A study of median nerve entrapment neuropathy at wrist in uremic patients

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ABSTRACT

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy seen in uremic patients. The study was undertaken to estimate the frequency of CTS in uremic patients and to identify the most sensitive electrodiagnostic test. Study was conducted on 80 subjects of age 30–60 years. End-stage kidney disease patients were recruited for the clinical evaluation, motor nerve conduction studies (NCS), sensory NCS, F wave study and median-versus-ulnar comparison studies (palm-to-wrist mixed comparison study, digit 4 sensory latencies study and lumbrical-interossei comparison study). Among three different diagnostic modalities, frequency of CTS was found to be 17.5% with clinical evaluation, 15% with routine NCS studies and 25% with median-versus-ulnar comparison studies. Among the median-versus-ulnar comparison studies, lumbrical-interossei comparison study was found to be most sensitive (90%). The comparative tests for CTS are more sensitive compared to routine NCS and clinical examination. Among the comparative tests, lumbrical-interossei comparison study is the most sensitive. Early diagnosis of CTS may help patients of uremia to seek proper treatment at an appropriate time.

Key words: Carpal tunnel syndrome, electrophysiologic tests, sensitivity, uremia

Introduction

Uremia is associated with a number of neurologic manifestations. Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, produced by compression of the median nerve inside the carpal tunnel because of overuse or strain in hand activities.[1,2] The prevalence of CTS was estimated to be around 5% in the general population.[3] Recently, mononeuropathies in patients on dialysis, caused by entrapment at sites that are physiologically prone to stenosis, such as ulnar neuropathy at the elbow and median neuropathy at the carpal tunnel has become a topic of interest.[4] CTS can be diagnosed with the help of clinical examination and electrophysiological evaluation. The best diagnostic criteria for the syndrome have not been established, and there is considerable disagreement as to the relative importance of various clinical findings. To a certain extent, the absence of consensus on the best diagnostic criteria for the syndrome is related to a general reliance on the results of electrodiagnostic testing as a diagnostic gold standard.[5] In patients with typical CTS, the median distal motor and sensory latencies, and minimum F wave latencies, are moderately to markedly prolonged. However, in 10–25% of CTS patients these routine tests are normal, in such cases more sensitive nerve conduction studies (NCS) have to be performed, which usually involve a comparison of median nerve to another nerve in the same hand. Although literature is available regarding the prevalence of clinical and electrophysiological CTS in uremic population worldwide, it is insufficient in Indian context. Therefore, the present study is designed to find out the trends in clinical and electrophysiological CTS among uremic patients attending a rural hospital in Central India. We shall also attempt to label most sensitive nerve conduction test that can detect CTS earliest in these patients.

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Access this article online	
Quick Response Code:	Website: www.indianjnephrol.org
	DOI: 10.4103/0971-4065.144425

Materials and Methods

Study design

The cross-sectional study was conducted on 80 subjects aged 30–60 years from rural part of central India after

getting their informed written consent Subjects with stage 5 CKD referred from Department of Medicine were prospectively recruited for the study. Detailed history and thorough clinical examination parameters were recorded. Subjects with cardiac pacemakers or cardiac pathology, diabetes mellitus, rheumatoid arthritis, myelopathy, myopathy and neuromuscular junction disorders like myasthenia gravis were excluded from the study. Institutional Ethics Committee approval was obtained and study was conducted at fixed room temperature of 30°C.

Procedure and instruments

The study was performed on RMS EMG EP Mark-II machine in the Clinical Neurophysiology Unit. All tests were performed by the same investigator and under constant room temperature (30°C) to shortlist the errors. History and clinical examination was done in structured format.

Clinical evaluation of carpal tunnel syndrome

Patients were clinically evaluated as:

Highly suggestive of carpal tunnel syndrome

If there is presence of nocturnal paresthesias awakening patients from sleep; shaking or wringing the hands relieves the symptoms; pain/paresthesias associated with driving or holding a phone, book or newspaper; sensory disturbance of digits 1, 2, 3 and 4; weakness/wasting of thenar eminence; Phalen's maneuver reproduces symptoms.

Possible carpal tunnel syndrome

If there is hand, wrist, forearm, arm and/or shoulder pain; perception of paresthesia involving all five digits; no fixed sensory disturbance, or sensory disturbance of digits 1, 2, 3 and/or 4; decreased hand dexterity; Tinel's sign over the median nerve at the wrist.

Electrophysiological evaluation of carpal tunnel syndrome

Motor nerve conduction studies

Motor nerve conduction study involves stimulation of motor nerve at two different sites with maximum stimulus and calculation of conduction velocity. Nerves tested will be median and ulnar nerves. Setting was kept at sweep speed 5 ms/Day, intensity 2 mV, frequency 2 Hz, filter between 2 Hz and 5 Hz and stimulus strength duration will be 100 μs.

Sensory nerve conduction study

Sensory NCS will be done antidromically involving stimulation of sensory nerves proximally and recording sensory nerve action potentials with electrodes placed distally over the dermatomic distribution. Nerves tested were median and ulnar nerves. Setting were kept at sweep speed 2 ms/day, intensity 2 mV, frequency 2 Hz, filter between 20 Hz to 3 KHz and stimulus strength duration was 100 μs.

F-wave study

F-wave study involved supramaximal stimulation of motor nerves. Setting was kept at sweep speed 10 ms/Day, intensity 2 mV, frequency 2 Hz, filter between 2 Hz and 10 KHz, and stimulus strength duration was 100 μs.

Median-versus-ulnar comparison studies

Palm-to-wrist mixed comparison study

The technique was performed by stimulating the median nerve in the palm, recording the median nerve at the wrist, and comparing it with the ulnar nerve stimulated in the palm and recorded over the ulnar nerve at the wrist.

Digit 4 sensory latencies study

In this antidromic study, the median sensory recording from digit 4 was compared with the ulnar sensory digit 4 recording using identical distances between stimulation and recording site.

Lumbrical-interossei comparison study

In this study, the recording electrode was placed over just radial to middle of the third metacarpal and reference over proximal inter-phalangeal joint. Median and ulnar nerves were stimulated at wrist at a standard distance of 8–10 cm. Motor latencies were compared.

Statistical analysis

Statistical analysis was done by IBM SPSS Statistics software version 16 using Statistical Package for Social Science version 16. The study observations and results were noted and analyzed to find the sensitivity, specificity, positive predictive value and negative predictive value.

Results

Age- and gender-wise distribution of all the study subjects is depicted in Table 1. Age groups were not statistically different between males and females. Frequency of CTS by three different diagnostic tests is depicted in Table 2. Among the different diagnostic modalities, frequency was found to be 17.5%, 15%, 25% with clinical evaluation, routine electrophysiological test and median-versus-ulnar comparison respectively. Whereas in between three comparison tests, lumbrical-interossei study was found to most sensitive in diagnosing CTS and digit 4 comparison study was most specific [Table 3].

Table 1: Gender- and age-wise distribution of study subjects

Subjects	Males	Females	*P*
Number (*n*)	54	26	NS (*P*>0.05)
Age (years)	49.2±9.89	48.9±8.99	

Data are mean±SD. NS: Nonsignificant, SD: Standard deviation

Table 2: Overall prevalence of CTS in uremic population

Diagnostic tool	CTS positive cases	Percentage
Clinical examination	14	17.5
Electrophysiological with routine NCS tests	12	15.00
Electrophysiological with median versus ulnar comparison tests	20	25.00

CTS: Carpal tunnel syndrome, NCS: Nerve conduction studies

Table 3: Sensitivity, specificity, PPV, NPV among median versus ulnar comparison studies

Median versus ulnar comparison studies	Sensitivity	Specificity	PPV	NPV
Palm wrist comparison study	70	83.33	58.33	89.28
Digit 4 comparison study	65	90	68.42	88.52
Lumbrical interossei study	90	80	60	96

PPV: Positive predictive value, NPV: Negative predictive value

Discussion

Polyneuropathy is a common complication of end-stage renal failure especially when treatment with periodic hemodialysis is started too late. Large myelinated fibers bear the brunt of the many biological changes associated with renal failure. Nerve conduction slowing is common in this setting. Compression of the median nerve in the carpal tunnel commonly occurs in these patients.[6] CTS is the combination of symptoms and signs resulting from compression of the median nerve as it passes through the bony carpal canal, from the forearm to the palm. The absence of gold standard for its diagnosis has led to the development of various clinical diagnostic criteria as well as several laboratory methods of diagnosis viz., electrophysiological tests, quantitative sensory tests as well as imaging of the carpal tunnel. Electrophysiological tests are the most commonly used methods in providing objective diagnosis. Much has been reported about the various NCS diagnostic of CTS, which in essence demonstrates slowing of sensory and/or motor conduction across the carpal tunnel.[7,8]

American Academy of Orthopedic Surgeons (AAOS) recommendations are to obtain a confirmatory electrodiagnostic test in patients for whom surgery is being considered. A meta-analysis done by Fowler *et al*. concluded that although ultrasound may not replace electrodiagnostic testing as the most sensitive and specific test for the diagnosis of CTS. It is cost-effective for specialists to use ultrasound to confirm a clinical diagnosis of CTS; however, ultrasound may not be cost-effective when used as a first-line diagnostic tool by general practitioners.[9] AAOS (2007) guideline suggested that the physician should not routinely evaluate patients suspected of having CTS with new technology, such as magnetic resonance imaging, computerized axial tomography and pressure specified sensorimotor devices in the wrist and hand.

Electrophysiological examination should be considered as an extension of the clinical neurological examination. It is not a mere laboratory test, rather, it should be considered as an electrodiagnostic consultation. Hence, each patient needs to be approached with a clear-cut strategy after gathering the clinical information so that appropriate tests could be performed within a stipulated time frame. The following algorithm will help to sort out the electrical diagnosis of CTS in a systematic way.[10]

In the present study, we documented the frequency of CTS among three different diagnostic modalities. The frequency was found to be 17.5%, 15%, 25% with clinical evaluation, routine electrophysiological test and median-versus-ulnar comparison tests, respectively. And among the comparison tests, lumbrical-interossei study was found to be the most sensitive with 90% sensitivity and 60% positive predictive value.

Kohara reported that the clinical evaluation alone has limited diagnostic value in CTS. Golden standard for the diagnosis is the combination of the clinical findings and the electrophysiological study. Routine median NCS is valuable; prolonged terminal latency of motor or sensory nerve would be found in most CTS hands. If the routine study showed equivocal, more sensitive methods are needed. A difference between the median motor latency to the second lumbrical and the ulnar motor latency to the interossei muscles has also diagnostic value in some cases. The findings are comparable with our study.[11]

Badry *et al*. who studied 54 consecutive cases (108 hands) of end-stage renal failure on dialysis for routine NCS and second lumbrical-interosseus (2 L-INT) latency difference as a predictor of CTS found out that, the frequency of CTS in uremic patients on maintenance dialysis using standard nerve conduction parameters was 51.4%; however, the frequency increased substantially to 83.8% if 2 L-INT latency difference is included in the criteria for the diagnosis. CTS is common in patients with end-stage renal failure on dialysis. 2 L-INT latency difference is a sensitive test to predict median neuropathy at wrist in presence of peripheral neuropathy. These results are comparable to our study.[12]

Argyriou *et al*. studied 104 hands electrophysiologically and confirmed to have CTS. The 2 LI-DML test was abnormal in 99/104 (95.2%) hands with CTS with a mean value of 1.54 ± 1.12 ms. Among the other measures, the orthodromic median-ulnar palmar velocity comparison was the most frequently abnormal test (95/104 hands, 91.3%), followed by the double-peak morphology of orthodromic sensory action potential from digit 4 (94/104, 90.4%). Result demonstrates that the 2 LI-DML comparison is highly sensitive in diagnosing CTS, even in mild cases in which standard tests fail to detect abnormalities. We recorded the comparable results as these findings.[13]

Our study findings go hand in hand with previous reports, which demonstrate that electrophysiological studies across the palm to wrist segment may reveal more abnormalities, compared to conventional studies.[14-17] Meena *et al*.[18] evaluated subjects with clinically diagnosed CTS and CTS with incidental polyneuropathy with 2 Lumbrical interosseus distal motor latency difference LIDMLD in addition to other standard diagnostic tests reported that the second lumbrical is relatively less affected in severe CTS and median to ulnar comparison, using 2 LIDMLD, appears to be a reliable and a valuable technique in the localization of severe CTS and CTS associated with polyneuropathy, especially when the median sensory or motor responses are absent on routine conduction studies. This is co-existent with our findings.

Once confirmed, management of CTS varies depending upon the underlying cause and the severity of the condition. Conservative treatments include oral corticosteroid therapy and local corticosteroid injections. Approximately 80% of patients with CTS initially respond to conservative treatment; however, symptoms recur in 80% of these patients after 1 year.[19] Splinting the wrist at a neutral angle helps to decrease repetitive flexion and rotation, thereby relieving mild soft tissue swelling or tenosynovitis. Splinting is probably most effective when it is applied within 3 months of the onset of symptoms.[20] Diuretics, nonsteroidal anti-inflammatory drugs, pyridoxine (vitamin B_6), and orally administered corticosteroids have been used with varying degrees of success in patients with CTS. Ultrasound therapy may be beneficial in the longer-term management of CTS. Carpal tunnel release surgery should be considered in patients with symptoms that do not respond to conservative measures and in patients with severe nerve entrapment as evidenced by NCS, thenar atrophy or motor weakness.[21]

Conclusion

Based on the observation,we conclude that electrophysiologically using more sensitive tests, we can judge how severely median nerve is compressed in CTS, at its early stages. The comparative tests for CTS are more sensitive compared to routine NCS. Among the comparative tests, lumbrical-interossei comparison study is most sensitive. Early diagnosis of CTS may help patients of uremia to seek proper treatment at an appropriate time.

Limitations

It was cross-sectional study with quite lesser sample size, therefore future studies with larger sample size are recommended

Acknowledgment

We acknowledge with gratitude the financial help by Indian Council of Medical Research.

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How to cite this article: Shende VS, Sharma RD, Pawar SM, Waghmare SN. A study of median nerve entrapment neuropathy at wrist in uremic patients. Indian J Nephrol 2015;25:229-33.

Source of Support Nil, **Conflict of Interest** None declared.