



A COMPARISON OF FUNCTIONAL ASSESSMENT OF PRE- AND POST-SURGICAL CARPAL TUNNEL SYNDROME USING BOSTON CARPAL TUNNEL QUESTIONNAIRE AND NERVE CONDUCTION STUDY: A PROSPECTIVE STUDY FROM A TERTIARY CENTER OF SOUTH INDIA

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ABSTRACT

INTRODUCTION: Carpal tunnel syndrome (CTS) is the most common entrapment syndrome of median nerve causing frequent disability especially among working populations. Boston Carpal Tunnel Questionnaire and Electrophysiological study helps in detecting and aiding in the diagnosis of CTS and helps in determining level of improvement after surgical release of carpal tunnel.

OBJECTIVES: To assess functional outcome of patients with Carpal Tunnel Syndrome after surgery as assessed by Boston Carpal Tunnel Questionnaire and Electrophysiological study.

METHODS: A prospective observational study conducted over a period of one year (January 2017 to January 2018). The study was conducted among consecutive 31 electrophysiological confirmed carpal tunnel syndrome attending the outpatient department of Physical Medicine and Rehabilitation, Government Medical College, Thiruvananthapuram. All patients underwent open carpal tunnel release. Functional outcome was assessed using Boston Carpal Tunnel Questionnaire (BCTQ) both preoperatively and at interval of 3 weeks, 6 weeks and 3 months postoperatively. Electrophysiological study assessed using nerve conduction study both preoperatively and 3 weeks post operatively. Data was entered in Microsoft excel and analyzed using SPSS statistical software.

RESULTS: The study involves 31 confirmed cases of Carpal tunnel syndrome patients. Mean Boston Carpal Tunnel Questionnaire (BCTQ) score preoperatively was 58.52 ± 12.73 which was markedly improved postoperatively at 3 weeks with mean score of 29.77 ± 6.68 . At 6 weeks and 3 month follow up period it was reduced respectively to mean score of 23.94 ± 4.23 and 22.94 ± 4.62 . Preoperative NCS shows decreased conduction velocity with mean nerve sensory velocity (NSV) score 21.51 ± 8.19 and mean nerve motor velocity (NMV) score of 20.72 ± 8.81 which statistically improved following surgery with mean NSV score of 32.04 ± 9.01 and mean NML score of 33.78 ± 8.1 . Correlation between pre- and post-operative BCTQ and NCS parameters shows positive correlation with latency and negative correlation with amplitude and conduction velocity. Increased latency and decreased conduction velocity associated with higher BCTQ score with significant 'p' value ($p < 0.05$).

CONCLUSION: There is statistically significant improvement of functional outcome following carpal tunnel release surgery assessed through Boston Carpal Tunnel Questionnaire and Electrophysiological findings.

KEYWORDS : Carpal tunnel Syndrome, Open surgical release, Nerve Conduction Study, Carpal tunnel release

INTRODUCTION

Carpal tunnel syndrome (CTS) is a pressure induced neuropathy that causes sensorimotor disturbance of median nerve which impairs functional ability. ICD-10 classified CTS as G56. It accounts for 90% of all entrapment neuropathies and 7% of all peripheral neuropathies. (1) Carpal tunnel syndrome affects middle-aged individuals with predilection over females than males, peak incidence around 55 to 60 years. Idiopathic is most common cause yet anatomic, occupational and systemic factors influence CTS. Electrodiagnostic studies are used to confirm the diagnosis of carpal tunnel syndrome. Electrodiagnostic studies helps to locate the lesion, show involvement of motor, sensory fibers or both, to define physiological basis (axon loss, demyelination), severity of lesion (degree of axonal loss, continuity of axons), time course of lesion (evidence of reinnervation /ongoing axonal loss). Gold standard for diagnosis is the combination of the clinical findings and the electrophysiological study. (2,3) Other imaging studies like ultrasound and magnetic resonance imaging are also used. Pauda et al. found a functional link between the nerve electrophysiological findings and clinical signs of CTS, but no correlation in terms of the actual relief of clinical symptoms of the patient (1). Boston carpal tunnel questionnaire is a carpal tunnel syndrome specific outcome assessment questionnaire (4). It assesses the severity of symptoms and the functional status in patients who have undergone carpal tunnel release.

The aim of this present study is to compare the functional

assessment of pre- and post-surgical carpal tunnel syndrome through Boston Carpal Tunnel Questionnaire and Electrophysiological study.

Primary Objective:

To evaluate functional outcome of patients with Carpal Tunnel Syndrome attending PMR Department of Trivandrum Medical College after surgery using Boston Carpal Tunnel Questionnaire.

Secondary Objective:

To evaluate the Electrophysiological improvement of Median Nerve following surgery.

MATERIALS AND METHODS:**Study Design:**

Prospective Comparative Study.

Study Setting:

Department of Physical Medicine and Rehabilitation Outpatient Department, Medical College, Trivandrum.

Study Duration:

1 Year (January 2017-January 2018)

Case definition:

Initially clinical diagnosis of Carpal tunnel syndrome was made preliminarily based on symptoms and findings on

physical examination. Then the patients were evaluated using self-administered Boston Carpal Tunnel Questionnaire (BCTQ) and Electrophysiological study. After preoperative evaluation, all the patients included in the study had open carpal tunnel release under general anesthesia. After surgery, all the patients were evaluated using BCTQ at the interval of 3 weeks, 6 weeks and 3 months postoperatively. Electro physiological studies were conducted at the interval of 3 weeks postoperatively.

INCLUSION CRITERIA

Patient with Carpal tunnel syndrome confirmed with electrodiagnostic studies.

EXCLUSION CRITERIA:

CTS patient associated with diagnosis of polyneuropathy, ulnar neuropathy.

METHOD:

The study was conducted among 31 electrophysiological confirmed carpal tunnel syndrome cases who attended the outpatient department of Physical Medicine and Rehabilitation, Government Medical College, Thiruvanthapuram. Detailed history and clinical examination were done which includes Phalen's wrist flexion test, carpal compression test, Tinel's nerve percussion test, sensory test for light touch graded using ASIA scale 0: absent, 1: impaired, 2: normal, NT: unable to test and two-point discrimination were tested, motor assessed using power grip with the help of handheld dynamometer.

The BCTQ questionnaire has two components. The first part is a Symptom Severity Scale with 11 questions. The second is Functional Status Scale with 8 items that are rated for degree of difficulty on a five-point scale. Each scale generates a final score that ranges from 1 to 5, with a higher score indicating a greater disability.

Nerve conduction study were done using NATUS EMG MACHINE with standard surface stimulation and recording techniques on with standard filter settings and a surface stimulator using a 0.1 ms square wave pulse. Patients were studied for median nerve CMAP amplitude, latency, conduction velocity and SNAP latency and conduction velocity. Standard recording sites and stimulation to recording electrode distances was used. Active electrode placed over the center of the Abductor Pollicis Brevis and reference electrode placed 4 cm distal to active electrode. For median nerve, distal stimulation(S1) given 8 cm proximal to the active electrode between the Flexor Carpi Radialis and Palmaris Longus. Proximal stimulation (S2) was given in antecubital fossa, just medial to biceps tendon; ground electrode was placed between stimulating electrode and recording electrode. F-wave latency was recorded for median nerve. For motor NCS gain was kept at 2 mv/division, time sweep at 2ms / division and low and high frequency filters at 10 and 32 kHz respectively, while sensory studies gain was at 20 mv/division and time sweep at 1 ms/division, with the same filter settings. Temperature at the time of performing NCS was kept at room temperature, limb temperature was not monitored.

Compound muscle action potential (CMAP) were measured from the baseline to negative peak and onset latencies were measured from distal and proximal stimulation sites. Motor conduction velocity is measured by dividing latency difference by distance between stimulating and recording electrode. Sensory nerve action potential (SNAP) amplitude was measured from the initial positive peak to the negative peak or from the baseline to the negative peak if there was no initial positive peak. The results were calculated on the basis of average responses.

Table 1. shows the normal values of Electrophysiological study values.

| Nerve | Distance cm | Amplitude mV | Latency msec | NCV m/sec |
|------------------------|----------------|-----------------|-----------------|--------------|
| Median motor-APB | 7 | >4 | <4.5 | >48 |
| Median F wave | | | <32 | |
| Median sensory-digital | 14 | >25 | <3.5 | >56 |
| Median sensory-palmar | 8 | >50 | <2.3 | >56 |

Statistical analysis:

Data was entered in Microsoft excel and analyzed using SPSS statistical software. Qualitative data was expressed in percentage and proportion. Quantitative data was expressed in mean and standard deviation. Correlation was measured using Pearson correlation method.

RESULTS:

The study included 31 confirmed cases of CTS patients of which 32.3% (10 patients) were below 40 years, 35.5% (11 patients) were between 41-50 years and 32.3% (10 patients) were above 50 years. The age ranges from 22 to 64 years with mean age of 45.90 years. It was found to be more prevalent among females 67.7% (21 patients) than males 32.3% (10 patients).

Mean BCTQ score preoperatively was 58.52 ± 12.73 which was markedly improved postoperatively at 3 weeks with mean score of 29.77±6.68. At 6 weeks and 3 month follow up period it was reduced to mean BCTQ score of 23.94 ± 4.23 and 22.94 ± 4.62 respectively.

Comparison Of Pre And Post Operative Mean Boston Carpal Tunnel Questionnaire (bctq) Score

Table 2: Mean BCTQ Score

| Duration ↓ | BCTQ | |
|------------|-------|-------|
| | Mean | Sd |
| Pre OP | 58.52 | 12.73 |
| 3 week | 29.77 | 6.68 |
| 6 week | 23.94 | 4.23 |
| 3 months | 22.94 | 4.62 |

NCS was assessed using parameters like Nerve sensory latency (NSL), Nerve Motor Latency (NML), Nerve Sensory Velocity (NSV), Nerve Motor Velocity (NMV) and Nerve Motor Amplitude (NMA).

Comparison Of Pre And Post Operative Mean Nerve Motor Latency (nml) Score

Table 3: Mean NML Score

| Duration ↓ | NML | | Paired t test | |
|------------|------|------|---------------|--------|
| | Mean | Sd | T | P |
| Pre OP | 6.23 | 1.90 | 7.101 | <0.001 |
| 3 week | 5.47 | 1.57 | | |

Comparison Of Pre And Post Operative Mean Nerve Sensory Latency (nsl) Score

Table 4: Mean NSL Score

| Duration ↓ | NSL | | Paired t test | |
|------------|------|------|---------------|-------|
| | Mean | Sd | T | P |
| Pre OP | 7.15 | 3.83 | 3.595 | 0.001 |
| 3 week | 6.11 | 3.20 | | |

Preoperative NCS shows increased latency with mean NSL score 7.15± 3.83 and mean NML score of 6.23± 1.90 which statistically improved following surgery with mean NSL score of 6.11± 3.20 and mean NML score of 5.47±1.57.

Comparison Of Pre And Post Operative Mean Nerve Motor Velocity (nmv) Score

Table 5: Mean NMV Score

| Duration ↓ | NMV | | Paired t test | |
|------------|-------|------|---------------|--------|
| | Mean | Sd | T | P |
| Pre OP | 20.72 | 8.81 | 10.713 | <0.001 |
| 3 week | 32.04 | 9.01 | | |

Comparison Of Pre And Post Operative Mean Nerve Sensory Velocity (nsv) Score

Table 6: Mean NSV score

| | NSV | | Paired t test | |
|--------|-------|------|---------------|--------|
| | Mean | Sd | T | P |
| Pre OP | 21.51 | 8.19 | 11.807 | <0.001 |
| 3 week | 33.78 | 8.17 | | |

Preoperative NCS shows decreased conduction velocity with mean NSV score 21.51±8.19 and mean NMV score of 20.72±8.81 which statistically improved following surgery with mean NSV score of 32.04±9.01 and mean NML score of 33.78±8.1.

Comparison Of Pre And Post Operative Mean Nerve Motor Amplitude (nma) Score

Table 7: Mean NMA Score

| | NMA | | Paired t test | |
|--------|-------|------|---------------|--------|
| | Mean | Sd | T | P |
| Pre OP | 9.11 | 5.12 | 5.264 | <0.001 |
| 3 week | 10.89 | 5.22 | | |

There was significant improvement of amplitude with mean NMA score of 9.11±5.12 (TABLE 7) to mean NMA score of 10.89±5.22.

Correlation Between Preoperative Bctq And Preoperative Ncs Parameters

Table 8: Correlation between Preoperative BCTQ And Preoperative NCS Parameters

| Correlation of Pre OP BCTQ | Pearson Correlation r | P |
|----------------------------|-----------------------|--------|
| NML | .610 | <0.001 |
| NSL | .460 | 0.009 |
| NMV | -.452 | 0.011 |
| NSV | -.377 | 0.037 |
| NMA | -.412 | 0.021 |

Correlation between Preoperative BCTQ and Preoperative NCS parameters shows positive correlation with latency and negative correlation with amplitude and conduction velocity. Increased latency and decreased conduction velocity associated with higher BCTQ score with significant p value (p<0.05).

Correlation Between Postoperative Bctq And Postoperative Ncs Parameters

Table 9: Correlation between Postoperative BCTQ and Postoperative NCS Parameter

| Correlation of 3 week BCTQ | Pearson Correlation r | P |
|----------------------------|-----------------------|--------|
| NML | .698 | <0.001 |
| NSL | .574 | 0.001 |
| NMV | -.620 | <0.001 |
| NSV | -.636 | <0.001 |
| NMA | -0.271 | 0.141 |

Correlation between postoperative BCTQ and postoperative NCS parameters shows positive correlation with latency and negative correlation with amplitude and conduction velocity. Increased latency and decreased conduction velocity associated with higher BCTQ score with significant p value (p<0.05). Amplitude correlates with BCTQ with insignificant p value (p>0.05).

DISCUSSION:

The aim of this study was to evaluate the improvement in functional outcome following carpal tunnel release surgery through Boston Carpel Tunnel Questionnaire (BCTQ) and Electrophysiological study NCS. 31 subjects (21 females and 10 males) participated in the study. This is similar to the study by Vivek S et al (5), who found the ratio of female to male as 7.25:1.

The Boston Carpal Tunnel Questionnaire (BCTQ) evaluated preoperatively and postoperatively at interval of 3 weeks, 6 weeks and 3 months. Preoperatively mean BCTQ score was 58.22 ± 12.73 which was markedly improved following surgery with mean BCTQ score of 29.77 ± 6.68 at 3 weeks. Following succeeding follow up of 6 weeks and 3 months, it shows statistically significant improvement of mean BCTQ score with 23.94 ± 4.23 and 22.94 ± 4.62. Aldo Okamura et al assessed BCTQ score both preoperatively and post operatively which statistically improved following surgery (6).

NCS of median nerve evaluated for Compound Muscle Action Potential (CMAP) amplitude, latency and conduction velocity and Sensory nerve action potential (SNAP) latency and conduction velocity both preoperatively and postoperatively at 3 weeks. Preoperatively NCS shows increased latency with mean nerve motor latency (NML) score of 6.23 ± 1.90 and mean nerve sensory latency (NSL) score of 7.15 ± 3.83. Following surgery, at 3 weeks there is statistically significant improvement of mean NML score of 5.47 ± 1.57 and mean NSL score of 6.11 ± 3.20.

Preoperatively NCS shows decreased conduction velocity with mean nerve motor velocity (NMV) score of 20.72 ± 8.81 and mean nerve sensory velocity (NSV) score 21.51 ± 8.19 which was statistically improved following surgery with increased mean NMV score of 32.04 ± 9.01 and mean NSV score of 33.78 ± 8.17. There was significant improvement of amplitude with mean nerve motor amplitude (NMA) score of 9.11 ± 5.12 to mean NMA score of 10.89 ± 5.22. These findings were consistent with study conducted by Federica Ginanneschi et al in 2008 (7) who found that shortly after carpal tunnel release improved nerve sensory velocity (NSV) and nerve motor latency (NML) post operatively. Similar results were shown in study conducted by Mondelli M et al 2000 (1). Shurr et al 1986 also found the similar changes and the reason is that the CTS compression is in the distal part of the median nerve at the carpal tunnel rather than the proximal part in the forearm (8).

Correlation between Preoperative Nerve Conduction Study (NCS) Parameters and Preoperative BCTQ was evaluated using Pearson Coefficient. Strong positive correlation was found between Preoperative BCTQ and Preoperative Latency with r=0.460 (p<0.009) for NSL and r=0.610 (p<0.001) for NML suggestive of subjects with high NML and NSL score was associated with higher BCTQ score. Moderate negative correlation was observed between preoperative BCTQ and Preoperative amplitude and conduction velocity (NMV, NSV, NMA) with corresponding Pearson correlation coefficient of r= - 0.452 (p 0.011), r=-0.377 (p 0.037) and r=-0.412 (p<0.021). Subjects with high NMV, NSV, NMA score was associated with low BCTQ score.

Correlation between Postoperative BCTQ and Postoperative NCS parameters shows positive correlation with latency suggestive of increased latency associated with higher BCTQ score with Pearson Coefficient of r =0.698 for NML and r= 0.574 for NSL with significant p value (p<0.05). Negative correlation with amplitude and conduction velocity with Pearson Coefficient r=-0.620 (p<0.001) for NMV, r=0.636 (p<0.001) for NSV and r=-0.271 (p<0.141) for NMA. This suggests increased conduction velocity associated with decreased BCTQ score.

The correlation between pre- and post-operative BCTQ scores and Nerve conduction studies validate the role of BCTQ scoring in assessing improvement after CTR. Similar results were shown in study conducted by Mondelli *et al* 2000 (1).

CONCLUSION

1. This study concludes that there is statistically significant improvement of functional outcome following carpal tunnel release surgery assessed through Boston Carpal Tunnel Questionnaire and Electrophysiological findings.
2. Boston Carpal Tunnel Questionnaire is reliable and validated tool to assess both symptom severity and functional outcome following surgery.
3. Nerve conduction studies is considered as gold standard test to confirm carpal tunnel syndrome.
4. Nerve conduction studies parameters like nerve motor latency (NML) and sensory conduction velocity (NSV) shows early changes in carpal tunnel syndrome.
5. Clinically symptom severity correlates with increased latency and decreased conduction velocity.

Limitations:

There are some limitations to our study. We included only 31 patients in our study. All patients completed 6 months follow-up. The small sample size is the limitation of our study. The short-term follow up is also another limitation. A larger study with longer follow-up could probably be more effective in assessing functional outcomes post CTR surgery in cases of Carpal tunnel syndrome.

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