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Original Research

Comparison of Ultrasound-Guided Perineural 5% Dextrose Prolotherapy and Corticosteroid Injection in Mild to Moderate Carpal Tunnel Syndrome: A Retrospective Clinical Study

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ABSTRACT

Objective: Carpal tunnel syndrome (CTS) is a common entrapment neuropathy caused by median nerve compression. Steroid injections provide temporary relief in mild to moderate CTS, whereas 5% dextrose prolotherapy (PrT) has recently emerged as a regenerative alternative. This study compares the efficacy of ultrasound-guided perineural 5% dextrose PrT and corticosteroid injections.

Methods: In this retrospective analysis, 74 individuals aged between 18 and 70 years, meeting both clinical and electrophysiological criteria for mild to moderate CTS, were included. 36 patients received a single ultrasound-guided injection of 40 mg triamcinolone acetonide (steroid group), while 38 patients underwent three perineural 5% dextrose PrT sessions at three-week intervals (PrT group). All patients followed a 12-week conservative protocol with wrist splinting and nerve/tendon gliding exercises. Outcomes were assessed at baseline, week 6, and week 24. The primary outcome was Visual Analog Scale (VAS) pain and numbness score. Secondary outcomes were QuickDASH, grip and pinch strengths, and median nerve conduction studies.

Results: Both groups showed significant within-group clinical and functional improvements ($p<0.05$). At 6 weeks, the steroid group showed higher grip strength compared with PrT (MD = −1.25, 95% CI −4.12 to 1.62, p = 0.048) and pinch (MD = −0.32, 95% CI −0.87 to 0.23, p = 0.005) compared with the prolotherapy group. At 24 weeks, PrT resulted in lower daytime pain VAS compared with steroids (MD −1.15, 95% CI −2.23 to −0.07, p = 0.026), surpassing the minimal clinically important difference (MCID) for CTS pain reduction. Electrophysiological improvements occurred only in the steroid group, especially in motor and sensory conduction parameters, without corresponding long-term clinical superiority.

Conclusion: Perineural PrT and steroid injections appear to be effective non-surgical options for managing mild to moderate CTS. While steroids may provide faster symptom relief and earlier improvements in strength, dextrose PrT demonstrated more sustained pain reduction. It should be noted, however, that the injection protocols differed—the steroid group received a single dose, whereas the PrT group underwent three sessions—an approach based on our review of the existing literature. This discrepancy should be considered when interpreting the results. Further randomized controlled trials are needed to confirm these findings and clarify the regenerative mechanisms of dextrose prolotherapy.

Keywords: carpal tunnel syndrome, corticosteroid injection, perineural dextrose prolotherapy, ultrasound-guided injection

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common peripheral entrapment neuropathy, with a reported prevalence ranging from 3.5% to 10.5% [1,2]. It is characterized by compression of the median nerve within the carpal tunnel, leading to symptoms such as hand numbness, pain, paresthesia, and, in some cases, motor deficits, which may result in significant disability and reduced quality of life [3]. Although the exact pathophysiology remains incompletely understood, CTS is generally attributed to increased intracarpal pressure caused by thickening of the flexor retinaculum, tenosynovial proliferation, or fibrosis of the subsynovial connective tissue. As a result, nerve microcirculation and axoplasmic movement are compromised, producing ischemia, impaired electrical transmission, and swelling on both sides of the compression site [4].

The diagnosis of CTS involves a thorough evaluation comprising clinical examination, nerve conduction testing, and ultrasound (US) assessment. US offers particular benefits because the median nerve lies superficially and this method allows real-time visualization of both structural and functional changes [5,6].

Treatment strategies for CTS depend on disease severity and may be conservative or surgical. Conservative treatments include activity modification, splinting, physical therapy modalities, and various types of perineural injections [7]. In recent years, ultrasound-guided injections have gained prominence as a therapeutic approach for mild to moderate CTS [3,8]. Among injectable therapies, corticosteroids are the most commonly used due to their anti-inflammatory effects [6,9]. However, alternative agents such as 5% dextrose, platelet-rich plasma (PRP), hyaluronic acid, and saline have gained interest in recent years [10-12]. Dextrose prolotherapy (PrT) has emerged as a promising regenerative approach with a favorable safety profile and low cost [13-15].

Considering the high prevalence of CTS in the general population, the importance of its management cannot be overstated. To date, no consensus has been reached regarding the superiority of one injection therapy over another. Therefore, this retrospective study was designed to compare the efficacy of perineural 5% dextrose PrT with steroid injection therapy in patients with mild to moderate CTS.

Main Points

- Both ultrasound-guided perineural 5% dextrose prolotherapy (PrT) and corticosteroid injections provided significant clinical and functional improvements in patients with mild to moderate carpal tunnel syndrome.
- Corticosteroids showed more rapid symptom relief and strength gains at 6 weeks, while dextrose PrT provided more sustained pain reduction at 24 weeks.
- Only the corticosteroid group demonstrated electrophysiological improvement, though without clear long-term clinical superiority.

MATERIAL AND METHODS

This retrospective study included 74 patients aged 18-70, diagnosed with mild to moderate CTS using electrophysiological criteria, and treated in the Physical Medicine and Rehabilitation outpatient clinics of Antalya Training and Research Hospital and Beykent University Hospital, both tertiary centers. Ethical approval was obtained from the Clinical Research Ethics Committee of Beykent University (Decision no: 160504, Date: 13.09.2024). The study was conducted in accordance with the principles of the Declaration of Helsinki. Since the study design was retrospective, informed consent for study participation was not obtained; however, informed consent was obtained from each patient prior to the injection procedures.

The treatment received by the patients was determined in both clinics based on the patient's adherence potential to the treatment plan and the clinical experience and judgment of the treating physician. The study's retrospective nature precluded the possibility of blinding those responsible for outcome evaluation. To minimize potential bias, strict inclusion and exclusion criteria were applied, and clinical data were extracted using a standardized form by independent reviewers. Patients who were evaluated based on consistent clinical and electrophysiological criteria were included in the study. As this was a retrospective study, the sample size was determined by the number of eligible patients meeting the inclusion criteria during the study period.

Patients were eligible if they had used wrist splints, performed nerve and tendon gliding exercises, received either perineural 5% dextrose PrT or steroid injections, and had been followed up for at least 24 weeks, with available data from week 6 and week 24. CTS was diagnosed through physical examination (including Phalen and Tinel signs) and supported by nerve conduction studies. Patients were excluded if they had received any prior injection therapy other than PrT or steroid, had bilateral CTS, had a history of trauma, local infections, allergies, wrist surgery, were using anticoagulants, had uncontrolled hypertension, active endocrine or neurological disease, malignancy, or were pregnant or breastfeeding.

Patients were grouped as follows:

Steroid Group (n=36): Received one US-guided corticosteroid injection plus exercises.

PrT Group (n=38): Received three US-guided 5% dextrose injections at three-week intervals plus exercises.

All patients had a 12-week conservative treatment with splinting and exercises. Activity modification was recommended to avoid symptom aggravation.

Prolotherapy Procedure

Under sterile conditions, injections were administered using a 10 mL syringe and a 26Gx13 mm needle. With the patient's elbow flexed at 90°, wrist in neutral, and forearm supinated, 2 mL of 5% dextrose solution was injected into the carpal tunnel via the ulnar approach both over and under the median nerve with in-plane technique by musculoskeletal ultrasound (HI-VISION Avius, Tokyo, Japan) [13]. Additional 1 mL injections were delivered at the level of the Struthers' ligament, the pronator teres muscle, and the medial and lateral borders of the transverse carpal ligament. Patients were advised to apply local heat to the injection site three times daily for two days post-injection and to avoid NSAIDs during the treatment course [16,17].

Steroid Injection

In the seated position, with the elbow at 90° flexion, the forearm supinated, and the wrist neutral, the designated injection site underwent sterilization using povidone-iodine [8,9,18]. A single 40 mg dose of triamcinolone acetonide was injected between the median nerve and the transverse carpal ligament via the ulnar approach using a 22Gx32 mm needle and the in-plane technique under ultrasound guidance [18,19].

Data Collection

All clinical and electrophysiological assessments were retrospectively extracted from medical records at baseline, 6 weeks, and 24 weeks. All assessments were conducted using the same methods in both treatment groups to ensure comparability.

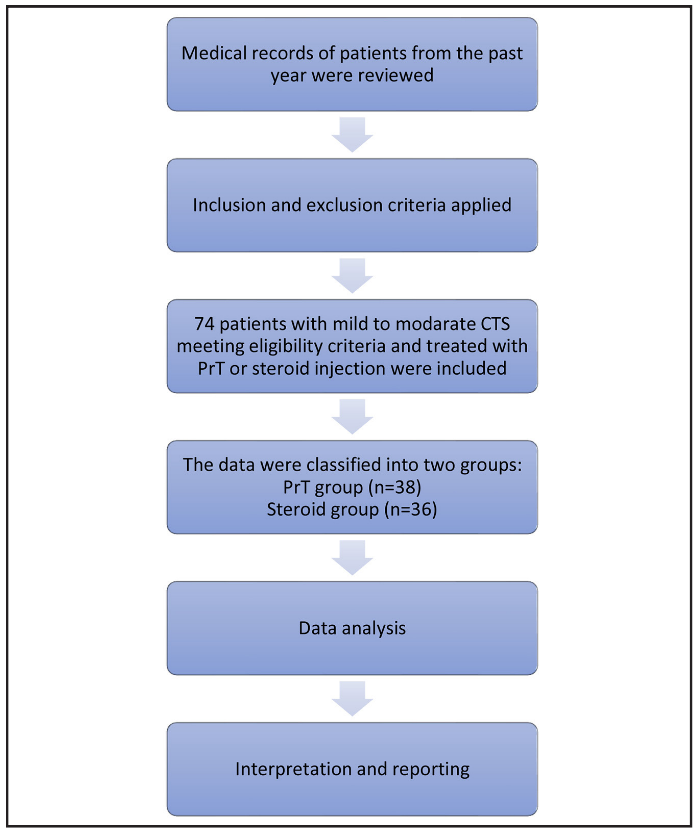

Figure 1. Flowchart of the study design and patient allocation

Outcome Measures

Pain and numbness were assessed using a Visual Analog Scale (VAS, 0-10) for day and night symptoms serving as the primary outcome measures. Function was evaluated using the QuickDASH questionnaire, validated in Turkish by Dogan et al [20]. A Jamar dynamometer (Baseline 200 lb) was used to assess both grip and pinch strength and a hydraulic pinchmeter (Baseline HiRes 50 lb). Tests were performed with patients seated, elbow at 90° and wrist in a neutral position, three times per patient, with the mean values recorded in joules. [21]. Nerve conduction studies (NCS) were performed under standardized conditions with Neuropack M1 device (Nihon Kohden, Tokyo). Room temperature was maintained between 22–24 °C to minimize temperature-related variability. The evaluator was blinded to the patients' treatment allocation. Nerve conduction values were interpreted using established reference ranges, with median nerve distal motor latency ≤4.2 ms and sensory conduction velocity ≥ 50 m/s considered normal. Ulnar motor and sensory NCS were also performed to exclude polyneuropathy or plexopathy [22]. The severity of CTS was classified according to findings from NCS [23]. Only mild and moderate cases were included.

Statistical Analysis

SPSS version 25 (IBM, Armonk, NY, USA) was used. Data were presented as mean ± SD, median, min, and max for continuous variables; and frequencies and percentages for categorical ones. Shapiro–Wilk test checked normality. Independent t-test was used for normally distributed variables; Mann–Whitney U for non-normal data. Chi-square or Fisher's exact test was used for categorical data. Within-group differences were evaluated using paired t-tests or Wilcoxon signed-rank test. Within-group comparisons across time were performed using the Friedman test, with post-hoc pairwise comparisons adjusted by the Bonferroni correction. Clinical significance was evaluated using minimal clinically important difference (MCID) thresholds from previous studies: ≥1.0 cm reduction on the 10-cm VAS for pain, For grip strength, changes of ~5–6.5 kg were considered meaningful, while no established MCID exists for pinch strength; thus, pinch outcomes were interpreted using effect sizes (24,25). Significance was set at p<0.05.

RESULTS

At baseline, the two groups were comparable in terms of demographic and clinical characteristics. The mean age was 51.89±9.78 years in the PrT group and 52.76±8.06 years in the steroid group (p=0.201). BMI values and symptom duration were also similar between the groups (p=0.068 and p=0.696, respectively). No significant differences were found regarding sex, dominant hand, affected side, education level, or occupational status (all p>0.05) (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Groups

Variable	Prolotherapy Group (n=38)	Steroid Group (n=38)	Between-group p-value[a-b]
Age (year, mean ± SD)	51.89 ± 9.78	52.76 ± 8.06	0.201[a]
BMI (kg/cm^2, mean ± SD)	29.34 ± 5.02	31.00 ± 3.90	0.068[a]
Symptom duration (month, mean ± SD)	19.05 ± 27.73	26.57 ± 29.03	0.696[b]
Sex			
Female (n, %) *Male (n, %)*	30 (78.9%) 8 (21.1%)	31 (86.1%) 5 (13.9%)	0.418[c]
Education			
Primary (n, %) *High school (n, %)* *University (n,* %)	16 (42.1%) 11 (28.9%) 11 (28.9%)	21 (58.3) 8 (22.2%) 7 (19.4%)	0.371 [c]
Occupation			
Retired (n, %) *Employed (n, %)* *Homemaker (n, %)*	8 (21.1%) 21 (55.3%) 9 (23.7%)	9 (25.0%) 16 (44.4%) 11 (30.6%)	0.644 [c]
Dominant side			
Right (n, %) *Left (n, %)*	32 (84.2%) 6 (15.8%)	31 (86.1%) 5 (13.9%)	0.818 [c]
Affected side			
Right (n, %) *Left (n, %)* *Bilateral (n, %)*	24 (63.2%) 13 (34.2%) 1 (2.6%)	28 (77.8%) 8 (22.2%) 0 (0.0%)	0.294 [c]

SD, standart deviation; BMI, body mass index; a, Independent t-test; b, Mann–Whitney U, c;Chi-square

At baseline, there were no statistically significant differences between the PrT and steroid groups in daytime or nighttime VAS scores for either numbness or pain (p>0.05 for all). Over time, both groups showed significant within-group improvements in all VAS parameters (p<0.001 for all). Between-group comparisons at the 6th and 24th weeks revealed no statistically significant differences in VAS scores for pain or numbness, with the exception of daytime pain at the 24th week, which was significantly higher in the steroid group compared to the Prt group. At 24 weeks, the PrT group demonstrated significantly lower daytime pain scores on the VAS compared with steroids between-group mean difference was −1.15 (95% CI −2.23 to −0.07; p = 0.026), corresponding to a moderate effect size (Hedges' g = −0.48, 95% CI −0.95 to −0.02). This difference exceeded the commonly reported MCID thresholds for pain reduction in CTS. No other significant between-group differences were observed in changes over time in any other VAS scores for pain or numbness (Table 2).

At baseline, there were no significant differences between the PrT and steroid groups in hand grip and pinch strengths, or QuickDASH scores (all p>0.05). At 6 weeks, the steroid group showed higher grip strength compared with PrT (MD = −1.25, 95% CI −4.12 to 1.62, p = 0.048), with a small effect size (Hedges' g = −0.19, 95% CI −0.65 to 0.26). At 6 weeks, the steroid group also showed higher pinch strength compared with PrT (MD = −0.32, 95% CI −0.87 to 0.23, p = 0.005), but the effect size was small (Hedges' g = −0.26, 95% CI −0.72 to 0.20). QuickDASH

Table 2. Comparison of VAS Scores for Numbness and Pain Between Groups

Variable	Prolotherapy Group (n=38)	Steroid Group (n=36)	Between-group p-value[b-c]
	Mean ± SD, (Min / Median / Max)	Mean ± SD, (Min / Median / Max)	
Baseline VAS numbness (day)	4.84 ± 2.44 (2.00 / 5.00 / 10.00)	5.17 ± 2.22 (3.00 / 5.00 / 10.00)	0.578
6th week VAS numbness (day)	1.84 ± 1.71 (0.00 / 2.00 / 6.00)	1.18 ± 1.09 (0.00 / 1.00 / 5.00)	0.153
24th week VAS numbness (day)	2.05 ± 2.81 (0.00 / 1.00 / 9.00)	1.72 ± 2.40 (0.00 / 0.00 / 9.00)	0.554
Within-group P value[a]	<0.001*	<0.001*	
Baseline VAS numbness (night)	6.95 ± 2.28 (0.00 / 7.00 / 10.00)	7.11 ± 3.04 (0.00 / 7.00 / 10.00)	0.349
6th week VAS numbness (night)	2.14 ± 2.34 (0.00 / 1.50 / 7.00)	1.19 ± 1.25 (0.00 / 1.00 / 4.00)	0.197
24th week VAS numbness (night)	2.33 ± 3.04 (0.00 / 1.00 / 9.00)	1.86 ± 2.33 (0.00 / 0.00 / 9.00)	0.620
Within-group P value[a]	<0.001*	<0.001*	
Baseline VAS pain (day)	3.84 ± 2.85 (0.00 / 4.00 / 9.00)	4.69 ± 2.55 (0.00 / 5.00 / 10.00)	0.269
6th week VAS pain (day)	1.16 ± 2.00 (0.00 / 0.00 / 8.00)	1.52 ± 1.87 (0.00 / 1.00 / 5.00)	0.328
24th week VAS pain (day)	0.91 ± 2.15 (0.00 / 0.00 / 8.00)	2.06 ± 2.54 (0.00 / 0.00 / 9.00)	**0.026***
Within-group P value[a]	<0.001*	<0.001*	
Baseline VAS pain (night)	4.71 ± 3.31 (0.00 / 5.50 / 10.00)	6.19 ± 2.86 (0.00 / 6.00 / 10.00)	0.072
6th week VAS pain (night)	1.22 ± 2.34 (0.00 / 0.00 / 8.00)	1.19 ± 1.74 (0.00 / 0.00 / 5.00)	0.554
24th week VAS pain (night)	0.83 ± 2.27 (0.00 / 0.00 / 9.00)	1.50 ± 2.72 (0.00 / 0.00 / 9.00)	0.181
Within-group P value[a]	<0.001*	<0.001*	

VAS, Visual Analog Scale; SD, standart deviation; a, Friedman test; b-c,Independent t-test or Mann–Whitney U test scores also decreased in both groups, although the between-group difference was not significant (p=0.941). At the 24th week, grip and pinch strength values remained relatively stable, and no statistically significant differences were found between the groups (p=0.521 and p=0.482, respectively). QuickDASH scores were also comparable (14.10±17.63 vs. 14.51±15.80, p=0.841). Within-group comparisons showed significant improvements from baseline to both the 6th and 24th weeks in grip and pinch strength, as well as QuickDASH scores in both groups (p<0.05 for all) (Table 3).

In the comparison of EMG parameters between the PrT and corticosteroid groups, no statistically significant differences were found in any of the measured outcomes (p>0.05 for all). Within-group analyses revealed that in the steroid group, median distal latency (MDL), motor conduction velocity (MCV), distal sensory latency (DSL), sensory conduction velocity (SCV) improved significantly from baseline (p<0.05), whereas the PrT group did not show statistically significant changes in any parameter (Table 4).

At baseline, the distribution of symptom severity levels was similar between the PrT and steroid groups. At the 24th week follow-up, symptom severity levels improved in both groups. In the PrT group, 10 participants reported no symptoms, 5 had mild symptoms, and 23 had moderate symptoms. In the steroid group, 8 participants reported no symptoms, 12 had mild symptoms, and 16 had moderate symptoms. Although clinical improvement was observed, the difference in the distribution of severity levels between the groups did not reach statistical significance (p=0.116).

No adverse effects were reported in any of the patients whose records were reviewed and included throughout the follow-up period.

Tablo 3. Comparison of Grip and Pinch Strength, and QuickDASH Scores Between Groups

Variable	Prolotherapy (n=38) Mean ± SD, (Min / Median / Max)	Steroid (n=36) Mean ± SD, (Min / Median / Max)	Between-group p-value [b-c]
Grip Strength (Baseline, joule)	21.26 ± 6.44 (5.00 / 21.50 / 34.00)	20.47 ± 4.97 (6.00 / 21.40 / 29.00)	0.750
Grip Strength (6th week, joule)	22.87 ± 7.44 (6.00 / 22.00 / 44.00)	24.12 ± 4.95 (6.00 / 24.50 / 35.00)	**0.048**
Grip Strength (24th week, joule)	22.45 ± 6.90 (8.00 / 22.00 / 43.00)	22.16 ± 5.25 (7.00 / 22.00 / 36.00)	0.521
Within-group p-value[a]	**0.016**	**<0.001**	
Pinch Strength (Baseline, joule)	2.27 ± 1.20 (0.50 / 2.00 / 5.40)	2.19 ± 0.93 (0.50 / 2.27 / 5.00)	0.844
Pinch Strength (6th week, joule)	2.77 ± 1.47 (1.00 / 2.25 / 7.50)	3.09 ± 0.89 (1.00 / 3.14 / 5.50)	**0.005**
Pinch Strength (24th week, joule)	2.95 ± 1.42 (1.50 / 2.50 / 7.50)	2.85 ± 1.13 (1.00 / 2.71 / 6.00)	0.482
Within-group p-value[a]	**<0.001**	**<0.001**	
Quick DASH (Baseline)	40.04 ± 19.07 (4.54 / 32.95 / 81.81)	44.61 ± 15.94 (11.36 / 40.90 / 86.36)	0.201
Quick DASH (6th week)	17.12 ± 16.34 (0.00 / 11.36 / 59.00)	15.62 ± 12.80 (0.00 / 13.50 / 38.63)	0.941
Quick DASH (24th week)	14.10 ± 17.63 (0.00 / 7.91 / 68.18)	14.51 ± 15.80 (0.00 / 6.81 / 40.90)	0.841
Within-group p-value[a]	**<0.001**	**<0.001**	

SD, standart deviation; DASH, Disabilities of the Arm, Shoulder, and Hand; min, minimum; max, maximum a, Friedman test; b-c, Independent t-test or Mann–Whitney U test

Table 4. Comparison of Electrophysiological Parameters Between Groups

Variable	Prolotherapy Group	Steroid Group	Between-Group p-value[c-d]
	Mean ± SD, (Min / Median / Max)	Mean ± SD, (Min / Median / Max)	
MDL (ms)-*Pre-treatment*	4.37 ± 0.85 (2.96 / 4.20 / 6.58)	4.59 ± 0.80 (3.08 / 4.39 / 6.64)	0.258
MDL (ms)- *Post-treatmen*t	4.25 ± 0.83 (2.90 / 4.20 / 5.54)	4.01 ± 0.78 (3.12 / 3.86 / 6.70)	0.387
Within-Group p-value[a-b]	0.388	**<0.001**	
CMAP (mV)-*Pre-treatment*	8.78 ± 3.42 (3.11 / 8.48 / 17.48)	8.56 ± 1.61 (4.58 / 8.36 / 12.93)	0.778
CMAP (mV)-*Post-treatment*	8.55 ± 2.72 (2.99 / 8.68 / 13.17)	8.64 ± 1.92 (4.53 / 8.23 / 14.04)	0.831
Within-Group p-value[a-b]	0.325	0.619	
MCV (m/s) -*Pre-treatment*	54.93 ± 5.58 (45.50 / 54.00 / 69.90)	53.86 ± 2.39 (49.50 / 53.80 / 59.00)	0.674
MCV (m/s) - *Post-treatment*	55.08 ± 4.81 (45.80 / 55.30 / 69.90)	54.76 ± 3.11 (47.40 / 54.70 / 61.40)	0.890
Within-Group p-value[a-b]	0.280	**0.037**	
DSL (ms) -*Pre-treatment*	3.17 ± 0.51 (2.48 / 3.02 / 4.56)	3.34 ± 0.42 (2.51 / 3.36 / 4.60)	0.072
DSL (ms) - *Post-treatment*	3.08 ± 0.62 (2.24 / 2.99 / 4.36)	3.03 ± 0.39 (2.58 / 3.05 / 4.20)	0.762
Within-Group p-value[a-b]	0.464	**<0.001**	
DSAP (µV) -*Pre-treatment*	23.27 ± 10.84 (9.80 / 20.00 / 48.70)	20.33 ± 5.40 (12.80 / 19.90 / 39.00)	0.692
DSAP (µV) - *Post-treatment*	22.29 ± 11.71 (4.90 / 18.90 / 50.50)	21.31 ± 4.39 (15.00 / 21.15 / 35.00)	0.370
Within-Group p-value[a-b]	0.456	0.051	
SCV (m/s) -*Pre-treatment*	38.96 ± 4.84 (27.40 / 39.30 / 46.50)	37.36 ± 2.89 (28.10 / 37.50 / 43.80)	0.058
SCV (m/s) - *Post-treatment*	39.61 ± 6.56 (29.80 / 39.05 / 53.60)	40.91 ± 4.11 (33.50 / 40.20 / 49.60)	0.162
Within-Group p-value[a-b]	0.751	**<0.001**	

SD, standart deviation; MDL, motor distal latancy; CMAP, Compound Muscle Action Potential; MCV, Motor Conduction Velocity; DSL, Distal Sensory Latency; DSAP, Distal Sensory Action Potential; SCV, Sensory Conduction Velocity; min, minimum; max, maximum; a-b, Paired t-tests or Wilcoxon signed-rank test; c-d, Independent t-test or Mann–Whitney U test

DISCUSSION

This retrospective study compared the efficacy of 5% dextrose PrT and steroid injections in patients with mild to moderate CTS over a 24-week follow-up period. Both groups showed significant improvements in pain and numbness levels (VAS), grip strength, and functional scores (Quick DASH). At the 6th week, the steroid group demonstrated significantly greater improvements in grip and pinch strengths and daytime numbness. However, by the 24th week, these differences diminished, with no significant differences between the groups in strength and function. Notably, daytime pain VAS scores were significantly lower in the PrT group. At the 24 week follow-up, significant improvements in motor and sensory conduction parameters were observed only in the steroid group. Symptom severity improved in both groups at the 24 week follow-up, with no statistically significant difference between them. This study demonstrated that both ultrasound-guided perineural 5% dextrose prolotherapy and steroid injections are effective non-surgical treatments for mild to moderate carpal tunnel syndrome.

Our findings suggest that while steroids provided more pronounced short-term gains in grip and pinch strength, these effects were not sustained at 24 weeks. Instead, PrT demonstrated a greater long-term reduction in daytime pain, which also surpassed the MCID threshold, indicating clinical relevance. These results are consistent with previous studies reporting that steroids may yield rapid functional improvements through anti-inflammatory effects, whereas PrT offers more durable pain relief via regenerative mechanisms (23,26-29).

The treatment of CTS includes non-surgical and surgical management depending on symptom severity [5,8,23]. Generally, non-surgical treatments (such as splints, exercises, NSAIDs, injections, and physical therapy) are recommended for mild-to-moderate CTS [8]. Ultrasound-guided perineural injection has emerged as a treatment approach for CTS, with studies reporting significant clinical and statistical benefits [8]. This technique provides real-time visualization of the median nerve and nearby structures, allowing precise administration of the therapeutic agent into the carpal tunnel [3,4,18,19]. This technique improves injection accuracy and efficacy and minimizes potential complications such as nerve injury or inadvertent vascular puncture [18]. Several studies have demonstrated that ultrasound-guided injections yield better clinical outcomes and patient satisfaction than landmark-based methods [3,18]. Therefore, ultrasound guidance is recommended to optimize efficacy and safety in CTS injection therapies. Accordingly, injections administered to this recent study patients were performed under ultrasound guidance.

Research findings consistently support the safety and efficacy of local steroid injection in CTS [7-9]. Babaei-Ghazani et al. [26] reported that ultrasound-guided steroid injections administered either above or below the median nerve provided comparable benefits in symptom relief, functional improvement, and electrophysiological and sonographic outcomes. Similarly, Lee et al. [19] found that a short-axis in-plane injection both above and below the median nerve led to superior improvements in symptoms, function, median nerve cross sectional area (CSA), and electrophysiological measures compared to a short-axis out-of-plane injection administered only below the nerve. Based on these findings, our study included patients who underwent ultrasound-guided in-plane triamcinolone injections (1 cc), administered both above and below the median nerve. Previous studies indicate that steroid treatment yields satisfactory short- to mid-term responses in CTS, though long-term results remain controversial [27].

In this recent study, while both groups showed symptomatic improvement, steroids led to more pronounced early gains in grip and pinch strengths and daytime numbness at week 6. This rapid effect aligns with studies showing steroids quickly reduce perineural inflammation, nerve edema, and synovial swelling, thereby improving nerve conduction and symptoms [28]. Although no established MCID thresholds exist for these outcomes, the observed effect sizes were small and confidence intervals crossed zero, suggesting that the short-term gains, while statistically significant, may have limited clinical relevance.

By week 24, differences in strength and function between the groups diminished, suggesting that PrT may have delayed but sustained effects. This is consistent with the regenerative mechanism of PrT, in contrast to steroids which primarily provide anti-inflammatory benefits without promoting tissue repair. Notably, the PrT group demonstrated significantly lower daytime pain at week 24. The between-group difference in daytime VAS (−1.15) exceeded the commonly accepted MCID of 1.0 cm, indicating both statistical and clinical significance. Functional improvement measured by QuickDASH did not surpass the MCID, highlighting that symptomatic relief may not always translate into meaningful functional gains.

Prolotherapy has gained attention as a minimally invasive regenerative treatment promoting tissue healing and pain modulation in musculoskeletal disorders [13]. CTS involves intraneural microcirculatory disturbances and connective tissue alterations due to nerve compression. In this context, PrT may support regeneration and analgesia. The delayed effect observed may relate to proposed mechanisms of dextrose PrT, including stimulation of fibroblast proliferation, collagen synthesis, and nociceptor modulation [29]. In vitro studies show that low dextrose concentrations (1-10%) result in low cytotoxicity while stimulating VEGF-A gene expression and angiogenic factor release [30]. This may reduce pain and accelerate recovery while promoting regeneration [31]. Some authors suggest 5% dextrose perineural injections may yield analgesia by directly affecting sensory pathways [32,33]. Dextrose may activate potassium channels in nerve fibers, leading to nociceptor inhibition via hyperpolarization [34]. Additionally, dextrose modulates glycine receptors that regulate nociceptive signal transmission [35]. For these mechanisms, 5% dextrose is preferred in CTS [13,15,17,35].

This study suggests that perineural 5% dextrose PrT may be effective for long-term pain relief, symptom reduction, and functional improvement in CTS. Consistent with these findings, a 2024 meta-analysis reported dextrose PrT improved symptoms and function in the short and long term, except for short-term pain relief [27]. Compared to steroids, PRP, and hyaluronic acid, dextrose demonstrated the highest long-term pain reduction efficacy. According to Li et al. [11], 5% dextrose injection is a safe and effective long-term treatment, with over 88% of patients reporting more than 50% symptom improvement. Oh et al. [13] reported that 5% dextrose improved function more than corticosteroids and had fewer adverse effects. Comparable results to steroids were observed in pain scores, symptom improvement, electrodiagnostic findings, and nerve CSA, endorsing 5% dextrose PrT as a recommended approach in mild to moderate CTS [13]. Gao et al. [36] found dextrose more effective than steroids in CTS. In another review, manual therapy and dextrose PrT were superior to other therapies [27]. Still, there is no consensus on optimal PrT dose and frequency. A study by Chao et al. [37] showed ultrasound-guided 5% dextrose PrT yielded lasting effects in patients with persistent or recurrent symptoms after surgery. In this study, 36 such patients were followed for 33 months; 22 patients (61%) reported over 50% improvement after an average of 3.1 injections. In this recent study, considering the inflammation cascade, patients who received a total of three sessions of PrT at 3-week intervals were included in the evaluation.

Although both injection agents effectively relieved symptoms and improved function, limited improvements were observed in electrodiagnostic parameters. MDL, MCV, DSL and SCV improved significantly only in the steroid group, consistent with previous studies showing steroids enhance conduction velocity and reduce latency [38]. This superior electrophysiological response is likely due to the rapid anti-inflammatory effects of steroids, which quickly reduce perineural edema and nerve compression, allowing earlier normalization of nerve conduction and nerve function. The lack of electrophysiological improvement in the PrT group suggests its benefits may not reflect in nerve conduction studies over the follow-up period. This may indicate PrT primarily aims to promote tissue healing and strengthen the connective tissue surrounding the nerve; this mechanism acts more slowly, and therefore electrophysiological improvement may be observed later. [27]. This aligns with prior studies showing symptom relief does not always correlate with electrophysiological recovery [39]. Since conventional electrodiagnostics assess large myelinated fibers, they may not detect small fiber improvement often implicated in CTS. Thus, electrophysiological tests may be limited in predicting response to conservative therapy. Additionally, CTS severity levels showed similar improvement in both groups at 24th weeks. This supports individualized CTS treatment and indicates PrT as an effective alternative for mild to moderate CTS [11,13,26,36].

Limitations

Despite promising results, several limitations should be acknowledged. First, the retrospective design precluded randomization, which may have introduced selection bias. Second, the sample size was relatively small, limiting statistical power and generalizability. Thirdly, the injection protocols differed between groups (single-dose steroid vs. three-session dextrose PrT), which may have influenced outcomes and complicates direct comparison. Electrophysiological assessments were performed under standardized conditions by a blinded operator, reducing the risk of measurement bias; however, potential variability in nerve conduction reference values could still affect the results. Although follow-up extended to 24 weeks, this period may still be insufficient to fully capture long-term regenerative effects of prolotherapy. Although no major adverse events were observed in this study, the sample size was not sufficient to detect rare complications. Future prospective, randomized controlled trials with larger samples, standardized protocols and longer follow-up are needed to confirm these findings, clarify safety profiles, and investigate the biological mechanisms of dextrose prolotherapy in CTS, potentially incorporating advanced imaging or biomarkers to assess nerve and connective tissue recovery.

CONCLUSION

Considering the study objectives and limitations, these findings suggest that both ultrasound-guided perineural 5% dextrose prolotherapy and steroid injections are effective for managing mild to moderate carpal tunnel syndrome. While steroids may offer quicker symptom relief and early strength gains, dextrose prolotherapy appears to provide more sustained pain control. However, these results should be interpreted cautiously due to the retrospective design and the relatively small sample size. Further large-size, well-designed, randomized controlled trials are needed to confirm these findings and elucidate the underlying regenerative mechanisms of dextrose prolotherapy and determine optimal dosage and injection frequency.

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REFERENCES

[1] Olney RK (2001) Carpal tunnel syndrome: complex issues with a "simple" condition. Neurology. 56(11):1431–1432. https://doi.org/10.1212/wnl.56.11.1431

[2] Burton CL, Chesterton LS, Chen Y, van der Windt DA (2016) Clinical Course and Prognostic Factors in Conservatively Managed Carpal Tunnel Syndrome: A Systematic Review. Arch Phys Med Rehabil. 97(5):836-852.e1. https://doi.org/10.1016/j.apmr.2015.09.013

[3] Tumpaj T, Potocnik Tumpaj V, Albano D, Snoj Z (2022) Ultrasound-guided carpal tunnel injections. Radiol Oncol. 56(1):14-22. https://doi.org/10.2478/raon-2022-0004

[4] Chang KV, Wu WT, Özçakar L (2020) Ultrasound imaging and guidance in peripheral nerve entrapment: hydrodissection highlighted. Pain Manag. 10(2):97-106. https://doi.org/10.2217/pmt-2019-0056

[5] Padua L, Coraci D, Erra C, Pazzaglia C, Paolasso I, et al (2016) Carpal tunnel syndrome: clinical features, diagnosis, and management. Lancet Neurol. 15(12):1273-1284. https://doi.org/10.1016/S1474-4422(16)30231-9

[6] Sconfienza LM, Adriaensen M, Albano D, Aparisi Gómez MP, Bazzocchi A, et al (2020) Clinical indications for image-guided interventional procedures in the musculoskeletal system: a Delphi-based consensus paper from the European Society of Musculoskeletal Radiology (ESSR)-Part II, elbow and wrist. Eur Radiol. 30(4):2220-2230. https://doi.org/10.1007/s00330-019-06545-6

[7] Jiménez Del Barrio S, Bueno Gracia E, Hidalgo García C, Estébanez de Miguel E, Tricás Moreno JM, et al (2018) Conservative treatment in patients with mild to moderate carpal tunnel syndrome: A systematic review. Neurologia. 33(9):590-601. https://doi.org/10.1016/j.nrl.2016.05.018

[8] Lam KHS, Wu YT, Reeves KD, Galluccio F, Allam AE, et al (2023) Ultrasound-Guided Interventions for Carpal Tunnel Syndrome: A Systematic Review and Meta-Analyses. Diagnostics (Basel). 13(6):1138. https://doi.org/10.3390/diagnostics13061138

[9] Badıl Güloğlu S, Bilgilisoy Filiz M, Kılıç KK, Koldaş Doğan Ş, Toslak İE, et al (2022) Treatment of carpal tunnel syndrome by low-level laser therapy versus corticosteroid injection: a randomized, prospective clinical study. Lasers Med Sci. 37(4):2227-2237. https://doi.org/10.1007/s10103-021-03489-6

[10] Lin CP, Chang KV, Huang YK, Wu WT, Özçakar L (2020) Regenerative Injections Including 5% Dextrose and Platelet-Rich Plasma for the Treatment of Carpal Tunnel Syndrome: A Systematic Review and Network Meta-Analysis. Pharmaceuticals (Basel). 13(3):49. https://doi.org/10.3390/ph13030049

[11] Li TY, Chen SR, Shen YP, Chang CY, Su YC, et al (2021) Long-term outcome after perineural injection with 5% dextrose for carpal tunnel syndrome: a retrospective follow-up study. Rheumatology (Oxford). 60(2):881-887. https://doi.org/10.1093/rheumatology/keaa361

[12] Catapano M, Catapano J, Borschel G, Alavinia SM, Robinson LR, et al (2020) Effectiveness of Platelet-Rich Plasma Injections for Nonsurgical Management of Carpal Tunnel Syndrome: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Arch Phys Med Rehabil. 101(5):897-906. https://doi.org/10.1016/j.apmr.2019.10.193

[13] Oh MW, Park JI, Shim GY, Kong HH (2025) Comparative Efficacy of 5% Dextrose and Corticosteroid Injections in Carpal Tunnel Syndrome: A Systematic Review and Meta-analysis. Arch Phys Med Rehabil. 106(2):300-310. https://doi.org/10.1016/j.apmr.2024.07.005

[14] Wu YT, Ke MJ, Ho TY, Li TY, Shen YP, et al (2018) Randomized double-blinded clinical trial of 5% dextrose versus triamcinolone injection for carpal tunnel syndrome patients. Ann Neurol. 84(4):601-610. https://doi.org/10.1002/

ana.25332

[15] Wu YT, Ho TY, Chou YC, Ke MJ, Li TY, et al (2017) Six-month Efficacy of Perineural Dextrose for Carpal Tunnel Syndrome: A Prospective, Randomized, Double-Blind, Controlled Trial. Mayo Clin Proc. 92(8):1179-1189. https://doi.org/10.1016/j.mayocp.2017.05.025

[16] Ciftci YGD, Tuncay F, Kocak FA, Okcu M (2023) Is Low-Dose Dextrose Prolotherapy as Effective as High-Dose Dextrose Prolotherapy in the Treatment of Lateral Epicondylitis? A Double-Blind, Ultrasound Guided, Randomized Controlled Study. Arch Phys Med Rehabil. 104(2):179-187. https://doi.org/10.1016/j.apmr.2022.09.017

[17] Ozge O, Derya G (2024) Perineural 5% dextrose versus corticosteroid injection in non-surgical carpal tunnel syndrom treatment. Ideggyogy Sz. 77(3-4):121-129. https://doi.org/10.18071/isz.77.0121

[18] Rayegani SM, Raeissadat SA, Ahmadi-Dastgerdi M, Bavaghar N, Rahimi-Dehgolan S (2019) Comparing The Efficacy Of Local Triamcinolone Injection In Carpal Tunnel Syndrome Using Three Different Approaches with or without Ultrasound Guidance. J Pain Res. 12:2951-2958. https://doi.org/10.2147/JPR.S212948

[19] Lee JY, Park Y, Park KD, Lee JK, Lim OK (2014) Effectiveness of ultrasound-guided carpal tunnel injection using in-plane ulnar approach: a prospective, randomized, single-blinded study. Medicine (Baltimore). 93(29):e350. https://doi.org/10.1097/MD.0000000000000350

[20] Koldas Dogan S, Ay S, Evcik D, Baser O (2011) Adaptation of Turkish version of the questionnaire Quick Disability of the Arm, Shoulder, and Hand (Quick DASH) in patients with carpal tunnel syndrome. Clin Rheumatol. 30(2):185-191. https://doi.org/10.1007/s10067-010-1470-y

[21] Fess EE (1992) Grip strength. In: Clinical assessment recommendations. 2nd edn, vol 5. American Society of Hand Therapists, Chicago.

[22] American Association of Electrodiagnostic Medicine, American Academy of Neurology, and American Academy of Physical Medicine and Rehabilitation (2002) Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: summary statement. Muscle Nerve. 25(6):918-922. https://doi.org/10.1002/mus.10185

[23] Shapiro LM, Kamal RN, Management of Carpal Tunnel Syndrome Work Group, American Academy of Orthopaedic Surgeons (2025) American Academy of Orthopaedic Surgeons/ASSH Clinical Practice Guideline Summary Management of Carpal Tunnel Syndrome. J Am Acad Orthop Surg. 33(7):e356-e366. https://doi.org/10.5435/JAAOS-D-24-01179

[24] Randall DJ, Zhang Y, Li H, Hubbard JC, Kazmers NH (2022) Establishing the Minimal Clinically Important Difference and Substantial Clinical Benefit for the Pain Visual Analog Scale in a Postoperative Hand Surgery Population. J Hand Surg Am. 47(7):645-653. https://doi.org/10.1016/j.jhsa.2022.03.009

[25] Bohannon RW (2019) Minimal clinically important difference for grip strength: a systematic review. J Phys Ther Sci. 31(1):75-78. https://doi.org/10.1589/jpts.31.75

[26] Babaei-Ghazani A, Nikbakht N, Forogh B, Raissi GR, Ahadi T, et al (2018) Comparison Between Effectiveness of Ultrasound-Guided Corticosteroid Injection Above Versus Below the Median Nerve in Mild to Moderate Carpal Tunnel Syndrome: A Randomized Controlled Trial. Am J Phys Med Rehabil. 97(6):407-413. https://doi.org/10.1097/PHM.0000000000000877

[27] Yang FA, Wang HY, Kuo TY, Peng CW, Liou TH, et al (2024) Injection therapy for carpal tunnel syndrome: A systematic review and network meta-analysis of randomized controlled trials. PLoS One. 19(5):e0303537. https://doi.org/10.1371/journal.pone.0303537

[28] Ginanneschi F, Filippou G, Bonifazi M, Frediani B, Rossi A (2014) Effects of local corticosteroid injection on electrical properties of aβ-fibers in carpal tunnel syndrome. J Mol Neurosci. 52(4):525-530. https://doi.org/10.1007/s12031-013-0107-4

[29] Reeves KD, Sit RW, Rabago DP (2016) Dextrose Prolotherapy: A Narrative Review of Basic Science, Clinical Research, and Best Treatment Recommendations. Phys Med Rehabil Clin N Am. 27(4):783-823. https://doi.org/10.1016/j.pmr.2016.06.001

[30] Güran Ş, Çoban ZD, Karasimav Ö, Demirhan S, Karaağaç N, et al (2018) Dextrose solution used for prolotherapy decreases cell viability and increases gene expressions of angiogenic and apopitotic factors. Gulhane Med J. 60(2):42-46. https://doi.org/10.26657/gulhane.00016

[31] Woo MS, Park J, Ok SH, Park M, Sohn JT, et al (2021)

The proper concentrations of dextrose and lidocaine in regenerative injection therapy: in vitro study. Korean J Pain. 34(1):19-26. https://doi.org/10.3344/kjp.2021.34.1.19

[32] Lyftogt J (2008) Pain conundrums: which hypothesis? Central nervous system sensitization versus peripheral nervous system autonomy. Australas Musculoskeletal Med. 13:72-74. https://search.informit.org/doi/10.3316/informit.483439107098154

[33] Maniquis-Smigel L, Dean Reeves K, Jeffrey Rosen H, Lyftogt J, Graham-Coleman C, et al (2016) Short Term Analgesic Effects of 5% Dextrose Epidural Injections for Chronic Low Back Pain: A Randomized Controlled Trial. Anesth Pain Med. 7(1):e42550. https://doi.org/10.5812/aapm.42550

[34] Capotosto S, Nazemi AK, Komatsu DE, Penna J (2024) Prolotherapy in the Treatment of Sports-Related Tendinopathies: A Systematic Review of Randomized Controlled Trials. Orthop J Sports Med. 12(11):23259671241275087. https://doi.org/10.1177/23259671241275087

[35] Breitinger U, Breitinger HG (2016) Augmentation of glycine receptor alpha3 currents suggests a mechanism for glucose-mediated analgesia. Neurosci Lett. 612:110-115. https://doi.org/10.1016/j.neulet.2015.11.051

[36] Gao N, Yan L, Ai F, Kang J, Wang L, et al (2023) Comparison of the Short-Term Clinical Effectiveness of 5% Dextrose Water, Platelet-rich Plasma and Corticosteroid Injections for Carpal Tunnel Syndrome: A Systematic Review and Network Meta-analysis of Randomized Controlled Trials. Arch Phys Med Rehabil. 104(5):799-811. https://doi.org/10.1016/j.apmr.2022.11.009

[37] Chao TC, Reeves KD, Lam KHS, Li TY, Wu YT (2022) The Effectiveness of Hydrodissection with 5% Dextrose for Persistent and Recurrent Carpal Tunnel Syndrome: A Retrospective Study. J Clin Med. 11(13):3705. https://doi.org/10.3390/jcm11133705

[38] Cartwright MS, White DL, Demar S, Wiesler ER, Sarlikiotis T, et al (2011) Median nerve changes following steroid injection for carpal tunnel syndrome. Muscle Nerve. 44(1):25-29. https://doi.org/10.1002/mus.22067

[39] Nehete SR, Raut BB, Hiremath AS, Thatte RM (2017) A study the various clinical and electrophysiological parameters of severity of carpal tunnel syndrome, their correlation with post-operative recovery. Indian J Plast Surg. 50(3):260-265. https://doi.org/10.4103/ijps.IJPS_41_17

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