ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Comparison of the Therapeutic Efficacy of Extracorporeal Shock Wave Therapy Versus Corticosteroid Iontophoresis in Carpal Tunnel Syndrome: A Prospective Randomized Study

Karpal Tünel Sendromunda Ekstrakorporeal Şok Dalgası Tedavisi ve Kortikosteroid İyontoforezi Tedavisinin Etkinliğinin Karşılaştırılması: Prospektif Randomize Çalışma

Kasım OSMANOĞLU[a], Mustafa Turgut YILDIZGÖREN[a], Hayal GÜLER[a], Ayşe Dicle TURHANOĞLU[a]

[a]Department of Physical Medicine and Rehabilitation, Mustafa Kemal University Faculty of Medicine, Hatay, TURKEY

ABSTRACT Objective: To compare the effectiveness of radial extracorporeal shock wave therapy (r-ESWT) and corticosteroid iontophoresis (CI) in patients with carpal tunnel syndrome (CTS). **Material and Methods:** This randomized prospective study included a total of 72 wrists diagnosed with CTS of 54 patients with a mean age of 42.2±8.7 years (range, 22-59 years). The patients were randomly separated into two groups. Group 1 (n=37) received r-ESWT, and Group 2 (n=35) received CI. Evaluations were made at baseline and at 0, 1 and 3 months after treatment using the visual analog scale (VAS), Boston Symptom Severity Scale (BSSS), Boston Functional Capacity Scale (BFCS), grip strength, and electrophysiological examination. **Results:** Compared to baseline, the VAS, BSSS, BFCS, grip strength values at the 0, 1 and 3 months after treatment improved significantly in both groups (all p<0.001). However the nerve conduction study results were significantly improved only in r-ESWT group (all p<0.001). When the change levels were compared between the groups, the decrease in VAS (all p<0.001), the improvement in BSSS (p=0.029, p=0.023 and p=0.040, respectively), BFCS (p<0.001, p=0.001 and p<0.001, respectively), grip strength (all p<0.001), sensory nerve conduction velocity (p=0.001, p<0.001 and p<0.001, respectively) and distal motor latency (p=0.001, p=0.001 and p<0.001, respectively) before and at 0, 1 and 3 months after treatment were significantly higher in the r-ESWT group than the CI group. **Conclusion:** This study revealed that both methods were useful in alleviating pain and improving function in CTS, however r-ESWT seems to be more effective than CI.

Keywords: Carpal tunnel syndrome;
radial extracorporeal shock wave therapy;
iontophoresis

ÖZET Amaç: Karpal tünel sendromlu (KTS) hastalarda radyal ekstrakorporeal şok dalgası tedavisi [radial extracorporeal shock wave therapy (r-ESWT)] ve kortikosteroid iyontoforez [corticosteroid iontophoresis (CI)] tedavisinin etkinliğini karşılaştırmak. **Gereç ve Yöntemler:** Bu randomize prospektif çalışmaya, ortalama yaşları 42,2±8,7 yıl (22-59) olan 54 hastanın, KTS tanısı konulan 72 bileği dâhil edildi. Hastalar rastgele 2 gruba ayrıldı. Grup 1 (n=37) r-ESWT aldı ve Grup 2 (n=35) CI aldı. Hastalar vizüel analog skala (VAS), Boston Semptom Şiddeti Ölçeği (BSŞÖ), Boston Fonksiyonel Durum Ölçeği (BFDÖ), kavrama gücü ve elektrofizyolojik inceleme kullanılarak başlangıçta ve tedavi sonrası 0, 1 ve 3. ayda değerlendirildi. **Bulgular:** Başlangıç ile karşılaştırıldığında, tedaviden 0, 1 ve 3. ay sonra VAS, BSŞÖ, BFDÖ, kavrama gücü değerleri her iki grupta da önemli ölçüde iyileşti (tümü p<0,001). Ancak sinir ileti çalışması sonuçları sadece r-ESWT grubunda anlamlı olarak iyileşti (tümü p<0,001). Gruplar arası değişim seviyeleri karşılaştırıldığında, VAS'da azalma (tümü p<0,001), BSŞÖ'de iyileşme (sırasıyla p=0,029, p=0,023 ve p=0,040), BFDÖ (sırasıyla p<0,001, p=0,001 ve p<0,001), kavrama gücü (tümü p<0,001), duyusal sinir iletim hızı (sırasıyla p=0,001, p<0,001 ve p<0,001) ve distal motor latensi (p=0,001, p=0,001 ve p<0,001), tedaviden önce ve tedaviden 0, 1 ve 3 ay sonra, r-ESWT grubunda CI grubuna göre anlamlı derecede daha yüksekti. **Sonuç:** Bu çalışma, her iki yöntemin KTS'de ağrıyı azaltmada ve fonksiyonu iyileştirmede yararlı olduğunu, ancak r-ESWT'nin CI'dan daha etkili olduğunu ortaya koymuştur.

Anahtar Kelimeler: Karpal tünel sendromu;
radyal ekstrakorporeal şok dalgası tedavisi;
iyontoforez

Correspondence: Mustafa Turgut YILDIZGÖREN
Department of Physical Medicine and Rehabilitation, Mustafa Kemal University Faculty of Medicine, Hatay, TURKEY/ TÜRKİYE
E-mail: ftr.mustafaturgut@hotmail.com

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Carpal tunnel syndrome (CTS), a compression neuropathy of the median nerve inside the carpal tunnel, is the most prevalent compression neuropathy in the general population.[1] CTS occurs more frequently in females, with a prevalence in the general adult population ranging from 2.7% to 6.0%.[2,3] Many different treatments have been suggested for CTS, which can be categorized as conservative and surgical methods. Conservative methods include activity modification, wrist splints, local corticosteroid injections, oral medications, vitamin B_6, electrotherapy (transcutaneous electrical nerve stimulation, ultrasound, laser therapy), and lifestyle or workplace modifications.[4,5] The treatment selected for patients depends upon the severity and duration, and patient preferences.[6] The efficacy of these treatments remains controversial, and as yet there is no universally accepted approach.

Iontophoresis is a noninvasive technique which leads to physical, chemical, and biochemical modifications and the transfer of ions to the body using direct galvanic current. It offers an opportunity to deliver medication without injection or deep penetration of the medication.[7] Corticosteroid administered by the iontophoresis technique reduces inflammation by inhibiting the synthesis of inflammatory substances.[8] Corticosteroid iontophoresis (CI) also prevents several complications that may occur with steroid injection, such as infection, tendon injury, and nerve injury, which manifest as severe pain with lasting or permanent sensory loss.[7,8] During the last decade, iontophoresis has become more widely used, especially as a treatment modality for CTS.

Extracorporeal shock wave therapy (ESWT) is a non-invasive procedure that uses single-pulse acoustic waves, which are generated outside the body and focused on a specific site within the body.[9] Recently, many studies have shown the efficacy of ESWT for soft tissue injuries, including lateral epicondylitis, rotator cuff tendinopathy, achilles tendinopathy, patellar tendinopathy, hamstring tendinopathy, and greater trochanteric pain syndrome.[10-12] Although the exact anti-nociceptive mechanisms of ESWT have yet to be elucidated, ESWT may induce analgesia in the nerve fiber itself through biochemical changes and may decrease inflammation of the soft tissues.[13] When planning this study, it was assumed that these effects of ESWT could reduce CTS symptoms. To the best of our knowledge, no studies have previously evaluated the effectiveness of ESWT vs. iontophoresis in CTS treatment. Thus, the aim of the present study was to compare the efficacy of ESWT and CI, on pain, symptom severity, functional capacity, nerve conduction, and grip strength in CTS patients.

MATERIAL AND METHODS

A total of 72 wrists of 54 participants (mean age 42.2±8.7 years; range, 22-59 years) with CTS were enrolled in this randomized prospective study. Participants at the Mustafa Kemal University Medical School, Physical Medicine and Rehabilitation outpatient clinic were enrolled between May 2017 and October 2017. The main inclusion criterion was the presence of moderate CTS, confirmed by electrophysiological studies.[14] Patients were excluded from the study if they were aged <18 years or had a chronic illness (diabetes mellitus, hypothyroidism, renal or hepatic disease), inflammatory rheumatologic disease, previous release surgery or steroid injection into the carpal tunnel, thenar atrophy, malignancy, pregnancy, or any other neurological disorder contributing to symptoms. The study protocol was approved by the Medical Ethics Committee of Mustafa Kemal University (protocol code: 25.04.2017/23). Written informed consent was obtained from all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The group allocation was made using a simple-random approach with a table of random numbers to place each patient in either the r-ESWT or iontophoresis group. As a result of the randomization procedure, there were 24 patients in the r-ESWT group, and 30 patients in the iontophoresis group. All the patients had been treated with nerve and tendon gliding exercises, static-wrist splint, and vitamin B_6 for 3 months. During the study period, the patients were discouraged from taking painkillers, but if necessary, were permitted to take paracetamol. The flowchart for the study is shown in Figure 1.

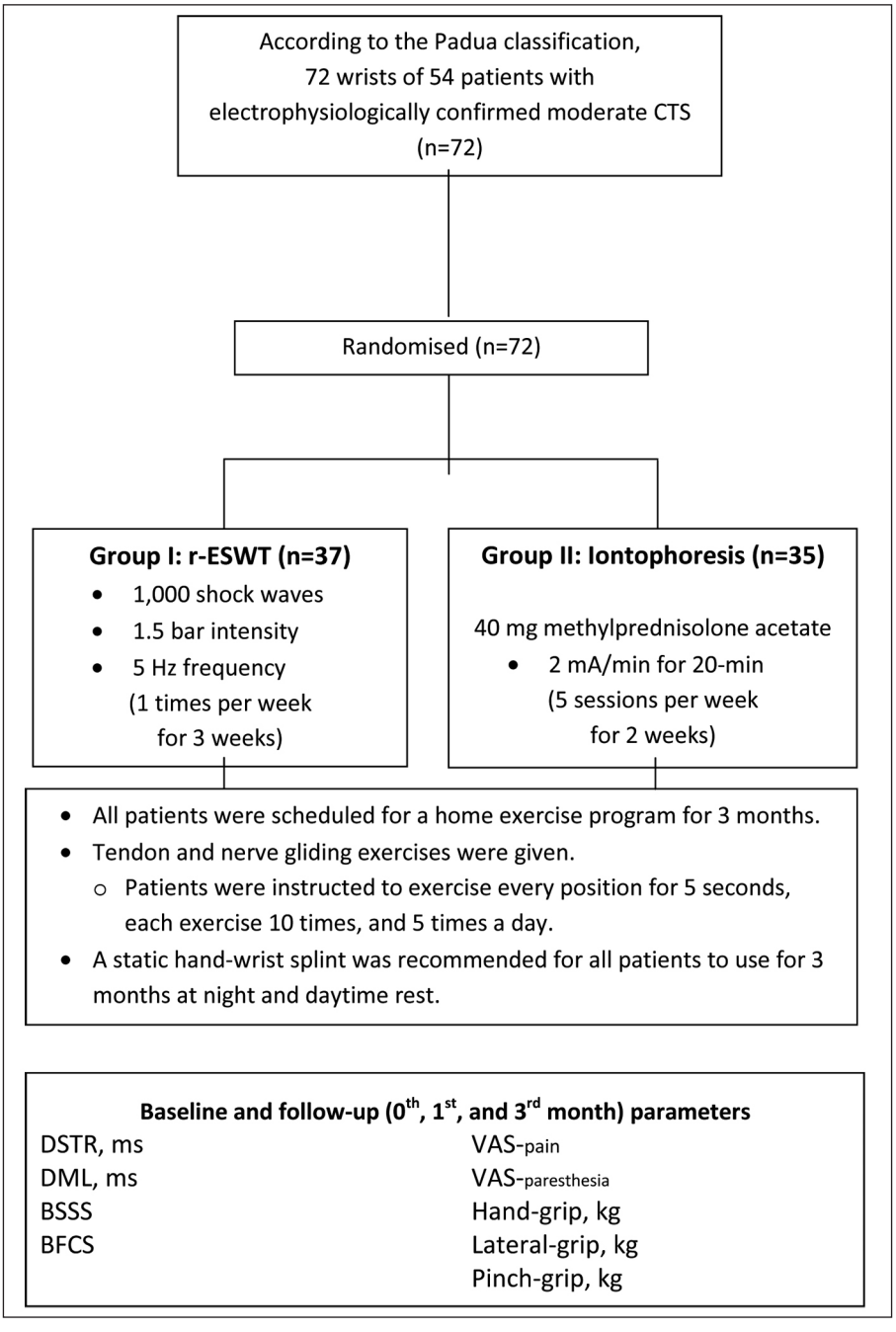

FIGURE 1: Flowchart of the study.

CTS: Carpal tunnel syndrome; ESWT: Extracorporeal shock wave therapy; DSTR: Distal sensory transmission rate; DML: Distal motor latency; BSSS: Boston symptom severity scale; BFCS: Boston functional capacity scale; VAS: Visual analog scale.

Extracorporeal Shock Wave Therapy Group

The patient's forearm was placed on a table with the palm facing up, the forearm supinated, and the elbow flexed. Then the pisiform and scaphoid bone are marked. The ESWT probe was placed 2 cm proximal of the pisiform bone on the medial side, and 2 cm proximal to the scaphoid bone on the lateral side. The treated area ranged from the pisiform level to 2 cm proximal to the median nerve, and from the scaphoid level to 2 cm proximal to the median nerve.[15] The patients received shockwaves of continuous frequency and intensity (1,000 shock

waves, at an intensity of 1.5 bar and 5 Hz frequency) for three sessions at 1-week intervals. ESWT was applied using a 15 mm head by passing the probe. ESWT was applied using a radial shock wave therapy system A Vibrolith Ortho ESWT (ELMED Turkey).

Iontophoresis Group

Group 2 (iontophoresis) patients received a total of 10 sessions of CI into the area of the carpal tunnel. This was applied using a 2- milliamp (mA) current in a 2-stage procedure. In the first stage, 2 mL of 40 mg methylprednisolone acetate, as a positively-charged solution, was placed on the active positively charged iontophoresis pad immediately over the carpal tunnel area as described by the subject. A second negatively charged pad, as the return pad, was placed 10-15 cm both ipsilateral and proximal to the active positively-charged pad. Iontophoresis was set for 20-minutes at 2 mA current, for a total of 40 mA minutes.[8]

Outcome Evaluation

All the clinical outcomes were assessed before treatment and at the end of treatment, then at 1, and 3 months after treatment. Pain severity and paresthesia level were measured using a visual analogue scale (VAS) ranging from 0 (no pain) to 10 (worst possible pain). The symptom severity and functional status of patients were measured using the Boston Functional Capacity Scale (BFCS) questionnaire. Grip strength was measured with a hydraulic hand dynamometer (Jamar Hydraulic Hand Dynamometer, Irvington, NY, USA). Lateral and pinch strength were measured using a pinch meter (Baseline Hydraulic pinch gauge, Irvington, NY, USA). Padua's classification was used for evaluating electrophysiological severity of the CTS.[14] The median motor distal latency and the median sensory nerve conduction velocity were recorded electrophysiologically by nerve conduction study.

STATISTICAL ANALYSIS

The data were analyzed using Statistical Package for the Social Sciences (Version 22.0 SPSS Inc., Chicago, IL, USA). Descriptive statistical results were shown as mean±standard deviation for continuous data, or number (n) and percentage (%) for categorical data. Demographic data were analyzed using the Mann-Whitney U test for continuous data and the X^2 test for categorical data. The time-variance of the scores of the groups was assessed with the repeated measures analysis of variance (ANOVA) test. Differences between the groups were compared using the Mann-Whitney U test. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

There was no significant difference between the two groups in terms of demographic data or clinical data, including the electrophysiology findings. The demographic and clinical features are given in Table 1.

In both groups, there were statistically significant differences between the before and after treatment values (at 0, 1, and 3 months of treatment) in terms of clinical assessments: VAS ($p<0.001$), Boston Symptom Severity Scale (BSSS) ($p<0.001$), BFCS ($p<0.001$), and grip strength ($p<0.001$) (Table 2, Table 3, Table 4). In the nerve conduction study, significant differences were found in the r-ESWT group at 0, 1, and 3-months after treatment compared to baseline values (Table 4).

When the groups were compared in terms of all the assessment parameters, there were significant differences between the ESWT and the iontophoresis groups in the VAS score and the BSSS at 1 and 3 months after treatment, and in grip strength, and in nerve conduction studies at 0, 1 and 3 months after treatment.

A comparison of the difference between the scores of the groups showed significantly superior improvements in the r-ESWT group in all parameters at the end of treatment, at 1 month, and at 3 months after treatment ($p<0.05$) (Table 5, Table 6).

DISCUSSION

In the current study, remarkable improvements were observed in the VAS-pain score, the Boston questionnaire and functional capacity scores, and grip strength scores in both the r-ESWT and iontophoresis groups, and the effects lasted for 3 months. The higher improvement was in the r-ESWT group. Moreover, there was also determined to be a significant increase in sensory nerve conduction velocity or

TABLE 1: Demographic and clinical features of the groups.

	ESWT (n=37)	Iontophoresis (n=35)	p values
Age, years	41.6±9.3	42.9±8.2	0.523
Gender, n (%)			
Male	3 (12.5)	9 (30)	0.124
Female	21 (87.5)	21 (70)	
Weight, kg	73.5±14.6	77.7±10.4	0.113
Height, cm	160.2±6.0	158.9±6.2	0.416
Symptom duration, mo	27.1±30.3	22.3±21.6	0.435
Body mass index, kg/m2	28.6±5.3	30.9±5.0	0.985
Affected side, n (%)			
Right	23 (62.2)	18 (51.4)	0.358
Left	14 (37.2)	17 (48.6)	
Baseline evaluations			
VAS for pain	6.6±2.2	6.0±1.8	0.110
VAS for paresthesia	7.1±2.5	6.6±1.0	**0.019**
Tinnel test positivity, n (%)	27 (73.0)	24 (68.6)	0.681
Phalen test positivity, n (%)	33 (89.2)	26 (74.3)	0.100
Boston symptom severity scale	2.7±0.8	2.9±0.6	0.565
Boston functional status scale	2.7±0.7	2.5±0.8	0.104
Nerve conduction study, m/sec			
• Sensory conduction velocity of distal median nerve	40.8±4.5	40.5±3.8	0.620
• Motor distal latency	5.1±1.0	5.0±1.0	0.689
Grip strength, kg			
• Hand grip	21.7±7.6	20.9±6.7	0.495
• Lateral grip	4.29±1.4	4.23±1.3	0.546
• Pinch grip	5.70±1.8	5.67±1.7	0.565

Bold p values show statistical significance (p<0.05); Repeated measures analysis of variance; *p<0.001 with baseline; **Mann-Whitney U test; ESWT: Extracorporeal shock wave therapy; VAS: Visual analog scale.

a decrease in motor distal latency at the end of treatment, and at 1 and 3 months after r-ESWT compared with the results of the iontophoresis group.

There is currently no defined standard treatment protocol for the application frequency, the energy intensity and total shots for the use of ESWT in CTS.[15] Reported pulse repetition frequency varies between 3 Hz and 5 Hz, and practice with 5 Hz is more common.[9,15,16] Studies have demonstrated the intensity of energy and total shots in a range of 0.03 mJ/mm^2 to 0.15 mJ/mm^2 and 800 to 2,500 shots, respectively. In the aforementioned studies, the ESWT group benefited clinically from all applications. In the present study, the more frequently used applications in literature was preferred and rESWT was applied with 1,000 shots, 1.5 bar intensity of energy, and frequency of 5 Hz.

In recent experimental animal model studies, it has been shown that low-energy ESWT which is focused directly on the nerve tissue has a positive effect on re-innervation and functional improvement with no evident adverse effects.[12,13] Although high-intensity ESWT may be harmful to the nerve tissues, it has recently been shown that this therapy causes no damage to the peripheral nerves. This is due to the recovery within 14 days of the temporary decreases in median nerve conduction velocity values with no significant weakness or impaired function.[17] The results of the current study demonstrated an increase in sensory nerve conduction velocity or a decrease motor distal latency, thereby confirming that r-ESWT can be safely used in the treatment of CTS.

In 2013, Seok et al. reported that ESWT can be as useful as corticosteroid injection for relieving

TABLE 2: Baseline and after treatment (0, 1, and 3. month) follow-up results of clinical measurements of the groups.

	ESWT (n=37)	Iontophoresis (n=35)	**p values
VAS for pain			
Baseline	6.6±2.2	6.0±1.8	
After treatment			
0th month	3.7±2.3*	4.8±1.4*	0.051
1st month	3.6±2.2*	4.8±1.4*	**0.042**
3rd month	3.5±2.3*	4.9±1.4*	**0.003**
VAS for paresthesia			
Baseline	7.1±2.5	6.6±1.0	
After treatment			
0th month	7.0±2.4	6.6±1.0	**0.018**
1st month	7.0±2.4	6.5±1.0	**0.017**
3rd month	7.0±2.4	6.6±1.0	**0.021**
Boston symptom severity scale			
Baseline	2.7±0.8	2.9±0.6	
After treatment			
0th month	1.7±0.4*	2.1±0.5*	0.051
1st month	1.7±0.5*	2.1±0.5*	**0.041**
3rd month	1.7±0.5*	2.1±0.6*	**0.005**
Boston functionalstatus scale			
Baseline	2.7±0.7	2.5±0.8	
After treatment			
0th month	1.8±0.6*	1.9±0.6*	0.573
1st month	1.9±0.5*	2.0±0.6*	0.948
3rd month	1.9±0.6*	2.1±0.7*	0.236

Bold p values show statistical significance (p<0.05); Repeated measures analysis of variance; *p<0.001 with baseline; **Mann-Whitney U test; ESWT: Extracorporeal shock wave therapy; VAS: Visual analog scale.

symptoms of CTS. In that study, the VAS score and symptom severity scale improved gradually in both groups at 3 months after treatment.[9] However, the nerve conduction study parameters of the ESWT group did not improve. In a prospective randomized study by Wu et al. in 2015, a significant improvement was reported in the pain and disability scores of patients who received r-ESWT once a week for 3 weeks plus a neutral night splint compared to a group applied with placebo r-ESWT plus the same type of splint.[18] Significant differences between the treatment groups were seen in favor of the r- ESWT group in respect of pain at least 3 months after treatment. In the current study, the pain and function scores of both groups were seen to have significantly improved at the end of treatment, and at the 1 and 3-month follow-up examinations.

The true mechanism of ESWT in CTS treatment remains unknown. In experimental studies it has been shown that the production of nitric oxide, angiogenesis, and neurogenesis are stimulated by low-energy ESWT through involvement of vascular endothelial growth factor.[18,19] ESWT creates an anti-inflammatory effect by lowering the levels of calcitonin gene-related peptide. It has also been shown that ESWT may reduce soft tissue inflammation around the median nerve, which then reduces the pressure on the median nerve.[9,20] Although ESWT has been shown to be effective and reliable in the CTS treatment, there is continuing uncertainty about the treatment intensity, the number of sessions required, the duration of treatment, and the length of intervals between sessions.

Iontophoresis is a transdermal drug delivery method, thereby allowing medication to be adminis-

TABLE 3: Baseline and after treatment (0, 1, and 3. month) follow-up results of grip strength scores of the groups.

	ESWT (n=37)	Iontophoresis (n=35)	**p values
Hand grip			
Baseline	21.7±7.6	20.9±6.7	
After treatment			
0th month	25.8±7.5*	21.2±6.8*	**0.003**
1st month	25.9±7.3*	20.9±6.6*	**0.003**
3rd month	26.1±7.3*	20.9±6.7*	**0.003**
Lateral grip			
Baseline	4.29±1.4	4.23±1.3	
After treatment			
0th month	5.35±1.5*	4.65±1.4*	**0.004**
1st month	5.53±1.7*	4.64±1.4*	**0.004**
3rd month	5.45±1.6*	4.58±1.4*	**0.011**
Pinch grip			
Baseline	5.70±1.8	5.67±1.7	
After treatment			
0th month	6.87±1.5*	6.00±1.7*	**0.010**
1st month	6.93±1.6*	5.91±1.7*	**0.008**
3rd month	6.91±1.7*	5.78±1.6*	**0.009**

Bold p values show statistical significance (p<0.05); **Mann-Whitney U test; Repeated measures analysis of variance; *p<0.001 with baseline; ESWT: Extracorporeal shock wave therapy.

TABLE 4: Baseline and after treatment (0, 1, and 3. month) follow-up results of nerve conduction velocity scores of the groups.

Nerve conduction study	ESWT (n=37)	Iontophoresis (n=35)	**p values
Sensory conduction velocity of distal median nerve			
Baseline	40.8±4.5	40.5±3.8	
After treatment			
0th month	43.8±7.7*	40.5±4.0	**0.041**
1st month	43.9±6.8*	40.6±3.9	**0.011**
3rd month	44.7±7.7*	40.6±3.7	**0.010**
Motor distal latency			
Baseline	5.1±1.0	5.0±1.0	
After treatment			
0th month	4.8±1.1*	5.0±0.9	0.146
1st month	4.8±0.9*	5.0±1.0	0.117
3rd month	4.7±1.0*	5.0±1.0	**0.009**

Bold p values show statistical significance (p<0.05); **Mann-Whitney U test; Repeated measures analysis of variance; *p<0.001 with baseline; ESWT: Extracorporeal shock wave therapy.

tered without injection. With the application of a low electric current into the skin, the ionically charged steroid medication is driven through the skin.[21] The advantages of iontophoresis include that it is non-invasive, absorption is uniform, and there are no systemic side effects such as gastrointestinal distress.[22]

In a study by Gökoğlu et al., CTS patients were divided into two groups, with Group 1 receiving 40 mg methylprednisolone acetate injected locally in the carpal tunnel, and Group 2 receiving iontophoresis of dexamethasone sodium phosphate.[8] Both dexamethasone iontophoresis and the corticosteroid injec-

TABLE 5: Comparison of difference between VAS, Boston Symptom Severity Scale, and Boston Functional Status Scale scores of the groups.

Δ%	BT-AF (0.mo)	BT-AF (1.mo)	BT-AF (3.mo)
VAS for pain			
r-ESWT	-46.0±24.2	-46.3±23.2	-48.6±24.3
Iontophoresis	-17.6±20.3	-18.4±20.5	-17.3±16.0
p values	**<0.001**	**<0.001**	**<0.001**
VAS for paresthesia			
r-ESWT	-1.7±4.6	-0.2±8.4	-2.0±4.6
Iontophoresis	-1.9±4.9	-0.9±8.9	-0.3±9.8
p values	**0.313**	**0.434**	**0.836**
Boston symptom severity scale			
r-ESWT	-33.6±13.6	-33.3±13.1	-33.9±13.6
Iontophoresis	-25.6±23.2	-25.7±24.3	-25.8±24.7
p values	**0.029**	**0.023**	**0.040**
Boston functional status scale			
r-ESWT	-31.2±11.6	-28.3±12.1	-29.6±12.3
Iontophoresis	-18.3±20.1	-18.1±17.5	-15.1±17.0
p values	**<0.001**	**0.001**	**<0.001**
Grip strength			
Hand grip			
r-ESWT	22.4±18.6	24.1±25.9	25.2±23.8
Iontophoresis	1.4±3.4	0.0±3.4	0.3±3.7
p values	**<0.001**	**<0.001**	**<0.001**
Lateral grip			
r-ESWT	27.2±28.6	31.0±28.4	29.2±25.9
Iontophoresis	10.2±9.5	10.4±11.7	9.0±11.6
p values	**<0.001**	**<0.001**	**<0.001**
Pinch grip			
r-ESWT	25.5±27.1	26.5±28.0	25.5±25.9
Iontophoresis	7.9±11.0	6.6±10.1	4.5±10.1
p values	**0.001**	**<0.001**	**<0.001**

Bold p values show statistical significance (p<0.05); VAS: Visual analog scale; BT: Before treatment; AT: After treatment; r-ESWT: Radial extracorporeal shock wave therapy.

TABLE 6: Comparison of difference between nerve conduction study scores of the groups.

Δ%	BT-AF (0.mo)	BT-AF (1.mo)	BT-AF (3.mo)
Nerve conduction study			
Sensory conduction velocity of distal median nerve			
r-ESWT	7.2±12.5	7.4±9.4	9.4±12.6
Iontophoresis	0.1±6.8	0.3±7.6	0.3±6.6
p values	**0.001**	**<0.001**	**<0.001**
Motor distal latency			
r-ESWT	-6.3±9.3	-6.0±9.0	-8.4±6.6
Iontophoresis	-0.6±3.7	-0.7±2.3	-0.7±1.6
p values	**0.001**	**0.001**	**<0.001**

Bold p values show statistical significance (p<0.05); BT: Before treatment; AT: After treatment; r-ESWT: Radial extracorporeal shock wave therapy.

tions were reported to be effective in the treatment of CTS, but symptom relief was greater at 2 and 8 weeks with the injection of corticosteroids. In contrast, Amirjani et al. compared iontophoresis with 0.4% dexamethasone sodium phosphate with placebo in patients with mild to moderate CTS and significant improvements were observed following iontophoresis of 0.4% dexamethasone according to subjective symptom severity based on the Levine self-assessment questionnaire.[7] In the current study, both groups showed significant improvements in the VAS scores, BSSS and the functional status scores, and grip strength scores at 0, 1 and 3 months after treatment compared with baseline values ($p<0.001$). A comparison of the difference between the scores of the 2 groups showed significantly superior improvements in the r-ESWT group in all follow-up periods ($p<0.05$).

The major limitation of our study was the short follow-up period. A future study of the long-term effects is needed to confirm these findings. The second limitation was the small sample size. Finally, factors that may influence the effectiveness of ESWT on CTS were not examined, such as the number of sessions, dosage, intensity and frequency.

CONCLUSION

In the light of our results, both r-ESWT and CI are effective treatment modalities for CTS. However, it was observed that r-ESWT was superior to CI in reducing pain, improving function, and increasing grip strength for up to at least 3 months.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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