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Original Article

Ultrasound-guided injection of carpal tunnel syndrome: A comparative study to blind injection

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is the most common upper limb neuropathy with increasing incidence especially among females, having a high economic and social impact on patients. CTS can be treated either with conservative measures or surgically. Steroid injection, as a conservative treatment, could be carried out using anatomical landmarks or via ultra-sonographic guidance.

Aim of the work: To compare the clinical outcomes of the ultrasound guided injection versus blinded one for management of CTS.

Patients and methods: Thirty patients with CTS were included in this study. Diagnosis was based on clinical, electro-physiological and ultrasound imaging. 28 patients had moderate CTS and 2 patients mild. Patients were equally grouped; 15 patients with ultrasound-guided injection technique and another 15 were injected blindly. Injection was performed once at baseline with 0.5 ml lidocaine 1% and 40 mg of triamcinolone. Evaluation at baseline and after 4 weeks of injection included Boston carpal tunnel questionnaire; symptom severity scale and functional status scale, nerve conduction study, ultrasound parameters (cross-sectional area, flattening ratio).

Results: Patients were 28 females and 2 males; their mean age was 35.3 ± 7.5 years with unilateral CTS and disease duration of 8.8 ± 1.9 years. Patients with ultrasound-guided injection had significant improvement of clinical, neurophysiological, ultrasound parameters outcomes than blind injected patients. Reported complications at baseline included tingling sensation in 6 (40%) patients injected blindly while non in US-guided injected. No complications were reported in all patients after 4 weeks.

Conclusion: Ultrasound-guided injection of the carpal tunnel provides precision, maximizes the effectiveness and reduces complications.

1. Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy [1]. It is caused by localized compression and entrapment of the median nerve at the wrist within the carpal tunnel positioned between the transverse carpal ligament and the carpal bones. It causes sensory (paresthesia and hypoesthesia), motor deficit, and pain especially at night within the median nerve distribution in the hand that are secondary to the mechanical compression and local ischemia. CTS is clinically diagnosed and classified by Boston carpal tunnel questionnaire, which was specifically developed [2]. Ultrasound (US) imaging is an emerging complementary tool in the diagnosis of CTS [3,4]. It also appears to be useful in clinically suspected CTS when electro-diagnostic testing is normal [5]. Common anatomic anomalies in the carpal tunnel such as a bifid median nerve, has also been reported [6]. It has been reported in Egyptian patients with moderate and severe CTS there could be an associated pronator syndrome [7] and CTS is a main cause of impairment in patients with fibromyalgia syndrome [8]. CTS has also been reported in association with tuberculous tenosynovitis [9]. The median nerve electrophysiological tests played a key role in confirming the diagnosis of CTS [10].

Local steroid injections of the carpal tunnel for treatment of focal median mononeuropathy at the wrist [11]; may be done blindly or ultrasound guided. Blinded injection of local steroids is not preferable as it may cause the risk of damaging structures contained within the carpal tunnel as well as the potential for relative ineffectiveness of this invasive procedure if the injected material is not adequately placed within the tunnel. However, As for US guidance, it has been described for CTS injection that provides optimal needle imaging [12]. Furthermore, US-guided injection of the carpal tunnel can increase the level of certainty compared with “blind” injection, that the injected fluid has been ideally placed so as to encompass the median nerve. In addition,

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more than 10% of individuals have a bifid median nerve [6]. Without US guidance, there is clearly no possibility to identify the presence of this anomalous anatomy or to alter the injection technique so as to minimize risk of damage to the median nerve segments. In addition, US imaging is of value in assessing the effectiveness of corticosteroid injection into the carpal tunnel for treatment of CTS by demonstrating reduction in the cross-sectional area of the median nerve [13].

This study was conducted in order to evaluate the effectiveness of US-guided compared to blinded local steroid injection; as well as short term outcome evaluation of improvement clinically and changes of electrophysiological and sonographic findings after US-guided and blinded local steroid injection.

2. Patients and methods

Thirty patients with CTS recruited from Rheumatology and Rehabilitation outpatient clinic Minia University Hospital in the period from October 2014 to March 2015 were enrolled in this study after local research ethics committee approval. Oral consents were obtained from the patients before inclusion. Patients diagnosed both clinically and electro-physiologically were included. Mononeuropathy at wrist with prolonged distal latency, that does not have evidence of axonal involvement in electrophysiologic studies were considered and disease duration not exceeding a year. Patients with history of previous carpal tunnel surgery, patients known to have CTS due to systemic illness and/or connective tissue disease were excluded. All Patients underwent local injection with steroid either US-guided in 15 patients (group I) or blindly in another 15 patients (group II). Follow up was scheduled for patients after 4 weeks. Patients were interviewed and subjected to Clinical examination at baseline and after 4 weeks from injection. Clinical assessment included hand sensation, paresthesia, hand strength, hand and forearm pain, night awakening and provocative tests for median nerve compression using Phalen test [14] and Tinel sign [15].

Symptom severity and functional status were conducted using the validated Boston Carpal Tunnel Questionnaire (BCTQ). It is the most commonly used outcome measure of assessment for improvements in clinical symptoms and functional recovery of patients with CTS [2]. BCTQ comprises of two scales; a Symptom Severity Scale (SSS) which consists of 11 questions and the Functional Status Scale (FSS) contains 8 items which have to be rated for degree of difficulty on a five-point scale. Patients were divided into five groups according to their mean score: Extreme (4.1–5 points), severe (3.1–4 points), moderate (2.1–3 points), mild (1.1–2 points) and minimal (0.1–1 point).

Electrophysiologic studies of the median nerve with sensory nerve conduction velocity (SNCV) and distal motor latency (DML) were performed. Progression of CTS severity was studied in accordance with recommendations of the American Association of Neuromuscular and Electrodiagnostic Medicine [16] and American Academy of Orthopedic Surgeon work group (AAOS) [11] as follows; *negative*: normal findings on all tests (including comparative and segmental studies), *minimal*: abnormal findings only on comparative or segmental tests, *mild*: SNCV slowed in the finger-wrist tract with normal DML, *moderate*: SNCV slowed in the finger-wrist tract with increased DML, *severe*: absence of sensory response in the finger-wrist tract with increased DML, *extreme*: absence of thenar motor response.

Musculoskeletal Ultrasonographic (MSUS) examination to carpal tunnel at wrist was performed using high-resolution USG system HD11 Siemen's; 18 MHz probe. The flattening ratio (FR) and the cross-sectional area (CSA) of the median nerve were measured according to the grading system proposed by *El Miedany and colleagues* [17]. The FR was defined as the ratio of the nerve's transverse axis to the anteroposterior axis and was assessed at the level of the pisiform bone. Cutoff value for diagnosis of CTS was considered 10 mm [18]. Depending on CSA of median nerve at inlet, it is classified as follows: *mild*: 10–13 mm^2, moderate: > 13–15 mm^2, Severe: > 15 mm^2.

Patients were seated facing the examiner. The arms were extended, the wrists were rested on a hard flat surface, the forearms were supinated, and the fingers were semiflexed. *First*, the volar was examined to exclude space occupying lesions or anatomical variants; *second*, the bony structures that limit the carpal tunnel proximally (pisiform, scaphoid) and distally (trapezium and hamate) were examined; *third*, transverse carpal ligament is identified as an arched hyperechoic strip; *fourth*, the median nerve was identified. Local injection technique either US guided or blinded injection of the carpal tunnel by one-needle, 2-syringe was used. Injection of 1% lidocaine from a first syringe was performed followed by injection with 40 mg of triamcinolone from a second syringe was performed to all 30 patients once at base line using an approach from the ulnar side of the wrist at proximal wrist crease. This allows full in-plane visualization of the needle in US-guided technique. As for blinded technique the injection was performed at a site just ulnar to the palmaris longus tendon and the proximal wrist crease. The needle was inserted at a 30 angle and directed toward the ring finger. If the needle met obstruction or if the patient experienced paresthesia, the needle was withdrawn and redirected in a more ulnar fashion. Complications were compared between the 2 methods of injection.

The nature of the present study was explained to all patients. The clinical examination, nerve conduction studies and ultrasound imaging represent standard care and pose no ethical conflicts.

2.1. Statistical analysis

Analysis of data was completed using SPSS (Statistical program for social science) version 16. Data were expressed as mean ± SD for parametric variables and as number and percent for non-parametric variable. Comparison between groups for parametric data was done by unpaired t-test and for non-parametric variables by Mann-Whitney U test. Chi–square (X^2) test was used to compare qualitative variables. P-values < 0.05 were considered significant.

3. Results

Thirty (30) patients were included in this study; they were 28 females and 2 males, their mean age was 35.3 ± 7.5 years (25–60 years) with unilateral CTS (30 wrists). Their duration of illness was 8.8 ± 1.9 years (6–12 months). Most of patients were high intensive hard workers 28/30. Patients were recruited from the Rheumatology and Rehabilitation outpatient clinic, Minia University Hospital, Minia Governorate, Egypt; in the period from October 2014 to March 2015.

In group I (US-guided injection technique) they were 14 females and 1 male, their age was 34.9 ± 6.6 years (25–45 years) and disease duration 6.1 ± 3.2 years (2–12 months). In group II (blindly injected) they were also 14 females and 1 male, their age was 35.8 ± 8.6 years (25–60 years) and disease duration 5.7 ± 3.3 years (1–12 months). According to the electrophysiological studies and clinical examination there were 28 patients with moderate CTS and 2 patients with mild CTS and they were equally distributed between groups.

Patients were assessed before and after injection in each group according to clinical data, BCTQ, nerve conduction studies and US imaging (Table 1). It showed significant difference within the group and by comparing both groups after injection, only, tingling and numbness was significantly different; 2(13%) in group I *vs* 11(73%) in group II ($p = 0.001$). There was a significant difference within the groups with respect to SSS ($p = 0.03$) in group I and ($p = 0.05$) in group II. Similar findings could not be detected with respect to FSS within groups. However, both scales tended to improve after 4 weeks (Table 2).

Both groups showed significant improvement in their NCS after injection ($p < 0.0001$) (Table 3). In group I, the median nerve CSA at baseline was 14.5 ± 1.7 mm (11–17 mm) and significantly improved after injection 9.6 ± 1.7 mm (7–12 mm) ($p < 0.0001$). Similarly, in group II the CSA was 14.5 ± 1.7 mm (12–18 mm) at baseline and