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Efficacy of Ultrasound-Guided Deep Perineural Platelet Rich Plasma versus Corticosteroid Injection in Patients with Ulnar Neuropathy at Elbow, A Comparative Randomized Trial

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ABSTRACT

Background: Ulnar neuropathy at elbow (UNE) is the 2nd most common compressive neuropathy in the upper extremities, following carpal tunnel syndrome. It occurs when compression and traction are applied to the ulnar nerve (UN) at the elbow.

Aim: This study aimed to assess and compare the therapeutic effects of ultrasound-guided deep perineural platelet rich plasma (PRP) against injection of corticosteroid (CS) among individuals with ulnar neuropathy at elbow (UNE).

Subjects and methods: This randomised prospective study was performed on sixty adult participants with mild to moderate UNE who were categorized into 2 groups. Group I received single US-guided perineural PRP injection, and group II underwent single US-guided perineural corticosteroid injection.

Results: In comparison with baseline, almost all primary outcome measures in groups II and I significantly improved after the first- and third-months post-injection, respectively. Almost all participants in the two groups under study had successful results with ultrasound guided perineural injection of either PRP or corticosteroid with no adverse effects. Linear regression of tested variables showed that ulnar nerve cross-sectional area (CSA) and nerve conduction velocity (NCV) slowing across elbow were among the potential predictors for favorable outcomes after corticosteroid and /or PRP injection.

Conclusions: Ultrasound guided deep perineural PRP and corticosteroid injection are a safe and effective tool for mild to moderate cases of UNE without any difference in outcome measures. Milder cases of UNE were identified to predict better recovery with regard to nerve healing after PRP more than corticosteroid injection as a long-term therapy.

Keywords: Platelet rich plasma, Corticosteroid injection, Ultrasound guided perineural injection, Ulnar neuropathy at elbow.

INTRODUCTION

UNE is the 2nd most common compressive neuropathy in the upper extremities, following carpal tunnel syndrome**.** It occurs when compression and traction are applied to the ulnar nerve (UN) at the elbow. The most often compressed areas are the humeroulnar arcade and the retro epicondylar groove. UNE can be identified mainly through clinical examination, though occasionally further testing may be required to confirm the diagnosis. The UN compression can result in sensory and motor impairments that range from temporary to permanent loss of function [(1)], and in severe cases, muscle atrophy [(2)]**.**

Axonal degeneration and segmental demyelination are two different types of nerve pathology that can be distinguished using electrodiagnostic studies to help with diagnosis and localization of the compressed area, and investigation of the extent of UN harm, which has occurred [(1)]. While, ultrasonography (US) is particularly useful in this regard, there is universal agreement that electrodiagnostic testing cannot diagnose a sizable fraction of UNEs [(3)].

In order to relieve pressure on the ulnar nerve, conservative therapy for UNE has primarily relied on elbow flexion splints, patient education, and activity modification to avoid hazardous elbow postures. These interventions, meanwhile, are only recommended for a brief period of time and have not been shown to work for the majority of patients. Additional therapeutic options, such as corticosteroid (CS) and platelet rich plasma (PRP) injections, are required to prevent turning to major surgical procedures like ulnar nerve decompression if conservative treatment fails [(4)].

Local PRP improves tissue remodeling, nerve axonal regeneration, and local healing. Also, cell signaling molecules such fibronectin, vascular endothelial growth factor, and nerve growth factor are released in response to PRP [(5)]. These biomarkers have been demonstrated to have a role in modulating the activation of cell-like myelinating Schwann cell, inflammatory resolutions, fibrogenesis, and angiogenesis. As such, they maintain substantial promise as a neurogenic, neuroprotective, and neuro-inflammatory therapeutic modulator system as well as a booster of motor and sensory functioning nerve-muscle unit recovery [(6)]. Additionally, the swelling, oedema, and inflammation resulted from local ischemia brought on by the ulnar nerve's compression that can be treated with local corticosteroids injections [(7)].

Perineural corticosteroid and PRP ultrasound guided injections has been employed extensively for the

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management of patients with Carpal Tunnel Syndrome. However, no other previous publications studied the efficacy of perineural PRP injection and a few studies used perineural corticosteroid injection in management of UNE. Thus, the purpose of our work was to assess and contrast the therapeutic effects and safety of US-guided deep perineural PRP and corticosteroid injections among individuals with UNE.

METHODS

Study design: This prospective randomized comparative study was conducted from June 2021 to July 2022 in Rheumatology & Rehabilitation and Physical Medicine Department, Faculty of Medicine, Tanta University. The sample size was 60 patients estimated utilising the Rao soft sample size calculator.

Inclusion criteria: Mild to moderate UNE diagnosed clinically based on classifications of **Gu's** [8] with either electrophysiological and/or Ultrasound findings.

Exclusion criteria: Individuals with severe UNE, brachial plexopathy, cervical radiculopathy, any systemic disease leading to peripheral neuropathy, previous or recent bleeding problems, malignant tumour, surgery, trauma at elbow, and pregnancy. Other exclusion criteria involved patients with contraindications for injecting PRP such as substantial liver or kidney disease, septicemia, anemia, thrombocytopenia, platelet dysfunction disorders, localized infections at the area of intervention, frequent usage of nonsteroidal anti-inflammatory medications within the previous two weeks, as well as local injections at the probable intervention area throughout the last month.

Randomization & allocation concealment: The participants were allocated at random using opaque closed envelopes into: PRP group (30 participants, **group I**), and corticosteroid group (30 participants, **group II**). The process, the medications used, and any potential advantages or disadvantages were explained to the participants. The first physiatrist conducted all of the evaluations that were not engaged in the participant's therapies. The second physiatrist, who wasn't engaged in the evaluation and treatment of the participants, carried out the randomization. The same ultrasound guided injection technique, for both groups, was done by the third physician, who avoided from participating in the evaluations or randomisation of the participants.

Injection technique: UN scanning started with a cross-sectional view of the nerve utilizing a 12 MHz linear array transducer from SAMSUNG MEDISON (UGEO H60). The patients were placed on the examination table with their shoulders extended and internally rotated, and at the level of the medial epicondyle, close to the cubital tunnel, the probe was positioned perpendicular to the path of the ulnar nerve. On the test table, the elbow is 90 degrees flexed and the palm is flat. Once the nerve was located, it was traced distally into the middle of the forearm and proximally into the upper arm. The location with maximal nerve swelling was found, and CSA was then calculated by following the echogenic rim with an in-plane approach, the UN was seen in the short axis [9]. This method enables continuous imaging of the needle tip and borders of the nerve during the process. The risk of injectate intraneural application was decreased by using this technique. A 25-gauge needle was utilised for the process. The area of intervention (i.e., area of greatest nerve swelling) had been sterilised with chlorhexidine and draped. The retro-epicondylar retinaculum was penetrated by inserting the needle into the cubital tunnel at the level of the medial epicondyle with direct guiding of ultrasound in an in-plane orientation. The needle point should be positioned near to the nerve between the ulnar nerve and the medial epicondyle. PRP, CS and lidocaine were injected after a test injection to ensure the epineural position of the tip of the needle and demonstrate the epineural flow of the injectants [10, 11]. [Figure 1]

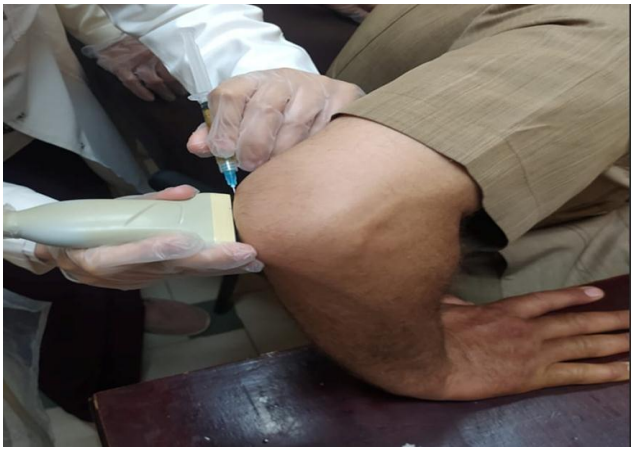

Figure (1): Ultrasound-guided deep perineural ulnar nerve injection technique.

The retro-epicondylar retinaculum was penetrated by inserting 25-gauge needle into the cubital tunnel at the level of the medial epicondyle.

The interventionist has injected either 3 mL (PRP) or 1 mL (Triamcinolone acetonide 40 mg/mL) combined with 1 mL of 1% lidocaine hydrochloride according to the group. All patients were evaluated clinically and electrophysiologically before intervention, then at 1 month and 3 months after the intervention. Received medications as nonsteroidal anti-inflammatory drugs (NSAIDs) and systemic steroid should be stopped for 2 weeks before and after the injection because they are likely to interfere with the inflammatory phase of PRP,

which may preclude regeneration [6]. Following injection, all of the participants were monitored for ten minutes to check for any signs of dysesthesia or bleeding. Post-injection cryotherapy, such as using cold packs, might be utilised to lessen inflammation and pain.

Preparation of platelet rich plasma (PRP): 20 mL of whole blood were drawn by venipuncture and 3 mL of PRP were made using one milliliter of 10% sodium citrate for every milliliter of blood. The platelets from the autologous blood were concentrated using the double centrifugation process. First, the blood is centrifuged at 3500 rpm for ten minutes, or a "soft" spin, to separate the red blood cell layer below, the intermediate buffy coat, and the top plasma layer. Utilizing a sterilized pipette, the supernatant plasma comprising platelets has been put into another sterilised tube (without anticoagulant). The supernatant plasma was centrifuged a second time for seven minutes at a harder spin speed of 4000 rpm. Finally, platelets became leukocyte poor (PRP), and the top third and fourth supernatants were thrown away [12].

Outcome measures:

The following outcomes measures were evaluated 1 and 3 months after injection and included:

1. **Manual testing of ulnar innervated muscles**: Including the flexor digitorum profundus, flexor digiti minimi (ADM), flexor carpi ulnaris, and first dorsal interosseous. The Modified Medical Research Council muscle strength scale rates muscular power on a range of 0 to 5 with respect to the maximum predicted for that particular muscle (from 0-5) considering range of motion and resistance [13]. Sum scores for the previously mentioned muscles was taken and analyzed
2. **Sensory examination of little finger**: Using British Medical Research Council score of sensory recovery. It includes 8 grades (S0, S1, S1†, S2, S2†, S3, S3†, S4) according to static and dynamic two point discrimination. In which, (S0) denotes no return of sensitivity in the nerve's autonomous zone, and (S4) denotes complete recuperation [14].
3. **Functional evaluation**: Michigan Hand Outcomes Questionnaire (MHQ) was used. Overall hand function, pain, activities related to everyday life, productiveness at work, aesthetics, and the participant's satisfaction with the functioning of the hands are the six different measures that make up the questionnaire. The total of each hand's answers on each scale was determined. Higher scores on the pain scale correspond with greater pain. Higher scores correspond to greater hand performance on the other five measures. After normalisation, the scores fall between 0 and 100. Overall MHQ score per hand = [Function + activities of daily living + work + (100-pain) + aesthetics + satisfaction]/6 [15].
4. **Electrophysiological assessment**: Ulnar nerve Distal Motor Latency (DML), Amplitude, Nerve Conduction Velocity (NCV), and NCV slowing across elbow were estimated [16].
5. **Ultrasonographic assessment**: Ulnar nerve CSA was measured utilizing a 12 MHz linear array transducer from SAMSUNG MEDISON (UGEO H60). With an in-plane approach, the UN was seen in the short axis and the location with maximal nerve swelling was found and CSA was then calculated by following the echogenic rim.

Ethics statement: The human subjects in this study have been evaluated and authorised by The Local Ethical Committee of Faculty of Medicine, Tanta University, Egypt with the approval code (34743/6/21). Also, the study was registered on Clinical Trials.gov with no. NCT05567081. Each participant gave informed written consent to take part in this work. The study was conducted in accordance with Declaration of Helsinki. CONSORT statement guidelines were also followed for reporting this study.

Statistical analysis

The SPSS software Version 20 was used to analyse the data [17]. Numbers and percentages were used to describe the qualitative data. Chi-square test had been utilized for categorical variables. Normally distributed quantitative variables had been contrasted among both study groups utilizing the student t-test. Mann Whitney test was utilized for comparison of quantitative parameters with abnormal distributions. Spearman & Pearson coefficients were utilized to correlate two quantitative parameters with either abnormal or normal distributions respectively. Linear regression was used to identify the most significant, independent variables influencing the response to PRP and CS injection. $P \leq 0.05$ was considered significant.

RESULTS

This study included 60 patients, 30 patients in each studied group. Ultrasonographic evidence of UNE was found in all patients. Ulnar nerve CSA's upper cutoff value of 10 mm^2 at the medial epicondyle level was taken for UNE diagnosis [18]. Only 35 patients showed positive electrophysiologic testing. Our patients' age ranged from 22-74 years (mean was 47.60 ± 15.85 years) and 28– 62 years (mean age 43.30 ± 9.85 years) in group I and group II respectively with symptom duration range from 0.05 to 3.0 years (mean 1.25 ± 0.86) in group I, and from 0.05 to 4.0 years (mean 1.30 ± 1.57) in group II. Males represented 40% and 30%, while right elbow represented 40% & 50% in groups I & II respectively (Table1).

Table (1): Demographic data of UNE patients in the two studied groups

Variables	Group I (PRP) (N=30)	Group II (CS) (N=30)	p-value
Gender Male (n, %) Female (n, %)	 (12)40.0% (18)60.0%	 (9)30.0% (21)70.0%	0.507
Age (years), Mean ± SD	47.60 ± 15.85	43.30 ± 9.85	0.309
Elbow Right (n, %) Left (n, %)	 (12)40.0% (18)60.0%	 (15)50% (15)50%	0.752
Duration of symptoms (years), Mean ± SD.	1.25 ± 0.86	1.30 ± 1.57	0.602

Data are expressed as: mean ± SD, number (%), UNE: ulnar neuropathy at elbow. PRP: platelet rich plasma, CS: corticosteroid

Both groups had similar findings in most outcome measures with no substantial variation among both groups was found as regards Manual muscle testing, (MRC) Sum score of sensory recovery, (MHQ), (NCV) across elbow & in forearm segment, slowing rate in NCV across elbow, ulnar nerve CMAP and CSA (Tables 2 & 3). Most outcome measurements showed significant improvement in group I after 3 months compared to baseline, except for UN slowing across elbow, which revealed no significant enhancement at either point of follow-up periods **(Tables 2 & 3)**.

Table (2): Comparison between the two studied groups according to clinical assessment measures

			Baseline (Mean ± SD)		1st Follow up (Mean ± SD)		2nd Follow up (Mean ± SD)		P-value
Sum score of manual muscle testing	**Group I (PRP)**		17.95 ± 2.06		19.05 ± 1.10		19.75 ± 0.44		P<0.001* p1=0.082 p2=0.001* p3=0.082
	Group II (CS)		17.90 ± 1.92		19.40 ± 1.05		19.20 ± 1.01		P<0.001* p1=0.002* p2=0.040* p3=0.268
	P0		**0.883**		**0.314**		**0.108**		
MRC of sensory recovery sum score	**Group I(PRP)**		**N**	**%**	**N**	**%**	**N**	**%**	p <0.001* p1=0.082 p2=0.010* p3=0.429
		S3	15	50.0	6	20.0	6	20.0	
		S3+	12	40.0	18	60.0	12	40.0	
		S4	3	10.0	6	20.0	12	40.0	
	Group II(CS)		**N**	**%**	**N**	**%**	**N**	**%**	p= 0.024* p1=0.048* p2=0.114 p3=0.693
		S3	12	40.0	3	10.0	9	30.0	
		S3+	9	30.0	18	60.0	9	30.0	
		S4	3	10.0	9	30.0	12	40.0	
	P0		**0.581**		**0.610**		**0.710**		
Michigan hand outcomes Questionnaire	**Group I**		61.17 ± 17.06		69.10 ± 18.38		86.03 ± 10.72		P<0.001* p1=0.065 p2=0.007* p3<0.001*
	Group II		59.69 ± 14.79		86.97 ± 8.66		83.55 ± 12.91		P<0.001* p1<0.001* p2<0.001* p3=0.125
	P0		**0.771**		**<0.001***		**0.512**		

MRC: Medical Research Council Score of sensory recovery p_0: p value comparing between **PRP and CS group,** p: p value for comparing between the different studied periods, p_1: p value for comparing between **baseline** and **1st Follow up**, p_2: p value for comparing between **baseline** and **2nd Follow up**, p_3: p value for comparing between**1st Follow up** and **2nd Follow up*significant P≤0.05**

Table (3): Comparison between the two studied groups according to electrophysiological assessment measures and CSA of ulnar nerve

		Baseline (Mean ± SD)	**1st Follow up** (Mean ± SD)	**2nd Follow up** (Mean ± SD)	**P-value**
NCV forearm segment (m/s)	**Group I (PRP)**	56.87 ± 3.79	57.19 ± 3.57	57.57 ± 3.46	p=0.054 p1=0.330 p2=0.065 p3=0.073
	Group II (CS)	56.37 ± 3.76	57.43 ± 4.49	58.01 ± 2.85	P=0.058 p1>0.05 p2 >0.05 p3 >0.05
	p0	**0.217**	**0.852**	**0.245**	
NCV across elbow (m/s)	**Group I(PRP)**	58.52 ± 12.75	58.45 ± 13.82	59.46 ± 15.40	p=0.004* p1=0.064 p2=0.011* p3=0.120
	Group II(CS)	60.39 ± 11.32	60.59 ± 12.86	60.41 ± 14.06	p=0.030* p1=0.166 p2=0.042* p3=0.131
	P0	**0.064**	**0.201**	**0.163**	
NCV slowing across elbow (m/s)	**Group I(PRP)**	-2.36 ± 15.67	-5.14 ± 12.90	-5.14 ± 12.66	p=0.424 p1>0.05 p2 >0.05 p3 >0.05
	Group II(CS)	-3.32 ± 16.52	-6.46 ± 13.84	-6.10 ± 13.71	p=0.059 p1=0.149 p2=0.206 p3=0.752
	p0	**0.120**	**0.068**	**0.096**	
CMAP at elbow (mV)	**Group I(PRP)**	5.95 ± 3.09	6.09 ± 2.97	7.16 ± 2.52	P=0.007* p1=0.429 p2=0.011* p3=0.082
	Group II(CS)	5.82 ± 3.95	8.34 ± 1.88	7.17 ± 1.91	P=0.009* p1=0.049* p2=0.752 p3=0.206
	p0	**0.087**	**0.004***	**0.060**	
CSA of ulnar nerve (normal up to10 mm^2)	**Group I(PRP)**	13.60 ± 1.76	12.45 ± 1.50	9.92 ± 2.77	p<0.001* p1<0.001* p2<0.001* p3=0.032*
	Group II(CS)	13.0 ± 1.59	10.80 ± 1.77	10.97 ± 2.33	p<0.001* p1<0.001* p2<0.001* p3=1.000
	p0	**0.075**	**0.003***	**0.948**	

NCV: nerve conduction velocity, m/s: meter per second, CMAP: compound motor action potential, mv: millivolt, CSA: cross sectional area. p_0: p value comparing between **PRP and CS group,** p: p value for comparing between the different studied periods,p_1: p value for comparing between **baseline** and **1st Follow up**, p_2: p value for comparing between **baseline** and **2nd Follow up**, p_3: p value for comparing between**1st Follow up** and **2nd Follow up, *significant P ≤ 0.05**

However, additional significant improvement was noted in UN CSA after one month of PRP injection. (Figures 2 A, B & C).

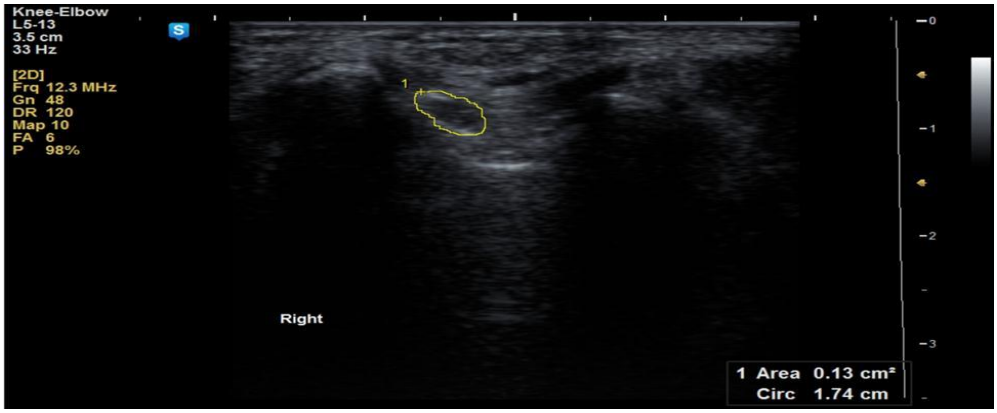

Figure (2 A): Gray scale ultrasound transverse scan of ulnar nerve at right elbow before PRP injection in group I showing CSA=13 mm^2 [**PRP**: Platelet Rich Plasma, **CSA**: Cross Sectional Area]

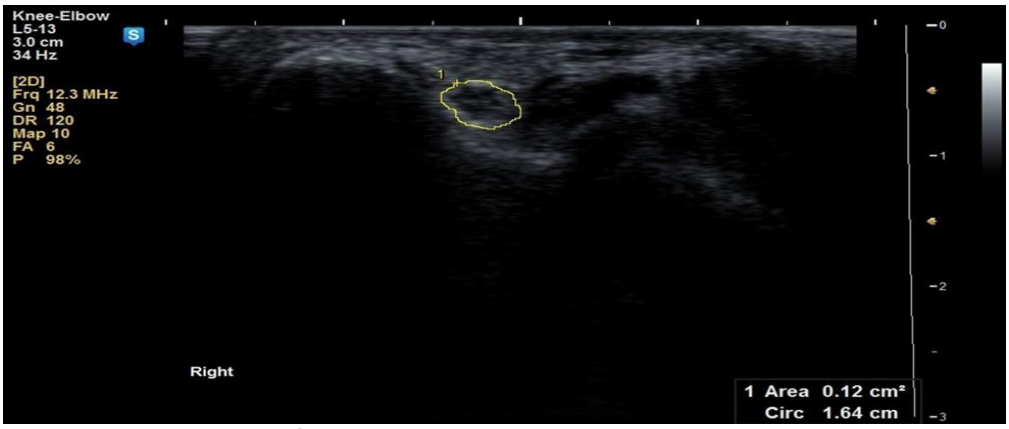

Figure (2 B): Gray scale ultrasound transverse scan of ulnar nerve at right elbow of the same patient after one month of PRP injection showing reduction of CSA=12 mm^2

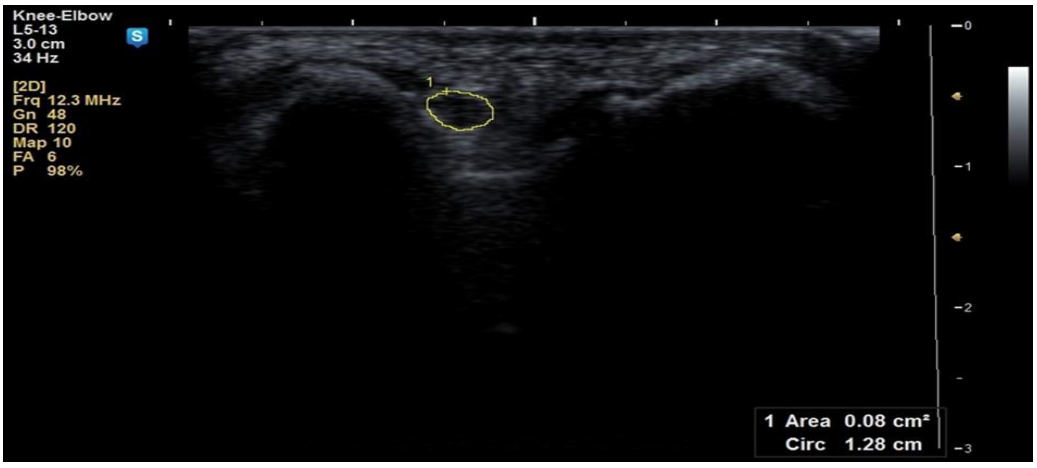

Figure (2 C): Gray scale ultrasound transverse scan of ulnar nerve at right elbow of the same patient 3 months post injection of PRP showing more reduction of CSA=8mm^2

As regards group II, significant improvement after one month was noted in previously mentioned outcome measurements with additional significant improvement after 3 months post-injection regarding sum score of manual muscle testing and MHQ (Figure 3).

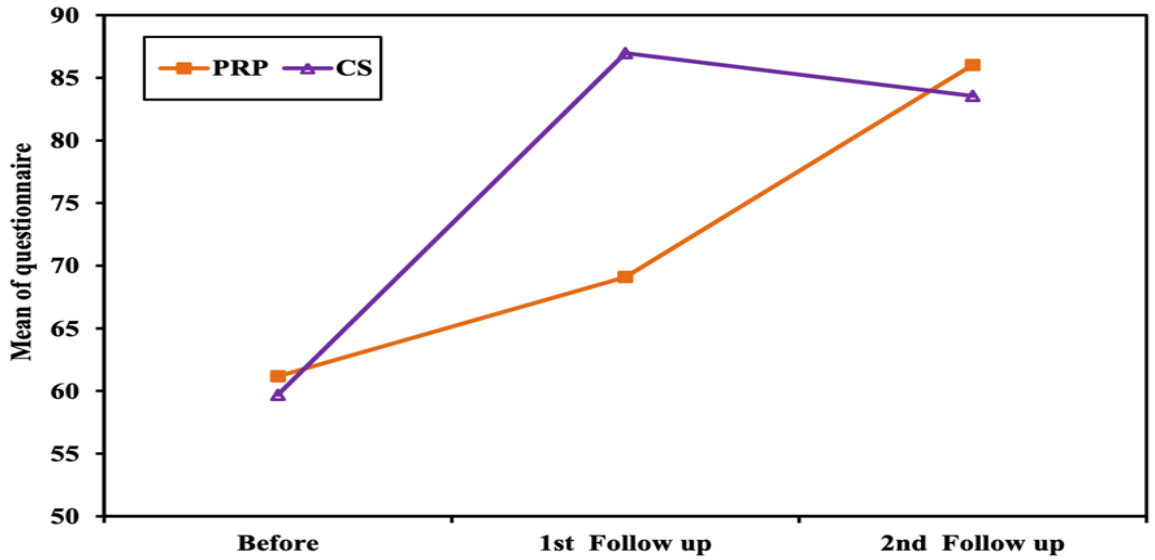

Figure (3): Comparison between the two study groups as regard Michigan hand outcomes questionnaire at each follow up period (after one- & 3-months post-injection).
PRP: Platelet Rich Plasma. **CS:** Corticosteroid. **1st follow up**: one month post injection, 2nd **follow up**: 3 months post injection
Meanwhile, NCV across elbow showed improvement after 3 months post injection (Figure 4).

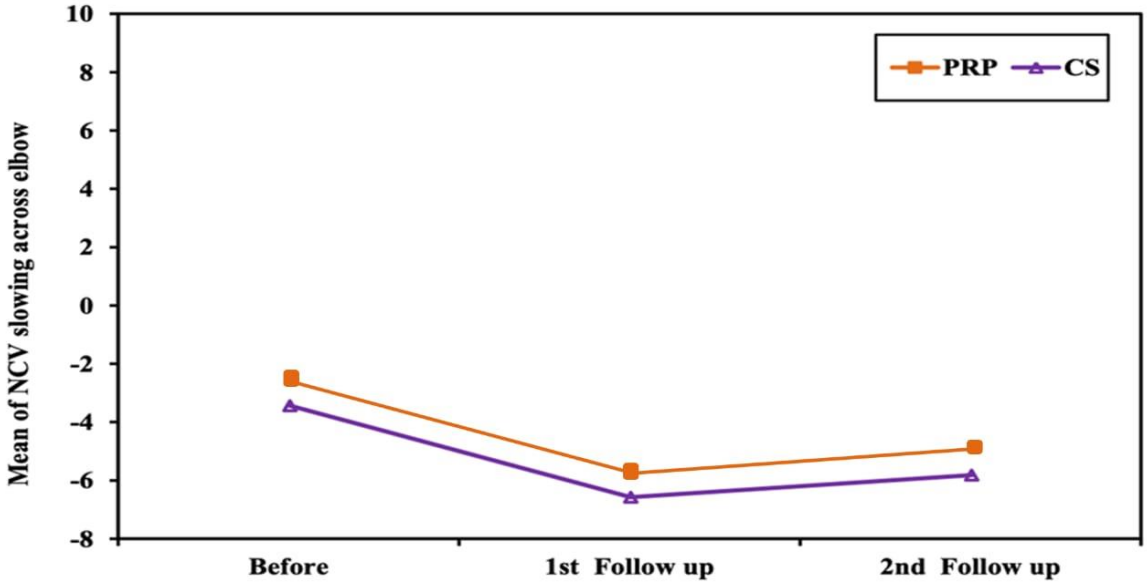

Figure (4): Comparison between the two study groups as regard ulnar nerve conduction velocity (NCV) slowing across elbow at each follow up period(after one & 3 months post-injection) **[PRP:** Platelet Rich Plasma. **CS:** Corticosteroid.

1st follow up: One month post injection, **2nd follow up**: 3 months post injection. **NCV**: Nerve Conduction Velocity].

In contrast, no significant improvement was noted in UN compound muscle action potential (CMAP) in forearm segment. Overall, within the initial month, greater improvement in all outcomes was noted in group II. However, better improvement of outcomes in group I was noted after 3 months post injection. There was significant negative correlation between sum score of manual muscle testing and NCV slowing across elbow after 1 & 3 months in group I ($p < 0.005$, 0.041) & in group II ($p < 0.001$, 0.032). Moreover, there was a positive correlation between NCV slowing across elbow and CSA of ulnar nerve, in group I (p 0.04, 0.031, 0.05) & in group II (p 0.022, 0.040, 0.05) before injection as well as after 1 & 3 months post-injection respectively. Linear regression of tested variables showed that ulnar nerve CSA and NCV slowing across elbow were among the potential predictors for favorable outcomes after CS and /or PRP injection. (**Table 4**).

Table (4): Univariate Logistic regression analysis for various variables affecting response to PRP and CS injection

Variables	Univariate	
	p	OR (LL – UL 95%C. I)
Age	**0.303**	1.026 (0.977 – 1.078)
Duration of disease	**0.898**	0.968 (0.585 – 1.600)
CSA Before injection	**0.010***	1.781 (1.146 – 2.766)
CSA after 1 month	**0.007***	1.807 (1.175 – 2.777)
CSA after 3 months	**0.946**	0.991 (0.762 – 1.289)
NCV slowing across elbow Before injection	**0.023***	1.063 (1.009 – 1.121)
NCV slowing across elbow after 1 month	**0.019***	1.027 (0.986 – 1.070)
NCV slowing across elbow after 3 months	**0.066**	1.053 (0.997 – 1.112)
MHQ Before injection	**0.003***	1.006 (0.967 – 1.047)
MHQ after 1 month	**0.004***	0.909 (0.853 – 0.970)
M HQ after 3 months	**0.501**	1.019 (0.965 – 1.075)

OR: Odd`s ratio * significant p ≤0.05, CI: Confidence interval, LL: Lower limit, UL: Upper Limit, CSA: cross sectional area, NCV: nerve conduction velocity, PRP: platelet rich plasma, CS: corticosteroid, MHQ: Michigan hand outcomes Questionnaire.

Adverse events: No adverse events were noticed among our patients.

DISCUSSION

As far as we are aware, this represented the first prospective randomised comparison study to assess and contrast the efficacy of corticosteroid injections against PRP perineural injections in mild to moderate cases of UNE. Both groups showed functional and symptomatic improvement as measured by manual muscle testing, sensory evaluation, MHQ, MNCV, CMAP, and ulnar nerve CSA. However, after a month following injection, group II showed earlier and more noticeable improvement. We think this was because of corticosteroid's quick anti-inflammatory action. On the long term and after 3 months, group I showed greater improvement. Contrary to CTS, the literature on CS injection in UNE cases is contradictory, with few trials documenting its effectiveness.

However, proximal ulnar entrapment is typically attributed to compression between the fibrous humeroulnar arcade and bone. One theory holds that corticosteroid decompresses median nerve in CTS via thinning of flexor tenosynovium. As a result, corticosteroid injections will not produce any additional positive effects when compared to other injectables [(19)]. Other researchers, however, contend that the identical pathophysiology of CTS and UNE can result in considerable improvements following CS injection. In both conditions, local nerve compression causes ischemia, inflammation, and oedema that can be reduced by CSs to reduce symptoms [(7)]. Additionally, the potency of corticosteroids may be influenced by the direct analgesic effect [(20)]. In 1996, **Hong *et al.*** [(21)] reported that corticosteroid injection didn't add a significant change in UNE patients when compared to elbow splinting. However, after six weeks and three months of injection, two small studies found that corticosteroid was effective in treating UNE [(7, 29)]. In 2012, **Kim *et al.*** [(22)] aimed to describe the approach for the injection of cubital tunnel in their research. They claimed that in-plane technique offered better and safer approach than out-of-plane technique by enabling good visualization and control of the needle tip during the injection, this was compatible with our technique. Later, **Choi *et al.*** [(23)] reported improvements in VAS and ulnar nerve CSA at first and forth weeks, and NCS at forth weeks as compared to before the injection of 40 mg triamcinolone acetonide and 2 ml 1% lidocaine in 10 patients using the in-plane technique. Moreover, **Chen *et al.*** [(11)] reported that both corticosteroid and dextrose 5% water had similar efficacy and suggested the use of dextrose 5% water as a safer option for injection with fewer side effects. **VanVeen *et al.*** [(24)], in contrast, found no discernible difference between the corticosteroid and placebo groups 3 months after injection.

In our study, we found that after one month post-injection, a significant enhancement was existed in the sum scores of manual muscle testing & sensory recovery, MHQ, CSA of ulnar nerve, NCV slowing across elbow, CMAP at elbow, with further improvement in the sum scores of manual muscle testing & sensory recovery, MHQ, and CSA of ulnar nerve after the 3rd month**.** The NCV across the elbow, however, didn't improve until three months following the injection in both groups. These results can be interpreted by the theory that when PRP is injected, it promotes the growth and activation of Schwann cells by releasing a number of growth factors, including platelet-derived growth factor, VEGF, transforming growth factor-b1, b-fibroblast growth factor, epidermal growth factor, and insulin-like growth factor, which supports normal neuronal regeneration [(25, 26)]**.** Additionally, Schwann cells have been proposed as the therapeutic target in the management of peripheral neuropathy by **Lehmann *et al.*** [(27)]**.** This happens because Schwann cells build the basal lamina as a need for myelin development and express chemicals that promote axon

growth on their surfaces. Also, the effectiveness of PRP injection in treating peripheral nerve injuries and entrapment neuropathies has been documented in numerous articles. PRP injection has been described as a secure and efficient therapeutic approach for CTS, for instance, by **Kuo *et al.*** [28], **Wu *et al*.** [29], **Uzun *et al*.** [30], and **Malahias *et al.*** [21]. In addition, intraneural and perineural US-guided PRP injection were effective in treating a chronic common peroneal nerve palsy that developed after 11 months of trauma, according to a case study by **Sanchez *et al.*** [22]. Also, a perineural PRP injection has been reported to improve sensory recovery in another trial on the leprosy neuropathy [25]. In patients with diabetic neuropathy, longer-term investigations by **Hassanien *et al.*** [6] showed sensory improvement 1, 3, and 6 months following PRP injection. The impact of PRP on the restoration of nerve integrity has also been studied in the past. In two animal model studies on acute nerve damage in guinea pigs and rabbits, PRP was given to Schwann cells, and improvements were shown in the quantity of myelination, nerve axons, and electrophysiological characteristics [33]. Moreover, **Zhu *et al.*** [34] showed that ultrashort wave treatment and serial US-guided autologous PRP injecting were necessary and successfully treatment for a 10-mm sciatic nerve crush injury in rabbits**.**

Almost all patients in the two study groups experienced improvement on the clinical, electrophysiological base as well as reduction of ulnar nerve cross-sectional area without any adverse events. However, perineural PRP injection, in our opinion, is preferable in patients with UNE since CS injection may inhibit the production of proteoglycans and collagen, limiting tenocyte activity, thereby lowering the mechanical strength of the tendon. The neurotoxicity of the administered CSs increases the possibility of ulnar nerve damage [30]. The smaller ulnar nerve CSA as well as the minimal NCV slowing across the elbow prior to injection were identified to be possible predictors for positive results with regard to nerve healing after PRP and CS injection. This may be supported by the fact that a demyelinated nerve (with slowed NCV) has a better chance of healing and remyelinating faster than an axonal lesion (with reduced CMAP amplitude) in terms of recovery [35]. Moreover, enlargement of the ulnar nerve and increased CSA can be brought on by a number of alterations, including demyelination, fibrosis, axonal edoema, and inflammation. As a result, the precise underlying mechanism of UNE is still unclear, and further studies will be required in the future to clarify this topic. In contrast to our findings, **VanVeen *et al.*** [24] discovered that the only substantial indicator of a favourable result was the length of the symptoms. They reported that those who fared well had symptoms for a shorter period of time.

A limitation of our study was that the treating physician was not blinded to treatment allocation as well as the short duration of follow up. Also, different injectates with different volumes can yield variable results at different sites of entrapment. Furthermore, lack of control group (placebo effect and hydro-dissection effect) may add another limitation. Hence, additional publications evaluating and comparing PRP to CS injections with longer follow-up durations at the various sites of entrapment are required.

CONCLUSION

While ultrasound guided deep perineural corticosteroid injection may aid with short-term management among individuals with UNE who are not responding to conservative and physical management, platelet rich plasma deep perineural injection may help with long-term management. It may be determined that the decreased ulnar nerve CSA and the limited NCV slowing across the elbow prior to injection are potential indicators of successful nerve healing following PRP and CS injection. UNE patients with either solely ultrasonographic manifestations or combination of ultrasonographic & mild electrophysiologic manifestations had better clinical & functional outcomes than patients with ultrasonographic & moderate electrophysiologic evidence of UNE.

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