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DIAGNOSTIC ACCURACY OF ULTRASOUND PARAMETERS IN CARPEL TUNNEL SYNDROME

Radiology

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ABSTRACT

Introduction: Carpal tunnel syndrome (CTS) is caused by pressure on the median nerve. Morphological changes of the median nerve are expected in CTS, as the compression of the surrounding non-rigid structures alters its shape. Thus, the cross-sectional area of the median nerve is the most commonly applied criterion for diagnosing CTS on ultrasound. **Objectives:** The purpose of the research was to see how useful high-frequency ultrasonography is in identifying a patient's surgical eligibility in carpal tunnel syndrome. **Methodology:** 30 patients were taken up for the study, to examine the accuracy of ultrasound in diagnosing carpal tunnel syndrome if negative by clinical diagnosis. All the sonographic examination will be performed using a GE voluson machine with linear array transducer (5–13MHz) at wrist and forearm of hand. Movements included an extension of wrist and fingers, supination of the forearm, full flexion of the elbow, and 60-degree shoulder flexion. **Conclusion:** Ultrasonography with high frequency is a safe, secure, fast, cheap, non-invasive, and easily available radiographic tool with high diagnostic accuracy, thus is useful in the diagnosis of median entrapment neuropathy.

KEYWORDS

Carpal tunnel syndrome, Radiographic diagnosis, Ultrasound

INTRODUCTION

Carpal tunnel syndrome also called median nerve compression, is a condition that causes numbness, tingling, or weakness in the hand.[1] It happens because of pressure on the median nerve, which runs the length of the arm, goes through a passage in the wrist called the carpal tunnel, and ends in the hand.[2]

This median nerve entrapment neuropathy is diagnosed using clinical symptoms and indicators, including the Tinel's sign (paresthesia felt when the median nerve is tapped along its course), Phalen's sign (paresthesia felt on flexing the wrist), and the nerve conduction studies.[3] But these clinical predictors have less sensitivity and specificity rates, and the nerve conduction studies provide false-negative and false-positive results. Non-invasive imaging methods like high-resolution ultrasonography (USG) can now be used to examine the nerve in the carpal tunnel.[4] It enables the evaluation of nerve compression characteristics such as modified signal, increased cross-section area of the nerve, flattening of the median nerve, and flexor retinaculum bowing towards the palmar surface.[5] The cut-off cross sectional area at which neuropathy is produced varies from 0.09 - 0.15 cm^2.[6]

Recent advances in high- frequency USG like advanced post-processing capability, transducer technology, resolution of images, signal strength, and spectral analysis, have improved their ability in visualizing and grading the abnormalities, thereby creating a less invasive, cost-effective, real-time assessment tool for evaluating the median nerve in Carpal tunnel syndrome.[7,8]

Assessment of the accuracy of high-frequency USG and Colour Doppler imaging of the median nerve as compared to the nerve conduction tests in the diagnosis of Carpal tunnel syndrome is the sole purpose of this study. We further tried to establish an independent USG predictor in Carpal tunnel syndrome by evaluating how accurate the data of gray-scale imaging is in diagnosing the median neuropathy.

METHODOLOGY

The present observational descriptive study was conducted in the Department of Radiology, Chettinad Hospital and Research Institute, Chennai after receiving approval from the Institutional Ethics Committee. 30 patients were taken up to examine the accuracy of ultrasound in diagnosing carpal tunnel syndrome in cases which were proved negative by clinical diagnosis. All the sonographic examination was performed using a GE voluson machine with linear array transducer (5–13MHz) at wrist and forearm of hand. Subjects were asked to extend wrist and fingers, keep the forearm supine, completely flex the elbow and perform 60º flexion of the shoulder. The course of the median nerve was traced in transverse and longitudinal planes. The diameter of the nerve was measured proximal to the canal, at the inlet, middle and outlet of the canal along with the longitudinal diameter, by continuous tracing of the boundary of the nerve. The diameter of the nerve at inlet of the canal is the best diagnostic indicator of Carpel tunnel syndrome. The severity of Carpel tunnel syndrome was assessed based on the circumference of the median nerve as recorded in the USG. Less than 10 mm was considered normal, circumference between 10-13mm was considered as mildly severe, the measurement between 13-15mm was considered as moderately severe, and size more than 15mm was considered as severely severe. The other sonographic parameters recorded were nerve swelling, edema, and flattening, along with palmar bowing of flexor retinaculum. Colour Doppler was used to note the vascularity of the nerve. In the patients who were clinically diagnosed with Carpel tunnel syndrome nerve conduction studies were carried out to confirm the diagnosis. A drop in the conduction velocity of the sensory part of the median nerve more than 49 m/sec and a delay in motor latency greater than 4.4 m/sec was considered aberrant nerve conduction. All the diagnostic tests were performed by the same radiologist to eliminate inter-observer bias.

RESULTS

The study involved 30 patients (23 female and 7 male) (Fig. 1) and a total of 41 wrists were examined. Of them majority (19) were more than 40 years of age (Fig. 2). Significant association exists between Carpel tunnel syndrome and the patients' age. Multivariate stepwise logistic regression analysis of median nerve cross section area calculated 0.11 cm^2 as a threshold value, which can predict Carpel tunnel syndrome. Hence, this study defines the enlargement of median nerve cross section area of at least 0.11 cm^2 as nerve swelling. Among 41 wrists, nerve conduction studies revealed Carpal tunnel syndrome in 29 wrists. Color Doppler USG showed abnormal vascularity in the median nerve in 6 patients and correctly diagnosed them. Among 41 wrists with Carpal tunnel syndrome, 7 subjects had only a single sonographic criterion. Among those subjects 6 wrists had nerve swelling as the sole USG criterion (Fig. 3). 1 subject had nerve edema as the sole criterion (Fig. 4). On individual wrist basis sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were measured. Logistic regression analysis of USG criteria revealed swelling of the median nerve as the most significant grayscale USG variable that predicts the nerve conduction studies outcome independently ($p< 0.001$). There is a significant association of Carpal tunnel syndrome with flattening of the median nerve (Fig. 5) and the palmar bowing of flexor retinaculum (Fig. 6). Sonographic predictors like edema of the median nerve and nerve vascularity (Fig. 7) had no significance. USG predictors of carpal tunnel syndrome like swollen

median nerve, flattened median nerve, and bow in flexor retinaculum showed a statistically significant *p*-value of < 0.05. Swelling of the median nerve had high significance with a *p-value* of p<0.001 and yielded the best detectability. In ROC analysis, AUC was 0.934 with a 95% CI of 0.858-1. It was statistically significant.

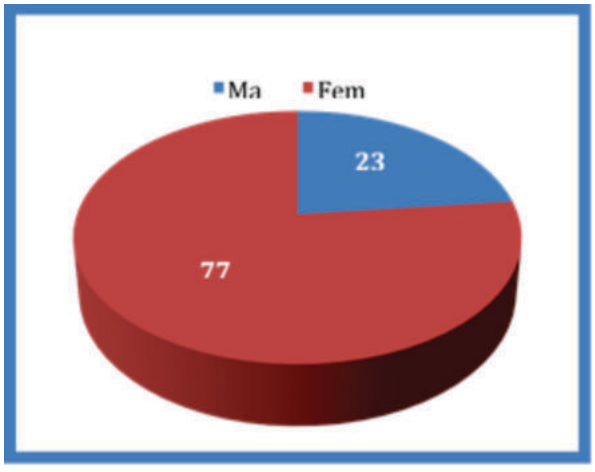

Fig: 1 Gender Distribution

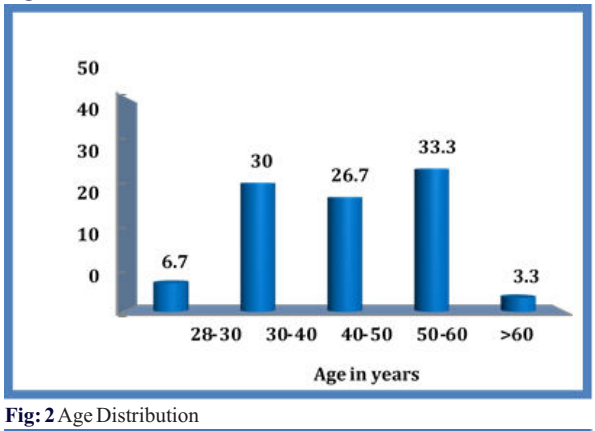

Fig: 2 Age Distribution

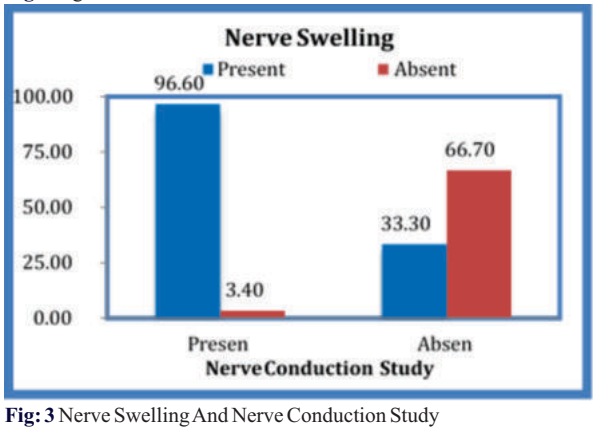

Fig: 3 Nerve Swelling And Nerve Conduction Study

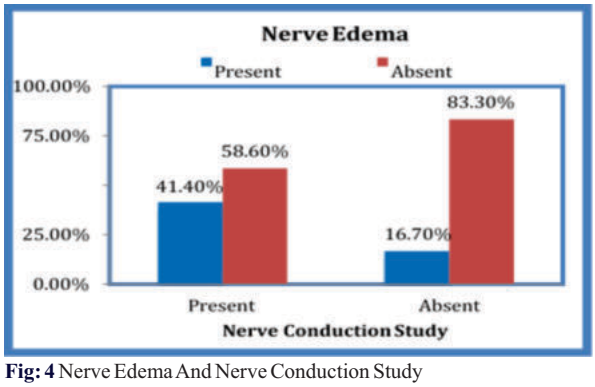

Fig: 4 Nerve Edema And Nerve Conduction Study

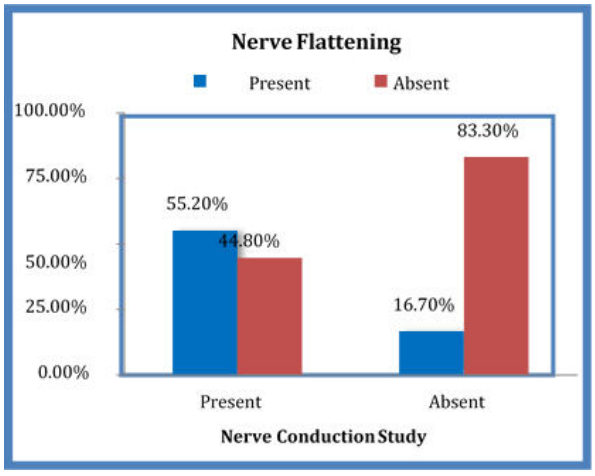

Fig: 5 Nerve Flattening And Nerve Conduction Study

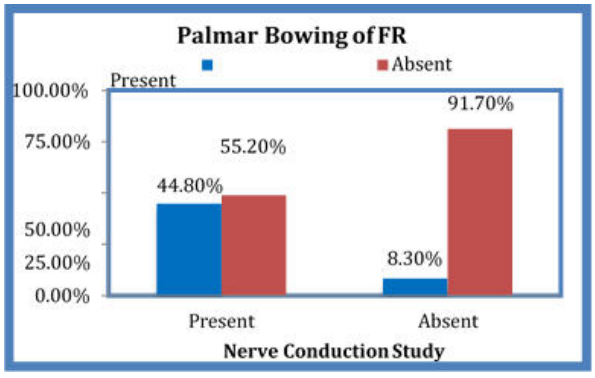

Fig: 6 Palmar Bowing Of Flexor Retinaculum And Nerve Conduction Study

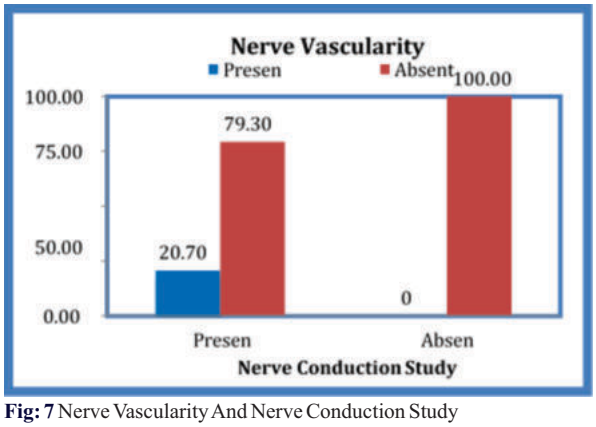

Fig: 7 Nerve Vascularity And Nerve Conduction Study

DISCUSSION

Recognizing the entrapment of the median nerve is essential in subjects with strong doubt of Carpal tunnel syndrome clinically, especially for considering surgery.[9] Magnetic resonance imaging and ultrasonography are the most commonly used non-invasive investigations for diagnosing the median nerve entrapment neuropathy.[10] These two investigations have the advantage of visualizing the median nerve directly thus assessing median nerve swelling, edema, flattening,and bowing in flexor retinaculum.[11] The study by Buchberger et al. concluded that the cross section area of the median nerve is a major criteria in diagnosing Carpal tunnel syndrome.[12]Cross sectional area of the median nerve at which Carpal tunnel syndrome can be indicative ranges from 0.09 to 0.15 cm^2 based on the studies by Duncan I and Lee D. [13]Study by Buchberger et al. has shown that the sensitivity of the sonographic criterion - swelling of median nerve ranges from57- 89%, flattening of median nerve ranges from 38-65%, and bowing in flexor retinaculum ranges from 45-81%. Thorough literature search reveal no established relationship between edema of median nerve and Carpal tunnel syndrome. This is in contrast to the present study. Based on the results of the present study we

observed that median nerve swelling serves as the best parameter in terms of accuracy and sensitivity in diagnosing Carpal tunnel syndrome when compared to others. In contrast to the grayscale ultrasonography, Doppler ranks with great specificity and positive predictive value but it lacks sensitivity.[14] MRI is considered as an investigation of choice for Carpal tunnel syndrome diagnosis because of its ability to capture subtle changes in median nerve as well as carpal tunnel more than that of other investigations.[15] However, it is costly, time-killing, not readily available, and needs an intravenous injection of contrast substance for assessing the median nerve.[16] Hence we opine that high resolution ultrasonography integrated with Colour Doppler provides exact assessments of abnormal vasculature in the median nerve, cross-sectional area of the nerve, and thus better characterization of injury to the nerve.

CONCLUSION

USG with higher frequency has the edge of good resolution and provides accurate anatomical information of the median nerve.[17] USG criteria like median nerve swelling, flattened median nerve, and bowed flexor retinaculum has shown excellent ability to capture median neuropathy in the present study. Median nerve swelling had the best yield in finding out median nerve entrapment neuropathy when compared to the gold standard test like nerve conduction studies. Sonography having these advantages is taken as the first investigatory choice. So B mode ultrasonography with high frequency and Doppler is safe, secure, faster, cheaper, non-invasive, readily available with high diagnostic accuracy, thus helps in the diagnosis of median entrapment neuropathy.

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