The Egyptian Journal of Hospital Medicine (July 2025) Vol. 100, Page 3747-3753

Platelet-Rich Plasma in Treatment of Idiopathic Carpal Tunnel Syndrome

Elsayed M. Zaki, Ahmed A. Ebied, Mohamed F.I. Morgan*
Orthopedic Surgery Department, Faculty of Medicine, Menoufia University
*** Corresponding author: Name:** Mohamed Fathy Ibrahim Morgan, **Phone:** (020)1022716313,
E mail: mohamed.morgan230@gmail.com

ABSTRACT

Background: Carpal tunnel syndrome (CTS) is the most common debilitating disorder affecting the upper extremities. Platelet-rich plasma (PRP) is an emerging injectable therapy derived from the patient's own blood, containing a higher platelet concentration than whole blood. By delivering growth factors autologously, PRP may promote peripheral nerve regeneration. **Objectives:** This study aimed to evaluate the efficacy of wrist-administered platelet-rich plasma (PRP) injections in the management of idiopathic carpal tunnel syndrome, and to measure outcomes by using the Visual Analogue Scale (VAS), the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ), and nerve conduction studies (NCS). **Patients and Methods:** Twenty patients with idiopathic carpal tunnel syndrome who received PRP injections as treatment were included in this study. All patients underwent laboratory testing, imaging to rule out secondary causes, and electrophysiological testing in the form of median nerve conduction investigations. All patients were assessed before treatment and three months after the injection using the BCTQ, VAS score, and Nerve Conduction Studies (NCS) for the median nerve. **Results:** Three months after PRP injection, there was a highly significant improvement in median sensory conduction velocity, median sensory peak latency, and comparative median and ulnar sensory latency at the ring finger. Three months after local PRP injection, there was a notable improvement in the VAS, symptoms severity score, and function disability score.

Conclusion: A single wrist-administered PRP injection is an effective treatment for CTS, reducing symptom severity and improving patients' functional status.

Keywords: platelet-rich plasma, idiopathic carpal tunnel syndrome.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most frequently recognized disabling condition affecting the upper extremities. It is the most common and well-known type of entrapment neuropathy, accounting for around 90% of all cases [(1)].

Compression of the median nerve results in CTS, which causes nocturnal numbness, paresthesia, and pain throughout its distribution [(2)]. Nerve conduction tests (NCS) are performed to confirm the diagnosis and evaluate its severity in order to choose the best course of treatment [(3)].

The initial line of treatment is typically non-operative management, which includes wrist splinting, neurotonics, local corticosteroid injections, oral non-steroidal anti-inflammatory medications, and rehabilitation methods [(4)].

Even while local corticosteroid injections in the wrist have been shown to have an anti-inflammatory impact and help individuals with mild carpal tunnel syndrome [(5)], some patients still report that their symptoms worsen after receiving the injection. Furthermore, well-known side effects such degenerative tendon ruptures and median nerve damage are linked to local corticosteroid injections [(6)].

Through platelet-released proteins, platelet-concentrated blood derivative, or PRP, stimulates cellular development, morphogenesis, and inflammation control [(7)].

By providing growth factors, improving Schwann cell development, and increasing neurotrophic factor release, it may facilitate peripheral nerve regeneration [(8)]. Its function in axon regeneration and neurological rehabilitation is supported by evidence [(9)].

The present study focused on evaluating the clinical and electrophysiological effectiveness of PRP injections in the management of idiopathic CTS.

PATIENTS AND METHODS

This prospective randomized controlled study included 20 patients with clinically suspected CTS who attended the Department of Orthopedics at Menoufia University Hospitals. This study was conducted between (mention period e.g., June 2022 and January 2025).

Inclusion criteria: Patients with clinically suspected idiopathic CTS, including both men and women who met the clinical diagnostic criteria. Cases involving either the left or right hand were included. Eligible patients were between 30 and 60 years of age.

Exclusion criteria: Patients were excluded if they had congenital abnormalities, endocrine disorders, diabetes mellitus, or systemic conditions such as autoimmune, vasculitis, paraneoplastic, or chronic inflammatory diseases (e.g., systemic lupus erythematosus, rheumatoid arthritis). Other exclusions included space-occupying lesions in the carpal tunnel, cervical radiculopathy, polyneuropathy, brachial plexopathy, thoracic outlet syndrome, or severe abnormalities on nerve conduction studies. Patients with coagulopathy, pregnancy, prior wrist surgery, previous local injections or non-surgical CTS treatments, current warfarin therapy, local injury, tumor, or infection at the injection site, or intolerance to corticosteroids were also excluded.

Received: 24/04/2025
Accepted: 23/06/2025

Every patient underwent a detailed history taking, including personal history, presenting complaints, history of present illness, and past medical history. A general and local clinical examination was conducted. The Boston Carpal Tunnel Questionnaire (BCTQ) [10] was used for clinical evaluation; it consists of two sections: a functional status scale and a symptom severity scale **(Table 1).**

Table (1): Functional status scale

To calculate score, add together the scores for all 11 questions in part 1, to give a total out of 55.

Part 1 of 2: Symptom severity scale (11 items)	1	2	3	4	5
1 How severe is the hand or wrist pain that you have at night?	Normal	Slight	Medium	Severe	Very serious
2 How often did hand or wrist pain wake you up during a typical night in the past two weeks?	Normal	Once	2 to 3 times	4 to 5 times	More than 5 times
3 Do you typically have pain in your hand or wrist during the daytime?	No pain	Slight	Medium	Severe	Very serious
4 How often do you have hand or wrist pain during daytime?	Normal	1-2 times / day	3-5 times / day	More than 5 times	Continued
5 How long on average does an episode of pain last during the daytime?	Normal	< 10 minutes	10 – 60 minutes continued	> 60 minutes	Continued
6 Do you have numbness (loss of sensation) in your hand?	Normal	Slight	Medium	Severe	Very serious
7 Do you have weakness in your hand or wrist?	Normal	Slight	Medium	Severe	Very serious
8 Do you have tingling sensations in your hand?	Normal	Slight	Medium	Severe	Very serious
9 How severe is numbness (loss of sensation) or tingling at night?	Normal	Slight	Medium	Severe	Very serious
10 How often did hand numbness or tingling wake you up during a typical night during the past two weeks?	Normal	Once	2 to 3 times	To 5 times	More than 5 times
11 Do you have difficulty with the grasping and use of small objects such as keys or pens?	Without difficulty	Little difficulty	Moderate difficulty	Very difficult	Very difficult

Part 2 of 2: Functional status scale (8 items)	No difficulty	Little difficulty	Moderate difficulty	Intense difficulty	Cannot perform the activity at all due to symptoms
1 Writing	1	2	3	4	5
2 Buttoning of clothes	1	2	3	4	5
3 Holding a book while reading	1	2	3	4	5
4 Gripping of a telephone handle	1	2	3	4	5
5 Opening of jars	1	2	3	4	5
6 Household chores	1	2	3	4	5
7 Carrying of grocery basket	1	2	3	4	5
8 Bathing and dressing	1	2	3	4	5

A visual analogue scale (VAS) clinical evaluation was conducted **(Figure 1).**

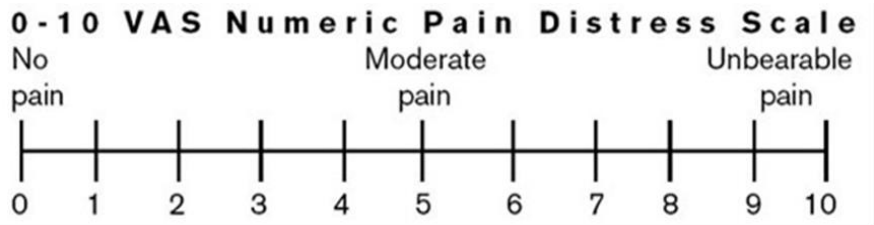

Figure (1): Visual analogue scale (VAS)

Blood sugar levels [13], thyroid function tests [12], CBC, ESR, CRP [11], and autoimmune panels including ANA, Rheumatoid factor, Anti-DsDNA, and Anti-CCP [14]. Additionally, electrophysiological investigations were conducted, including nerve conduction studies and AFC latency studies.

PRP preparation:
PRP preparation of 10 milliliters of blood was obtained from each patient. The blood was collected on citrated tubes with a mixing ratio of 9:1 by volume. Tubes underwent first centrifugation at a speed of 3000 rpm (704 g) for 3 min (to separate red blood cells from plasma). Plasma was then removed by syringe and then placed into another sterile tube with no anti-coagulant and then underwent second centrifugation at a speed of 4000 rpm (1252 g) for 15 min. The supernatant platelet poor plasma was then removed leaving 2 ml of PRP pellets in the sediment and suspend the PRP pellets by gentle shaking of the tube. PRP is activated by adding 200 µl of 0.025 calcium chloride.

Treatment procedure:
With the patient's wrist extended and forearm supinated, the injection site was identified 1 cm above the distal wrist crease, midway between the palmaris longus and flexor carpi radialis tendons, in line with the middle finger **(Figure 2)**.

Figure (2): Local injection technique in carpal tunnel.

Chlorhexidine or povidone-iodine solution was used to clean the region. The needle was positioned distally at a 45-degree angle until its tip was beneath the flexor retinaculum's midpoint. The injection was administered gradually; if the patient felt paresthesias or shock-like discomfort, the injection was paused, and the needle was moved medially. When injecting, there should be neither pain or paresthesia, nor any resistance.

Patients were instructed to make certain lifestyle changes following the injection, such as refraining from heavy lifting, repetitive fine hand movements, and extended wrist flexion, and to take acetaminophen only when necessary and during the following 48 hours. The NCS, VAS, and BCTQ were repeated at post-injection follow-up visits three months later.

Local PRP injection:
Twenty patients received a single, local injection of 2 ml of platelet-rich plasma (PRP) in the wrist. On the ulnar side of the palmaris longus tendon, a 25-gauge needle was carefully inserted 1 cm proximal to the distal wrist-flexion crease. The carpal tunnel received an injection of two milliliters of PRP. It was advised to rest the injected wrist for a full day. Due to the potential for platelet function inhibition, the use of NSAIDs was limited **(Figure 3)**.

Figure (3): Injection technique.

Outcome measures:
The Boston CTS Questionnaire was used to evaluate the results (BCTQ). The Symptom Severity Scale (SSS) and the Functional Status Scale (FSS) were the two components of this patient-based questionnaire used to measure CTS [15]. A greater degree of disability was indicated by a higher score on both subscales, which ranged from 1 to 5. For additional analysis, the mean of the FSS and SSS scores overall was divided by the score of each item. The FSS and SSS have minor clinically significant variations of 0.5 and 0.8 points, respectively.

***Ethical Consideration*:**
This study was ethically approved by Menoufia Faculty of Medicine's Local Ethical Research Committee (code no. 7/2021ORTH11). Written informed consent was obtained from all participants. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human subjects.

Statistical analysis
Data were processed using IBM SPSS Statistics (Version 23.0) and analyzed with arithmetic mean, standard deviation, Student's t-test, and chi-squared test. Statistical significance was set at $p < 0.05$, with p

> 0.05 considered non-significant and p < 0.001 considered highly significant.

RESULTS

This study included 20 patients with idiopathic carpal tunnel syndrome who underwent platelet-rich plasma injections for treatment. Their ages ranged from 32 to 74 years, with a mean ± SD of 45.7 ± 10.2. Five patients (25%) were male and 15 patients (75%) were female. Symptoms duration ranged from 3 to 18 months, with a mean ± SD of 8.35 ± 3.79. (60%) had right side affection, (30%) had left side affection and (10%) had both sides affected **(Table 2)**.

Table (2): Demographic data among the studied patients

Variables		All patients (n=20)
Age (years)	Mean ± SD	45.7 ± 10.2
	Range	(32 – 74)
Sex (number / %)	Male	5 (25%)
	Female	15 (75%)
Symptom duration (months)	Mean ± SD	8.35 ± 3.79
	Range	(3 – 18)
Hand affected (n. %)	Right	12 (60%)
	Left	6 (30%)
	Bilateral	2 (10%)

The Boston symptom severity score (BSSS) was significantly reduced from baseline score 3.48 ± 0.73 to 1.81 ± 0.41 (P<0.001) after 3months **(Table 3)**.

Table (3): Clinical examination findings over time among the studied patients

Variables		At baseline	After 3 months	P Value
Phalen's test	Negative	1 (5%)	13 (65%)	<0.001
	Positive	19 (95%)	7 (35%)	
Tinel's sign	Negative	3 (15%)	16 (80%)	<0.001
	Positive	17 (85%)	4 (20%)	
Thenar muscle atrophy	Negative	12 (60%)	18 (90%)	0.03
	Positive	8 (40%)	2 (10%)	

The Boston symptom severity score (BSSS) was significantly reduced from baseline score 3.48 ± 0.73 to 1.81 ± 0.41 (P<0.001) after 3months **(Table 4)**.

Table (4): Boston symptom severity score over time among the studied patients

Variables		All patients (n=20)
Baseline	Mean ± SD	3.48 ± 0.73
	Range	(2.1 – 4.5)
After 1 month	Mean ± SD	2.38 ± 0.49
	Range	(1.5 – 3)
After 3 months	Mean ± SD	1.81 ± 0.41
	Range	(1 – 2.5)
% of change from baseline		↓47.9%
P value		<0.001

*Repeated measures ANOVA test, Non-significant: P >0.05, Significant: P ≤0.05.

The Sensory nerve conduction velocity (SNCV) was significantly increased from baseline 38.1 ± 3.67 to 46.6 ± 3.65 (P<0.001) after 3 months **(Table 5)**.

Table (5): Boston functional status score over time among the studied patients

Variables		All patients (n=20)
Baseline	Mean ± SD	3.17 ± 0.66
	Range	(2 – 4.2)
After 1 month	Mean ± SD	2.31 ± 0.51
	Range	(1.5 – 3.2)
After 3 months	Mean ± SD	1.92 ± 0.75
	Range	(1.2 – 4.6)
% of change from baseline		↓39.4%
P value		<0.001

*Repeated measures ANOVA test, Non-significant: P >0.05, Significant: P ≤0.05.

The Sensory nerve conduction velocity (SNCV) was significantly increased from baseline 38.1 ± 3.67 to 46.6 ± 3.65 (P<0.001) after 3 months **(Table 6)**.

Table (6): Sensory nerve conduction velocity over time among the studied patients

Variables		All patients (n=20)
Baseline	Mean ± SD	38.1 ± 3.67
	Range	(32 – 45)
After 1 month	Mean ± SD	42.4 ± 3.53
	Range	(35 – 48)
After 3 months	Mean ± SD	46.6 ± 3.65
	Range	(40 – 52)
% of change from baseline		↑22.3%
P value		<0.001

*Repeated measures ANOVA test, Non-significant: P >0.05, Significant: P ≤0.05.

The axillary F central latency (AFC latency) was significantly reduced from baseline 28.5 ± 3.07 to 24.2 ± 2.02 (P<0.001) after 3 months **(Table 7)**.

Table (7): Distal motor latency over time among the studied patients

Variables		All patients (n=20)
Baseline	Mean ± SD	4.75 ± 0.63
	Range	(3.5 – 6.2)
After 1 month	Mean ± SD	3.96 ± 0.62
	Range	(3 – 5)
After 3 months	Mean ± SD	3.52 ± 0.56
	Range	(2.8 – 4.5)
% of change from baseline		↓25.9%
P value		<0.001

*Repeated measures ANOVA test, Non-significant: P >0.05, Significant: P ≤0.05

A statistically in clinical examination findings was significantly improvement from baseline (95%) of the patients had a positive phalen's test, (85%) had a positive tinel's sign and (40%) had Thenar muscle atrophy, to (35%) of the patients had a positive phalen's test, (20%) had a positive tinel's sign and (10%) had thenar muscle atrophy (P<0.001), (P<0.001) and (P=0.03) respectively after 3 months only **(Table 8)**.

Table (8): Axillary F central latency over time among the studied patients

Variables		All patients (n=20)
Baseline	Mean ± SD	28.5 ± 3.07
	Range	(24 – 34)
After 1 month	Mean ± SD	26.1 ± 2.66
	Range	(22 – 32)
After 3 months	Mean ± SD	24.2 ± 2.02
	Range	(20 – 27)
% of change from baseline		↓15.1%
P value		<0.001

*Repeated measures ANOVA test, Non-significant: P >0.05, Significant: P ≤0.05.

DISCUSSION

Numbness, discomfort, paresthesia, and weakening are the clinical manifestations of carpal tunnel syndrome (CTS), a compressive neuropathy of the median nerve (MN) in the carpal tunnel. Electrodiagnostic tests (EDX), which have a moderate sensitivity of 49% to 84% and a high specificity of 95% to 99%, are a useful tool to support diagnosis and quantify severity, even though the diagnosis of CTS is primarily clinical [(16)].

The first line of treatment is non-surgical management, which consists of a mix of local corticosteroid injections, neurotonics, oral non-steroidal anti-inflammatory medicines (NSAIDs), wrist splinting, rehabilitation, and other measures. Since platelet-rich plasma (PRP) can promote peripheral nerve regeneration by supplying autologous growth factors, it is also gaining traction as a possible therapeutic alternative in injectable forms [(4)].

The goal of this prospective randomized controlled experiment was to assess PRP injections' clinical and electrophysiological efficacy in treating idiopathic CTS. After obtaining informed agreement, PRP injection treatment was administered to twenty individuals with idiopathic CTS. Before PRP was administered, a comprehensive history, physical examination, and median and ulnar nerve NCS were conducted. In order to target the carpal tunnel, PRP (2 ml) was administered with a 25-gauge needle placed 1 cm proximal to the distal wrist-flexion crease, immediately ulnar to the palmaris longus tendon. The Boston Carpal Tunnel Questionnaire (BCTQ) was used to determine the intensity of symptoms and function

The duration of symptoms varied from 3 to 18 months (mean ± SD: 8.35 ± 3.79 months), while the patients' ages ranged from 32 to 74 years (mean ± SD: 45.7 ± 10.2 years). Most people had CTS on their right side 60% of the time, then their left (30%), and 10% on both sides. These results align with previous research. In line with the female predominance of CTS, **Wanitwattanarumlug *et al.*** [(17)] revealed a mean age of 46.92 ± 7.97 years among the group of CTS patients, which was primarily female, as reported by **Uzun *et al.*** [(18)] and **Atwa et al.** [(19)]. Consistent with this gender ratio, **Soliman *et al.*** [(20)] observed that 87.5% of their idiopathic CTS population were female.

CTS symptoms can be present in various forms. Prior to notable problems with electrodiagnostic testing, which primarily evaluates bigger nerve fibers, paresthesia may manifest [(21)]. Numbness was the most common condition in our study (20%), followed by pain (65%), paresthesia (55%), and weakness (20%).

With **Tas *et al.*** [(22)] reporting postoperative morphological improvements in median nerves using high-definition ultrasonography, surgical decompression is still a recognized treatment; nonetheless, scar pain was a frequent postoperative complaint.

Three months after the PRP treatment, the study demonstrated notable clinical benefits. The functional status score dropped from 3.17 ± 0.66 to 1.92 ± 0.75, a reduction of 39.4%, and the Boston symptom severity score dropped from a baseline of 3.48 ± 0.73 to 1.81 ± 0.41, a reduction of 47.9%. These improvements are in line with those of **Uzun *et al.*** [(18)], who likewise saw notable reductions in BCTQ scores three months after PRP treatment in

moderate CTS and attributed symptom relief to the structural remodeling of neural tissue from stiff scar to softer scar tissue.

With a notable improvement in symptom severity and functional status 10 weeks following a single PRP injection in conjunction with wrist splinting for mild and moderate CTS, **Raeissadat *et al.*** [23] corroborated these findings.

In terms of electrophysiology, the study found that in three months, DML decreased from 4.75 ± 0.63 ms to 3.52 ± 0.56 ms (a drop of 25.9%) and SNCV increased statistically significantly from 38.1 ± 3.67 m/s to 46.6 ± 3.65 m/s (a 22.3% increase). In individuals with mild, moderate, and severe CTS, **Davey *et al.*** [24] also noted elevated SNCV after PRP injection.

Once more, this is a single case report with design and PRP volume discrepancies that preclude generalizability. **Kuo *et al.*** [25] observed improvement in median nerve conduction parameters with two infusions of ultrasound-guided PRP in a conservatively resistant CTS patient.

Results are partially consistent with corticosteroid injection experiments. Three months following local triamcinolone injections, **Karimzadeh *et al.*** [26] observed increased sensory and motor conduction speeds, which may have been facilitated by the concurrent administration of local anesthetics—something that PRP methods do not offer.

A sensitive diagnostic tool for CTS is the ultrasound measurement of the median nerve cross-sectional area (CSA) at the proximal carpal tunnel; elevated CSA indicates the greatest degree of nerve swelling and edema [27].

Following PRP injection, the CSA in the current study significantly decreased from 12.79 ± 1.64 mm^2 to 9.71 ± 0.99 mm^2 (a decrease of 24.1%). In their investigation, **Wanitwattanarumlug *et al.*** [17] reported that patients with CTS had mean CSA values of roughly 10 mm^2. The measurement of median nerve CSA is recommended by AANEM standards as level A evidence for the diagnosis of CTS [28].

The visual analogue scale (VAS) showed a significant improvement in pain as well, going from a baseline of 5.85 ± 0.88 to 2.45 ± 1.15 at three months (a reduction of 58.1%). Similar VAS improvements were also noted by **Wu *et al.*** [29] after 1-, 3-, and 6-months following ultrasound-guided PRP injections. Similar VAS and symptom score improvements after PRP injection were observed by **Raeissadat *et al.*** [23], **Atwa *et al.*** [30] in patients with idiopathic CTS, confirming the therapeutic effect.

Additionally, the clinical symptoms were improved. At the beginning, 40% had thenar muscle loss, 85% had Tinel's sign, and 95% had Phalen's test results. At three months following injection, these were reduced to 35%, 20%, and 10%, respectively, with statistical significance ($P<0.001$, $P<0.001$, and $P=0.03$). Although Phalen's and Tinel's tests are common clinical findings for CTS, **Atwa *et al.*** [30] noted that their sensitivity and specificity vary widely, ranging from 25% to 75% and 70% to 90%, respectively, depending on the diagnostic reliability.

CONCLUSION

Platelet-rich plasma (PRP) wrist injections provide effective and safe short-term, non-surgical treatment for carpal tunnel syndrome (CTS). A single targeted injection significantly reduced pain, improved symptom severity and functional status, and enhanced electrophysiological parameters, including sensory peak latency, conduction velocity, and distal motor delay. No adverse effects were observed, supporting PRP as a low-risk therapeutic option for CTS management.

- **Consent for publication:** Not applicable
- **Availability of data and materials:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request .
- **Conflict of interests:** The authors declare that they have no competing interests.
- **Funding:** No funding for this research.

REFERENCES

1. **Genova A, Dix O, Saefan A *et al.* (2020):** Carpal tunnel syndrome: a review of literature. Cureus, 19:12(3).
2. **Lewis K, Coppieters M, Ross L *et al.* (2020):** Group education, night splinting and home exercises reduce conversion to surgery for carpal tunnel syndrome: a multicentre randomised trial. Journal of Physiotherapy, 66:(2):97-104.
3. **Farrag D and El-Zohiery A (2018):** Electrophysiological Phalen's provocation test in carpal tunnel syndrome. Egyptian Rheumatology and Rehabilitation, 1: 45(1): 13.
4. **Cao M, Hu H, Chen J (2022):** Surgical treatment versus non-surgical treatment for Carpal Tunnel Syndrome: A Systematic Review. https://doi.org/10.21203/rs.3.rs-2104545/v1
5. **Hofer M, Ranstam J, Atroshi I (2021):** Extended follow-up of local steroid injection for carpal tunnel syndrome: a randomized clinical trial. JAMA. network open, 1:4(10):e2130753-.
6. **Guo K, McCool L, Wang H *et al.* (2021):** The modified ultrasound-guided distal-to-proximal carpal tunnel injection with median nerve hydrodissection: a retrospective safety review of 827 procedures. Hand, 16:(3):407-9.
7. **Fice M, Miller J, Christian R *et al.* (2019):** The role of platelet-rich plasma in cartilage pathology: an updated systematic review of the basic science evidence. Arthroscopy: The Journal of Arthroscopic & Related Surgery, 1:35(3):961-76.

8. **Saffari T, Bedar M, Hundepool C *et al.* (2020):** The role of vascularization in nerve regeneration of nerve graft. Neural regeneration research, 15:(9):1573.
9. **Zheng C, Zhu Q, Liu X *et al.* (2016):** Effect of platelet-rich plasma (PRP) concentration on proliferation, neurotrophic function and migration of Schwann cells in vitro. Journal of tissue engineering and regenerative medicine, 10(5): 428-36.
10. **Levine D, Simmons B, Koris M *et al.* (1993):** A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. JBJS., 1:75(11):1585-92.
11. **Dacie G and Lewis S (1985):** Practical hematology, 6th edition. London: Churchil Livingstone, 33-5.
12. **Whitley R, Meikle A, Watts N *et al.* (1996):** Endocrinology. In: Brutis CA, Ashwood ER, editors. Tietz fundamentals of cinical chemistry. 4th edition. Saunders Company (Philadelphia), 673-49.
13. **Van Dijk M, Reitsma J, Fischer J *et al.* (2003):** Indications for requesting laboratory tests for concurrent diseases in patients with carpal tunnel syndrome: a systematic review. Clin Chem., 49:1437.
14. **Shiri R (2016):** Arthritis as a risk factor for carpal tunnel syndrome: a meta-analysis. Scand J. Rheumatol., 45:339.
15. **Schulze D, Nilsen K, Killingmo R *et al.* (2021):** Clinical Utility of the 6-Item CTS, Boston-CTS, and Hand-Diagram for Carpal Tunnel Syndrome. Frontiers in Neurology, 12:1258.
16. **Ciloglu O, Gorgulu F (2020):** Which Ultrasound Parameter Is More Accurate in the Diagnosis of Carpal Tunnel Syndrome: Cross-Sectional Area, Resistive Index, or Strain Ratio? Am J Phys Med Rehabil., 99:(9): 842-846.
17. **Wanitwattanarumlug B, Varavithya V, Bathala L (2011):** Evaluating the mean cross-sectional area (CSA) of median nerve by use of ultrasound in Thai population. J Med Assoc Thai., 95: (12): S21-5.
18. **Uzun H, Bitik O, Uzun Ö, Ersoy US and Aktaş E(2017):** Platelet-rich plasma versus corticosteroid injections for carpal tunnel syndrome. Journal of Plastic Surgery and Hand Surgery, 51(5): 301-5.
19. **Atwa E, Esh A, Abd I *et al.* (2018):** Platelet-rich plasma versus corticosteroid injections for carpal tunnel syndrome: Clinical and electrophysiological study. The Egyptian Rheumatologist, 41(3):237-41.
20. **Soliman S, Labeeb A, El-Gazzar S *et al.* (2024):** Study of platelet-rich plasma local injection in idiopatihc carpal tunnel syndrome. The Egyptian Journal of Hospital Medicine, 95: 1286-1290.
21. **Moran L, Perez M, Esteban A *et al.* (2009):** Sonographic measurement of cross-sectional area of the median nerve in the diagnosis of carpal tunnel syndrome: correlation with nerve conduction studies. J Clin Ultrasound., 37(3): 125-131.
22. **Tas M, Johnson E, Babis G *et al.* (2015):** Single injection of platelet-rich plasma as a novel treatment of carpal tunnel syndrome. Neural Reagen Res., 10(11): 1856-1859.
23. **Raeissadat S, Karimzadeh A, Hashemi M *et al.* (2018):** Safety and efficacy of platelet-rich plasma in treatment of carpal tunnel syndrome; a randomized controlled trial. BMC musculoskeletal disorders, 19(1): 49.
24. **Davey M, Davey M, Hurley E (221):** Platelet-rich plasma in non-operative management of mild to moderate carpal tunnel syndrome–A systematic review & meta-analysis of short-term outcomes. Journal of Orthopaedics, 25: 155-161.
25. **Kuo Y, Lee C, Hsieh L (2017):** Ultrasound-guided perineural injection with platelet-rich plasma improved the neurophysiological parameters of carpal tunnel syndrome: A case report. Journal of Clinical Neuroscience, 44: 234-6.
26. **Karimzadeh A, Bagheri S, Raeissadat S (2019):** The comparison of the effectiveness between different doses of local methylprednisolone injection versus triamcinolone in Carpal Tunnel Syndrome: a double-blind clinical trial. Journal of Pain Research, 19: 579-584.
27. **Preston D, Shapiro B (2021):** Median neuropathy at the wrist, in Electromyography and neuromuscular disorders: clinical-electrophysiologic-ultrasound correlations correlations. Fourth edition. Elsevier Health Sciences, 334–368.
28. **Cartwright M, White D (2012):** Median nerve changes following steroid injection for carpal tunnel syndrome. Muscle Nerve, 44: (1): 25-29**.**
29. **Wu Y, Ho T, Chou Y *et al.* (2017):** Six-month efficacy of platelet-rich plasma for carpal tunnel syndrome: a prospective randomized, single-blind controlled trial. Scientific reports, 7(1): 94.
30. **Atwa E, Hosny Esh A, Awad Y *et al.* (2019):** Platelet Rich Plasma As A Novel Treatment for Carpal Tunnel Syndrome. Zagazig University Medical Journal, 25:(1): 110-5.