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Comparing the effectiveness of ultrasound-guided versus blind steroid injection in the treatment of severe carpal tunnel syndrome

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Background/aim: This study aimed to compare the effectiveness of ultrasound (US)-guided injection versus blind injection of corticosteroids in the treatment of carpal tunnel syndrome (CTS).

Materials and methods: This prospective, randomized clinical trial included patients with severe CTS based on clinical and electrophysiological criteria. The patients were evaluated for clinical and electrophysiological parameters at baseline and 4 weeks after treatment. Symptom severity and hand function were assessed by the Boston questionnaire. The patients underwent blind injection or US-guided injection.

Results: When compared with baseline, both groups showed significant improvement in Boston questionnaire scores and all electrophysiological parameters. Significant differences were observed between the groups for clinical parameters (Boston Symptom Severity Scale: $P = 0.007$; Functional Status Scale: $P < 0.001$) in favor of the US-guided group.

Conclusion: This study demonstrated that both US-guided and blind injections were effective in reducing symptoms and improving hand function. US-guided injections may yield more effective clinical results in the short-term than blind injections in the treatment of patients with severe CTS.

Key words: Carpal tunnel syndrome, ultrasound-guided, blind, injection, corticosteroid

1. Introduction

Carpal tunnel syndrome (CTS) is the most frequent entrapment neuropathy in the upper limbs (1). The carpal tunnel is bordered by the transverse carpal ligament superiorly and carpal bones inferiorly. As the median nerve crosses the wrist, it passes through the carpal tunnel along with nine flexor muscle tendons. While the precise etiology of increased carpal tunnel pressure in CTS is uncertain, experimental evidence suggests that anatomic compression and/or inflammation are possible mechanisms (2,3).

Local steroid injection into the carpal tunnel is an effective treatment option and is frequently used. According to the Cochrane database, local steroid injection for CTS provides greater clinical improvement in symptoms 1 month after injection compared with placebos (4,5). In our previous study, we found that local steroid injection and surgical decompression achieved favorable improvements in clinical and electrophysiological parameters within the short term without superiority of one treatment over other (6). Therefore, in patients for whom surgical decompression cannot be applied, a local steroid injection can be recommended as a less invasive and promising treatment alternative.

Injections are commonly performed with a blind technique using palpation of anatomical landmarks in daily clinical practice (7,8). This technique does not provide certainty on whether the injected steroid is adequately placed in the carpal tunnel. A cadaveric study has demonstrated that there is wide variability of injectate distribution following injection (9). Moreover, steroid injections tend to cause complications such as nerve insult, vessel insult, and skin lesions (e.g., color change) (10–12). Median nerve injury is the most serious complication associated with local steroid injection for CTS (10). Therefore, injection under ultrasound (US) guidance may increase precision and therapeutic outcomes and decrease complication rates. There are only a few studies that have investigated US guidance for injections in CTS, and they generally determined that US-guided injections result

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in better symptom relief and increased and long-lasting therapeutic effects compared to blind injections (11–13). Since the studies in this area are limited in number, this study was conducted to compare the effectiveness of US-guided injection versus blind injection of corticosteroids in the treatment of severe CTS according to symptom severity, hand function, and electrophysiological parameters.

2. Materials and methods

2.1. Study design

This prospective, randomized clinical trial evaluated patients who presented to the physical medicine and rehabilitation outpatient clinic and were treated with a steroid injection using US-guided versus blind techniques for severe CTS between March 2016 and January 2017. The diagnosis of CTS was based on clinical and electrophysiological findings.

The protocol was explained to all patients, and informed consent was obtained at the beginning of the study. The ethics committee of the institute approved the study protocol, and all procedures were performed in compliance with the Helsinki Declaration (14).

2.2. Participants

Patients with severe idiopathic CTS according to clinical diagnosis and a validated CTS electrophysiological severity scale were included in this study. All patients had complaints of paresthesia and/or numbness along the median nerve distribution area of the hand with nocturnal worsening. Patients with systemic diseases such as inflammatory rheumatic disease, diabetes mellitus, thyroid disease, history of CTS surgery, or peripheral nerve lesion of the forearm were excluded from the study. Demographic data concerning age, sex, dominant hand, basic symptoms of CTS (pain, weakness, awkwardness), and duration of symptoms were collected.

The patients were randomly assigned by a computer-generated randomization schedule into two groups as follows: the blind injection group (n = 19 hands) and the US-guided injection group (n = 21 hands). The injections were performed by the same physician (ÖZK).

2.3. Electrophysiological examination

Nerve conduction studies were performed using Medelec Synergy equipment (Oxford, UK). Bilateral motor and sensory studies were performed for median and ulnar nerves according to Oh's protocol (15). Distal motor latency, compound muscle action potential (CMAP) amplitude, sensory nerve conduction velocity (SNCV), and sensory nerve action potential (SNAP) of the median nerve were recorded. In line with the prolongation of the motor and sensory latencies, inability to elicit SNAP or CMAP with lower amplitude or inability to induce CMAP were considered signs of severe CTS (15).

2.4. Injection techniques

In blind injections, after skin antisepsis, a 22-gauge needle was inserted into the proximal carpal tunnel at the distal wrist crease found at the ulnar side of the palmaris longus tendon. The needle was introduced slowly, and 1 mL of betamethasone sodium phosphate (2.63 mg)/ betamethasone dipropionate (6.43 mg) was injected. The injection was stopped if the patient experienced a "pins and needles" sensation or pain in the fingers. If resistance was felt, the needle was withdrawn a few millimeters and then repositioned.

In US-guided injections, an in-plane approach was performed. The patient was sitting and the elbow was flexed 90° with the hand on the cushion/table. The needle was started from the ulnar aspect of the transducer while keeping the median nerve in view (Figure). The US-guided injections were performed using a 7–12 MHz linear array transducer and a US device (Logiq P5, GE Medical Systems, USA) (16). All US examinations were performed by a single physiatrist with more than 3 years of experience in musculoskeletal US (ÖZK). The same techniques were used for CTS injection of the patients with bilateral CTS.

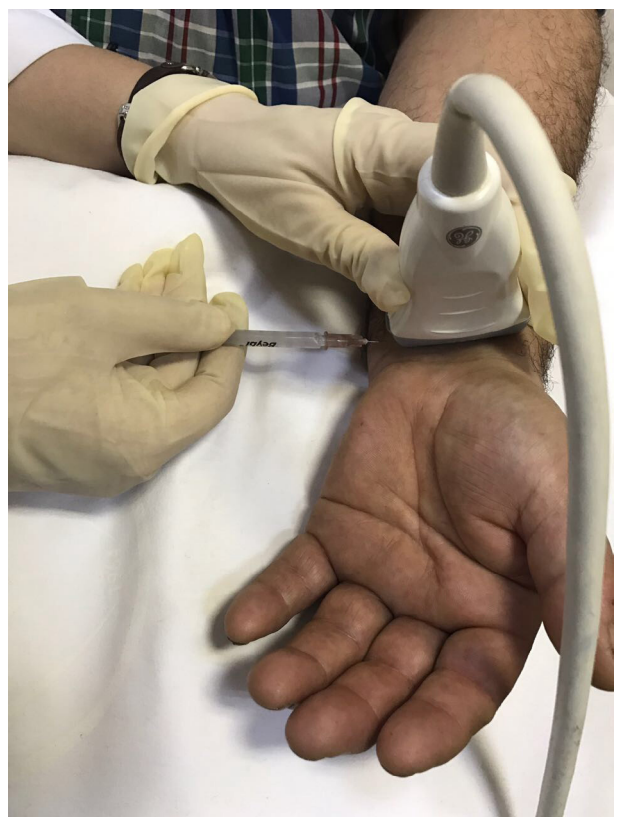

Figure. The position of the transducer and needle during in-plane ultrasound-guided approach for carpal tunnel injection.

2.5. Outcome parameters

The severity of pain was evaluated using a visual analog scale (17). The Boston questionnaire consists of two sections: the Boston Symptom Severity Scale (BSSS) and the Functional Status Scale (FSS) items (18,19). The BSSS and FSS are the most commonly used outcome measures of assessment for improvements in clinical symptoms and functional recovery of patients with CTS. The BSSS evaluates clinical symptoms, including pain, numbness, weakness, paresthesia, and clumsiness, using 11 questions each with 5 separate responses ranging from no complaints to very severe or continuous complaints. The FSS is calculated from 8 questions regarding difficulties with daily activities. Each score is calculated as the mean of the responses of the individual items. A higher score indicates the most deteriorated symptom or function.

2.6. Statistical analysis

Statistical analyses were performed using SPSS 13.0 for Windows (SPSS Inc., Chicago, IL, USA). Normality of distribution was assessed by Kolmogorov–Smirnov test. The Fisher exact test was used to assess the qualitative differences between the groups. Numerical variables were compared using the Student t-test or Mann–Whitney U test as appropriate. The paired t-test or Wilcoxon test was used to reveal whether there was a significant difference within the groups. When investigating the effect of treatment, analysis of covariance was used to adjust for differences in baseline values between the groups. Statistical significance was set at $P < 0.05$.

3. Results

A total of 34 patients were enrolled in this study. Three patients from the blind-injection group were lost to follow-up and thus a total of 31 CTS patients (N = 40 hands; 9 bilateral, 22 unilateral) completed the study. Demographic and clinical findings are presented in Table 1. The groups were similar in terms of findings at baseline, except for BSSS ($P = 0.006$) and CMAP ($P = 0.009$) (Tables 1 and 2). At follow-up visits performed 4 weeks after the injection, no complications were encountered.

In both groups, significant differences were recorded within the groups regarding the clinical and electrophysiological parameters (Table 2) (all $P < 0.05$). Delta (D) analyses are also given in Table 2. Significant differences were observed between the groups for clinical parameters (BSSS: $P = 0.007$; FSS: $P < 0.001$) in favor of the US-guided group. Meanwhile, SNAP, SNCV, and CMAP illustrated more improvements in the blind-injection group than the US-guided group ($P = 0.020$, $P = 0.008$, and $P = 0.044$, respectively). After treatment, two patients had complete improvement only in the US-guided group. In the US-guided group, a statistically significant decrease was detected in the cross-sectional area of the median nerve between pre- and posttreatment values (mean ± SD: 0.18 ± 0.04 and 0.15 ± 0.05, respectively; $P = 0.000$).

4. Discussion

This study compared the effectiveness of in-plane US-guided versus blind injections in the treatment of CTS for only severe cases. The results indicated that both techniques were effective in reducing the symptoms, improving the hand function and all of the electrophysiological parameters. However, US-guided steroid injection showed superior results regarding clinical outcomes.

Our findings of improved effectiveness of injections when they are performed under US guidance are in line with the results of previous studies (11,12,20). Üstün et al. compared the efficacy and safety of US-guided versus blind steroid injections in 46 CTS patients (11). The authors concluded that although both US-guided and blind steroid injections were effective in reducing the symptoms of CTS and improving the function, an earlier

Table 1. Demographics and clinical findings of the patients.

Variables	Blind group (N = 16)	US-guided group (N = 15)	P
Age (years)	61.5 ± 10.3	59.4 ± 12.4	0.567
Sex (F/M)	15/1	13/2	0.475
Dominant hand (R/L)	18/1	21/0	0.475
Affected hand (dominant/nondominant)	12/7	10/11	0.252
Involved side (bilateral/unilateral) Symptom duration (days)	3/13 38.5 ± 40.4	6/9 28.5 ± 3 0.6	0.280 0.381
Pain (VAS, 0–10)	4.0 ± 0.9	4.0 ± 0.8	1.000

Data are given as mean ± SD or ratio.
US, Ultrasound; F, female; M, male; R, right; L, left; VAS, visual analog scale.

Table 2. Comparison of the clinical variables within and between the groups

Variables		Blind group (N = 19 hands)	US-guided group (N = 21 hands)	P
Boston questionnaire				
BSSS	Baseline	33.5 ± 5.5	38.6 ± 5.7	0.006
	After treatment	25.5 ± 8.2	21.4 ± 8.9	0.138
	P	<0.001	<0.001	
	Δ change	7.9 ± 6.7	17.1 ± 8.6	0.001
	ANCOVA*			0.007
FSS	Baseline	25.0 ± 6.4	28.4 ± 5.7	0.081
	After treatment	20.0 ± 6.6	16.5 ± 7.7	0.129
	P	0.001	<0.001	
	Δ change	5.0 ± 5.6	12.0 ± 4.7	<0.001
	ANCOVA*			<0.001
Electrodiagnostic findings				
SNAP (μV)	Baseline	6.0 ± 7.2	3.9 ± 4.6	0.390
	After treatment	18.1 ± 13.1	8.0 ± 7.2	0.004
	P	0.002	0.008	
	Δ change	–12.1 ± 14.7	–3.9 ± 5.3	0.022
	ANCOVA*			0.020
SNCV (m/s)	Baseline	14.0 ± 14.1	10.2 ± 11.7	0.294
	After treatment	27.2 ± 8.0	17.7 ± 13.5	0.010
	P	0.001	0.010	
	Δ change	–13.3 ± 12.5	–6.8 ± 10.8	0.074
	ANCOVA*			0.008
DML (ms)	Baseline	6.2 ± 1.2	7.1 ± 1.7	0.065
	After treatment	4.9 ± 1.4	6.3 ± 1.7	0.011
	P	<0.001	<0.001	
	Δ change	1.3 ± 0.9	1.2 ± 0.7	0.169
	ANCOVA*			0.079
CMAP (mV)	Baseline	4.0 ± 1.7	2.4 ± 1.9	0.009
	After treatment	5.8 ± 1.8	3.4 ± 2.4	0.001
	P	0.001	0.003	
	Δ change	–1.7 ± 1.9	–0.9 ± 1.3	0.101
	ANCOVA*			0.044

Data are given as mean ± SD. BSSS, Boston Symptom Severity Scale; FSS, Functional Status Scale; SNAP, sensory nerve action potential; SNCV, sensory nerve conduction velocity; DML, distal motor latency; CMAP, compound muscle action potential.

*ANCOVA: Analysis of covariance was used to adjust for differences in baseline values between the groups for investigating the treatment effect.

onset/better improvement of symptoms suggested that US-guided steroid injection may be more effective than blind injections in CTS. In another study, which was a large community-based cohort over a longer period of follow-up, US-guided injections were found more effective in comparison to blind injections in the treatment of CTS (20). In a study of 44 patients with CTS receiving corticosteroid injections using either one of two different US-guided approaches or blind injection, the investigators reported that US-guided carpal tunnel injections were

more effective in improving electrodiagnostic and US findings and symptoms than blind injection, and the in-plane ulnar approach was superior to the out-plane approach and blind injections in improving median-to-ulnar sensory nerve distal latency ratios, CSA, and Boston questionnaire symptom scores (12). In this study, although higher improvement rates for SNAP, SNCV, and CMAP were obtained in the blind-injection group than the US-guided group, complete cure was obtained in two patients only in the US-guided group. CMAP baseline values were significantly higher in the blind-injection group compared to the US-guided group. Further improvement in the EMG parameters in the blind group be can explained by the high initial CMAP values.

For many years, a wide range of injections have been performed blindly. After musculoskeletal physicians started to use US imaging in their clinical practice, they began to investigate the place of US guidance for injections (21). In US-guided injection, the structure and location can be seen and so the physician can view the needle tip continuously and ensure that the needle is placed precisely in the desired location, avoiding the risk of damage to nerves and surrounding structures. Moreover, US enables visualization of the distribution of the injected substance with little or no patient discomfort (22,23). The in-plane method has some advantages, including visualization of all of the carpal tunnel structures around the nerve, which facilitates an accurate perineural injection (12). Although steroid injections are routinely administered for CTS, direct needle injury of the median nerve is the major complication of these injections. Racasan et al. reported that the median nerve is at risk if the injection is performed within 1 cm on either the ulnar or radial side of the palmaris longus tendon (10). They reported that the safest location of injection is through the flexor carpi ulnaris tendon. Patients with CTS are more vulnerable to needle injury than healthy subjects even if the needle is inserted at the correct position because the median nerve is swollen and/or flattened around the wrist crease. Anatomic variations such as an abnormally located or bifid median nerve may also affect the procedure (24). In our study, the bifid median nerve was detected in one patient, and the injection was performed without any problem. Complications related to the injection were not observed in either group.

On the contrary, the most important disadvantage of US-guided injection is user dependency. US-guided injection techniques require experience and training. Basic knowledge of US and detailed knowledge of the anatomy of the target tissue are required for US-guided interventions. In the current study, to minimize the user dependency problem, US examinations and injection procedures were performed by a single physiatrist with more than 3 years of experience in musculoskeletal US.

In the present study, marked clinical improvement occurred in both groups for severe CTS. In the treatment of severe CTS, steroid injection and surgical decompression achieved favorable improvements in clinical and electrophysiological parameters within the short term without superiority of one treatment over the other (6). Therefore, in patients for whom surgical decompression cannot be applied, local steroid injections can be recommended as a less invasive and a promising treatment alternative.

A limitation of our study was that the treatment outcome was assessed only at a 4-week follow-up. As such, we had no data regarding the long-term benefits/side effects of the treatments. Additionally, the small sample size may limit the generalizability of our findings. Nonetheless, we think that our prospective randomized study contributes to US-guided injection studies, particularly in severely affected cases.

In conclusion, the present study suggests that both US-guided and blind steroid injection techniques achieved favorable improvements, particularly in the symptoms, hand functions, and electrophysiological findings. Additionally, US-guided injections may be more effective regarding clinical findings compared to blind injections in the treatment of severe CTS cases within the short term.

References

1. Katz JN, Simmons BP. Clinical practice. Carpal tunnel syndrome. N Engl J Med 2002; 346: 1807-1812.
2. Jillapalli D, Shefner JM. Electrodiagnosis in common mononeuropathies and plexopathies. Semin Neurol 2005; 25: 196-203.
3. Amirfeyz R, Gozzard C, Leslie IJ. Hand elevation test for assessment of carpal tunnel syndrome. J Hand Surg Br 2005; 30: 361-364.
4. Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. Cochrane Database Syst Rev 2007; 18: CD001554.
5. Karadas O, Tok F, Akarsu S, Tekin L, Balaban B. Triamcinolone acetonide vs procaine hydrochloride injection in the management of carpal tunnel syndrome: randomized placebo-controlled study. J Rehabil Med 2012; 44: 60-64.
6. Gurcay AG, Karaahmet OZ, Gurcan O, Kazanci A, Karsli PB, Umay EK, Acer S, Unlu E. Comparison of short-term clinical and electrophysiological outcomes of local steroid injection and surgical decompression in the treatment of carpal tunnel syndrome. Turk Neurosurg 2017; 27: 447-452.
7. Wilson JK, Sevier TL. A review of treatment for carpal tunnel syndrome. Disab Rehabil 2003; 25: 113-119.

8. Kim DH, Jang JE, Park BK. Anatomical basis of ulnar approach in carpal tunnel injection. Pain Physician 2013; 16: 191-198.

9. Ozturk K, Esenyel CZ, Sonmez M, Esenyel M, Kahraman S, Senel B. Comparison of carpal tunnel injection techniques: a cadaver study. Scand J Plast Reconstr Surg Hand Surg 2008; 42: 300-304.

10. Racasan O, Dubert T. The safest location for steroid injection in the treatment of carpal tunnel syndrome. J Hand Surg Br 2005; 30: 412-414.

11. Üstün N, Tok F, Yagız AE, Kizil N, Korkmaz I, Karazincir S, Okuyucu E, Turhanoglu D. Ultrasound-guided vs. blind steroid injections in carpal tunnel syndrome: a single-blind randomized prospective study. Am J Phys Med Rehabil 2013; 92: 999-1004.

12. Lee JY, Park Y, Park KD, Lee JK, Lim OK. Effectiveness of ultrasound-guided carpal tunnel injection using in-plane ulnar approach: a prospective, randomized, single-blinded study. Medicine (Baltimore) 2014; 93: 350.

13. Makhlouf T, Emil NS, Sibbitt WL Jr, Fields RA, Bankhurst AD. Outcomes and cost-effectiveness of carpal tunnel injections using sonographic needle guidance. Clin Rheumatol 2014; 33: 849-858.

14. World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. J Int Bioethique 2004; 15: 124-129.

15. Oh SJ. Clinical Electromyography: Nerve Conduction Studies. 2nd ed. Baltimore, MD, USA: Williams and Wilkins; 1993. pp. 84-105.

16. Kara M, Özçakar L, De Muynck M, Tok F, Vanderstraeten G. Musculoskeletal ultrasound for peripheral nerve lesions. Eur J Phys Rehabil Med 2012; 48: 665-674.

17. Kersten P, Küçükdeveci AA, Tennant A. The use of the visual analogue scale (VAS) in rehabilitation outcomes. J Rehabil Med 2012; 44: 609-610.

18. Levine DW, Sõmmons B, Korõs MJ, Daltroy LH, Hohl GG, Fossel AN, Katz JN. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. J Bone Joint Surg Am 1996; 75: 1585-1592.

19. Sezgin M, Incel NA, Serhan S, Camdeviren H, As I, Erdoğan C. Assessment of symptom severity and functional status in patients with carpal tunnel syndrome: reliability and functionality of the Turkish version of the Boston Questionnaire. Disabil Rehabil 2006; 28: 1281-1285.

20. Evers S, Bryan AJ, Sanders TL, Selles RW, Gelfman R, Amadio PC. The effectiveness of ultrasound-guided compared to blind steroid injections in the treatment of carpal tunnel syndrome. Arthritis Care Res 2017; 69: 1060-1065.

21. Ozçakar L, Tok F, De Muynck M, Vanderstraeten G. Musculoskeletal ultrasonography in physical and rehabilitation medicine. J Rehabil Med 2012; 44: 310-318.

22. Tagliafico A, Bodner G, Rosenberg I, Palmieri F, Garello I, Altafini L, Martinoli C. Peripheral nerves: ultrasound-guided interventional procedures. Semin Musculoskelet Radiol 2010; 14: 559-566.

23. Özçakar L, Onat ŞŞ, Gürçay E, Kara M. Are blind injections ethical or historical?: Think twice with ultrasound. Am J Phys Med Rehabil 2016; 95: 158-160.

24. Kim HJ, Park SH. Median nerve injuries caused by carpal tunnel injections. Korean J Pain 2014; 27: 112-117.