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Original Research Article

Comparative study between pre- and post- operative clinical and electrophysiological parameters in determining the recovery of carpal tunnel syndrome

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a neuropathy caused by entrapment of the median nerve at the wrist. CTS is the most well-known and frequent form of median nerve entrapment and accounts for 90% of all entrapment neuropathies. CTS, in the form of median nerve entrapment, remains a perplexing and debilitating disorder. We report a comparative study between the Boston questionnaire (BQ) and median nerve conduction study parameters in patients with CTS treated by division of the flexor retinaculum through a short incision at the palm.
Methods: The prospective cross-sectional, hospital-based study was conducted in department of burns, plastic and reconstructive surgery at SCB Medical College, Cuttack.
Results: The average age was 44.49 years (SD=10.51; range=24-70), and the average symptom duration was 19.9 months (range=6-36). There are 36 hands in the severe group, 22 with the moderate group, and 12 with the mild category. The mean symptom severity scale score for severe group A was 40.92 (SD=5.84) and for moderate group B was 31.67 (SD=5.72), and for the mild group, C was 26.0 and SD=3.82). We found significant correlation between symptomatic recovery and Boston severity scales.
Conclusions: Clinical correlation of pre- and post-op symptoms is the only full proof way to predict recovery after surgery in CTS-affected, patients.

Keywords: Carpal tunnel syndrome, Boston questionnaire, Electrophysiological examination, Sensory nerve action potential

INTRODUCTION

Carpal tunnel syndrome (CTS) is a neuropathy caused by entrapment of the median nerve at the wrist. CTS is the most well-known and frequent form of median nerve entrapment and accounts for 90% of all entrapment neuropathies.[1] An entrapment neuropathy is a chronic focal compressive neuropathy caused by a pressure increase inside non-flexible anatomical structures of the carpal tunnel, delimitated by the carpal bones and by the transverse carpal ligament.[2] Physiological evidence indicates increased pressure within the carpal tunnel and therefore decreased function of the median nerve at that level. It is the most prevalent kind of entrapment neuropathy, with a male incidence of 139 per 100000 person-years and a female incidence of 506 per 100000 person-years. CTS, in the form of median nerve entrapment, remains a perplexing and debilitating disorder.[3] Overall, incidence rates of up to 276: 100,000 per year have been reported, with a prevalence rate up to 9.2% in women and 6% in men.[2] More common in females than in males, its occurrence is commonly bilaterally with a peak age range of 40 to 60 years, although it occurs in all age groups.[4] Although the results of carpal tunnel release are generally regarded as satisfactory, some patients still have unsatisfactory outcomes.[5] CTS's primary symptoms include hand discomfort, unpleasant tingling, pain and numbness in the distal distribution of the median nerve (thumb, index, middle finger, and radial side of ring finger), and a loss in grip strength and function of the afflicted hand. Symptoms are worse at night, and clumsiness is described throughout the day with wrist flexion exercises. The patient often describes a phenomenon termed the "flick sign" or "thermometer sign" in which shaking/flicking their wrist relieves symptoms. Complications may occur after surgical procedures and reoperations maybe required caused by entrapment of the median nerve at the level of carpal tunnel delimited by the carpal bones and by the transverse carpal ligament. Several tools have been used to assess carpal tunnel syndrome treatment outcome. These include nerve conduction studies, symptom surveys, sensibility testing, pinch or grip strength measurement, complication rates, assessment of pain levels and agility, return to work, and functional capacity.[6] Nerve conduction studies have been used to diagnose carpal tunnel syndrome and evaluate the outcome of treatment. Some authors regard them as a standard part of assessment though others believe that they are unnecessary.[7] Carpal tunnel syndrome necessitates the use of a standardised, cost-effective, and easily adaptable evaluation instrument.

Self-administered questionnaires have been proposed for CTS to assess the severity of the condition from the patient's point of view.[10] Such questionnaires can be used to check whether a certain therapy relieves symptoms and improves the functional status. We report a comparative study between the Boston questionnaire (BQ) and median nerve conduction study parameters in patients with CTS treated by division of the flexor retinaculum through a short incision at the palm. The presurgical BQ score was assessed for predictivity of the post-surgical outcome, as has been done with nerve conduction findings. The Boston questionnaire is one of the self-administered questionnaires that have been produced. In this study, we looked to see if changes in the questionnaire's symptomatic and functional outcome ratings after surgery were connected to changes in nerve conduction investigations. Nerve conduction study (NCS) help to diagnose and decide on the treatment plan (conservative treatment or surgery) as well as predict the surgery. Furthermore, NCS is the only useful test for objective CTS assessment. NCS and the clinical symptom severity scale were found to be correlated.[8] Moreover, NCS was reported as a predictor of poor outcomes for surgical release.[11] Thus, predicting clinical outcomes following surgical release is very useful for patients and surgeons. However, the relationship between clinical outcomes following surgical release and preoperative/postoperative NCS is unclear.[9] This study aimed to examine the prediction improvement in patient-oriented and motor outcomes after operation using Boston scale preoperative and 1 and 3 months postoperatively and also to find out a relation between Boston scale with nerve conduction study parameters.

METHODS

The study is cross-sectional study in a tertiary care hospital. A total of 70 patients were chosen between December 2019 and 2021 at SCB Medical College asked to complete questionnaires before and after surgery.

Inclusion criteria

All patients who came to the department with complaints of CTS and required surgery were enrolled.

Exclusion criteria

Patients age less than 18 and more than 70, with pregnancy, post-traumatic neuropathy, those patients who did not give consent to participate, and patients having proximal neuropathies and other peripheral neuropathies were excluded.

This clinical study aimed to assess the severity of symptoms and functional status in patients with carpal tunnel syndrome using BQ.

Preop scores in BQ were recorded along with NCS, surgery performed, and the patient was called for follow up after one- and three-months post-surgery.

Parameters considered in the nerve conduction study were: sensory nerve action potential amplitude, peak latency of sensory nerve action potential (SNAP), sensory conduction velocity, motor nerve action potential amplitude, motor conduction velocity, and distal motor latency.

Post-op BQ scores with NCS study at one and three months were recorded.

Means of pre- and post-op Boston scores were calculated, also means of values of considered electrophysiological parameters were calculated.

Comparison between the pre and post scores of the BQ was done by paired t test to know their significance ($p<0.005$).

Correlation between the means of electrophysiological scores and means of BQ scores, both pre- and post-op were done by Spearman's correlation.

All the data were computed with IBM statistical package for the social sciences (SPSS) software 28.0.0.0.0.

The questionnaires were semi-structured, predesigned, pretested and validated used for data collection as a research tool. Patient demographics, comorbidities, and baseline scores were considered potential predictors for the amount of symptom relief on the Boston carpal tunnel questionnaire (BCTQ) score, which was the primary outcome measured. Differences between the BQ scores and the nerve conduction parameters between two successive observations were compared by a parametric test for paired data (paired t-test).

Cases with no sensory or motor response of the median nerve were not included in the statistical analysis. Correlations between the clinical severity score, the electrophysiological scales and the BQ scores were analysed by the Spearman test. This test was also used to test for correlations between improvement in the BQ score and in the neurophysiological scales (calculated as differences between the basal values and those at the second follow-up) and, clinical severity score and basal values of BQ and neurophysiological scales.

RESULTS

The data sets were tested for normality and exhibited a normal distribution. A p-value <0.05 was deemed statistically significant. Table 1 presents the patients 'characteristics. This study included 70 (6men and 64 women) patients, The average age was 44.49 years (SD: 10.51; range=24-70), and the average symptom duration was 19.9 months (range=6-36).

No reoperation cases were included in this study. Sixty patients with 70 hands suffering from CTS were studied in the present study. It included 56 (93.3%) females and 4 (6.7%) males. Only one patient out of the 60 was left-hand dominant. Among the 70 affected hands, the right hand was affected 21 times, left hand 16 numbers, bilateral hand 23 patients with 33 hands (Figure 2).

There are 36 hands in the severe group, 22 with the moderate group, and 12 with the mild category.

We compared the BQ scores preop and post-op (1 month and 3 months), SNAP, conduction velocity sensory and motor), Distal motor latency both preop and post-op (1 month and 3 months). Paired t-test was done between these parameters to know the significance of the mean difference of the variables.

Spearman correlation has been done to check the correlation between the groups.

The mean values of various electrophysiological parameters studied with the SD in the modified Padua's groups were as shown in Figure 2.

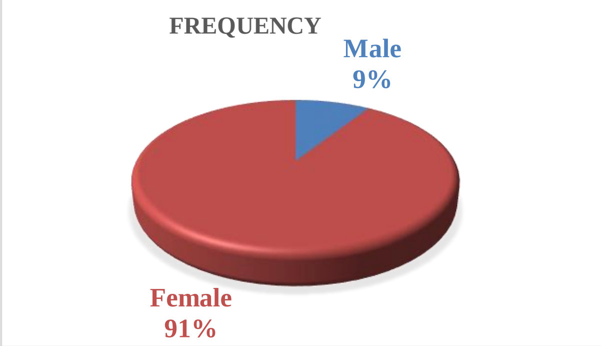

Figure 1: Patients characteristics.

Boston questionnaire comparisons

The mean symptom severity scale score for severe group A was 40.92 (SD: 5.84) and for moderate group B was 31.67 (SD: 5.72), and for the mild group, C was 26.0 and SD: 3.82. The mean functional status scale score for group A was 23.54 (SD 1.36) and for group B was 18.07 (SD: 1.24) and for mild 16.50 with SD: 2.95. The total mean of post-op (1 and 3 months) BCTQ scores for group A were 32.05 (SD: 7.05) (20.54 SD: 5.17) and for group B was 23.93 (SD: 6.60), (17.67 SD: 5.19) and for the mild group (17 SD: 3.79, 13 SD: 3.03). The mean post-op functional status scale group A (18.31 SD: 1.04, 13.5 SD: 3.38), group B (15 SD: 3.57, 15 2.97) and group C (13.33 SD: 3.14, 10.67 SD: 1.03). The change in the clinical severity score from preoperative value to the post-operative value should indicate clinical improvement or deterioration. Hence, we compared the difference between preoperative and post-operative scores (pre-and post-operative) in the three electrophysiological severity groups. The difference between the pre-and post-operative scores was compared to analyse clinical post-operative recovery.

The differences of means (paired t test) (pre-1 month, 1 month-3-month, pre-3 month) was conducted among various groups: A (8.088, 12.308, 20.385) Boston questionnaire functional status score (BQFS) (5.23, 5.14, 10.38), all are having p value <0.001; B (7.33,6.26,14.00) BQFS (4.0,3.20,7.20), all are having p value <0.001; and C (9.0, 4.00, 13.00) BQFS (3.16, 2.66, 5.88) not significant.

From the above data we found significant correlation between symptomatic recovery and Boston severity scales.

Relation between the electrophysiologic parameters

SNAP

In group A, all the SNAP values in - preop cases were non-reactive and in 1 month post op, except one, post op 3-month value mean was 15.30 range from (4.98-34.30).

In group B, pre op mean 19.80, post-op (24.88, 36.83) at one and three months, respectively.

Group mean diff (pre-post 1=5.9 nos., post 1-post 3=11.73 (p<0.001) post 3 – pre=17.03 (p<0.001).

Group C-pre op mean 20.38, post 1-23.32, post 3-39.76; group mean diff (post 1-pre=2.94) ns post 3-post 1=16.46) ns (post 3-pre=19.40) ns.

Peak latency of SNAP

Group A

In this severe group, proximal latency was not recordable in preop and post-op 1 month, and at the end of three months, it was 4.19, which was below normal limits.

Group B

The means in this group improved slightly at post-op 1-month values but again remained the same as the pre op values at the end of three months.

Group C

In this mild group, there was slowing in the preop period, which became normal at the end of one month and thereafter.

The paired mean difference was significant in the mild group (post 1-3-month values), and (pre-post 3-month values).

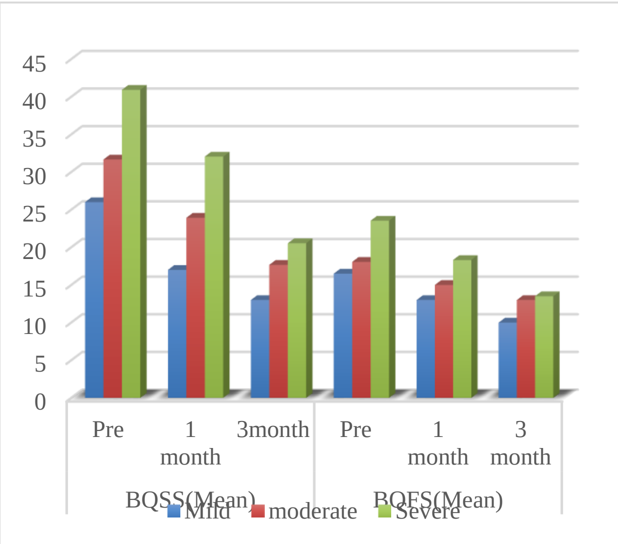

Figure 2: Mean clinical severity scores.

The values of distal motor latency were compared among three groups, and paired t-test was done to see their significance.

In group A, the mean distal motor latency was 6.16 -op, which improved to 6.13 (1st month) and 5.78 (3rd month).

The paired mean differences were insignificant.

In group B, the preop mean was 5.63 (SD: 1.20), which improved to 5.04 (SD: 1.15), 4.01 (SD: 0.574) at 1 and 3 months, respectively.

The paired mean difference at 1 month (0.59), 1-3 months (1.03), 3 month (1.61) to its pre-value. Improvement was statistically significant in the 1-3 month and pre to 3 months.

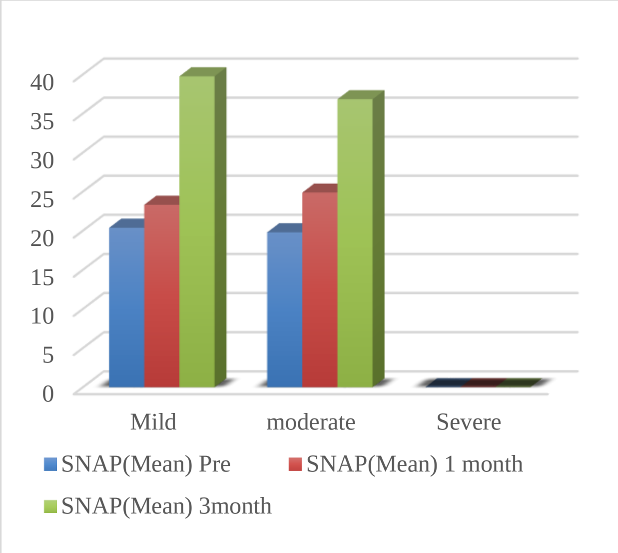

Figure 3: Mean values of SNAP.

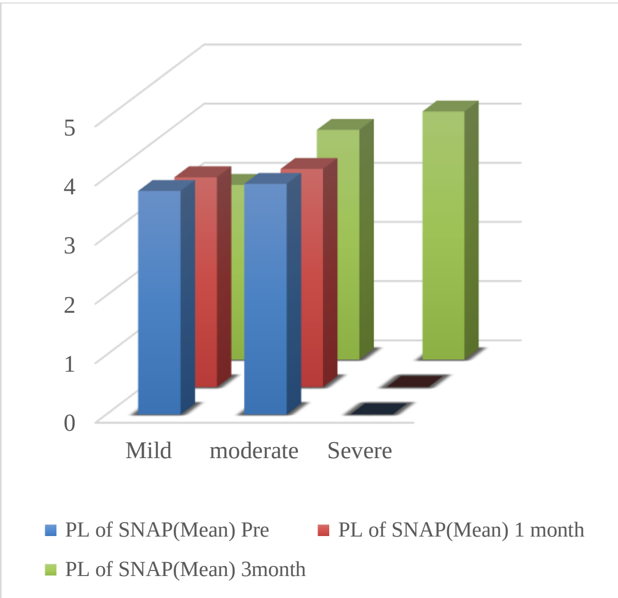

Figure 4: Peak latency of SNAP.

In group C, the preop mean for distal motor latency was 3.98 (SD: 267), which improved to 3.79 (SD: 408), 3.26 (SD: 20) at 1 and 3 months, respectively.

The paired mean of pre-op with post-1 month 0.19 (not significant), 1-3-month post-op is 0.531 (not significant), pre with post 3 month was 0.72 (p value significant).

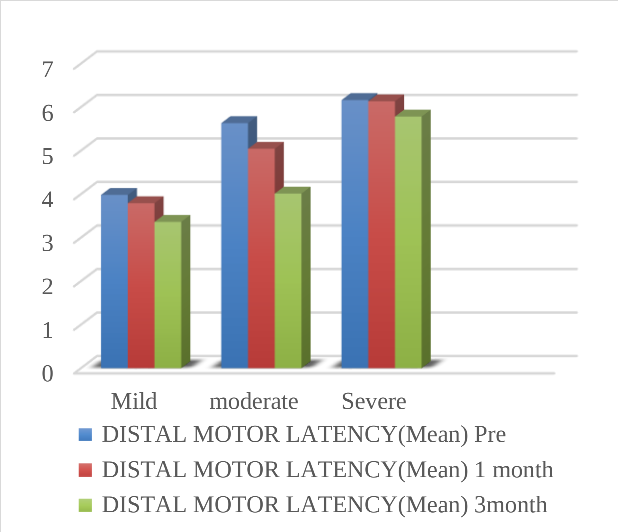

Figure 5: Values for distal motor latency.

Conduction velocity

The mean conduction velocities and their paired differences were calculated to know their significance. Both sensory and motor conduction velocities are calculated.

In group A, in the majority of cases, there was no readings in sensory conduction velocity in pre- and post-op 1-month period. Mean 3rd-month post-op velocity was 31.50 (SD: 8.69).

The mean motor conduction velocity is (45.09) pre-op, which improved to (46.21) and (53.45) post-op at one and 3 months, respectively.

In group B, the mean conduction velocity (motor) pre-op was 55.65 (SD: 9.31), which improved to 56.54 (SD: 7.99), 62.00 (SD: 5.67) at one and three months, respectively.

The paired mean difference was 0.88 (pre-1 month), 5.45 (1-3 month) statistically significant, 6.34 (pre-3-month post) statistically significant.

The mean sensory conduction velocity was 35.29 (SD: 6.00), improved to 41.01 (SD: 7.3), and (50.63) (SD: 6.06). Their paired mean difference was 5.75 (pre 1 month), 8.63 (1-3-month post), 14.99 (pre-3-month post). All were clinically significant ($p<0.001$).

In group C, the mean conduction velocity (sensory) pre-op was 37.40 (SD: 7.10), which improved to 43.82 (SD: 7.74), 54.02 (SD: 3.35) at one and three months, respectively.

The paired mean difference was 6.4 (pre- 1 month) ns, 10.1 (1-3 month) statistically insignificant, 16.34 (pre-3-month post) statistically significant.

The mean motor conduction velocity was 51.74 (SD: 4.74), improved to 53.98 (SD: 6.06), and (60.61) (SD: 5.20). Their paired mean difference was 2.235 (pre 1 month), 6.63 (1-3-month post), 8.87 (pre and 3-month post). All were clinically insignificant ($p<0.001$).

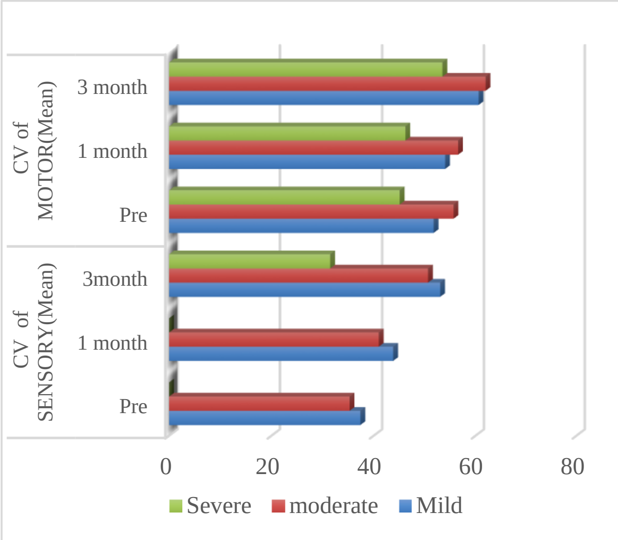

Figure 6: Mean conduction velocity.

Correlation between Boston symptom scale with neurophysiologic studies

To correlate between these two parameters, which is also the objective of the study, we applied Spearman's coefficient relationship.

In group A, significant relation was found between 3-month BQSS and 3-month SNAP; 1-month BQFS with 1-month snap, 3-month BQFS with 3-month SNAP; 3-month BQSS with 3-month sensory CV; and no relation was found between BQSS, BQFS with distal motor latency, BQFS with conduction velocity.

In group B, significant co relation was found between BQSS 3 month with SNAP 3 month; BQFS 1-month and BQFS 3 month with SNAP 1 month and 3-month; BQSS 3 month with 3-month sensory conduction velocity; BQSS, BQFS with proximal latency SNAP; and no relation was found between BQSS, BQFS with DML, BQFS with sensory conduction velocity.

In group C, significant relationship was found with BQSS 3 month with SNAP 3 month; BQSS 3 months with DML 3 month, BQFS 1 month with DML 1 month; BQSS 1 month with 1-month sensory conduction velocity; and no relation was found between BQFS with SNAP, BQFS with conduction velocity, BQSS and proximal latency of SNAP.

The BQ and electrophysiological scale scores and the nerve conduction parameters before and at 1 and 3 months after surgery are shown in Figures 5 and 6 and comparisons of these measurements at these times are shown in All the scores showed statistically proved significant. At the 1-month follow-up, there was a mean decrease of (2.1±70) points in symptom severity scale, indicating a reduction in symptoms. Five patients had no residual symptoms. At the 3-month follow-up, ten patients had complete relief of symptoms, and 33 cases had only minimal residual symptoms. improvement on post-operative evaluation.

DISCUSSION

Besides history and clinical examination, an electrophysiological examination is the only reliable means of confirming CTS. Electrophysiological examination is highly specific and is reasonably sensitive in diagnosing CTS. It helps rule out other neuropathic and comorbid conditions as a cause of the signs and symptoms seen in the patient.[9] The patient was examined to rule out other causes of hand symptoms such as cervical spondylosis or generalised diabetic neuropathy.

Electrophysiological evaluation of each patient was done pre-operatively from the department of neurology in our hospital to avoid inconsistency in comparing values attributed to machine or operator. Readings of SNAP (in mV), the peak amplitude of compound muscle action potential (in mV), peak latency of SNAP (in ms) and conduction velocity of the SNAP (in m/s) were recorded, along with distal motor latency, motor conduction velocity.

Variable and outcome measures

To summarise, the following data of each patient were recorded for comparison before and after surgery: SSS (pre-and post-operative), and FSS (pre-and post-operative).

These data were studied to analyse the correlation with the following electrophysiological variables of median nerve.

We tried to find out a relation between the pre-op SSS and FSS with the parameters of nerve conduction study as well as post-op (1 and 3 months) SSS and FSS with the changes in electrophysiological parameters.

According to Nehete et al, the difference between pre operative and post-operative scores is a good indicator of post-operative recovery, but it does not show any correlation when compared with electrophysiological severity.[10] The study reconfirms the diagnostic role of NCV in CTS, but the electrophysiological severity does not always match the clinical severity.[10] Our study showed that there is no definitive relation between electrophysiological severity and clinical severity scores. In our study, we found the difference between preoperative and post-operative scores is a good indicator of post-operative recovery, but it does show a weak correlation when compared with electrophysiological severity. You et al studied the relationship between preoperative clinical severity scales and abnormal electrodiagnostic measures in CTS patients.[11] You et al used the same Levine questionnaire which was also used in the present study. They found significant relationships between the clinical scales and nerve conduction measures.[13] In the present study, we compared the difference between pre-operative and post-operative SSS, which is obviously an indicator of recovery from the symptom complex the patient was suffering from and a weak relation with electrophysiologic severity.

Schrijver et al studied 138 patients with completed Levine questionnaire and nerve conduction studies (NCS) before and after treatment to correlate NCS and clinical outcome measures but could not identify any relationship between preoperative NCS and the outcome of the surgery, which was also similar to the results of Longstaffet al.[9,13] Schrijver et al also studied the relationship between nature or duration of symptoms and severity of electrophysiological impairment.[13] They also concluded that EMG NCS could not be considered essential in assessing outcomes in CTS after surgery.

Mondelli et al compared subjective symptoms with psychological factor as well as with electrophysiological severity, and they concluded that subjective symptoms are more correlated with psychological factors than with objective electrophysiological severity of the disease.[14] They even suggested antidepressant drugs in select patients as a treatment apart from analgesics.[14]

Heybeli et al observed a significant improvement in both measures after surgery, and the symptom severity and functional status scale scores correlated well with each other, though not with the nerve conduction study findings.[6] The improvements in distal motor and sensory conduction after surgery did not correlate with the changes in the symptom severity and functional status scales. In addition, the improvements in the functional status scale and symptom severity scale scores did not correlate with the age of the patients or the electrophysiological scores.

Mondeli et al, one month after the operation, there was a statistically significant ($p<0.001$) improvement in distal motor and sensory conduction velocities of all hands.[14] A further significant ($p<0.001$) improvement was observed between the second and the first follow-up.

Statistically significant correlations were found between patient age and presurgical clinical severity score and the various electrophysiological scales ($p<0.001$). The neurophysiological scales were significantly correlated with each other ($p<0.001$).

There was no direct correlation between improvement in electrophysiological class and pre-surgical electrophysiological score, age of patients and clinical severity score.

According to Osiak et al, the majority of publications did not confirm the prognostic value of EDX (only 2 of 28 articles).[15] Padua et al revealed a strong correlation between neurophysiological severity of CTS and recovery, while 8 of 28 publications suggest a weak prognostic value of the EDX.[16]

Limitations

Small sample size, with one study setting, and short period of follow up were limitations.

CONCLUSION

From the above findings, we conclude that the various clinical severity scores of Boston can be effectively used to assess patient's post-operative recovery from symptoms, but these scores fail to predict the extent of recovery the patient will have after surgery just by knowing the preoperative scores. The difference between preoperative and post-operative scores is a good indicator of post-operative recovery, but it does not show any correlation when compared with electrophysiological severity. My study reconfirms the diagnostic role of NCV in CTS, but the electrophysiological severity does not always match the clinical severity. My study showed that there is no definitive relation between electrophysiological severity and clinical severity scores.

Maximum improvement in clinical scores was seen in patients in the severe group after carpal tunnel release when compared to the other groups, symptoms like tingling sensation improved significantly in all the three groups. There was also a significant improvement in motor functions, including grip strength.

In the severe and moderate group, the electrophysiological parameters did not return to normal at the end of three months, while it was near normal in mild group.in the few subjects which were followed up to 6 months, the electrophysiological parameters returned to normal.

In this study, most of the patients were referred from the neurologist after months of conservative management, patients who were referred late had more severe scores and took more time to recover especially the motor functions. Hence, clinical correlation of pre- and post-op symptoms is the only full proof way to predict recovery after surgery in CTS-affected, patients, while nerve conduction studies mostly aid in diagnosis'.

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