrome (CTS) is a combination of signs and symptoms due to compression and trapping of the median nerve at the wrist. It is the most commonly reported peripheral nerve entrapment syndrome.^[10] It is crucial to diagnose median nerve entrapment early and accurately. Although electrodiagnostic studies are commonly used as the diagnostic reference standard method, its shortfalls in the diagnosis of CTS have led physicians to search for an alternative method. Nowadays, the US rapidly becomes more popular and used, mainly because of its greater accessibility, noninvasiveness, relatively low cost, and short examination times.^[11] US can assess anatomy and biomechanics of nerve such as CSA at various levels, flattening ratio, swelling ratio, bowing of the flexor retinaculum, and decreased longitudinal excursion on dynamic assessment.^[12] A few studies performed in the United States revealed that CTS accounts for 0.2% of all ambulatory care visits and over 500,000 carpal tunnel releases in 2006.^[13,14]

One earlier study reported that in 52% of hypothyroid patients with peripheral nervous system involvement, entrapment neuropathy was the commonest (35%) and axonal neuropathy was recorded in 9% of these patients.

In our study, all our selected hypothyroid patients had significantly higher TSH levels and significantly lower FT4 and FT3 levels before the hormone replacement therapy. At the initial time of assessment, all patients had electrodiagnostic evidence of carpal tunnel syndrome. In our patients, there were higher sensory and motor distal latencies with lower both motor, sensory nerve conduction velocities and lower motor and sensory median nerve amplitude.

Some studies revealed that despite obtaining euthyroid state, most patients with diagnosis of primary hypothyroidism continue to experience symptoms and electrophysiological signs of carpal tunnel syndrome.^[15] In the current study, all patients were newly diagnosed cases with hypothyroidism and the carpal tunnel syndrome symptoms and/or signs and they showed a significant improvement of symptoms in 40 of patients after their thyroid functions were normalized with hormonal replacement therapy. This was compatible with the results of Kececi and Degirmenci 5, in their study, they found that 13 out of 15 patients with newly diagnosed hypothyroidism associated with carpal tunnel syndrome improved after 3 months of appropriate hormone replacement treatment. Also, Arafat and his colleagues 16 concluded that 84.2% (n=48) of their patients had improvement in their median nerve functions after hormonal treatment, while 15.8% (n=9) still had carpal tunnel syndrome symptoms. This variation of response to treatment may be related to severity, duration and treatment regimens of carpal tunnel syndrome.

Electrodiagnostic study has its own limitation as it does not provide information about structures surrounding the nerve, it does not allow visualization of abnormalities intrinsic to the nerve, and it is painful.^[17] Over the past years, high-resolution ultrasonography has been proposed as a useful tool for the diagnosis of CTS.^[18] The attraction of ultrasonography for diagnosis of CTS lies in its wide availability, lower cost, noninvasiveness, and shorter examination time. The measurement of cross-sectional area (CSA) of the median nerve at the wrist is the most widely used ultrasonography method in CTS diagnosis. Normal ranges for median nerve area at the distal wrist crease have varied among reports, ranging from 7.2 to 9.8 mm²; the values for diagnosing CTS range from 9 to 15 mm².^[19] The sensitivity and specificity range from 70 to 88% and 57 to 97%, respectively. In our study, the means of distal CSA were 12.5 and 12.4 mm² in right and left median nerve respectively, ranging from 9 to 17 mm². Also, Tengfei et al.^[20] reported that, the mean inlet CSA was 8.7 mm² in healthy controls and 14.6

mm² in CTS. Additionally, Andrea et al,^[21] reported that distal CSA was 16.8 mm², Seok et al,^[22] found that the distal CSA were significantly different from mild, moderate to severe (13.5 mm², 14.67 mm² and 18.74 mm²) cases of carpal tunnel syndrome respectively. In our study right median nerve distal and proximal CSA were 13.5±1.4 mm² and 10.6±1.5 mm² respectively. On the left side CSA values were 13.1±2.1 mm² and 9.9±0.5 mm² respectively. After hormone replacement, values changed to 11.0±1.4 mm² (distal) and 0.086±0.003 mm² (proximal) on the right side and 11.0±1.6 mm² (distal) and 8.2±0.4 mm² (proximal) on the left side. 40 patients showed significant electrophysiological and radiological improvement with hormonal control.

CONCLUSION

With hormonal replacement therapy, carpal tunnel syndrome can be controlled in patients with hypothyroidism after three months of euthyroidism. We concluded that the US as a noninvasive and convenient test which may serve as a diagnostic method for the investigation of CTS. In patients having a symptomatic median nerve entrapment, the median nerve cross sectional area can be used as a guide for selection of patients that may benefit from surgery.

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