ISSN: 0975-3583, 0976-2833 VOL15, ISSUE7, 2024

Original Research Article

To comparatively evaluate the clinical efficacy of three treatment approaches: standard conservative treatment (SCT), SCT combined with tendon and nerve gliding exercises, and tendon and nerve gliding exercises alone in the management of Carpal Tunnel Syndrome

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Abstract

Background & Methods: the aim of the study is to evaluate the clinical efficacy of three treatment approaches: standard conservative treatment (SCT), SCT combined with tendon and nerve gliding exercises, and tendon and nerve gliding exercises alone. An interventional study was conducted in the Department of Orthopaedics, Gandhi medical college (GMC), Hamidia Hospital, Bhopal (MP) with 34 patients to assess the clinical efficacy between 3 randomized groups.

Results: A total of 34 patients diagnosed with intermediate-stage CTS participated in the study. By the end of the treatment, all groups showed significant improvements in symptoms and functionality. However, patients in Groups 1 (n=12) and 2 (n=11) experienced significantly greater recovery compared to those in Group 3 (n=11; $P<0.05$). Patient satisfaction was assessed an average of 11 months post-treatment, revealing that the percentages of asymptomatic patients were significantly higher in Groups 1 and 2 compared to Group 3 ($P=0.03$ and $P=0.008$, respectively).

Conclusion: This study demonstrated that all three conservative treatment modalities—Steroid Combined Therapy (SCT), SCT combined with tendon and nerve gliding exercises, and tendon and nerve gliding exercises alone—are effective in managing Carpal Tunnel Syndrome (CTS). However, SCT combined with tendon and nerve gliding exercises was found to be the most effective in reducing symptoms, improving functional outcomes, and achieving higher patient satisfaction.

Keywords: clinical, conservative treatment (SCT), nerve, tendon.

Study Design: Prospective Interventional Study.

1. Introduction

Carpal Tunnel Syndrome (CTS) was first described by Paget in 1854 [1]. It is classified as a compressive neuropathy, which refers to a mononeuropathy or radiculopathy caused by mechanical distortion from a compressive force [2]. According to the American Academy of Orthopaedic Surgeons (AAOS) Clinical Guidelines on the Diagnosis of CTS, it is defined as a symptomatic compression neuropathy of the median nerve at the wrist level [3].

Carpal Tunnel Syndrome (CTS) is the most recognized and prevalent form of median nerve entrapment [3-4], accounting for 90% of all entrapment neuropathies [8]. Entrapment neuropathy is a chronic focal compressive neuropathy resulting from increased pressure within non-flexible anatomical structures [9].

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CTS specifically involves the entrapment of the median nerve within the carpal tunnel, which is bordered by the carpal bones and the transverse carpal ligament [2]. Physiological evidence shows that increased pressure within the carpal tunnel leads to reduced function of the median nerve at that location [3].

The symptoms of Carpal Tunnel Syndrome (CTS) can vary among patients and are thus classified into mild, moderate, and severe categories. CTS is characterized by pain in the hand, as well as numbness and tingling in areas served by the median nerve. These sensations typically occur in the thumb, index finger, middle finger, and the radial side of the ring finger [5]. The pain may lead to reduced grip strength and hand function.

Prolonged CTS can result in muscle wasting at the base of the thumb. Approximately 4% to 5% of the global population is affected by CTS, with the most vulnerable group being elderly individuals aged 40 to 60 years [6]. CTS is also more prevalent in women than in men. For example, data from the UK General Practice Research Database in 2000 indicated that the prevalence of CTS was 88 per 100,000 in men and 193 per 100,000 in women [5]. More recent assessments show higher incidence rates for women aged 45 to 54 years, while men aged 75 to 84 years are at increased risk [7]. CTS is often linked to musculoskeletal disorders associated with repetitive strain and manual labor, leading to increased work absences and additional healthcare concerns.

CTS should be treated as early as possible using multiple modalities. Compressive forces on the median nerve can be alleviated through both conservative and surgical methods [10].

The aim of this study was to comparatively evaluate the clinical efficacy of three treatment approaches: standard conservative treatment (SCT), SCT combined with tendon and nerve gliding exercises, and tendon and nerve gliding exercises alone.

2. Material and Methods

A hospital based prospective, interventional study was conducted in the Department of Orthopaedics, Gandhi medical college (GMC), Hamidia Hospital, Bhopal (MP) with 34 patients to assess the clinical efficacy between 3 randomized groups:

Group 1: SCT, which consists of splinting and local steroid injections, in the treatment of CTS. Total 12 patients received this treatment

Group 2: SCT plus tendon and median nerve gliding exercises developed by Totten and Hunter. Total 11 patients received this treatment

Group 3: tendon and median nerve gliding exercises only. Total 11 patients received this treatment

Inclusion criteria:

1. Adults 18 years old and above.
2. Cases with intact surgical anatomy of wrist joint.
3. The presence of two or more of the following symptom :
    a. 1.numbness and tingling sensation in the area innervated by median nerve
    b. 2.night time paraesthesia
    c. 3.pain in the wrist area radiating to shoulder
4. Confirmed diagnosis by positive NCS as suggested by diminished median nerve conduction values (below 50 m/s) and/or increased motor latency (above 4m/s).
5. Patients with Phalen's Test, Tinel's Test, Durkan's Carpal Compression Test Positive for carpal tunnel syndrome.
6. Both sexes- males and females

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Exclusion criteria:

1. Significant Medical Comorbidities like Diabetes Mellitus, Thyroid diseases, rheumatoid arthritis peripheral neuropathy, cervical radiculopathy, CTS with thenar atrophies, were pregnant, or had a history of steroid injections or splinting were excluded.
2. Patient with bilateral CTS.
3. Patients not giving consent for study.
4. Patient age group <18 years of age.

CLINICAL TEST :

1. Phalen's Maneuver
2. Reverse Phalen's Maneuver
3. The Two-Point Discrimination Test
4. Tinel's Sign
5. Durkan's Carpal Compression Test

Electrophysiological Test: Nerve conduction studies

Symptom total point (STP):

In all three groups, subjective symptoms (hand pain, tingling, numbness, nocturnal numbness, and interrupted sleep) were assessed before and after treatment. Patients were scored as symptomatic (1 point) or asymptomatic (0 points) for each symptom. The total score from all five symptoms was referred to as the symptom total point (STP).

Functional status scale (FSS):

To assess hand functionality, seven daily activities (writing, buttoning clothes, gripping a telephone receiver, opening jars, doing housework, carrying grocery bags, bathing) were evaluated. Each activity was rated based on difficulty: 1 = easy, 2 = somewhat difficult, 3 = moderately difficult, 4 = very difficult, 5 = impossible. The total score from these activities was referred to as the functional status scale (FSS).

Treatment:

1. Standard conservative treatment (SCT)

The treatment protocol consisted of applying a wrist splint in a neutral position and administering a 20mg/1ml Triamcinolone Acetonide injection into the carpal groove. The injection was given just medial (towards the thumb side) to the Palmaris longus tendon approximately 1cm proximal to distal palmar crease (at proximal wrist crease) using a 25-gauge needle.

Fig 1: Steroid Injection

2. Tendon Gliding Exercises

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Fingers positioned in five ways (straight, hook, fist, table top, and straight fist) for 7 seconds each.

Figure 2: Tendon Gliding - part 1
Straighten fingers of involved hand as shown

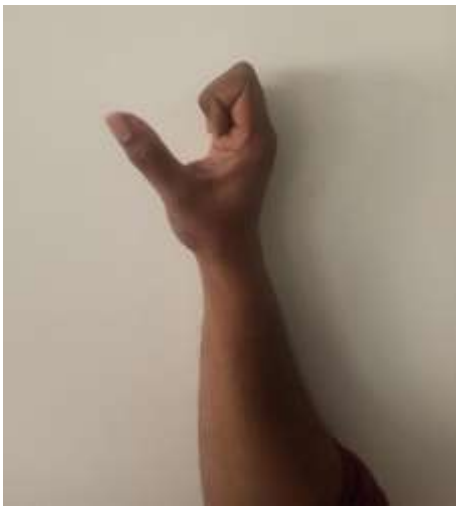

Fig 3: Tendon Gliding - part 2
Bend fingers at the top and middle knuckles (like a hook fist) while keeping bottom knuckles straight

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Figure 4: tendon gliding part - 3
Bend fingers at the bottom knuckles while keeping the top and middle knuckles straight - " Duck Bill "

Figure 5: tendon gliding part - 4
Bend fingers at the middle and bottom knuckles while keeping top knuckles straight - "Show finger nails "

Figure 6: tendon gliding part - 5
Bend all knuckles of fingers as shown (to make full fist) - " Hide finger nails "

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3. Median Nerve Gliding Exercises

Wrists and hands positioned in six ways, each held for 7 seconds, with neck and shoulders neutral and elbows at 90° flexion.

Fig 7:
Starting position 1
Wrist in neutral ,fingers and thumb in flexion

Fig 8:
position 2
Wrist in neutral , fingers and thumb
in extension

Fig 9: Position 3
Wrist in neutral, fingers extended, thumb in neutral

Fig 10: Position 4
Wrist, fingers and thumb extended,

Fig 11: Position 5

As in position four ,with palm facing up

Fig 12: Position 6

gently stretching thumb As in position five, other hand

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3. Result

A total of 34 patients were evaluated, and those with electromyographically confirmed intermediate-stage idiopathic CTS were included in the study. The mean age of the patients was 46.18 ± 11.80 years, ranging from 19 to 69 years. Patients were randomized into three groups: Group 1 (SCT, n=41); Group 2 (SCT plus tendon and median nerve gliding exercises, n=35); and Group 3 (tendon and median nerve gliding exercises only, n=35). The baseline demographic characteristics, STP, and FSS scores of the patients are listed in Table 1. There were no significant demographic differences among the three groups except in profession .

Table 1. Baseline demographic features, physical findings, and functional and symptom scores of patients.

Feature	Group 1 (n=12)	Group 2 (n=11)	Group 3 (n=11)	P-value
Sex				
Men, n	4	1	5	0.1620
Women, n	8	10	6	
Age,years (mean±SD)	43.50 ± 13.22	46.00 ± 13.72	49.27 ± 7.75	0.0738
Profession				
Job associated with forceful and repetitive wrist movements, n (%)	n=22, (64.71%)			0.0160
Job associated with non forceful and non repetitive wrist movements , n(%)	n=12, (35.29%)			

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Table 2. Comparison of clinical variables, symptom status, and functional status pre- and posttreatment (at 6 months).

	Group 1 (n=12)			Group 2 (n=11)			Group 3 (n=11)		
	Pretreatment	Posttreatment	P	Pretreatment	Posttreatment	P	Pretreatment	Posttreatment	P
Phalen's test positive, n (%)	09 (75%)	02 (16.67%)	0.0210	10 (90.91%)	04 (36.36%)	0.0491	09 (81.82%)	08 (72.73%)	0.8214
Tinel's test positive, n (%)	07 (58.33%)	02 (16.67%)	0.0061	08 (72.73%)	08 (72.73%)	0.0469	06 (54.55%)	07 (63.64%)	0.9451
Reverse Phalen's test positive, n (%	09 (75%)	03 (25%)	0.0161	09 (81.82%)	03 (27.27%)	0.0482	09 (81.82%)	08 (72.73%)	0.7740
Compression test positive, n (%)	08 (66.67%)	01 (8.33%)	0.0083	09 (81.82%)	03 (27.27%)	0.0379	06 (54.55%)	06 (54.55%)	0.4751
STP (mean±SD)	4.25 ± 0.75	1.25 ± 0.97	<0.0001	4.09 ± 0.83	0.82 ± 0.75	<0.0001	4.55 ± 0.52	3.73 ± 0.79	0.0094
FSS (mean±SD)	14.25 ± 2.34	10.83 ± 2.04	0.0009	15.09 ± 3.24	9.55 ± 2.16	0.0001	16.73 ± 3.61	13.55 ± 3.45	0.0475

In the posttreatment period, the positivity rates for Tinel's, Phalen's, reverse Phalen's, and compression tests significantly decreased in Group 1 and Group 2 compared to pretreatment results ($P<0.05$). In Group 3, although the positivity rate for Phalen's test and Reverse Phalen's test decreased, the change was not statistically significant ($P>0.05$). Additionally, the positivity rate for Tinel's test increased, but this change was not statistically significant ($P=0.9451$).

The Symptom Total Point (STP) and Functional Status Scale (FSS) scores were compared within each group, and a statistically significant difference between pre- and posttreatment values was observed in all groups.

Table no: 3 Comparison of mean Symptom Scores - STP with Treatment Modalities between two groups

STP	Treatment Modalities		P Value	Results
	Group 1	Group 2		
	Mean ± s.d	Mean ± s.d		
Pre treatment	4.25 ± 0.75	4.09 ± 0.83	0.6322	Not Significant
After 6 months	1.25 ± 0.97	0.82 ± 0.75	0.2508	Not Significant

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Table no: 4 Comparison of mean Symptom Scores - STP with Treatment Modalities between two groups

STP	Treatment Modalities		P Value	Results
	Group 1	Group 3		
	Mean ± s.d	Mean ± s.d		
Pre treatment	4.25 ± 0.75	4.55 ± 0.52	0.2886	Not Significant
After 6 months	1.25 ± 0.97	3.73 ± 0.79	<0.0001	Significant

Table no: 5 Comparison of mean Symptom Scores - STP with Treatment Modalities between two groups

STP	Treatment Modalities		P Value	Results
	Group 2	Group 3		
	Mean ± s.d	Mean ± s.d		
Pre treatment	4.09 ± 0.83	4.55 ± 0.52	0.1350	Not Significant
After 6 months	0.82 ± 0.75	3.73 ± 0.79	<0.0001	Significant

When comparing post treatment STP scores, no statistically significant difference was found between Groups 1 and 2 ($P>0.05$, table 3). However, Group 1 showed a significantly greater improvement compared to Group 3 ($P<0.05$, table 4). Similarly, the STP scores of Group 2 were significantly better than those of Group 3, indicating more improvement in Group 2 ($P<0.05$, table 5).

Table no: 6 Comparison of mean Symptom Scores - FSS with Treatment Modalities between two groups

FSS	Treatment Modalities		P Value	Results
	Group 1	Group 2		
	Mean ± s.d	Mean ± s.d		
Pre treatment	14.25 ± 2.34	15.09 ± 3.24	0.4810	Not Significant
After 6 months	10.83 ± 2.04	9.55 ± 2.16	0.1587	Not Significant

Table no: 7 Comparison of mean Symptom Scores - FSS with Treatment Modalities between two groups

FSS	Treatment Modalities		P Value	Results
	Group 1	Group 3		
	Mean ± s.d	Mean ± s.d		
Pre treatment	14.25 ± 2.34	16.73 ± 3.61	0.0610	Not Significant
After 6 months	10.83 ± 2.04	13.55 ± 3.45	0.0301	Significant

Table no: 8 Comparison of mean Symptom Scores - FSS with Treatment Modalities between two groups

FSS	Treatment Modalities		P Value	Results
	Group 2	Group 3		
	Mean ± s.d	Mean ± s.d		
Pre treatment	15.09 ± 3.24	16.73 ± 3.61	0.2754	Not Significant
After 6 months	9.55 ± 2.16	13.55 ± 3.45	0.0039	Significant

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When comparing posttreatment FSS scores, no significant difference was observed between Groups 1 and 2 (P>0.05, table 6). However, the differences between Groups 1 and 3 (table 7), as well as between Groups 2 and 3 (table 8), were statistically significant (P<0.001), favoring Groups 1 and 2 respectively.

Table no: 9 Comparison of Patient Satisfaction Assessments with Treatment Modalities between two groups (SCT & SCT + Exercise)

Patient Satisfaction Assessments	Treatment Modalities				P Value	Results
	SCT (n=12)		SCT + Exercise (n=11)			
	No.	%	No.	%		
EXCELLENT	08	66.67%	09	81.82%	0.4188	Not Significant
FAIR	04	33.33%	02	18.18%		
POOR	0	0%	0	0%		

Table no: 10 Comparison of Patient Satisfaction Assessments with Treatment Modalities between two groups (SCT + Exercise & Exercise)

Patient Satisfaction Assessments	Treatment Modalities				P Value	Results
	SCT + Exercise (n=11)		Exercise (n=11)			
	No.	%	No.	%		
EXCELLENT	09	81.82%	02	18.18%	0.0089	Significant
FAIR	02	18.18%	06	54.55%		
POOR	0	0%	03	27.27%		

Table no: 11 Comparison of Patient Satisfaction Assessments with Treatment Modalities between two groups (SCT & Exercise)

Patient Satisfaction Assessments	Treatment Modalities				P Value	Results
	SCT (n=12)		Exercise (n=11)			
	No.	%	No.	%		
EXCELLENT	08	66.67%	02	18.18%	0.0307	Significant
FAIR	04	33.33%	06	54.55%		
POOR	0	0%	03	27.27%		

When comparing post treatment Patient Satisfaction Assessments, no significant difference was observed between Groups 1 and 2 (P>0.05, table 9). However, the differences between Groups 1 and 3 (table 10), as well as between Groups 2 and 3 (table 11), were statistically significant (P<0.001), favoring Groups 1 and 2 respectively.

4. Discussion

SCT alone was found to be effective in reducing symptoms and improving functional outcomes in CTS patients. Over time, significant improvements were noted in symptom scores and functional scores. These findings are consistent with those of Huisstede et al. (2017), who reported the effectiveness of steroid injections and splinting in managing CTS symptoms .[11] Gelberman et al. (1980) also documented positive outcomes with steroid

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injections, highlighting their role in reducing inflammation and pain in CTS patients.[12] The significant improvement in patient satisfaction and functional scores confirms the efficacy of SCT in CTS management, fulfilling the first objective of the study.

The mechanism by which corticosteroids alleviate CTS symptoms involves reducing inflammation and swelling around the median nerve, thereby decreasing pressure within the carpal tunnel. This reduction in pressure helps alleviate pain and improve nerve function. The positive outcomes observed in this study, including significant improvements in symptom and functional scores, underscore the importance of SCT as a viable conservative treatment option for CTS. However, it is essential to consider potential side effects and contraindications associated with steroid use, such as potential tendon weakening and systemic effects, which should be discussed with patients during treatment planning.

Combining SCT with tendon and nerve gliding exercises showed significant improvements in symptom and functional scores compared to SCT alone and exercises alone. Over six months, patients in the SCT + exercises group showed more substantial improvements in Two-point Discrimination, STP, and FSS scores. These results support the findings of Kim (2015) and Ballestero-Pérez et al. (2017), which emphasized the benefits of combining conservative treatments for CTS.[13] Additionally, Rozmaryn et al. (1998) reported that nerve and tendon gliding exercises significantly improve outcomes in CTS patients when combined with other treatments. The higher patient satisfaction in this group also supports the efficacy of this combined treatment modality, fulfilling the second objective of the study.

Nerve and tendon gliding exercises are designed to enhance the mobility of the median nerve and the tendons within the carpal tunnel. These exercises help reduce adhesions and improve the sliding mechanism of the nerve and tendons, thereby decreasing symptoms of CTS. The significant improvements observed in this study suggest that combining SCT with gliding exercises provides synergistic benefits, enhancing the overall treatment efficacy. This combined approach not only addresses inflammation and swelling through corticosteroids but also promotes mechanical mobility and flexibility through exercises, resulting in better functional outcomes and higher patient satisfaction.

Nerve gliding exercises alone showed improvements in symptom and functional scores, though less significant compared to SCT alone and SCT combined with exercises. While there were improvements, the p-values indicated less significance in comparison to the other two modalities. This aligns with the findings of Huisstede et al. (2017), which reported that exercises alone might be less effective than combined treatment approaches.[14] Kim (2015) also noted that while nerve gliding exercises are beneficial, their efficacy is enhanced when combined with other treatments.[15] The lower patient satisfaction in this group further highlights the need for combining exercises with other treatment modalities for better outcomes, addressing the third objective of the study.

Nerve gliding exercises aim to improve nerve mobility and reduce entrapment within the carpal tunnel. While beneficial, their standalone efficacy may be limited due to the lack of anti-inflammatory action provided by corticosteroids. The findings of this study suggest that while nerve gliding exercises are an essential component of CTS management, their full potential is realized when combined with other conservative treatments such as SCT. This combination approach addresses both the mechanical and inflammatory aspects of CTS, resulting in more comprehensive symptom relief and functional improvement.

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5. Conclusion

This study demonstrated that all three conservative treatment modalities—Steroid Combined Therapy (SCT), SCT combined with tendon and nerve gliding exercises, and tendon and nerve gliding exercises alone—are effective in managing Carpal Tunnel Syndrome (CTS). However, SCT combined with tendon and nerve gliding exercises was found to be the most effective in reducing symptoms, improving functional outcomes, and achieving higher patient satisfaction.

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