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Comparison between pre-operative and post-operative clinical and neurophysiological outcomes in carpal tunnel release for median nerve entrapment

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Abstract

Background: Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy of the upper limb caused by compression of the median nerve in the carpal tunnel at wrist. Surgical decompression remains the definitive treatment for patients who fail initial conservative management. This study evaluates the improvement in clinical and neurophysiological parameters before and after Carpal Tunnel Release (CTR) for carpal tunnel syndrome.

Methods: A prospective study was conducted on 30 patients diagnosed with idiopathic CTS confirmed by Nerve Conduction Studies (NCS). Patients underwent either open or microscopic carpal tunnel release. Pre-operative and post-operative evaluations included clinical assessment using the Boston Carpal Tunnel Questionnaire (BCTQ) and electrophysiological parameters—Motor latency (LAT M), motor duration (DUR M), motor Amplitude (AMP M), motor Nerve Conduction Velocity (NCV M), sensory Latency (LAT S), sensory Duration (DUR S), sensory Amplitude (AMP S), and sensory Conduction Velocity (NCV S). Post-operative assessments were performed at three months. Statistical significance was set at $p<0.05$.

Results: Among 30 patients (20 females, 10 males; mean age≈51 years), unilateral involvement occurred in 63% and bilateral in 37%. The mean pre-operative Boston Score was 55.40±8.30, which significantly decreased post-operatively to 26.93±5.67 ($p=0.000$). Motor latency improved significantly (6.23±1.63 → 4.47±0.93 ms, $p=0.000$), whereas motor duration, amplitude, and conduction velocity showed non-significant changes. Sensory latency improved significantly ($p=0.030$) while sensory amplitude and NCV exhibited an improving trend ($p = 0.060$ and 0.054).

Conclusion: Carpal tunnel release significantly improves both clinical symptoms and certain neurophysiological parameters, particularly motor and sensory latency. However, full electrophysiological recovery may lag behind clinical improvement, underscoring the value of combined clinical and NCS follow-up for comprehensive evaluation of surgical outcome.

Keywords: Carpal tunnel syndrome; Median nerve entrapment; Boston score.

Introduction

Carpal Tunnel Syndrome (CTS) is a prevalent neuropathic disorder resulting from compression of the median nerve within at wrist, leading to pain, numbness, and tingling in the hand and arm. Several factors contribute to its onset, including obesity, repetitive wrist motion, pregnancy, genetic predisposition, and rheumatoid inflammation [1].

Clinically, CTS severity ranges from mild to severe, with symptoms typically involving sensory disturbances in the thumb, index, middle, and radial half of the ring finger [2]. Prolonged cases may have muscle wasting at the base of the thumb and diminished grip strength. Globally, approximately 4-5% of the population is affected, particularly among individuals aged 40-60 years [3].

Women exhibit a higher prevalence compared to men; data from the UK General Practice Research Database (2000) recorded an incidence of 193 per 100,000 in females and 88 per 100,000 in males [2]. Peak incidence occured among women aged 45–54 years and men aged 75–84 years [4]. CTS is also recognized as a work-related musculoskeletal disorder linked to repetitive strain and occupational overuse, often contributing to absenteeism and reduced work productivity.

Aims and objectives

- To study the NCV profile and functional outcome following carpal tunnel release in CTS.

Materials and methods

Study design and setting

A prospective observational study was conducted in the Department of Neurosurgery, Himalayan Institute of Medical Sciences, Dehradun, over 18 months.

Participants

Thirty patients with idiopathic CTS confirmed by NCS were included.

Inclusion criteria:

- NCS showing median neuropathy at wrist (DML ≥4.5 ms, sensory latency ≥3.5 ms, or SCV <40 m/s).
- Positive results on ≥2 clinical tests (Phalen's, Reverse Phalen's, Tinel's, Durkan's, Hand-Elevation).

- Symptoms >3 months and poor response to ≥6 weeks conservative therapy.

Exclusion criteria:

- Cervical radiculopathy, inflammatory arthropathy, uncontrolled diabetes, pregnancy, trauma, or previous CTR.

Surgical technique

All patients would be subjected to clinical evaluation, electrophysiological testing (NCV) and Boston questionnaire for severity of symptoms and functional status. The patients who were taken for surgery were recruited for the study after due informed consent regarding the illness and type of surgery. Patients underwent ipsilateral carpal tunnel release. Neurological status of the patient were evaluated preoperatively, at one month and three months interval based on the fixed questionnaire and NCV findings. Quality of life and functional outcome as found by the 'Boston questionnaire and functional outcome score was determined. Along with Boston questionnaire and functional outcome score, NCV finding were also considered (both pre and post operatively).

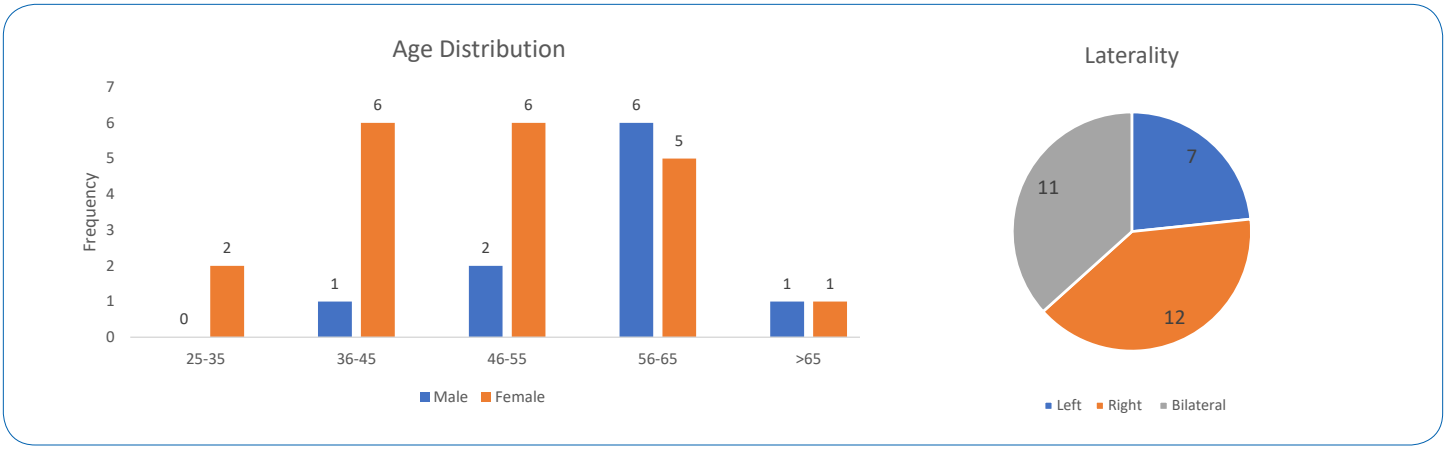
Statistical analysis

Data were analyzed using SPSS v26.0. Continuous variables were expressed as mean±SD. Pre- and post-operative comparisons were made using paired *t*-test. $p<0.05$ was considered statistically significant.

Results

Demographic profile

Among 30 patients, 20(66.7%) were female and 10(33.3%) male. The majority were aged 46–65 years. Laterality: right 12(40%), left 7(23.3%), bilateral 11(36.7%).



Clinical outcomes

The mean BCTQ (Boston Score) significantly improved from 55.40±8.30 pre-operatively to 26.93±5.67 post-operatively ($p=0.000$). This indicates a marked reduction in pain, numbness, and functional limitation.

Neurophysiological outcomes

Parameter	Pre-op (Mean±SD)	Post-op (Mean±SD)	*p*-value	Interpretation
Motor Latency (LAT M)	6.23±1.63	4.47±0.93	0.000	Significant ↓
Motor Duration (DUR M)	10.73±4.17	9.07±3.14	0.072	NS trend ↓
Motor Amplitude (AMP M)	7.03±3.99	7.63±3.21	0.504	NS
Motor NCV (M)	49.17±8.36	48.00±11.72	0.613	NS
Sensory Latency (LAT S)	6.13±5.61	3.80±0.55	0.030	Significant ↓
Sensory Duration (DUR S)	4.20±1.84	3.87±0.57	0.071	NS trend ↓
Sensory Amplitude (AMP S)	16.90±17.67	25.93±18.36	0.060	Trend ↑
Sensory NCV (S)	34.47±10.23	38.87±11.05	0.054	Trend ↑

LAT M and LAT S showed statistically significant postoperative improvement, whereas other parameters displayed improvement trends but lacked statistical significance.

Discussion

The present study was conducted to evaluate the clinical and neurophysiological improvement following Carpal Tunnel Release (CTR) in patients with idiopathic carpal tunnel syndrome. Our findings revealed a significant postoperative reduction in symptom severity and improvement in selected nerve conduction parameters, confirming the effectiveness of surgical decompression in alleviating median nerve entrapment.

Out of 30 patients, 20(66.7%) were females and 10(33.3%) were males, demonstrating a clear female predominance, consistent with prior epidemiological trends. The mean age of patients ranged from 46–65 years, reflecting the typical age group affected by CTS. Laterality analysis showed right-hand involvement in 40%, left in 23.3%, and bilateral in 36.7% of cases.

Clinically, the Boston Carpal Tunnel Questionnaire (BCTQ) score significantly improved from a preoperative mean of 55.40±8.30 to 26.93±5.67 postoperatively (*p=0.000*), reflecting remarkable symptom relief and functional recovery. The statistically significant improvement in the **Boston score** validates the functional success of CTR, echoing the results of Gilveg et al. [5], who demonstrated substantial symptomatic and functional recovery at six months following both open and endoscopic release (BCTQ SSS ≈ 2.8 → 1.1, $p<0.01$).

Neurophysiological testing revealed a statistically significant improvement in motor latency (LAT M) from 6.23±1.63 ms to 4.47±0.93 ms (*p=0.000*), and sensory latency (LAT S) from 6.13±5.61 ms to 3.80±0.55 ms (*p=0.030*). While other parameters such as motor duration, sensory duration amplitude, and conduction velocity displayed non-significant but positive trends toward recovery. These findings indicate that demyelination-related conduction delay resolves earlier, whereas axonal regeneration continues beyond the short-term follow-up period. The reduction in motor latency seen in our study reflects effective decompression of the median nerve and initiation of remyelination. The persistence of non-significant improvement in amplitude and velocity supports the concept that electrophysiological normalization lags behind symptomatic recovery, a pattern attributed to gradual axonal repair.

Our observations align with Cudlip et al. [6], who demonstrated postoperative morphological recovery of the median nerve using MR neurography—showing reduced flattening ratio and restoration of normal T2 signal intensity after surgical release. Likewise, Jazayeri et al. [7] found that sensory latency and conduction velocity were more sensitive indicators of postoperative improvement than motor parameters. The improvement in sensory parameters and motor parameters in our cohort did not reinforces that sensory fibers recover faster, which was believed to be so due to less structural damage compared with motor fibers, which often sustain deeper myelin and axonal injury.

Conclusion

Carpal tunnel release results in significant symptomatic relief and objective neurophysiological improvement, particularly in latency parameters mainly of both motor and sensory components. While electrophysiological recovery may be incomplete within 3 months, sustained follow-up suggests progressive nerve function restoration.

Microscopic CTR provides equivalent outcomes to open CTR, supporting either technique as an effective intervention when performed by experienced surgeons.

Limitations

- Small sample size (n=30) and short follow-up (3 months).
- MRI correlation and long-term recurrence data were not included.
- Randomization limited to surgical technique; blinding of evaluators could strengthen validity.

Recommendations

Future studies should include larger multicenter cohorts, longer follow-up (≥12 months), and MRI neurography correlation to better elucidate nerve recovery dynamics.

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