Original Article

A Comparative Study of Local Ultrasound Therapy and Local Steroid Injection in Patients of Carpal Tunnel Syndrome

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Abstract

Introduction: Carpal tunnel syndrome is the most common compressive neuropathy of upper extremity affecting predominantly females of middle age group. Symptoms include pain, paracsthesia, numbness in median nerve distribution of hand. **Study design:** Comparative type of interventional study. **Study area:** Department of Physical Medicine and Rehabilitation, SMS Medical College and attached group of hospitals, Jaipur. **Duration of study:** One and a half years April 2014-October 2015. **Aims and objective:** To compare the efficacy of local ultrasound therapy and local corticosteroid injection for carpal tunnel syndrome management. **Study population:** A total of sixty patients with CTS (age ≥18 years) were randomly assigned to the steroid treatment plus splinting(group A) or ultrasound treatment plus splinting(group B). **Results:** The mean age of study population was 45.47±12.24 years with males comprising 13.3% and females 86.6% of whole study. At baseline all outcome variables were comparable statistically in both the groups ($p>0.05$). In follow-up assessment at 8th week, statistically significant improvement was obtained in all clinical and electrophysiological parameters in group A: Grip strength, symptom severity score, functional status score, median DML, sensory nerve conduction velocity ($p<0.001$ for each). Also the group B showed improvement in all parameters except grip strength. At the end of 24th week all outcome variables showed decline in improvement as comparative to 8th week, but still they were better than baseline in both groups. There was no significant difference between the groups in outcome variables except for the grip strength. **Conclusion:** Ultrasound treatment provided improvement comparable to steroid injection in all clinical and electrophysiological parameters in patients with CTS except grip strength. Overall steroid therapy is more effective than ultrasound therapy. Effectiveness of treatment persist for at least 6 months then it lessens, so long follow-up is required.

Key words: **Carpal tunnel syndrome, steroid treatment, ultrasound treatment, splinting.**

Introduction:

Carpal tunnel syndrome (CTS) is defined as a complex of symptoms arising from compression of the median nerve at the carpal tunnel. It is the most common compressive neuropathy of the upper extremity with estimated annual incidence rate of 0.5-5.1 per 1000[1]. It is more common in women than men.

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From actiological point of view most are idiopathic. Risk factors include repetitive manual labou e.g. Meat packers, supermarket checkout clerks, surgeons, computer operators or exposure to vibration. Of the non-occupational risk factors, the major ones are: females of middle age group, dominant hand, and certain predisposing diseases and conditions such as pregnancy, obesity, amyloidosis, myxocdema, diabetes mellitus, hypothyroidism, rheumatoid arthritis, etc[2].

Symptoms of CTS include numbness and tingling in the median nerve distribution of the thumb, index finger, long finger, and radial half of the ring finger. Patients also frequently complain of pain in the wrist at night or after frequent use of the hands or fingers. In more advanced cases thumb or index finger weakness may occur. On physical examination, sensory changes may be evaluated by 2-point discrimination, vibration, and monofilament testing. Motor changes may be elicited by testing thumb abduction.

Commonly used clinical signs include Phalen test,

Tinel sign, Durkan carpal compression test, tourniquet test, closed fist test. Unfortunately there is no recognised criterion standard for diagnosis of CTS. Nerve conduction studies are considered to be the most precise and objective tests for the diagnosis of CTS. Their sensitivity ranges from 61 to 85% and specificity from 87 to 92%[3].

Patients with mild and moderate CTS symptoms can be managed with conservative treatment, however, in severe cases, surgery may be required. Conservative treatment options include splint wear, modality application (e.g. heat, ultrasound, laser), exercise, activity modification and corticosteroid injection[4].

The ultrasound therapy may have the potential to induce biophysical effects within the nerve tissue. Ultrasound is assumed to have thermal effect on target tissues resulting in an increase in blood flow, local metabolism and tissue regeneration and also reducing inflammation, oedema and pain. But there is limited evidence in the literature on the effectiveness of ultrasound treatment for CTS[5].

The rational for splinting the wrist is that the pressure in carpal tunnel is at its lowest when the wrist is placed in a neutral position, and is at its highest when the wrist moves into flexion and extension.

Surgery is needed in rare cases. It is indicated when the medical and conservative therapy fails or if there is severe motor affection resulting in impairment of day to day activities.

To acquire a greater insight into conservative treatment options, it is necessary to compare the efficacy of ultrasound treatment with local corticosteroid injection on symptoms and electrophysiological findings in CTS.

Materials and Methods:

A comparative randomised interventional study was done between April 2014 and October 2015 at Department of Physical Medicine and Rehabilitation, SMS Medical College, Jaipur. A total of 60 patients with clinical symptoms and signs consistent with CTS who fulfill inclusion criteria were enrolled for study purpose. Inclusion criteria were as follows[6]: Any 3 out of 4: 1) presence of pain in the distribution of the median nerve, (2) presence of paracsthesia in the distribution of the median nerve, (3) nocturnal exacerbation of symptoms, (4) positive Phalen test and/or Tinel sign. Patients with pregnancy and having any other condition which percludes the use of ultrasound therapy or steroid injection were excluded from the study. Approval from Institutional Ethics Committee (IEC) SMS Hospital, Jaipur was taken before starting the study. Written informed consent from all patients was taken prior to the study.

Physical examination included general physical examination, local examination (observation of deformity, swelling, atrophy, any skin trophic changes), the Phalen test, the Tinel sign, the Durkan carpal compression test. All eligible cases were randomised into two groups: Steroid injection group and ultrasound group by use of computer generated randomisation.

All patients were instructed in both groups to wear light weight, neutral positioned, polypropylene wrist splints for a minimum of 6 hours a day.

Outcome variables included grip strength, Boston questionnaire score and electrophysiological parameters. Grip strength was measured by hand held electronic dynamometer. Three measurements were taken in Kgf, from which the mean result was considered for analysis. Boston questionnaire score consists of symptom severity score (sss) and functional status score. SSS asseses the symptoms with respect to severity, frequency, time and type. The scale consists of 11 questions with multiple choice responses scored from 1 point (mildest) to 5 points (most severe). Overall score is mean of the score for the 11 individual items.

Functional status scale consists of 8 activities (difficulty in writing, buttoning clothes, opening jars, holding a book, gripping a telephone handle, household chores, carrying grocery bags, bathing and dressing. The answers were rated from 1 point (no difficulty in activity) to 5 points (cannot perform activity at all). Overall score will be mean of 8 items.

Electrophysiological Studies:

Median sensory and motor nerve conduction studies were performed on both hands of all the patients. Electrophysiological criteria for diagnosis of CTS was as follows[5]: Distal median motor latency should be > 4.4 msec, or median sensory velocity should be < 40 m/sec, or median and ulnar distal motor latency difference > 1.1 msec. Stainless steel surface disc electrodes were used for motor nerve conduction studies while ring electrodes were used for antidromic sensory nerve conduction studies.

The median motor conduction studies were performed by recording the compound muscle action potential (CMAP) from the abductor pollicis brevis, with active electrode (G1) placed over muscle belly and reference electrode (G2) over distal tendinous insertion. Ground

electrode (GND) was placed over dorsum of the hand. The median nerve was stimulated supramaximally at the wrist 7 cm proximal to G1. The distal motor latency was measured from the onset of CMAP.

The median nerve sensory conduction velocity was determined by antidromic stimulation at the wrist 14 cm proximal to the recording electrodes placed over MCP joint of 2nd finger and reference electrode over DIP joint of same finger. Velocity was calculated by dividing the distances by onset latencies.

Local steroid injection was given using a 24 gauge needle at volar wrist surface just proximal to the distal wrist crease between the palmaris longus and flexor carpi radialis tendons involving 0.5 ml methylprednisolone acetate (20 mg) + 0.5 ml. xylocaine[7].

Ultrasound therapy was administered 5 times/week for 2 weeks with an intensity of 1.5 watt/ cm for 5 minutes with a 5 cm sound head. Frequency was 3MHz (continuous mode).

The clinical, electrophysiological and outcome variable assessment were done in each patient at baseline, at 2nd week, at 8th week and finally at 24th week.

Statistical Analysis:

Data was entered in excel sheet to prepare master chart and were subjected for statistical analysis. Data on ratio and interval scale were summarized as mean and standard deviation and were analysed by using paired and unpaired t- test as per indication.

Data on ordinal scale were summarised as mean and standard deviation and were analysed by using Mann-Whitney rank sum test and Wilcoxon signed rank test as per indication.

Categorical data and data on nominal scale were summarised as percentages and were analysed by using McNemar test and Chi-square test as per indication.

P-value <0.05 was taken as significant. Medcalc 12.2.1.0 software was used for all statistical calculation.

Results:

The 60 patients included in study were allocated randomly to the steroid group and ultrasound group (30 in each group). All sixty patients completed 8 weeks follow-up. Ten patients in steroid group and 8 patients in ultrasound group did not complete the 24th week follow-up. But still they were included in statistical analysis following intention to treat analysis. The mean age of patients in steroid group was 43.4±11.2 years and in ultrasound group it was 47.53±13.06 years. Males comprised 13.3% and females 86.6% in whole study. According to statistical analysis, the baseline characteristics of patients in both groups were comparable (p > 0.05) as shown in Table 1.

Table 1: *Baseline Characteristics of Patients*

Variables	Steroid group (N=30)	Ultrasound group (N=30)	P-value
Age (years) Mean ± SD	43.4±11.2	47.53±13.06	0.286
Gender Male/female	2/28	6/24	0.255
Duration of symptoms(months) Mean±S.D.	10.7±14.46	8.65±17.88	0.627
Phalen sign: Positive(n,%) Negative(n,%)	30(100%) 0(0%)	29(96.66%) 1(3.33%)	1.000
Tinel sign: Positive(n,%) Negative(n,%)	26(86.66%) 4(13.33%)	21(70%) 9(30%)	0.210
Durkan carpal compression test: Positive(n,%) Negative(n,%)	27((90%) 3(10%)	24(80%) 6(20%)	0.470

Table 2: *The Comparison of Clinical Variables before and after Treatment*

Clinical Variables	Baseline-1	2nd week-2	8th week-3	24th week-4
Grip strength(kgf): Steroid	19.77±4.71	22.17±4.84 P1-2<0.001	23.72±5.15 P1-3<0.001	21.42±4.84 P1-4<0.05
Ultrasound	20.62±4.19	21.2±4.37 P1-2=0.171	21.1±4.74 P1-3=0.358	20.9±4.34 P1-4=0.603
PgroupA-B	>0.05	>0.05	<0.05	>0.05
Symptom severity score: Steroid	2.719±0.59	1.773±0.29 P1-2<0.001	1.306±0.27 P1-3<0.001	1.537±0.60 P1-4<0.001
Ultrasound	2.471±0.60	1.831±0.40 P1-2<0.001	1.364±0.24 P1-3<0.001	1.656±0.83 P1-4<0.001
PgroupA-B	>0.05	>0.05	>0.05	>0.05
Functional status score: Steroid	2.58±0.57	1.844±0.40 P1-2<0.001	1.263±0.32 P1-3<0.001	1.562±0.64 P1-4<0.001
Ultrasound	2.382±0.40	1.675±0.36 P1-2<0.001	1.245±0.31 P1-3<0.001	1.382±0.53 P1-4<0.001
PgroupA-B	>0.05	>0.05	>0.05	>0.05

P^{1-2}; Comparison of baseline values with the values at 2nd week

P^{1-3}; Comparison of baseline values with the values at 8th week

P^{1-4}; Comparison of baseline values with the values at 24th week

PgroupA-B; Comparison of values between the group A and group B

Data are expressed as mean ± SD

P-value <0.05 was taken as significant

As shown in Table 2, the mean grip strength in both groups was comparable at baseline statistically. At the end of 2nd week grip strength increased significantly in steroid group only ($p<0.001$) and this improvement remained upto 8th week in steroid group, while in ultrasound group it somewhat decreased. At the end of 24th week grip strength decreased in both groups as comparative to 8th week, but still it was higher than baseline.

Mean symptom severity score and functional status score were statistically comparable at baseline in both groups. At the end of 2nd week and 8th week both groups showed significant reduction in scores ($p<0.001$). When we compare both groups, difference was statistically non-significant ($p>0.05$). But at the end of 24th week, severity of symptoms increased and functional status decreased in both groups as comparative to 8th week. But still the scores were better than baseline.

Table 3 shows conduction values in both the groups. Motor distal latency of median nerve decreased significantly at 2nd and 8th weeks when compared to baseline values in both groups ($p<0.001$). At the end of 24th week DML somewhat increased in steroid group, while in ultrasound group it become almost similar to baseline levels. Similarly sensory conduction velocity of median nerve increased significantly at 2nd week in both groups ($p<0.001$) and this improvement remained at 8th week also. At 24th week SNCV decreased in both groups, but still SNCV was higher than baseline. When we compare electrophysiological parameters between both groups, no significant difference was obtained ($p>0.05$) before and after treatment except SNCV at 24th week.

Table 3: *The Comparison of Electrophysiological Parameters before and after Treatment*

Electrophysiological Parameters	Baseline-1	2nd week-2	8th week-3	24th week-4
Motor distal latency (msec): Steroid	5.344±1.54	4.535±1.29 P1-2<0.001	4.073±1.10 P1-3<0.001	4.422±1.23 P1-4<0.001
Ultrasound	4.798±1.49	4.456±1.26 P1-2<0.001	4.267±1.23 P1-3<0.001	4.588±1.25 P1-4>0.05
PgroupA-B	>0.05	>0.05	>0.05	>0.05
Sensory nerve conduction velocity (m/sec): Steroid	34.32±11.86	43.27±11.46 P1-2<0.001	51.79±9.91 P1-3<0.001	47.23±8.6 P1-4<0.001
Ultrasound	39.41±10.7	46.59±8.85 P1-2<0.001	48.16±9.19 P1-3<0.001	42.38±8.55 P1-4>0.05
Pgroup A-B	>0.05	>0.05	>0.05	<0.05

P^{1-2}; Comparison of baseline values with the values at 2nd week
P^{1-3}; Comparison of baseline values with the values at 8th week
P^{1-4}; Comparison of baseline values with the values at 24th week
PgroupA-B; Comparison of values between the group A and group B
Data are expressed as mean± S.D.
P-value <0.05 was taken as significant

Discussion:

In the study, the mean age of study population was 45.47±12.24 years. This suggested that CTS predominantly affects middle age group. On comparing both groups they were found statistically comparable(p=0.286). Becker *et al* [8] also found in case control study that the age of patients varied from 18 to 87 years, with a mean of 49.1 ±11.9. Frequency of females were higher than males with a female: male ratio of 6.5:1 with almost similar results as obtained by Becker *et al*[8]. So CTS predominantly affects females.

CTS is associated with many systemic diseases. In our study population, almost 40% patients in steroid group and 30% patients in ultrasound group had hypothyroidism. Other underlying diseases were diabetes mellitus, hypertension, and rheumatoid arthritis.

All patients were instructed to wear neutral wrist splint for a minimum of 6 hours a day. Rationale for the use of splint was that it kept the carpal tunnel pressure towards the low side, so that there was no exacerbation of symptoms. Similarly. Werner *et al*[9] and Brininger *et al*[10] also showed that wrist splinting significantly reduced CTS symptoms and improved functional status.

Mean grip strength in steroid and ultrasound group was 19.77±4.71 and 20.62±4.1 kgf respectively. At 2nd week grip strength increased in both groups with statistically significant improvement in steroid group only (p<0.001). At the end of 8th week this improvement sustained in steroid group while in ultrasound group it somewhat decreased. Finally at 24th week grip strength decreased in both groups. It indicates that ultrasound has somewhat little effect on grip strength as compared to steroid injection as also shown by Bilgici *et al*[5] in 2010.

The mean symptom severity score in steroid and ultrasound group was 2.719±0.59 and 2.471±0.60 respectively. At baseline both groups were comparable (p>0.05). This score decreased significantly up to 8th week in both groups. On comparing both groups no statistically significant difference was noted. After 24th week symptom severity increased in both groups indicating recurrence of symptoms, but symptom severity score was still lower than baseline values. Isam Atroshi and Ranskin[11] Chang *et al*[12] also found similar results. Similarly functional status score decreased[12] up to 8th week in both groups, but at 24th week it increased indicating decline in functional level.

Chan *et al*[13] in their study found no statistically significant relationship between electrodiagnostic

findings and self-reported CTS-related functional limitations and symptom severity. The reason for this can be that in CTS, patient symptoms could be more closely related to the function of small diameter myelinated and unmyelinated nerve fibres that are not assessed in a normal electrodiagnostic study.

In our electrophysiological study, the mean DML of median nerve in steroid and ultrasound group was 5.344±1.54 and 4.798±1.49 msec respectively. Both groups were comparable statistically. Distal motor latency improved significantly up to 8th week in both groups, as seen by Agarwal *et al*[6], Ebenbichler *et al*[14]. But at the end of 24th week both groups showed increased latency. So effectiveness of both treatments remained up to 6 months. Sensory nerve conduction velocity in steroid and ultrasound group was 34.32±11.86 and 39.41±10.7 m/sec respectively at baseline. It increased at 2nd and 8th week follow-up in both groups. At the end of 24th week sensory nerve conduction velocity declined in both groups, but still it was higher than baseline in steroid group statistically. Our findings showed similar results as observed by Bakhtiary *et al*[15], Bilgici *et al*[5]. At the end of 24th week SNCV decreased in both groups.

Conclusions:

- For treatment of carpal tunnel syndrome, local steroid injection and ultrasound therapy-both are effective treatment.
- Ultrasound treatment provided improvement comparable to steroid injection in all clinical and electrophysiological parameters in patients with CTS except grip strength.
- Overall steroid therapy is more effective than ultrasound therapy.
- Effectiveness of treatment persists for at least 6 months then it lessens, so long follow-up is required.

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