International Journal of Medical Anesthesiology

E-ISSN: 2664-3774
P-ISSN: 2664-3766
www.anesthesiologypaper.com
IJMA 2024; 7(2): 06-14
Received: 08-02-2024
Accepted: 13-03-2024

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Ultrasound guided intra-carpal injection of platelet rich plasma versus corticosteroids injection in carpal tunnel syndrome

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DOI: https://doi.org/10.33545/26643766.2024.v7.i2a.465

Abstract
Background: Administration of platelet-rich plasma (PRP) via injection has demonstrated enhancements in the clinical outcomes for individuals afflicted with mild to moderate cases of carpal tunnel syndrome (CTS). This research compared the injection efficiency of PRP versus corticosteroids intra-carpal under the guidance of ultrasound for CTS treatment.
Methods: A randomized, prospective, controlled, double-blind study encompassed 66 patients, both sex, ranging in age from 20 to 80 years, exhibiting unilateral or bilateral mild to moderate CTS, classified electrophysiologically, with symptomatic manifestations persisting for a minimum of 3 months, corroborated by electrophysiological assessment. The participants were segregated into three equal cohorts: Group I received medical treatment with gabapentin 100 mg thrice daily; Group II underwent intra-carpal PRP injection; and Group III received intra-carpal corticosteroid injection.
Results: An inverse correlation was observed between nerve conduction and body mass index (BMI) (P=0.007), while a positive correlation existed between nerve conduction and PRP (P=0.035). The Boston Carpal Tunnel Questionnaire (BCTQ) scores, encompassing both symptom severity (BCTQs) and functional status (BCTQf), were significantly lower in Groups (II, III) compared to Group I at 1 month and 2 months (p<0.05). Furthermore, BCTQs and BCTQf scores were markedly lower in Groups (II, III) than in Group I at 3 months and 4 months (p<0.05). The consumption of pregabalin and acetaminophen was significantly reduced in Groups (II, III) relative to Group I throughout the 4^{th}-6^{th}, 6^{th}-8^{th}, 8^{th}-10^{th}, and 10^{th}-12^{th} weeks, as well as during the 3^{rd}-4^{th} month and 4^{th}-5^{th} month (p<0.05).
Conclusions: High efficacy of both steroids and PRP in CTS compared to medical treatment using gabapentin, both Steroids and PRP showed the same efficacy in CTS treatment regarding numerical rating scale BCTQs, BCTQf as well as nerve conduction study.

Keywords: Ultrasound guided intra-carpal injection, platelet rich plasma, corticosteroids injection, carpal tunnel syndrome

Introduction
Carpal tunnel syndrome (CTS) stands out as the utmost prevalent form of mononeuropathy, constituting roughly 90% of all peripheral entrapment neuropathies encountered clinically [1]. Within industrialized populations, estimates on CTS prevalence range widely, falling between 4% and 20% [2]. The prevailing theory regarding CTS etiology centers on the progressive swelling of tissues within the carpal tunnel, which subsequently compresses the median nerve (MN) in a manner resembling an hourglass. This compression is thought to compromise blood flow to the MN, ultimately leading to ischemic degradation of the nerve itself [3].
The clinical presentation of CTS varies considerably and can be linked to the extent of nerve damage in each individual. This explains the wide spectrum of symptoms, ranging from mild to severe pain, which may or may not be accompanied by neurological signs [4]. Treatment for CTS follows a tiered approach, Less severe situations were given priority for non-invasive therapies. Patients do not show sufficient improvement or recurrence following non-operative treatment are usually the ones who have surgery [3, 5].
A growing body of research suggests the potential efficacy of platelet-rich plasma (PRP) injections as a non-surgical CTS management [6]. PRP has emerged as a versatile therapeutic tool with a safety profile demonstrated across various medical fields [7].

This biological agent is a concentrated platelet suspension enriched in degradation products. These products include epidermal growth factor (EGF), insulin-like growth factor-1 (IGF-1), platelet-derived growth factor (PDGF), transforming growth factor (TGF), and vascular endothelial growth factor (VEGF), it is thought to be involved in regenerating and repairing tissues [8].

The growing body of research on PRP injections for CTS primarily supports its effectiveness in improving clinical outcomes for patients having milder cases [9]. Evidence from both laboratory and field investigations provide evidence for PRP's on peripheral nerves neurotrophic properties [10, 11].

Researchers believe that PRP injections stimulate a cascade of growth factors that strengthen the blood-nerve barrier, promote neural blood flow, and speed up the regeneration of the median nerve. While these findings suggest promise for PRP's potential as a therapy for milder CTS, it's important to note that severe cases may not respond as well and likely require alternative or additional interventions [9].

Although corticosteroid treatments are known to effectively reduce CTS symptoms, their benefits appear to be short-lived. Research suggests that roughly half of patients experience symptom recurrence within a year, necessitating further treatment [12]. Ultrasound, a safe and cost-effective imaging technique, offers a potential solution. By guiding needle placement during the injection, ultrasound can enhance the procedure's accuracy, allowing physicians to target the area closer to the MN while minimizing the risk of injury to surrounding tissues and the nerve itself. This increased precision may translate to improved efficacy and potentially longer-lasting symptom relief for CTS patients [13].

This research compared the injection efficiency of PRP versus corticosteroids intra-carpal under the guidance of ultrasound for CTS treatment.

Patients and Methods

This prospective study employed a randomized, controlled, double-blinded design to assess the efficiency of two treatments for CTS. Sixty-six individuals ranging in age from 20 to 80 years old of both sexes were enrolled. All participants presented with unilateral or bilateral, mild to moderate CTS, confirmed by electrophysiological assessment using Padua's criteria.

Inclusion criteria stipulated CTS-like symptoms that persist for a minimum of three months along with other symptom. This clinical picture encompassed: Paresthesia or dysesthesia (tingling or burning discomfort) accompanied by hand weakness and clumsiness, symptoms exacerbated by repetitive wrist flexure, which can be relieved by mobilizing the wrist or shaking hands, numbness in the MN innervation territory (Index, middle, radial half of ring finger, thumb), atrophy and/or weakening of the thenar muscles, a positive Phalen's test (pain or paresthesia with prolonged wrist flexion) with or not Tinel's sign (tingling or pain along the MN path with percussion). A diagnosis of CTS was established when a patient met criterion 1 (electrophysiological confirmation) alongside at least one of the other clinical criteria (2, 3, or 4) [14, 15]. The present study, conducted between December 2022 and December 2023, adhered to ethical guidelines set forth by the Tanta University Hospitals Ethics Committee (approval code: 35986/10/22). Written informed consent was obtained from all contributors.

Enrollment criteria excluded individuals having blood clotting disorders, malignancy, platelet dysfunction, pregnancy, prior CTS injection within the past six months, systemic infection, wrist surgery history. Additionally, individuals with uncontrolled diabetes mellitus within the last three months, severe CTS, or CTS secondary to systemic conditions (acromegaly, thyroid dysfunction, rheumatoid arthritis, gout, psoriatic arthritis) were excluded. Likewise, any participant presenting with an infection at the injection site was disqualified.

Randomization and blindness

Group allocation was done by using computer generated random numbers in closed sealed envelopes. All carpal tunnel injections were performed by the same pain consultant, while measurements were recorded by another pain physician who had no idea about the patient's groups. The patients, pain physician who collected and analyzed the data were blind to the patients' group allocation. The patients were allocated in to three equal groups: Group I: (control group) was given medical treatment gabapentin 100 mg 3 times per day, Group II: (PRP group) received intracarpal PRP and Group III: (S group) received intracarpal steroids. All patients received the treatment regimen for CTS.

PRP preparation

Blood was drawn from the upper limbs of participants via peripheral venipuncture. The platelet count was determined using 1.5 mL of the 15 mL sample. Next, 1.5 mL of sodium citrate 3.2% was added to a sterile 15 mL centrifuge tube with the remaining 13.5 mL. The combination underwent centrifugation at 4000 rpm/10 min. After the process of centrifugation, a volume of 2.5 mL of PRP was obtained from the buffy coat, which is the layer located between the red blood cells and the plasma. An extra 0.5 mL of PRP was isolated for further examination of platelet count.

Group P intracarpal PRP injection

In a supine position, the injection site was disinfected with an antiseptic solution. To maintain sterility, a sterile barrier was used to cover the ultrasound probe. The participant's forearm was kept supinated (palm facing upwards), and the wrist held in a neutral position. Using ultrasound guidance, the flexor retinaculum was identified as a hyperechoic (highly reflective) structure traversing the carpal bones between the scaphoid and pisiform bones. The MN was visualized directly beneath the flexor retinaculum. Employing the ulnar approach, a 23-gauge needle was inserted. The needle was originally inserted through the skin from the ulnar side and subcutaneous tissue, staying superficial to the ulnar artery (with doppler ultrasound guide) and ulnar nerve. The needle then pierced the flexor retinaculum and was advanced until its tip positioned slightly beyond the MN. The injection of 2 mL of PRP was then performed. If the person felt pain or a tingling sensation that spread throughout the distribution of the MN during the injection, the procedure was immediately stopped.

Group S Intracarpal Steroids injection

The corticosteroid injection procedure mirrored that of the PRP injection technique [16]. Patients were positioned supine, and the injection site was disinfected with an

antiseptic solution. A sterile barrier ensured the ultrasound probe remained sterile throughout the procedure. The participant's forearm was maintained in a supinated position (palm upwards) with the wrist held neutral. Under ultrasound guidance, the flexor retinaculum was identified as a hyperechoic (highly reflective) structure traversing the carpal bones between the scaphoid and pisiform. The MN was visualized directly beneath the flexor retinaculum. Similar to the PRP injection, a 23-gauge needle was inserted using the ulnar approach. The needle was initially directed through the skin and subcutaneous tissue on the ulnar side, staying superficial to the ulnar artery (identified by Doppler ultrasound) and ulnar nerve. It then pierced the flexor retinaculum and advanced until its tip positioned slightly beyond the MN. A 1 mL dose of triamcinolone acetonide (40mg/mL) was then injected. As with the PRP injection, If the person felt pain or a tingling sensation that spread throughout the distribution of the MN during the injection, the injection was immediately stopped. Figure 1.

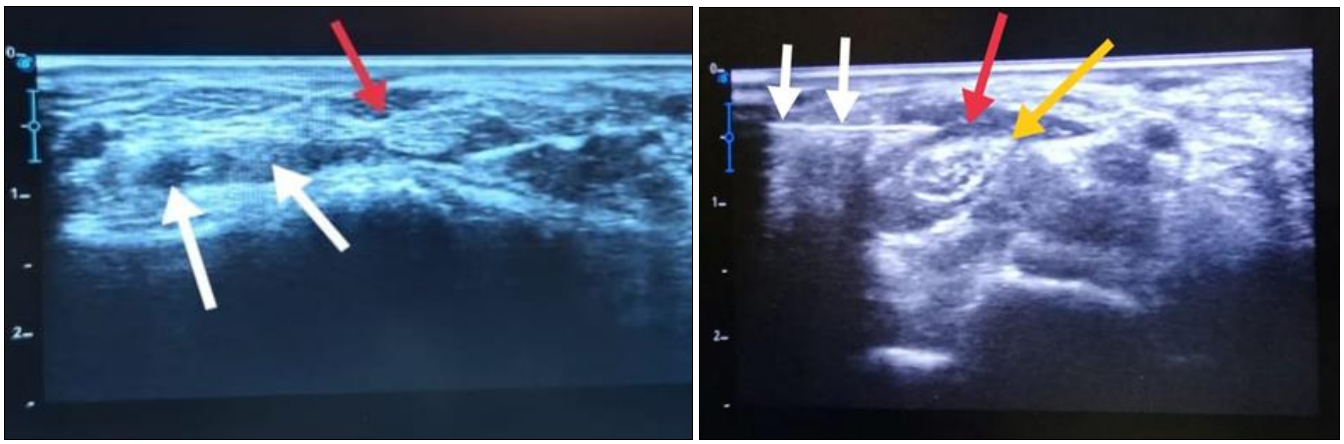

Fig 1: Median N (A) before injection and (B) after injection

Boston carpal tunnel syndrome questionnaire (BCTQ)
The Boston Carpal Tunnel Questionnaire (BCTQ) served as a primary method for clinical CTS evaluation in this study. This patient-reported outcome measure consists of two subscales: the symptom severity scale (BCTQs) and the functional status scale (BCTQf). Each subscale includes a series of questions, typically ranging from 11 to 8, respectively [17]. The response options for each question are scored on a scale of 0 (indicating no symptoms or functional difficulty) to 5 (representing severe symptoms or limitations). For further analysis, a total of all questions from each subscale had their mean scores determined.

Electrophysiological study and CTS grading
Electrophysiological assessment was performed to confirm CTS diagnosis of and determine its severity. The cathode electrode was placed 8 cm proximal to the active electrode on the abductor pollicis brevis muscle in order to evaluate the distal motor latency (DML) of the MN. An antidromal recording of sensory nerve conduction velocity (SNCV) was performed at the second interphalangeal joints, 14 cm from the active electrode. Established cut-off points were used for diagnosis: CTS was diagnosed when the median nerve DML was less than 4.3 ms and the SNCV was more than 36 m/s. Next, Padua's criteria were used to classify the CTS severity: (1) Mild: abnormal SNCV with normal DML, (2) Moderate: abnormal values for both SNCV and DML, and (3) Severe: absent SNCV with abnormal DML [18].
The primary outcome measure focused on quantifying pain improvement using the An established method for evaluating pain, the Numeric Rating Scale (NRS) uses a scale from 0 (no pain) to 10 (extreme pain). NRS grades were obtained at baseline (0 months) and evaluation conducted three and six months later post-injection. Secondary outcomes investigated the effectiveness of both treatments using two complementary approaches. First, the BCTQ was employed to evaluate clinical improvement. This result as stated by the patient includes subscales for symptom severity and functional status, providing valuable insights into the impact of treatment on patients' daily lives. Second, electrophysiological evaluation based on Padua's criteria was conducted to assess changes in nerve conduction [19].

Sample Size Calculation
A power analysis was performed using the Epi-Info software (version 2002) developed by the World Health Organization and the Centers for Disease Control and Prevention (Atlanta, Georgia, USA) to determine the appropriate sample size for this study. The analysis aimed to achieve a 95% confidence level and 80% power to detect a clinically meaningful difference in pain control between the two treatment groups. The anticipated scenario was a 90% pain control rate in the most effective treatment group compared to a 50% rate in the less favorable group. Based on these criteria, the calculated sample size was N=20 per group. To account for potential incomplete data, the researcher opted to increase the sample size to 22 participants in each arm of the study.

Statistical analysis
Statistical analysis was performed using IBM SPSS Statistics version 27 (IBM©, Chicago, IL, USA). The normality of data distribution was assessed using the Shapiro-Wilks test and visually inspected with histograms. Quantitative data with normal distributions were expressed as mean and standard deviation (SD) and analyzed using one-way analysis of variance (ANOVA) with a post hoc Tukey's test for multiple comparisons. Conversely, quantitative data with non-normal distributions were presented as median and interquartile range (IQR) and analyzed using the Kruskal-Wallis test with a Bonferroni

correction for multiple comparisons. Categorical variables were summarized as frequency and percentages (%) and analyzed using the Chi-square test. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

Ninety five patients were assessed for eligibility, 12 patients did not meet the criteria, seven patients refused to participate in the study and ten patients were missed and replaced during the study. The remaining patients were randomly allocated into three equal groups (22 patients in each). All allocated patients were followed-up and analyzed statistically. Figure 2

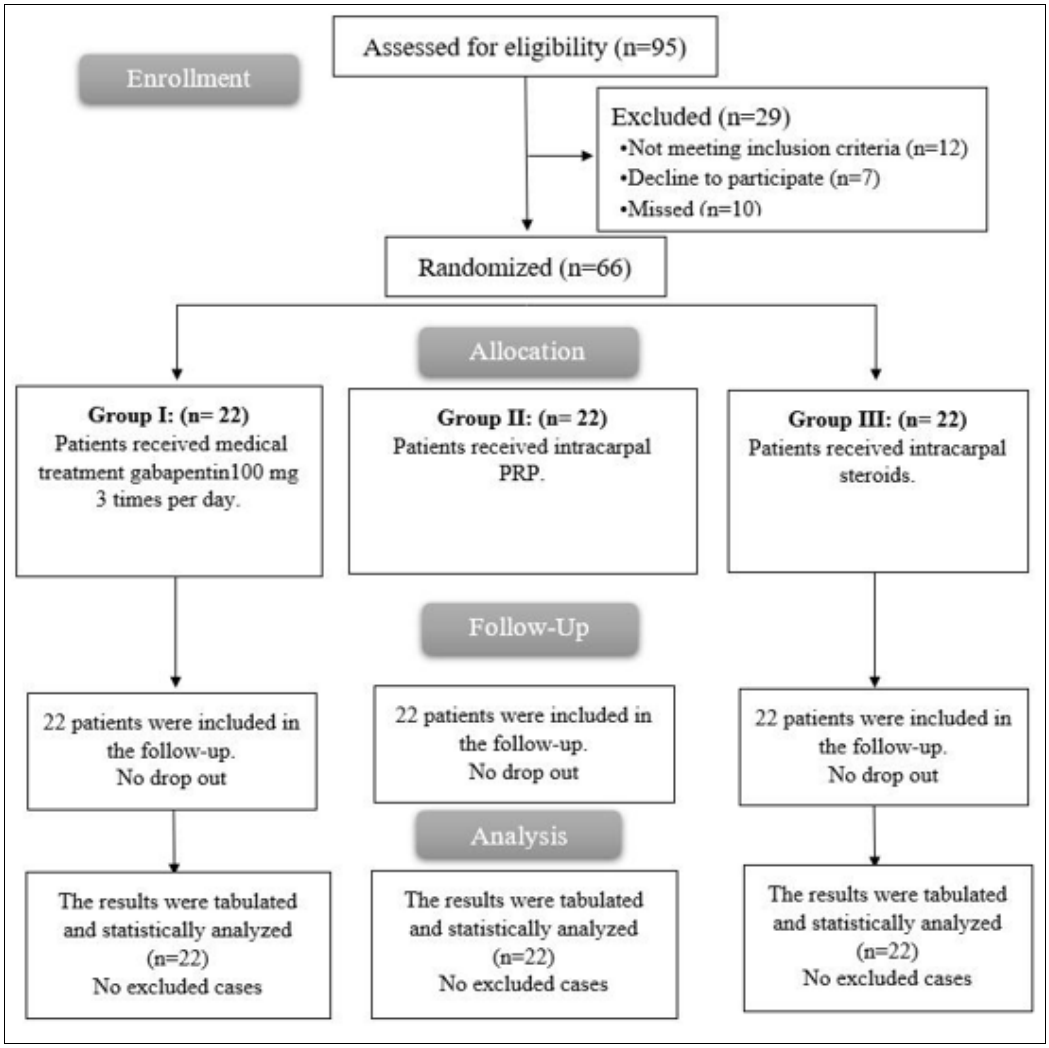

Fig 2: Consort flowchart of the enrolled patients

Age, BMI, HTN, duration of disease, lesion site and grade were insignificantly different among the three groups. Females were higher than males among the three groups. Table 1.

Table 1: Patients' characteristics, duration of disease, lesion site and grade of the studied groups

		Group I (n=22)	Group II (n=22)	Group III (n=22)	P
Age (years)		48.5±3.79	48.8±3.78	48±4.05	0.794
Sex	Male	2(9.09%)	3(13.64%)	2(9.09%)	0.852
	Female	20(90.91%)	19(86.36%)	20(90.91%)	
BMI (kg/m^2)		24.7±2.57	24.6±3.11	23.5±1.25	0.219
HTN		7(31.82%)	3(13.64%)	5(22.73%)	0.355
Duration of disease (months)		23.5±2.92	25±3.21	25.2±3.25	0.172
Lesion site	Right	14(63.64%)	15(68.18%)	13(59.09%)	0.822
	Left	8(36.36%)	7(31.82%)	9(40.91%)	
Grade	Mild	7(31.82%)	10(45.45%)	10(45.45%)	0.569
	Moderate	15(68.18%)	12(54.55%)	12(54.55%)	

Data are presented as mean ± SD or frequency (%). BMI: Body mass index, HTN: hypertension.

The NRS scores revealed that groups show no significant differences at baseline and at several follow-up time points, including the 7th day, 2 weeks, 3 weeks, 5 months, and 6 months. Notably, NRS scores in both the PRP (Group II) and corticosteroid (Group III) groups were significantly lower than those in the control group (Group I) during the

early post-injection period, specifically from the 1st to the 6th day. Furthermore, while NRS scores remained statistically similar between the PRP and corticosteroid groups throughout the study, both exhibited significantly lower scores compared to the control group at the 3 and 4 month follow-up assessments (p<0.001). Table 2.

Table 2: NRS measurements of the studied groups

	Group I (n=22)	Group II (n=22)	Group III (n=22)	P
Before injection	7 (7-8)	7 (7-7)	7(6-8)	0.351
1st day	6 (6-7)	5 (4-5)	4(4-4)	< 0.001*
	P1=0.002*, P2<0.001*, P3 =0.81			
2nd day	4 (4-5)	3 (3-4)	3(3-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3 =0.271			
3rd day	4 (4-5)	3 (2-3.75)	3(2-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3=0.457			
4th day	5 (5-5)	4 (2.25-4)	3(3-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3 = 0.147			
5th day	4 (4-5)	3 (3-4)	3(3-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3= 0.295			
6th day	4 (4-4)	3 (2-4)	3(3-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3 =0.964			
7th day	2 (2-3)	2.5 (2-3)	2(2-3)	0.714
2 weeks	2 (2-3)	2 (2-3)	2(2-2)	0.278
3 weeks	2 (2-3)	2 (1-4)	2(2-3)	0.490
4 weeks	3 (2-3)	2 (1.25-3)	2(2-2)	0.001*
	P1=0.005*, P2<0.001*, P3 =0.572			
6 weeks	3 (2-3)	2 (1-2.75)	2(2-2)	<0.001*
	P1=0.001*, P2<0.001*, P3 =0.793			
8 weeks	3 (2-3)	2 (2-2.75)	2(2-2)	<0.001*
	P1=0.004*, P2<0.001*, P3 =0.490			
10 weeks	3 (2-3)	2 (1.25-3)	2(2-2)	0.005*
	P1=0.022*, P2=0.002*, P3 =0.401			
12 weeks (3 months)	6 (5-6.75)	4 (4-5)	3(2.25-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3=0.074			
4 months	6 (5-6.75)	4 (4-5)	3(3-3)	< 0.001*
	P1<0.001*, P2<0.001*, P3=0.066			
5 months	4.5 (3.25-5.75)	4 (3-4.75)	4(3-4.75)	0.102
6 months	4 (3-4.75)	4 (3.25-4)	3.5(3-5)	0.692

Data are presented as median (IQR). * Significant P value ≤ 0.05, P1:P value between group I and group II, P2:P value between group II and group III, P3:P value between group II and group III. NRS: Numerical rating scale for pain scores.

Pregabalin and acetaminophen consumption were insignificantly different among the three groups at 2nd - 3rd week, 3rd - 4th week and 5th - 6th month. Pregabalin and acetaminophen consumption were insignificantly different between group (III, II) while were significantly lower in group III and group II than group I at 4th-6th week, 6th-8th week, 8th -10th week and 10th-12th week, at 3rd-4th month and at 4th-5th month (p<0.05). Table 3

Table 3: Pregabalin and acetaminophen consumption of the studied groups

	Group I (n=22)	Group II (n=22)	Group III (n=22)	P
Pregabalin consumption				
2nd - 3rd week	263.6 ± 49.24	245.5 ± 73.85	236.4 ± 49.24	0.298
3rd - 4th week	236.4 ± 65.8	195.5 ± 95.01	190.9 ± 75.02	0.122
4th - 6th week	231.8 ± 71.62	177.3 ± 68.53	163.6 ± 72.67	0.005*
	P1=0.035*, P2=0.006*, P3=0.800			
6th - 8th week	218.2 ± 90.69	154.5 ± 80.04	145.5 ± 67.1	0.007*
	P1=0.028*, P2=0.01*, P3 = 0.925			
8th - 10th week	181.8 ± 79.5	127.3 ± 63.11	118.2 ± 39.48	0.003*
	P1=0.015*, P2=0.004*, P3= 0.881			
10th - 12th week	131.8 ± 47.67	109.1 ± 29.42	104.5 ± 21.32	0.002*
	P1=0.011*, P2=0.002*, P3 =0.872			
3rd - 4th month	204.5 ± 84.39	127.3 ± 45.58	113.6 ± 35.13	<0.001*
	P1<0.001*, P2<0.001*, P3 =0.725			
4th - 5th month	209.1 ± 92.11	132.1± 45.41	118.2 ± 39.48	<0.001*
	P1<0.001*, P2<0.001*, P3 =0.149			
5th - 6th month	222.7 ± 81.25	227.3 ± 70.25	186.4 ± 88.88	0.190
Acetaminophen consumption				
2nd - 3rd week	3.5 ± 0.67	3.4 ± 0.66	3.1 ± 0.77	0.231
3rd - 4th week	3.3 ± 0.77	2.9 ± 0.99	2.7 ± 0.98	0.132
4th - 6th week	3.2 ± 0.87	2.4 ± 1.01	2.2 ± 0.85	<0.001*

	P1=0.011*, P2<0.001*, P3=0.688			
6th - 8th week	2.9 ± 0.92	2.1 ± 0.99	2 ± 0.76	0.002*
	P1=0.015*, P2=0.004*, P3 = 0.869			
8th - 10th week	2.6 ± 1.18	1.7 ± 0.88	1.6 ± 0.67	<0.001*
	P1=0.005*, P2=0.001*, P3= 0.87			
10th - 12th week	1.9 ± 0.99	1.3 ± 0.55	1.2 ± 0.39	0.003*
	P1=0.017*, P2=0.005*, P3 =0.901			
3rd - 4th month	2.9 ± 1.08	1.7 ± 0.99	1.2 ± 0.43	<0.001*
	P1<0.001*, P2<0.001*, P3 =0.211			
4th - 5th month	2.7 ± 1.25	1.9± 1.06	1.6 ± 0.9	<0.001*
	P1<0.001*, P2=0.006*, P3 =0.350			
5th - 6th month	3.1 ± 1.13	2.9 ± 0.9	2.4 ± 1.05	0.095

Data are presented as median (IQR). * Significant P value ≤ 0.05, P1:P value between group I and group II, P2:P value between group II and group III, P3:P value between group II and group III.

BCTQs and BCTQf were insignificantly different at baseline, 5m and 6m among the three groups. BCTQs and BCTQf were insignificantly different between group (III, II) while was significantly lower in group (II, III) than group I at 1m and 2m (p<0.05). BCTQs and BCTQf were insignificantly different between group (II, III) and was significantly lower in group (II, III) than group I at 3m and 4m (p<0.05). Table 4

Table 4: BCTQs and BCTQf of the studied groups

	Group I (n=22)	Group II (n=22)	Group III (n=22)	P
BCTQs				
Baseline	33.09±8.96	29.91±8.95	30.64±7.82	0.441
1m	32.86±8.71	26.68±9.11	21.82±7.44	<0.001*
	P1=0.047*, P2<0.001*, P3=0.145			
2m	33.86±8.71	27.59±8.53	22.68±6.25	<0.001*
	P1=0.029*, P2<0.001*, P3=0.107			
3m	37.41±8.68	30.95±9.2	26.27±7.69	<0.001*
	P1=0.039*, P2<0.001*, P3=0.172			
4m	34.86±8.74	28.9±9.9	26.73±7.28	0.011*
	P1=0.039*, P2=0.008*, P3=0.196			
5m	34.14±8.55	30.27±9.45	27.68±9.03	0.065
6m	33.41±8.84	31.5±9.74	27.36±9.14	0.094
BCTQf				
Baseline	29.45±6.47	29.77±5.78	26.41±5.03	0.113
1m	29.23±6.34	24.05±5.66	20.41±5.99	0.001*
	P1=0.015*, P2<0.001*, P3=0.118			
2m	28.68±6.74	22.05±7.54	18.14±7.93	<0.001*
	P1=0.012*, P2<0.001*, P3=0.196			
3m	30.73±5.95	25.05±7.43	20.55±7.65	<0.001*
	P1=0.026*, P2<0.001*, P3=0.095			
4m	30.68±6.03	26.41±8.38	22.23±7.52	0.044*
	P1=0.026*, P2=0.044*, P3=0.153			
5m	27.77±6.32	27.36±7.69	23.77±7.1	0.127
6m	28.36±6.41	28.5±8.05	24.18±7	0.085

Data are presented as mean ± SD. * significant P value ≤ 0.05, P1:P value between group I and group II, P2:P value between group II and group III, P3:P value between group II and group III. BCTQs: Boston carpal tunnel questionnaire.

Sensory conduction velocity and DML were insignificantly different at baseline among the three groups. Sensory conduction velocity was insignificantly different between group (II, III) while was significantly higher in group (III, II) than in group I at 3m (p<0.001). DML was insignificantly different between group (II, III) while was significantly lower in group (II, III) than in group I at 3m (p<0.05). The mean of platelet PRP was 412.1 ± 11.52 103/µL. Table 5.

Table 5: Sensory conduction velocity, DML and platelet PRP of the studied groups

		Group I (n=22)	Group II (n=22)	Group III (n=22)	P
Sensory conduction velocity	Baseline	41±6.81	41.23±7.63	40.82±8.87	0.985
	3m	42.73±7.11	48.27±6.94	50.95±6.79	<0.001*
		P1<0.001*, P2<0.001*, P3=0.073			
DML	Baseline	5.36±1.56	4.55±1.77	4.41±1.99	0.166
	3m	3.73±1.42	2.55±1.5	2.09±1.15	<0.001*
		P1=0.015*, P2<0.001*, P3=0.516			
Platelet PRP (103/µL)		--	412.1±11.52	--	--

Data are presented as mean ± SD. * significant P value ≤ 0.05, P1:P value between group I and group II, P2:P value between group II and group III, P3:P value between group II and group III. PRP: Platelet-rich plasma, DML: Distal motor latency.

A negative correlation was observed between nerve conduction and BMI (P = 0.007), suggesting that higher BMI may be associated with poorer nerve conduction. Conversely, a positive correlation was found between nerve conduction and PRP (P = 0.035), hinting at a potential benefit of PRP treatment on nerve function. Table 6.

Table 6: Correlations between nerve conduction and (BMI and platelet PRP) of the studied groups

		Nerve conduction
BMI	r	-0.325
	P	0.007*
Platelet PRP	r	0.451
	P	0.035*

r: Pearson coefficients. * Significant P value ≤ 0.05, BMI: Body mass index, PRP: Platelet-rich plasma.

Discussion

The CTS develops when the median nerve becomes compressed within the carpal tunnel [20]. The process of compression often manifests as a constellation of symptoms including impaired muscle strength, numbness, pain, and tingling. Everyday tasks like getting dressed, taking care of personal hygiene, and writing might be greatly affected by these manifestations and can further extend to hinder efficiency in work and general well-being [21, 22].

The CTS management encompasses various surgical and non-surgical approaches. However, most patients prioritize conservative treatment before resorting to surgery. Unfortunately, several conservative options, including magnet therapy, ultrasound, yoga, hand splints, and chiropractic care, lack substantial evidence for symptom improvement compared to placebo or control groups [23]. Corticosteroid injections, a mainstay of conservative CTS treatment, have also faced growing scrutiny. A systematic review by Marshall *et al*. revealed that while steroid injections provided greater symptomatic improvement at the one month mark compared to placebo, their long-term benefits for pain or function remain unsubstantiated [24, 25].

Our analysis of pain scores, measured using the NRS, revealed no statistically significant differences between the three groups at baseline and at several follow-up time points. These time points included the 7th day, 2 weeks, 3 weeks, 5 months, and 6 months. Interestingly, both the PRP (Group II) and corticosteroid (Group III) groups showed significantly lower NRS scores compared to group I in the early days following the injection (from day 1 to day 6). This suggests a potential early pain-relieving effect for both interventions compared to no treatment. While NRS scores remained statistically similar between the PRP and corticosteroid groups throughout the study, both groups exhibited significantly lower scores compared to the group I at the later 3 and 4-month follow-up assessments (p<0.001). Our findings regarding pain relief are consistent with those reported by Hashim *et al*. [26]. Their study compared the efficacy of a single-dose, locally injected PRP preparation with that of corticosteroids in patients with CTS. Sixty contributors with milder unilateral CTS were allocated to receive PRP or a local corticosteroid injection. Pain assessment via VAS was conducted at 1.5 and 3 months post-injection. Additionally, to assess the intensity of symptoms and functional results, the BCTQ was administered, while neurophysiological analyses were conducted. Similar to our study, Hashim *et al*. observed no significant differences between the PRP and steroid groups according to VAS scores at both follow-up time points (1.5 and 3 months). Lending support to our findings, Raeissadat *et al*. [27] investigated the safety and effectiveness of PRP injection as a novel treatment for CTS. Their randomized controlled trial involved 41 female participants, PRP group showed significantly lower pain scores compared to controls, supporting PRP's potential for pain relief in CTS.

Our analysis of the Boston BCTQ scores revealed no significant differences between the three groups at baseline, 5 months, and 6 months post-injection. Similarly, no significant differences were observed between the (PRP or Group II) as well as (corticosteroid or Group III) at any time point. However, compared to the control group (Group I), both the PRP and corticosteroid groups exhibited significantly lower BCTQ scores at the 1, 2, 3, and 4-month follow-up assessments.

Our findings on patient-reported outcomes, as measured by the BCTQ, align with some previous research. Senna *et al*. [28] similarly reported no significant difference in BCTQ scores between steroid and PRP injection groups at 1 and 3 months post-injection. However, our results diverge from those of Hashim *et al*. [26], who observed statistically lower BCTQ scores (both symptom severity and functional aspects) in the PRP group compared to the steroid group at 1.5 and 3 months. This discrepancy might be attributed to variations in injection techniques or baseline characteristics of the participants included in each study. Further investigation is warranted to elucidate the influence of such factors on treatment outcomes.

Our analysis revealed no statistically significant differences in baseline sensory conduction velocity (SCV) between the three groups. Similarly, no significant differences in SCV were observed between group II and group III. However, at the 3 m, SCV was significantly higher in the combined group (group III and group II) compared to group I. Likewise, baseline DML showed no significant variations across the groups. While group (II, III) exhibited no significant differences in DML, both groups demonstrated significantly lower DML values compared to group I at the 3 m. Our results regarding nerve conduction studies align with previous research. Similar to Atwa *et al*. [29], who observed significant improvements in motor and sensory nerve conduction velocities across both groups, with no significant difference detected between them. This finding mirrors the observations of Uzun *et al*. [30] who reported no inter-group differences in nerve conduction studies at the 3-month measurement point. However, our results diverge from those of Hashim *et al*. [26] who reported statistically significant increases in DML and sensory peak latency within the steroid group compared to the PRP group.

Our findings support a negative correlation between nerve conduction and Body Mass Index (BMI), indicating that lower BMI coincides with improved nerve conduction. This aligns with previous research by Chen *et al*.[31] who similarly observed a decrease in nerve conduction velocity with increasing BMI levels.

This study is subject to several limitations. First, the relatively small sample size restricts the generalizability of our findings to larger populations. Second, the single-center design raises concerns about external validity, limiting the applicability of our results to other healthcare settings. Finally, the study did not explore the efficacy of different PRP dosages, and no data on potential side effects associated with PRP therapy were collected.

Conclusion

Our investigation demonstrated comparable efficacy between corticosteroids and PRP therapy in treating CTS. This conclusion is supported by the absence of significant differences in patient-reported outcomes measured by the NRS, BCTQs, and the BCTQf. Furthermore, nerve conduction studies revealed no significant disparities between the two treatment groups. These findings suggest that both corticosteroids and PRP may be viable options for CTS management, with similar effectiveness in improving both subjective patient experiences and objective nerve function.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

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How to Cite This Article
Hagrass AS, El-Badry AA, Youssef AAE, Afandy ME. Ultrasound guided intra-carpal injection of platelet rich plasma versus corticosteroids injection in carpal tunnel syndrome. International Journal of Medical Anesthesiology. 2024;7(2):06-14.