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Original Article

Effectiveness of ultrasound and median nerve gliding with and without shock-wave therapy in patients with moderate carpal tunnel syndrome

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Abstract. [Purpose] The aim of this research was to see how ultrasound and nerve gliding with and without shock wave therapy effects on clinical and sonographic data of patients with carpal tunnel syndrome (CTS). [Participants and Methods] Forty four patients with moderate carpal tunnel syndrome participated in this research. One group got shock-wave therapy in addition to median nerve glide exercises and ultrasound, whereas the other group received median nerve glide exercises and ultrasound alone. Hand grip strength (HGS), pinch grip strength (PGS), Visual Analogue Scale (VAS)-pain, Boston Questionnaire (BQ), and Cross-sectional area (CSA) of median nerve were examined before and after 10 sessions of treatment. [Results] HGS, PGS, VAS, BQ and CSA of median nerve improved considerably after therapy. [Conclusion] Patients with moderate CTS who received ultrasound and median nerve glide exercises with and without shock-wave therapy improved considerably without preference of adding shock-wave therapy to other treatment.

Key words: Ultrasonic therapy, Shock-wave therapy, Cross sectional study

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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most frequent form of peripheral entrapment neuropathy, which results in median nerve injury and loss of hand use if not treated on time[1)]. Nerve compression is caused due to specific location of nerve in the tunnel, and this condition might emerge after repeated wrist motion[2)]. Numbness, tingling, and nocturnal discomfort or pain after hard effort is common symptoms of CTS. Severe neuropathy causes hand weakness, as well as grip insufficiency and sometimes objects dropping from the hand[3)]. The severity of CTS dictated how it was treated. Surgical decompression should be provided to patients with severe CTS or whose symptoms have not improved following conservative treatment[4)]. Splints, exercises[5)], low-level laser therapy (LLLT)[6–8)], mobilization[9, 10)], ultrasound[11)], and shock wave therapy[12)] are advised for mild to moderate problems. Shock-wave therapy (SWT) has been studied as a new treatment for peripheral nerve injury owing to its good influence on nerve cell regeneration. A shock wave is a sonic pulse with precise physical features that is generated outside the body and directed on a specific portion of the body. SWT decreases the pain of peripheral nerve injury while improving local vascular remodeling and cellular regeneration[13)]. It has been shown to be effective in the treatment of a variety of painful inflammatory soft tissue conditions[12)]. In individuals with mild to severe CTS, ultrasound and shock wave had a favorable impact on pain and function[15)]. Some research indicated shock wave with splint had the best effects

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on pain and disability in compared to splint alone[16, 17]. Also in patients with mild to severe CTS, conservative therapy with ultrasound or LLLT combined with gliding exercises is beneficial[18]. According to the studies mentioned above, and to the best of our knowledge, no research has been done on combining US with nerve gliding exercises with and without SWT. SWT is considered very new and its use has recently become common. Additionally, SWT have anti-inflammatory and analgesic effects, it has been also suggested that ESWT can lead to tissue remodeling and reinnervation of the median nerve by generating acoustic waves within the tissue and increasing the metabolic rate of tissues[12]. Based on research, a combined therapy seems to be the most successful choice, and clinics often use a mix of modalities or exercises[19]. As a result, we decided to examine US and median nerve gliding with and without SWT in patients with mild CTS. As well besides clinical symptoms, ultrasonography seems to be beneficial in diagnosing CTS and detecting CSA of the median nerve[20, 21]. Therefore the second goal was to analyze changes in median nerve CSA following therapy.

PARTICIPANTS AND METHODS

A total of 44 participants (12/10, 11/11 male and female) with age (42 ± 8, 41 ± 7 years), BMI (27 ± 5.6, 27.7 ± 4.3 kg/m^2) with duration of disease (8 ± 1.3, 7.8 ± 1.8 months) respectively in group A and B were enrolled in this double-blind randomized study. The patients, outcome assessor and the person who analyzed the outcomes were blinded to details of treatment protocols. But, interventions were performed by a physical therapist who was not blinded. Positive "phalen's test, tinel's test" and neurophysiological diagnostic of moderate CTS, regardless of the length of CTS were inclusion criteria. Patients with orthopedic, neurologic, or rheumatologic illnesses in upper limb, or NSAIDS injections in previous 6 months, as well as diabetics and pregnant females, were excluded[16]. All patients referred by a neurological expert physician in Yasoj city. Patients were randomly assigned based on a computer-generated list to group A and B. Sample size were determined using the G*Power software version 3.1.7 (G*Power from University of Dusseldorf, Germany) for statistical power of 80%, confidence interval of 95%, and medium effect size (0.56) based on pinch variable[23]. The Ethics Committee of Tehran University of Medical Sciences authorized this research since it included human beings (IR.TUMS.FNM.REC.1399.107). All participants were told about the research and given formal informed permission. Twenty two patients in Group A underwent ultrasound, median nerve glide exercise and shock wave therapy without priority for modality use order. Twenty two patients in group B received ultrasound and median nerve glide exercise alone. Shock-way (The Novin, 90 G (Isfehan, Iran) device) was regularly calibrated with probe positioned between the thenar and hypothenar eminences (position of elbow in 90 degrees of flexion and forearm supination) twice a week for two weeks. Shock wave therapy consisting of 900 shocks, 4 bar, 3 to 5 minutes, and 15 Hz[16, 22]. Ultrasound (210/ NOVIN/Iran: probe 1 MHz, 1w/cm^2, pulse width 1 ms (1:4)) with wrist in semi-flexion was applied for five min during five days a week, for two weeks. Nerve glide exercise were performed 10 times each session and held for 10 seconds each time. This medication was provided five times each week for a total of fourteen days[23].

For outcome measures pain was quantified using a visual analog scale[24]. Grip strength was assessed by Hydraulic Hand Dynamometer with participants sitting comfortably with their shoulders abducted and neutrally rotated, elbows flexed to 90 degrees, and forearms and wrists in a neutral posture[25]. Pinch dynamometer (Hydraulic Pinch gauge, Saehan, SH5005, Nottingham, England) was applied to measure the degree of lateral pinch power for all patients. Symptom severity scale (SSS) and Functional status scale (FSS) evaluated by Boston Carpal Tunnel Questionnaire (BCTQ)[26]. Cross section of area (CSA) of median nerve was calculated with high-resolution ultrasonography device (2100, Hundai, Seoul, Korea) with linear transducers, 7–10 MHz. All patients were in neutral with their palms facing upwards. Average of three measurements of full course of the median nerve in carpal tunnel was evaluated for CSA measurement[27]. SPSS Version 22 (IBM Inc., Armonk, NY, USA) was used for analysis of data. The Kolmogorov Smirnov test was performed to establish that the data followed a normal distribution ($p>0.05$). The paired t-test and independent t-test were used to assess the changes in variables before and after the intervention and across groups. The range of confidence was set at 0.95, and the statistical significance was 0.05. Cohen's d effect size was used for effect size analysis. Cohen states that the effect size is low if $d=0.2$, medium if $d=0.5$, and big if $d=0.8$[28].

RESULTS

A total of 44 participants (12/10, 11/11 male and female) with age (42.2 ± 8.12, 42.2 ± 8.12 years), BMI (27.2 ± 5.61, 27.7 ± 4.31 kg/m^2) with duration of disease (8 ± 1.3, 7.8 ± 1.8 months) respectively in group A and B were enrolled in this study with similarity between two groups. Tables 1–5 shows the significant change ($p<0.05$) of pain reduction, Functional Status Score (FSS) and Symptom Severity Score (SSS), grip and pinch strength and cross sectional area (CSA) of median nerve from pre-intervention to post-intervention in pain, Functional Status score, and Symptom Severity score within the groups. There was no statistically significant difference between groups A and B in all on outcome measures ($p>0.05$).

Table 1. Comparative analysis of Visual Analogue Scale (n=22 in each group)

VAS (cm)	Group A	Group B
Pre	7.70 ± 2.21	8.62 ± 1.42
Post	3.00 ± 2.31*	4.22 ± 2.41*
Effect size	2.08	2.22

VAS: visual analogue scale. *indication missing.

Table 2. Comparative analysis of grip strength score (n=22 in each group)

GS	Group A	Group B
Pre	22.8 ± 5.72	19.5 ± 5.62
Post	27.7 ± 4.62*	23.3 ± 5.42*
Effect size	0.94	0.69

GS: grip strength. *indication.

Table 3. Comparative analysis of Pinch strength score (n=22 in each group)

PS	Group A	Group B
Pre	9.07 ± 2.72	8.62 ± 2.93
Post	12.8 ± 1.75*	10.9 ± 3.06*
Effect size	1.63	0.76

PS: pinch strength. *indication.

Table 4. Comparative analysis of SSS and FSS between two groups (n=22)

SSS/FSS		Group A	Group B
SSS	pre	3.41 ± 0.81	3.52 ± 0.70
	post	1.90 ± 0.70*	2.00 ± 0.91*
Effect size		1.99	1.87
FSS	pre	3.30 ± 0.81	3.51 ± 0.71
	post	1.76 ± 0.75*	2.21 ± 0.90*
Effect size		1.97	1.60

SSS: symptom severity score: FSS: functional status score. *indication.

Table 5. Comparative analysis of CSA (n=22 in each group)

CSA (mm^2)	Group A	Group B
Pre	11.3 ± 2.3	10.8 ± 2.11
Post	10.1 ± 2.40*	9.71 ± 2.02*
Effect size	0.51	0.52

CSA: cross sectional area. *indication.

DISCUSSION

In this research we aimed to declare the effect of ultrasound and median nerve glide exercises with and without SWT in patients with moderate CTS. Pain, grip and pinch strength, functional status score and symptom severity score and cross-sectional area of the median nerve improved. Group A identified a greater effect size on lateral pinch and grip strength, FSS and SSS. This may be was due to superimposing effects of SWT to therapeutic US and nerve glide exercise. Previous researches investigated about the effect of SWT with US and cryo-US therapy, or US plus nerve gliding with LLLT plus nerve gliding or median nerve glide exercises alone[14, 19, 29, 30]. It seems that anti-inflammatory effect of therapeutic US associated with nerve glide exercise could provide relief of pain with improving of strength and function. Anti-inflammatory effect associated with reduction of pressure in soft tissue around the wrist and improving of ischemia are different causes of these results. Although based on effect size, group A had a higher effect on pinch and grip strength, as well as FSS and SSS than group B that received ultrasound and nerve gliding exercise alone. ESWT involves vascular endothelial growth factor result in decreasing of local inflammation and release of pressure on the median nerve. Likewise ESWT leads to anti-inflammatory effects through reduction of the levels of calcitonin gene-related peptide and effects on inflammation of the soft tissues around the median nerve[22]. Median nerve gliding exercises leads to widening the carpal tunnel and stretching the transverse carpal ligament, and with therapeutic US leads to reduction of pain, and strength and function improving. Due to differences in methods we couldn't compare our research findings with previous study; therefore our results are unique to our approach. CSA changing of median nerve is caused by reduction of inflammation in soft tissues around the median nerve[21]. Several studies have shown the beneficial effects of SWT in reducing inflammation and enhancing CSA. However, we did not see any further superiority effects of SWT in groups A.

Evaluation of short-term effects and combination of therapeutic US with SWT were two limitations of our study. In future study it is recommended to investigate long term effect of intervention with single treatment (SWT or US in each group).

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The authors declared no conflict of interest.

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