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ORIGINAL ARTICLE

CLINICAL AND ELECTROPHYSIOLOGICAL PROFILE OF CARPAL TUNNEL SYNDROME IN A TERTIARY-LEVEL HOSPITAL IN KATHMANDU, NEPAL

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ABSTRACT

Introduction: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, resulting from compression of the median nerve at the wrist. Symptoms vary with disease severity and typically include numbness, tingling, burning, and pain in the thumb, index, middle, and lateral half of the ring finger. Pain or tingling may radiate to the forearm and shoulder, often accompanied by hand weakness or clumsiness. Limited data exist regarding CTS in the Nepalese population. This hospital-based study aimed to evaluate the clinical and electrophysiological profiles of CTS patients.

Method: This retrospective analysis included all patients diagnosed with CTS who underwent nerve conduction studies in the Neurology OPD of the National Academy of Medical Sciences, Bir Hospital, between June 1, 2022, and May 30, 2023. Diagnosis was based on clinical presentation and electrophysiological findings.

Result: Ninety-four patients met the inclusion criteria, with a female predominance (76.6%). The mean age was 44.23 ± 10.9 years (range: 23–71). Bilateral CTS was present in 35.1%, while the remainder had unilateral involvement. The mean disease duration was 0.96 ± 0.31 years. Comorbidities included hypothyroidism (24.5%), diabetes mellitus (19.1%), rheumatoid arthritis (3%), and prior trauma or fracture (6.4%). Electrophysiological studies frequently revealed pure sensory median neuropathy and demyelinating changes.

Conclusion: CTS predominantly affects middle-aged females in Nepal, with hypothyroidism and diabetes mellitus as common associated conditions. Electrophysiological assessment is crucial for confirming diagnosis and determining severity, with sensory neuropathy and demyelination being the most frequent findings.

Key words: Carpal Tunnel Syndrome (CTS); Electrodiagnosis; Nerve conduction study

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy of the upper extremity, affecting approximately 3% of the general adult population and accounting for about 90% of all entrapment neuropathies.[1,2] Women are nearly three times more likely to develop CTS than men, and both the prevalence and severity increase with age.[1,2] Occupational factors play a significant role—particularly activities involving repetitive wrist movements, forceful hand exertion, or the use of hand-operated vibratory tools, which markedly increase the risk of CTS.[3,5] A large prospective cohort study further identified forceful hand exertion as the single most significant predictor of CTS among workers.[4]

Additional predisposing factors include family history and a personal history of diabetes mellitus, obesity, hypothyroidism, pregnancy, and rheumatoid arthritis.[5] Clinically, CTS manifests with numbness, tingling, burning, and pain in the thumb, index, middle, and lateral half of the ring finger, corresponding to the median nerve distribution. Symptoms may radiate up the forearm toward the shoulder, and patients may also experience weakness or clumsiness of hand movements as the condition progresses.[2,6]

Several clinical tests have been described to aid in the diagnosis, though none are definitive when used alone. The Tinel's sign, a frequently used clinical test, has a reported sensitivity between 23–67% and specificity of 55%, whereas the Phalen's test demonstrates a sensitivity range of 10–91% and specificity between 33–100%.[7,8]

These findings indicate that such clinical tests should be interpreted in conjunction with other diagnostic modalities. Electrodiagnostic (EDx) studies play a critical role when the clinical diagnosis is uncertain. They assist in confirming or excluding CTS, assessing the severity of nerve compression, and guiding decisions regarding surgical management.[9,10] The combination of characteristic symptoms and signs with confirmatory electrophysiological testing provides the most accurate diagnostic approach.[9,10]

Electrodiagnostic studies are widely accepted as valid and reliable methods for confirming CTS. The amplitudes and conduction velocities of the sensory and motor nerve action potentials reflect axonal function and serve as valuable parameters complementing clinical grading in determining disease severity.[11,12]

Therefore, the aim of this study was to analyze the clinical and electrophysiological findings of Carpal Tunnel Syndrome in the Nepalese population.

METHODS

This hospital-based retrospective study was conducted in the Neurology Unit, Department of Medicine, Bir Hospital, Kathmandu, Nepal. The study was initiated after obtaining ethical approval from the Institutional Review Committee of National Academy of Medical Sciences (NAMS), Bir Hospital (Reference Number: IRB/079/080/125). All available records of patients who attended the Neurology Outpatient Department (OPD) for nerve conduction studies (NCS) and were diagnosed with Carpal Tunnel Syndrome (CTS) at NAMS, Bir Hospital, between 1 August 2022 and 30 July 2023, were reviewed retrospectively. Diagnosis was established based on clinical presentation and electrophysiological findings.
Nerve conduction studies were performed by a neurologist using standard surface stimulation and recording techniques. Both motor and sensory studies were conducted for the median and ulnar nerves. The motor component was

stimulated orthodromically, while the sensory component of each nerve was stimulated antidromically, and F-waves were recorded.

The recorded potentials included:

- Compound Muscle Action Potential (CMAP) for motor nerves, and
- Sensory Nerve Action Potential (SNAP) for sensory nerves.

The following parameters were obtained: onset latency, CMAP amplitude, duration, area, distance, and nerve conduction velocity (CV). When necessary, a comparison test between the median and ulnar nerves was performed to compare sensory conduction values from the wrist to the ring finger.[9,11]

The electrophysiological severity of CTS was classified as mild, moderate, or severe according to standard diagnostic criteria.[9,11,12]

- **Mild CTS:** Prolongation of distal latency and reduction in the amplitude of the median sensory nerve.
- **Moderate CTS:** In addition to the above, prolongation of the distal latency of the median motor nerve.
- **Severe CTS:** Absence of recordable sensory potential, prolongation of distal latency, and decreased amplitude of the median motor nerve.

Data were analyzed descriptively to assess demographic, clinical, and electrophysiological variables.

RESULTS

A total of 94 patients with a clinical and electrophysiological diagnosis of Carpal Tunnel Syndrome (CTS) were included in the study. The mean age of participants was 44.23 ± 10.9 years (range: 23–71 years). There was a clear female predominance, with 68 females (72.3%) and 26 males (27.7%), yielding a male-to-female ratio of approximately 1:2.6.

Bilateral CTS was observed in 33 patients (35.1%), while 61 patients (64.9%) had unilateral involvement. The mean duration of symptoms was 0.96 ± 0.31 years.

Among comorbid conditions, hypothyroidism was the most common, affecting 23 patients (24.5%), followed by diabetes mellitus in 18 patients (19.1%), rheumatoid arthritis in 5 patients (5.3%), and previous wrist or hand trauma/fracture in 6 patients (6.4%). Tinel's sign was positive in 39 patients (41.5%), while Phalen's sign was positive in 29 patients (30.9%).

Table 1. Demographic and Clinical Characteristics of Patients with Carpal Tunnel Syndrome

Characteristic	Value
Number of Patients	94
Age (years; mean ± SD, range)	44.23 ± 10.9 (23–71)
Male (%)	26 (27.7%)
Female (%)	68 (72.3%)
Diabetes Mellitus	18 (19.1%)
Hypothyroidism	23 (24.5%)
Rheumatoid Arthritis	5 (5.3%)
Trauma / Fracture	6 (6.4%)
Unilateral CTS	61 (64.9%)
Bilateral CTS	33 (35.1%)
Duration of Symptoms (years; mean ± SD)	0.96 ± 0.31
Tinel's Sign Positive	39 (41.5%)
Phalen's Sign Positive	29 (30.9%)

Electrophysiological findings revealed pure sensory neuropathy in 54 patients (57.4%) and sensorimotor neuropathy in 40 patients (42.6%). The demyelinating pattern was the most frequent electrophysiological abnormality, observed in 68 patients (72.3%), while combined demyelinating-axonal involvement was identified in 26 patients (27.7%).

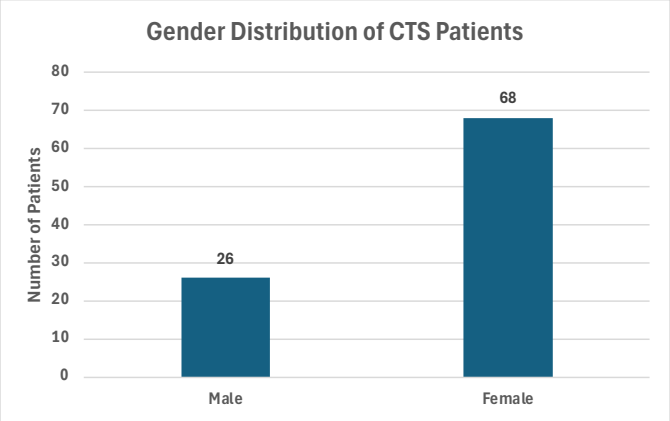

Figure 1. Gender distribution of patients diagnosed with CTS (n = 94)

Table 2. Nerve Conduction Study (NCS) Findings Among Patients with CTS

NCS Findings	n (%)
Pure Sensory Neuropathy	54 (57.4%)
Sensorimotor Neuropathy	40 (42.6%)
Demyelinating Neuropathy	68 (72.3%)
Demyelinating–Axonal Neuropathy	26 (27.7%)

Electrophysiological findings revealed pure sensory neuropathy in 54 patients (57.4%) and sensorimotor neuropathy in 40 (42.6%). Demyelinating neuropathy was the most frequent pattern (n = 68, 72.3%), while 26 (27.7%) demonstrated combined demyelinating-axonal involvement (Table 2).

Figure 2. Distribution of neuropathy subtypes detected on nerve conduction studies (NCS) among patients with Carpal Tunnel Syndrome (CTS), demonstrating demyelinating neuropathy as the most predominant finding.

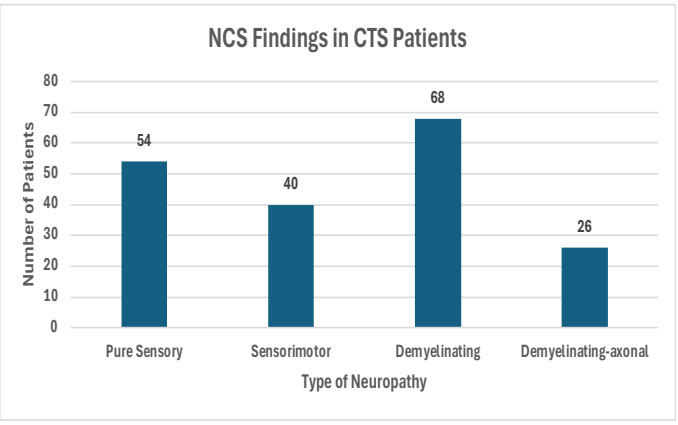

Figure 2. Distribution of neuropathy subtypes detected in NCS among patients with CTS

Overall, the results indicate a predominance of female patients, a high frequency of metabolic comorbidities (notably hypothyroidism and diabetes mellitus), and demyelination as the principal electrophysiological finding on nerve conduction studies.

DISCUSSION

Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy of the upper limb and may present with a range of sensory and motor symptoms, including numbness, tingling, burning, and pain involving the thumb, index, middle, and lateral half of the ring finger. Symptoms may radiate up the forearm toward the shoulder, and patients may experience weakness or hand clumsiness in advanced stages.[2,6]

In the present study, data from all patients who attended the Neurology Outpatient Department (OPD) for nerve conduction studies (NCS) at Bir Hospital and were diagnosed with CTS between June 2022 and May 2023 were retrospectively analyzed. The findings are comparable with several published studies.

In this study, 68 patients (72.3%) were female and 26 (27.7%) were male, confirming the well-documented female predominance of CTS. This finding is consistent with the study by Solomon et al., which reported that 74% of CTS patients were female,[13] and with the observations of Stevens, John, and Wing, who found that 70% of their patients were female.[14] The higher prevalence in women has been attributed to hormonal factors, smaller carpal tunnel dimensions, and greater susceptibility to fluid retention during certain physiological conditions such as pregnancy and menopause.[2,5]

The mean age in this study was 44.23 ± 10.9 years (range 23–71 years), aligning with Ferry et al., who reported a mean age of 41.9 years among CTS patients.[15] This supports the observation that CTS commonly affects individuals in middle age, particularly those with prolonged repetitive hand activity or systemic comorbidities.

Among the associated conditions, hypothyroidism (24.5%) was the most prevalent comorbidity, followed by diabetes mellitus (19.1%), rheumatoid arthritis (5.3%), and post-traumatic causes (6.4%). These findings are consistent with the study by Islam et al., which identified hypothyroidism as a major risk factor for CTS in Bangladesh.15 The strong association between CTS and metabolic disorders such as hypothyroidism and diabetes has been explained by mucopolysaccharide deposition and microangiopathic changes, which contribute to median nerve compression within the carpal tunnel.[5,14]

Tinel's sign and Phalen's sign, although commonly used clinical tests, demonstrated variable positivity in this study (41.5% and 30.9%, respectively). This variability mirrors the wide range of sensitivities and specificities reported in the literature, indicating that clinical signs alone are insufficient for diagnosis and must be complemented by electrodiagnostic confirmation.[7,8,9]

Electrophysiologically, demyelinating neuropathy was the most common finding (72.3%), followed by mixed demyelinating-axonal involvement (27.7%). These results correspond with other studies that describe demyelination as the hallmark of CTS, reflecting compression-induced segmental slowing of conduction across the carpal tunnel.[11,12,15] The presence of sensorimotor involvement in 42.6% of patients also indicates progression to more severe forms, which is consistent with the typical disease course described in prior electrophysiological research.[9,15]

However, this study had certain limitations. It was single-centered with a relatively small sample size, which may limit generalizability. As it was a hospital-based retrospective study, results may differ from those derived from community-based populations, where occupational and environmental factors vary.

Despite these limitations, the study provides valuable insight into the clinical and electrophysiological profile of CTS among Nepalese patients and highlights the importance of nerve conduction studies in confirming diagnosis and assessing disease severity.

CONCLUSION

This study highlights that Carpal Tunnel Syndrome (CTS) is a multifactorial condition influenced by both systemic and occupational risk factors. Among the studied patients, diabetes mellitus, hypothyroidism, obesity, and rheumatoid arthritis were common comorbidities, suggesting a strong association between metabolic and inflammatory disorders and the development of CTS.

A marked female predominance was observed, and the majority of cases occurred in middle-aged individuals, underscoring the demographic pattern commonly reported worldwide. Electrophysiological analysis revealed that pure sensory median neuropathy and demyelinating changes were the most prevalent findings, confirming the role of nerve conduction studies as a critical diagnostic and grading tool. In summary, this study reinforces the importance of electrodiagnostic evaluation in confirming CTS, determining its severity, and guiding management decisions. Future multicentric, community-based studies are recommended to better understand the epidemiological patterns and risk determinants of CTS in diverse populations.

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AUTHOR CONTRIBUTIONS

Sunil Ram Koirala, as the principal investigator, led the conceptualization, study design, data collection, electrophysiological coordination, manuscript drafting, and final approval, serving as the guarantor of the work. Poonam Pandey contributed to data collection, literature review, and supportive clinical coordination. Pradeep Bastola assisted with electrophysiological studies, methodology, and data collection. Shree Narayan Yadav provided statistical analysis, manuscript editing, corresponding author support, conceptual input, and final approval. Rajesh Kumar Gupta contributed through biochemical review, data verification, manuscript review, and final proofreading. All authors revised the draft critically and approved the final draft.

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CONFLICT OF INTEREST

All the authors declare no competing