Original Article

DOI: 10.7860/JCDR/2020/43471.13714

Others Section

Comprehensive Evaluation of Effect of Low Dose Local Steroid Injection in Carpal Tunnel Syndrome

JUNIS ALI[1], DIGANTA BORAH[2], NONICA LAISRAM[3], SY KOTHARI[4], C CHETHAN[5]

ABSTRACT

Introduction: Carpal Tunnel Syndrome (CTS) is one of the most common entrapment neuropathy with significant affection of hand function. Diagnosis is based on clinical, electrophysiological findings and ultrasonographic findings. Treatment may be nonsurgical or surgical. Of the nonsurgical methods, local glucocorticoid injection has yielded promising results in mild to moderate CTS. Use of different doses of steroid for CTS ranging from 12 mg to 40 mg with comparable results has been reported in the literature. To the best of our knowledge, efficacy of low dose steroid injection has not been evaluated in a comprehensive manner.

Aim: To assess the efficacy of a low dose local steroid injection in CTS patients utilising clinical, electrophysiological and ultrasonographic parameters.

Materials and Methods: Fifty five diagnosed patients of mild and moderate CTS, on the basis of electrophysiologic findings, were recruited for the study. Clinical evaluation was done in terms of grip strength and pain status. For baseline electrophysiological evaluation, nerve conduction studies were performed. This included Sensory Nerve Action Potentials (SNAPs), Sensory Distal Latency (SDL), Motor Distal Latency (MDL) and sensory and motor Conduction Velocity (CV) of median nerve as assessment parameters. Cross Sectional Area (CSA) of median nerve and bowing of flexor retinaculum was assessed using ultrasonography. Single dose of 20 mg methylprednisolone acetate was injected into the carpal tunnel under all aseptic precautions. Pain status was assessed at one week after the procedure. Overall, efficacy of the intervention was assessed using all the assessment parameters at one and three months after intervention. Statistical analysis was done using SPSS version 17 and p-value of <0.05 was considered as statistically significant.

Results: 44 patients completed three months follow-up period. Most of the parameters assessed showed improvement at one month and three months after the intervention. At one month, grip strength, pain, SNAP, MDL, sensory CV and CSA of median nerve were found to be significantly improved. At three months follow-up, in addition to the further improvement in these parameters, SDL also showed significant improvement in comparison to baseline. However, motor nerve CV showed no significant improvement during the study period.

Conclusion: Low dose local steroid injection is an effective intervention for treating CTS subjects. It provides rapid pain relief and improvement in objective parameters which persists till the end of three months.

Keywords: Electrophysiological assessment, Entrapment neuropathy, Methylprednisolone

INTRODUCTION

CTS is caused by compression of the median nerve in the wrist at its passage under the flexor retinaculum. It is one of the commonest entrapment neuropathy and significantly affects hand function. The symptoms of CTS include numbness and paraesthesia in the hand, along with pain. Symptoms typically are worse at night, often to the point of waking the patients. Loss of sensation and decreased grip strength renders the hand clumsy and affects activities that require fine motor control. This is a cause of considerable inconvenience to the patient. The diagnosis of CTS is based on both clinical and electrophysiological findings [1-3].

Most treatment options are designed for alleviation of pain and can be categorised into nonsurgical and surgical methods. Surgical treatment includes open release, endoscopic release, percutaneous ultrasound guided carpal tunnel release and nonsurgical treatment options include nonsteroidal anti-inflammatory drugs, diuretics, pyridoxine, wrist splints, ultrasonic therapy, oral steroids and local steroid injection. Nonsurgical treatment methods are effective in patients with mild to moderate CTS [4-6]. Local glucocorticoid injections have yielded promising results. However, the dose of steroid used varies among studies [7-13]. Most studies have used 40 mg [10-12]; few studies have used smaller doses like 20 mg or even 12 mg [7-9]. The outcome across various doses is reported to be comparable [6,13]. As steroids are not completely free from side effects, it seems logical that a lower dose be injected. However, this calls for a thorough assessment of its efficacy.

Hence, the aim of this study was to assess the efficacy of a low dose local steroid injection in CTS patients utilising clinical, electrophysiological and ultrasonographic parameters.

MATERIALS AND METHODS

This prospective interventional study was conducted over a period of two years in Department of Physical Medicine and Rehabilitation of a tertiary care Hospital after approval of Institutional Ethical Committee (S.No. VMMC/SJH/Ethics/Thesis/SEP-11/28).

Patients presenting with symptoms of CTS were evaluated clinically followed by ultrasonographic and electrophysiological assessment. Diagnosis of CTS was made on the basis of clinical symptoms, provocation tests (Tinel's sign, Phalen's test, tourniquet test), electrophysiological and ultrasonographic findings. Electrophysiological grading was done as per scale described by Bland JD [14]. On this basis, 55 cases of mild and moderate CTS were recruited into the study.

Patients with rheumatoid arthritis, diabetes mellitus, hypothyroidism, acromegaly, pregnancy, peripheral neuropathy, cervical radiculopathy, history of local steroid injection or surgery for CTS were excluded from the study. All the patients were explained about the nature of treatment and an informed signed consent was obtained prior to inclusion in the study.

Clinical evaluation was done in terms of grip strength and pain status. The former was measured by Jammar hand dynamometer and the latter was assessed using the 10-point Visual Analogue Scale (VAS) where zero represents no pain and 10 represents worst possible pain.

For electrophysiological evaluation, nerve conduction studies were performed in the electrophysiology laboratory of Neurology Department, using Nicolet Viking Quest four channel machine. The parameters measured included SNAPs, SDL, MDL and sensory and motor CV of median nerve.

Ultrasonographic evaluation was done with transverse images of the median nerve obtained immediately proximal to carpal tunnel inlet. The CSA of median nerve was obtained by the direct trace method just inside the hyperechoic rim at the levels of the pisiform and hook of hamate. Retinacular Bowing (RB) and flattening was measured as the maximal volar displacement of the flexor retinaculum from a line connecting its attachment to the hook of hamate and trapezoid.

After completion of the evaluation procedure, single dose of 20 mg methylprednisolone acetate was injected by the same researcher into the carpal tunnel using a 40 mm 24-gauge needle, under all aseptic precautions. The needle was inserted at the anterior wrist flexor crease just ulnar to the palmaris longus tendon. The angle of the needle during insertion was 45° distally and 45° radially. The needle was advanced approximately 1 cm so as to puncture the transverse carpal ligament following which the drug was injected.

Pain status was assessed at one week after the procedure. Overall, efficacy to the intervention was assessed using all the assessment parameters at one and three months after intervention.

STATISTICAL ANALYSIS

Descriptive statistics including mean and Standard Deviation (SD) were calculated for each quantitative variable. For non-parametric data, the mean change from baseline was estimated and mean changes at different follow-ups was analysed using Friedman test followed by Mauchly's test and Chi-square test.

RESULTS

A total of 55 subjects satisfying the inclusion criteria were enrolled in the study. Out of these, 44 patients completed three months follow-up period. There were 11 drop outs in the study; six cases were lost to first follow-up while another five cases were lost during second follow-up. Age group of patients ranged from 21-63 years with a mean of 42.02±11.28 years. Out of 44 subjects included in the study, 35 were females and 9 were males; 29 patients had bilateral while 15 had unilateral involvement of carpal tunnel [Table/Fig-1].

Characterstics	Types	Number of subjects
Age	Range 21-63 years	Mean age (42.02±11.28 years)
Gender distribution	Male	9
	Female	35
Extremity involved	Unilateral	15
	Bilateral	29
Severity	Mild	19
	Moderate	25

[Table/Fig-1]: Demographic characteristics of the subjects.

Significant improvement in grip strength was observed following intervention with local steroid injection. While comparing the data, it was noted that grip strength showed significant improvement from baseline to one month (p-value=0.001), from one month to three months (p-value=0.001) as well as baseline to three months (p-value=0.001) [Table/Fig-2].

Similarly, significant improvement in pain was also observed at one week and one month which remained so till three months follow-up. Improvement in pain status after local steroid injection was recorded as change in mean VAS from 4.04±1.08 at baseline to 1.62±0.81 at first week (p=0.001) [Table/Fig-3]. Similarly, significant improvement was observed from one week to one month. However, no significant improvement was seen from one to three months follow-up. The improvement in the pain continued till three months, as evidenced by the observation of significant improvement in pain from baseline to one month (p=0.001) and from baseline to three months (p=0.001).

Assessments	Mean±SD (in Kgm)	p-value		
		Baseline-1 month	1 month-3 months	Baseline-3 months
Baseline	18.48±5.50	**0.001**	**0.001**	**0.001**
1 month	19.52±5.34			
3 months	20.96±5.64			

[Table/Fig-2]: Grip strength at different assessments of the subjects.

Assessments	Mean±SD	p-value		
		Baseline-1 week	1 week-1 month	1 month-3 months
Baseline	4.04±1.086	**0.001**	**0.001**	0.321
1week	1.62±0.810			
1 month	0.04±0.200			
3 months	0.03±0.165			

[Table/Fig-3]: Visual analogue scale at different assessments of the subjects.

Most of the electrophysiological parameters evaluated in the study showed improvement at one and three months as compared to baseline [Table/Fig-4]. No significant improvement in SDL was observed from baseline to one month follow-up (p-value=0.088), however, a statistically significant improvement from baseline to three months and from one to three months were noted (p-value=0.001). Statistically significant improvement in SNAP was observed at one month and three months following intervention. The patients showed a significant improvement in MDL at one and three months. Mean MDL improved by 0.16±1.3 from 4.76±1.24 at baseline to 4.59±1.20 at one month and by 0.40±1.11 from one month and three months follow-up. There was significant increase in SCV from 35.98±9.57 at baseline to 42.36±10.12 at three months. However, motor nerve CV showed no significant improvement during the study period.

Parameters	Mean±SD		p-value		
			Baseline-1 month	1 month-3 months	Baseline-3 months
SDL (in m.sec)	Baseline	3.19±0.92	0.088	**0.001**	**0.001**
	1 month	3.14±0.93			
	3 months	2.69±0.81			
MDL (in m.sec)	Baseline	4.76±1.24	**0.001**	**0.001**	**0.001**
	1 month	4.59±1.20			
	3 months	4.18±1.11			
SCV (in m/sec)	Baseline	35.98±9.57	**0.001**	**0.001**	**0.001**
	1 month	37.71±9.51			
	3 months	42.36±10.12			

[Table/Fig-4]: Electrophysiological assessments of the subjects.
SDL: Sensory distal latency; MDL: Motor distal latency; SCV: Sensory conduction velocity

Ultrasonographic evaluation showed improvement following steroid injection. Significant reduction in CSA of median nerve was recorded at one and three months after the intervention [Table/Fig-5]. Mean CSA was 11.48±3.34 at baseline which was found to be 10.17±1.59 and 9.53±1.38 at one and three months, respectively. Reduction in bowing of flexor retinaculum was also noted, however this finding failed to reach statistical significance.

Assessments	Mean±SD (in sq. mm)	p-value		
		Baseline-1 month	1 month-3 months	Baseline-3 months
Baseline	11.48±3.34	0.001	0.001	0.001
1 month	10.17±1.59			
3 months	9.53±1.38			

[Table/Fig-5]: The cross-sectional area of median nerve at different assessments of the subjects.

Minor complications were reported by two patients, one reported mild exacerbation of pain during injection and the other reported whitish discolouration of skin at the site of injection.

DISCUSSION

Pain and numbness are frequently seen problems in individuals with CTS. Their quality of life is severely compromised due to pain and decreased mobility. Glucocorticoids injection into the carpal tunnel space adjacent to a median nerve is believed to combat the inflammatory response and thus reduce pain and numbness. The dose of steroid used is not fixed, with different reports studying a high (40-80 mg) or low (20 mg/12 mg) dose. The clinical outcome of either dose does not differ much. A complete clinical, electrodiagnostic and ultrasonographic assessment has rarely been reported in the literature.

Therefore, in the present study, the efficacy of low dose local steroid injection for CTS was assessed by both subjective and objective methods. The result of the study showed that the effect of local steroid injection in CTS on subjective pain report as well as clinical, ultrasonographic and electrophysiologic findings were significant.

Reduction of grip strength is frequently observed in patients with CTS which is expected to improve with treatment. The patients showed significant improvement in grip strength upto three months follow-up. This improvement of grip strength may be attributed to local steroid injection. Hui AC et al., compared the grip strength between CTS patients treated with surgery and local steroid injection [15]. Patients were followed-up at 6 and 20 weeks. They had found that the mean grip strength in surgery group was reduced by 1.7±5.1 kilograms compared with the gain of 2.4±5.5 kilograms in injection group.

Significant reduction in pain score after local steroid injection was also observed. This improvement in pain was evident at one week onwards following intervention. Improvement in pain continued throughout the study period. Although, the change in pain status from one month to three months was not significant, the same was significant while comparing between the baseline and final follow-up at three months.

Electrophysiologic studies also showed significant improvement as observed in terms of SDL, MDL, SNAPs and SNCV. Similar parameters were used in a study by Chang MH et al., [16].

The sensory component of the median nerve is affected much earlier than the motor component and in early stages of CTS, there is usually a delay in the sensory nerve CV [17]. In present study we observed no statistically significant improvement in SDL from baseline to one month follow-up (p-value=0.088), however, a statistically significant improvement in SDL from baseline to three months and from one to three months were noted (p-value=0.001). Similar results were reported in studies done by Hagebeuk EE and de Weerd AW and Agarwal V et al., [18,19].

The patients showed a significant improvement in MDL at one and at three months. These findings are in accordance with a study done by Giannini F et al., where significant improvements were recorded at one and three months from baseline [20]. Another study by Demirci S et al., also observed improvement in MDL post-injection after three months follow-up [21].

Similarly, there was statistically significant improvement in SNAP at three months follow-up. Girlanda P et al., reported significant improvement in SNAP at one, three and six months follow-up which is comparable with present study [22]. In another study by Giannini F et al., there was significant improvement in SNAP at baseline to one month, but there was no significant improvement in SNAP at six months follow-up [20].

No significant improvement in motor CV with local steroid injection at one month as well as at three month follow-up was observed in present study. However, there was significant increase in SNCV was recorded at three months in comparison to baseline. Similar findings in SNCV have been reported by Hagebeuk EE and de Weerd AW, and Agarwal V et al., [18,19].

Ultrasonographic CSA of median nerve just proximal to carpal tunnel inlet was recorded to be significantly reduced one month following steroid injection and further reduction was noted at three months. Similar findings were reported by Cartwright MS et al., where they observed reduction of CSA of median nerve at seven days which continued to reduce at 30 and till 180 days [23]. Relating this observation with the findings of Rydevik B and Lundborg G, on animal models proposed that this reduction in CSA is related to decrease in inflammation and oedema following local steroid injection [24]. Likewise, in a recent study, Wang JC et al., reported significant reduction in CSA of median nerve at 2, 6 and 12 weeks following steroid injection [25]. They also observed significant reduction in bowing of flexor retinaculum. However, there was no statistically significant reduction in flexor retinaculum bowing observed in the present study.

Limitation(s)

However, results of the present study do not allow us to comment on long term effects because of short duration of follow-up.

CONCLUSION(S)

The results of the present study suggest that low dose local steroid injection is an effective intervention for mild to moderate CTS. Single injection of local methylprednisolone injection provides appreciable pain relief and objective improvement persisting till three months. However, studies including larger sample size and longer follow-up are warranted to evaluate long term effect of the same.

REFERENCES

[1] Keith MW, Masear V, Chung K, Maupin K, Andary M, Amadio PC, et al. Diagnosis of carpal tunnel syndrome. J Am Acad Orthop Surg. 2009;17(6):389-96.
[2] Kleopa KA. In the clinic. carpal tunnel syndrome. Ann Intern Med. 2015;163(2):ITC1.
[3] Goldberg G, Zeckser JM, Mummaneni R, Tucker JD. Electrosonodiagnosis in carpal tunnel syndrome: A proposed diagnostic algorithm based on an analytic literature review. PMR. 2016;8(5):463-74.
[4] Huisstede BM, Hoogvliet P, Randsdorp MS, Glerum S, van Middelkoop M, Koes BW. Carpal tunnel syndrome. Part I: Effectiveness of nonsurgical treatments-A systematic review. Arch Phys Med Rehabil. 2010;91(7):981-1004.
[5] Marshall SC, Tardif G, Ashworth NL. Local corticosteroid injection for carpal tunnel syndrome. Cochrane Database Syst Rev. 2007;18(2):CD001554,.
[6] Karimzadeh A, Bagheri S, Raeissadat SA, Bagheri S, Rayegani SM, Rahimi-Dehgolan S, et al. The comparison of the effectiveness between different doses of local methylprednisolone injection versus triamcinolone in carpal tunnel syndrome: A double-blind clinical trial. J Pain Res. 2019;12:579-84.
[7] Badarny S, Rawashdeh H, Meer J, Abed S, Habib G. Repeated electrophysiologic studies in patients with carpal tunnel syndrome following local corticosteroid injection using a novel approach. Ir Med Assoc J. 2011;13(1):25-28.
[8] Habib GS, Badarny S, Rawashdeh H. A novel approach of local corticosteroid injection for the treatment of carpal tunnel syndrome. Clin Rheumatol. 2006;25(3):338-40.
[9] Chesterton LS, Blagojevic-Bucknall M, Burton C, Dziedzic KS, Davenport G, Jowett SM, et al. The clinical and cost-effectiveness of corticosteroid injection versus night splints for carpal tunnel syndrome (INSTINCTS trial): An open-label, parallel group, randomised controlled trial. Lancet. 2018;392(10156):1423-33.
[10] Dammers JW, Veering MM, Vermeulen M. Injection with methylprednisolone proximal to the carpal tunnel: Randomised double blind trial. BMJ. 1999;319(7214):884-86.
[11] Ertem DH, Sirin TC, Yilmaz I. Electrophysiological responsiveness and clinical outcomes of local corticosteroid injection in the treatment of carpal tunnel syndrome. Arq Neuropsiquiatr. 2019;77(9):638-45.
[12] Atroshi I, Flondell M, Hofer M, Ranstam J. Methylprednisolone injections for the carpal tunnel syndrome: A randomized, placebo-controlled trial. Ann Intern Med. 2013;159(5):309-17.
[13] Dammers JW, Roos Y, Veering MM, Vermeulen M. Injection with methylprednisolone in patients with the carpal tunnel syndrome: A randomised

double blind trial testing three different doses. J Neurol. 2006;253(5):574-77.
[14] Bland JD. A neurophysiological grading scale for carpal tunnel syndrome. Muscle Nerve. 2000;23(8):1280-83.
[15] Hui AC, Wong S, Leung CH, Tong P, Mok V, Poon D, et al. A randomized controlled trial of surgery vs steroid injection for carpal tunnel syndrome. Neurology. 2005;64(12):2074-78.
[16] Chang MH, Liao YC, Lee YC, Hsieh PF, Liu LH. Electrodiagnosis of carpal tunnel syndrome: which transcarpal conduction technique is best? J Clin Neurophysiol. 2009;26(5):366-71.
[17] Aroori S, Spence RA. Carpal tunnel syndrome. Ulster Med J. 2008;77(1):06-17.
[18] Hagebeuk EE, de Weerd AW. Clinical and electrophysiological follow-up after local steroid injection in the carpal tunnel syndrome. Clin Neurophysiol. 2004;115(6):1464-68.
[19] Agarwal V, Singh R, Sachdev A, Wiclaff, Shekhar S, Goel D. A prospective study of the long-term efficacy of local methyl prednisolone acetate injection in the management of mild carpal tunnel syndrome. Rheumatology (Oxford). 2005;44(5):647-50.
[20] Giannini F, Passero S, Cioni R, Paradiso C, Battistini N, Giordano N, et al. Electro physiologic evaluation of local steroid injection in carpal tunnel syndrome. Arch Phys Med Rehabil. 1991;72(10):738-42.
[21] Demirci S, Kutluhan S, Koyuncuoglu HR, Kerman M, Heybeli N, Akkus S, et al. Comparison of open carpal tunnel release and local steroid treatment outcomes in idiopathic carpal tunnel syndrome. Rheumatol Int. 2002;22(1):33-37.
[22] Girlanda P, Dattola R, Venuto C, Mangiapane R, Nicolosi C, Messina C. Local steroid treatment in idiopathic carpal tunnel syndrome: Short- and long-term efficacy. J Neurol. 1993;240(3):187-90.
[23] Cartwright MS, White DL, Demar S, Wiesler ER, Sarlikiotis T, Chloros GD, et al. Median nerve changes following steroid injection for carpal tunnel syndrome. Muscle Nerve. 2011;44(1):25-29.
[24] Rydevik B, Lundborg G. Permeability of intraneural microvessels and perineurium following acute, graded experimental nerve compression. Scand J Plast Reconstr Surg. 1977;11(3):179-87.
[25] Wang JC, Lin KP, Liao KK, Chang YC, Wang KA, Huang YF, et al. Sonographic median nerve change after steroid injection for carpal tunnel syndrome. Muscle Nerve. 2018;58(3):402-06.

PARTICULARS OF CONTRIBUTORS:
1. Medical Officer, Department of Health, J&K Health Services, Jammu, J&K Union Territory, India.
2. Professor, Department of Physical Medicine and Rehabilitation, VMMC and Safdarjung Hospital, New Delhi, India.
3. Professor and Head, Department of Physical Medicine and Rehabilitation, VMMC and Safdarjung Hospital, New Delhi, India.
4. Professor and Head, Department of Physical Medicine and Rehabilitation, AIIMS Bhopal, Bhopal, Madhya Pradesh, India.
5. Assistant Professor, Department of Physical Medicine and Rehabilitation, VMMC and Safdarjung Hospital, New Delhi, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Diganta Borah,
Department of Physical Medicine and Rehabilitation, VMMC and Safdarjung Hospital, New Delhi-110029, India.
E-mail: diganta29@yahoo.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 21, 2019
- Manual Googling: Mar 16, 2020
- iThenticate Software: Apr 24, 2020 (14%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Dec 20, 2019**
Date of Peer Review: **Jan 16, 2020**
Date of Acceptance: **Apr 15, 2020**
Date of Publishing: **May 01, 2020**