Original Article

Effect of extracorporeal shock wave therapy on the treatment of patients with carpal tunnel syndrome

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Abstract

Background: The carpal tunnel syndrome (CTS) is the most common neuropathy. The aim of this study was to evaluate the effect of a new and noninvasive treatment including extracorporeal shock wave therapy (ESWT) in the treatment of CTS.

Materials and Methods: This study is a clinical trial conducted on 60 patients with moderate CTS in selected health centers of Isfahan Medical University from November 2014 to April 2015. Patients with CTS were randomly divided into two groups. Conservative treatment including wrist splint at night for 3 months, consumption of nonsteroidal anti-inflammatory drugs for 2 weeks, and oral consumption of Vitamin B1 for a month was recommended for both groups. The first group was treated with ESWT, one session per week for 4 weeks. Focus probe with 0.05, 0.07, 0.1, and 0.15 energy and shock numbers 800, 900, 1000, and 1100 were used from the first session to the fourth, respectively. The evaluated parameters were assessed before treatment and after 3 and 6 months. Data were analyzed using SPSS version 19, Student's *t*-test, and Chi-square test.

Results: All parameters were significantly decreased in the ESWT group after 3 months. These results remained almost constant after 6 months compared with 3 months after treatment. However, only two parameters considerably improved after 3 months of treatment in the control group. The entire indexes in the control group implicated the regression of results in long-term period.

Conclusion: It is recommended to use ESWT as a conservative treatment in patients with CTS.

Key Words: Boston, carpal tunnel syndrome, extracorporeal shock wave therapy, visual analog scale

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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common neuropathy resulting from peripheral nerve trapping, its prevalence in adults general population has been reported 2.7–5.8%.[1] It is not clear, but it has been reported that 50% patients have bilateral CTS.[2] The annual rate of this disorder has been reported as 276–329 cases/hundred thousand.[3] The etiology of this disorder is not properly known, but any conditions such as obesity, diabetes, hypothyroidism, arthritis, repetitive movements of the wrist, and also increasing pressure in the tunnel can be associated with this disease.[4] Unfortunately, the patients with fingers' pain and paresthesia resulted from CTS, have dysfunction of daily activities, which make

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it necessary to treat.[1] So far, different methods are presented to treat CTS patients and they are divided into two main types: Noninvasive treatment that is used for patients with mild and moderate CTS and includes wrist splint, laser therapy, oral corticosteroids, nonsteroidal anti-inflammatory drugs, ultrasound therapy, and changing the working conditions with reducing repetitive movements, the efficacy of which is not known in short-term;[5] aggressive treatments include steroid injection, surgery, and releasing the transverse carpal ligament.[6] While the aggressive treatments cause 60–90% long-term improvement, because of their aggressive nature, they are not acceptable by patients as the first-line, and it is preferred to use noninvasive treatments in the primary steps of disease even in acute cases. On the other hand, local steroid injection has side effects including infection, severe pain, loss of sensation, and limitations such as tenocyte dysfunction and tendon degeneration.[7,8] Many studies revealed that using extracorporeal shock wave therapy (ESWT) has a long-term effect on the pain improvement raised from soft tissue disorders such as plantar fasciitis and Achilles, shoulder and elbow tendinopathy.[9,10] It seems that the therapeutic effect of ESWT acts in two ways; induction of anesthesia in nerve fibers by biomechanical changes and reducing the inflammation of soft tissues.[11,12] It is suggested that probably these effects reduce clinical symptoms of CTS patients. Only one study evaluated the effect of ESWT for CTS treatment in 2013. In this study, conducted by Seok and Kim, 36 patients with CTS were examined in two groups, applying local steroid injection and ESWT during 3 months. In patients with ESWT treatment, the pain range reduced significantly after 1 and 3 months, while in the patients with local steroid injection, a significant reduction was reported only after 3 months.[13] Nevertheless, the electro-diagnostic assessments in the ESWT group did not show a significant improvement. The purpose of the current study is to evaluate the EWST effect on reducing symptoms in patients with moderate CTS.

MATERIALS AND METHODS

This study is a single-blind, clinical trial survey conducted on patients with CTS in selected Medical Centers of Isfahan University of Medical Sciences during 2014–2015.

Initially, patients with symptoms such as wrist pain or numbness and paresthesia on the first, second, and third fingers along with night symptoms were examined by three tests: Phalen, tinel, and compression. If the second and third tests were found positive, the patient was referred to a physical medicine specialist for electrodiagnostic assessment, and if they had moderate CTS, entered in the study. The exclusion criteria include: Mild and severe cases, lack of patients' consent, consumption of systemic corticosteroids, pregnancy, history of distal forearm or wrist fracture and history of recent wrist or arm trauma, coagulation disorders, previous CTS surgery or steroid injection in carpal tunnel, systemic diseases such as diabetes, hypothyroidism, rheumatoid arthritis, thenar atrophy, active peptic ulcer, and renal failure.

Sixty patients were selected by simple nonprobability sampling and randomly divided into two groups. The diagnostic criteria of CTS based on electrodiagnostic findings included: Distal latency of median sensory nerve action potential (SNAP) of third finger <3.6 and distal latency of median compound muscle action potential (CMAP) of abductor pollicis brevis (APB) muscle <4.2. If only the SNAP distal latency was long, patient had mild CTS, but if both SNAP and CMAP distal latency were long and denervation was not observed in electromyography of APB, it was moderate CTS.[14] Electro-diagnostic assessment was conducted with Nihon Kohden device by a physical medicine specialist. During the study, the temperature of patients' hands was kept >32. For assessing the motor response, the recorder electrode was fastened on APB muscle and median nerve was stimulated at wrist region with stimulator electrode, 8 cm proximal to the active electrode and the amplitude parameters, and then the distal latency was recorded. However, regarding the sensory response, the recorder was fastened on the third finger, and stimulator electrode was placed 14 cm proximal to the recorder and was stimulated median nerve once at wrist and once at palm region, then distal latency was recorded. Meanwhile, for evaluating the pain and function of patients, visual analog scale (VAS) score was measured and Boston questionnaire was asked. Boston questionnaire consists of two sections. One section has 11 questions related to the severity of symptoms and the other has 8 questions related to the functional status.

Then, the conservative treatment was given to the both groups such as wrist splint at nights for 3 months, consumption of 200 mg celecoxib capsule daily (BID) along 2 weeks, and consumption of 300 mg Vitamin B1 tablet during 3 months. Furthermore, the first group was treated by ESWT in one session per week for 4 weeks with these conditions: Focus of hand piece with 0.05, 0.07, 0.1, and 0.15energy was used in the first to fourth sessions, respectively, similarly, numbers 800, 900, 1000, and 1100 shock and with constant 3 Hz frequencies in all sessions. The focus probe was placed

on the median nerve at flexor retinaculum in wrist region vertically when the patient seated, elbow 90° of flexion, and forearm and the hand were in supination.

In the second group, sham ESWT was used means the system was switched on, but the effective pulse was not given. Then, the patients were referred to the same center for electrodiagnostic evaluation after 3 and 6 months of the treatment. Energy-dispersive X-ray spectroscopy (EDX) was conducted by the same specialist, and parameters were recorded for following up symptoms severity, and functional status of patients, VAS score, and Boston questionnaire were asked again. It should be noted that the EDX man did not know which patients are being in the case or control groups. Finally, all the data were analyzed by SPSS version 19 (SPSS Inc., Chicago, Illinois, USA), for comparing data between the both groups, independent sample *t*-test was used.

RESULTS

Fifty-one women (85%) and 9 men (15%) of 60 patients with CTS were examined in two groups of ESWT and control, but the gender frequency distribution in both groups did not have significant difference ($P > 0.05$). Three patients were excluded from the control group and two subjects from ESWT group during the follow-up study. The patients' mean age was 51.5 ± 8.5 years in the case group and 49 ± 7.3 years in the control group. Moreover, the mean duration of disease in two groups was 14 ± 1.39 and 14.87 ± 2.14 weeks, respectively, which is not significantly different ($P > 0.05$).

Evaluating the pain average based on VAS score in the case and control groups showed that there was not a significant difference before (baseline) treatment ($P > 0.05$). A significant reduction was seen in pain score in both groups after 3 months from the baseline. However, the amount of this reduction was more significant in the ESWT group ($P < 0.05$). This result almost was maintained after 6 months of treatment in the ESWT group but was increased in the control group significantly, although in both groups was considerable rather to baseline [Figure 1].

Evaluating the mean score of symptoms based on Boston questionnaire in two groups showed that there was no significant difference in baseline ($P > 0.05$). After 3 months from the beginning of treatment, a reduction was seen in the mean score of symptoms severity, but it was only significant in the treatment group ($P > 0.05$). After 6 months from the beginning of treatment, the symptoms' mean score did not change significantly compared to the previous 3 months in the ESWT group ($P < 0.05$) but was increased in the control group even further of baseline [Table 1].

Assessing the functional status based on Boston questionnaire showed that the mean difference in two groups before the treatment was not significant ($P > 0.05$). After 3 months from the starting of treatment, a significant decrease was seen in the mean score of functional status in both groups, but this value was more in the ESWT group ($P < 0.05$). The mean of functional status reduction after 6 months of treatment was continued significantly regarding before 3 months in the case group ($P < 0.05$), but it was increased in the control group after 6 months rather than 3 months after the treatment [Table 2].

Assessing electrodiagnostic parameters including CMAP and SNAP distal latency showed the mean values' were decreased in both group, but in the treatment group, it is more significant after 3 months of treatment ($P < 0.05$). Evaluating SNAP changes after 6 months of treatment compared to before 3 months were small and not significant in the ESWT

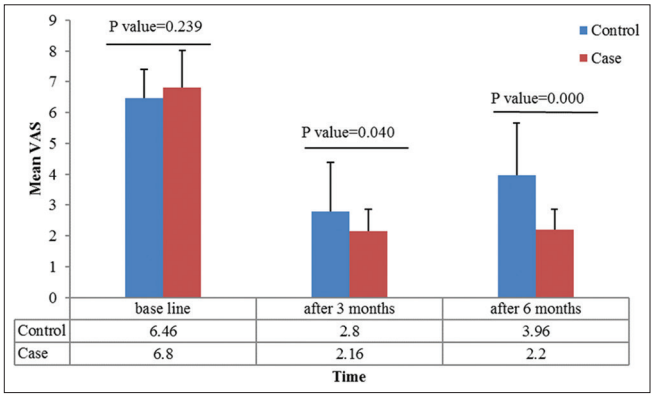

Figure 1: Bar chart of comparison of the mean visual analog scale scores before treatment and after 3 and 6 months

Table 1: Comparison of the mean score of Boston symptoms severity in two groups before treatment and after 3 and 6 months

Time	Group	Mean	SD	*P*
Base line	Control	2.763	0.267	0.980
	Case	2.557	0.615	
After 3 months	Control	2.644	0.452	0.040
	Case	1.278[a]	0.375	
After 6 months	Control	2.783	0.409	0.005
	Case	1.280[a]	0.470	
Δ0-3 months	Control	0.119	0.342	0.000
	Case	1.279	0.427	
Δ0-6 months	Control	−0.019	0.264	0.000
	Case	1.277	0.500	
Δ3-6 months	Control	−0.139	0.331	0.047
	Case	−0.002	0.154	

[a]*P*<0.05, compared with baseline. SD: Standard deviation

group and was worst in the control group. In addition, considering CAMP changes, the mean values in the ESWT groups was better after 6 months of treatment but was not considerable regard to 3 months after treatment, and was worst in the control group in this period [Figures 2 and 3].

DISCUSSION

The shock wave is a new and potential intervention for the reinnervation of peripheral nerve. The purpose of this study was to assess the effect of ESWT on CTS. In this study, considerable improvement was seen in VAS score, severity of symptoms, and functional status of Boston and electrodiagnostic parameters in the ESWT group after 3 months of treatment, whereas the changes were maintained after 6 months of treatments. However, in the control group with sham ESWT, clear changes in VAS score and symptoms severity of Boston questionnaire were seen during 3 months, which increased after 6 months. In other cases, regardless of reducing indexes, there were no significant changes. The only study that assessed the effect of ESWT on CTS was performed by Seok and Kim in 2013 which was conducted on 18 patients with CTS. In this survey, the patients were treated in one session with ESWT along with 1000 shocks and the maximum patient-tolerable energy. The VAS score, symptoms severity, and functional status based on Levine Self-assessment Questionnaire (LSQ), and electrodiagnostic parameters in the 1st and 3rd months after treatment were assessed. The results showed that the VAS score and symptoms severity in LSQ questionnaire had significant improvements, but about the other variables, there were no clear changes.[13]

As shown above, there was a significant and remarkable improvement in the VAS. Each group was evaluated for 3 months, and the improvement process was steady in the long-term (6 months) in the ESWT group, while the VAS score significantly increased in the control group. In Seok's study, VAS score was improved 1 month after treatment considerably and maintained 3 months later.[13]

Considering the symptoms severity based on Boston questionnaire, improvement has been observed in a short-term and it maintains for a long time, but there was not any significant improvement in the control group. In Seok's study, symptoms severity based on LSQ showed a significant recovery occurred after 1 month that was maintained 3 months after the treatment.[13]

Hence, it can be concluded that not only ESWT can make early reducing symptoms and VAS score in short time, but also it maintains for a long time. There was a significant improvement about functional status in short-term in which unlike two earlier items continued after 6 months. However, it was not significant in comparison with before 3 months. To put it simply, not only their effect continued, but

Table 2: Comparison of the mean scores of Boston functional status in ESWT and control groups before treatment and after 3 and 6 months

Time	Group	Mean	SD	*P*
Base line	Control	3.020	0.417	0.085
	Case	3.288	0.728	
After 3 months	Control	2.465[a]	0.511	0.000
	Case	1.780[a]	0.473	
After 6 months	Control	2.655[ab]	0.545	0.000
	Case	1.563[ab]	0.527	
Δ0-3 month	Control	0.554	0.372	0.000
	Case	1.508	0.526	
Δ0-6 month	Control	0.364	0.398	0.000
	Case	1.725	0.645	
Δ3-6 month	Control	−0.190	0.206	0.000
	Case	0.217	0.329	

[a]*P*<0.05, compared with baseline, [b]Significant difference between two groups compared 6 with 3 months, *P*<0.05. ESWT: Extracorporeal shock wave therapy, SD: Standard deviation

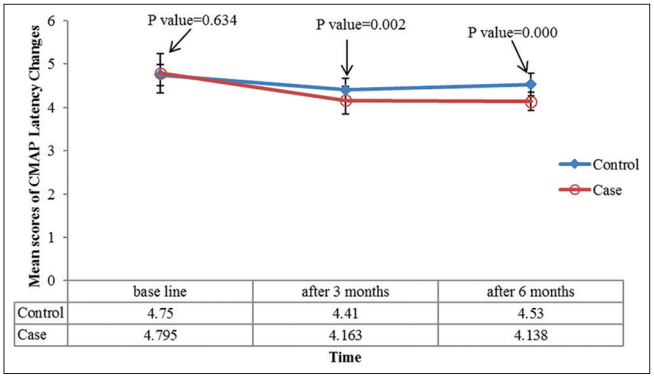

Figure 2: Bar chart of comparison of the average scores of compound muscle action potential before treatment and 3 and 6 months after treatment

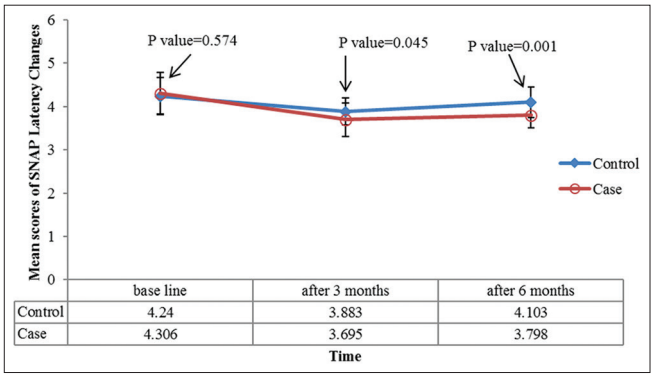

Figure 3: Bar chart of comparison of the average scores of sensory nerve action potential before treatment and 3 and 6 months after treatment by the two groups

also the improvement progressed. With respect to the recovery progress in Seok's study, these changes were not significant,[13] the difference in two studies can be due to ESWT protocol. The current study was done in four sessions and the patients were given specific amount of shocks and energy. In contrast, 1000 shocks and tolerable energy were given to the patients in Seok's survey.[13]

It was observed that the electro-diagnostic parameters of both SNAP and CMAP distal latency had clearly decreased after 3 months and this process continued constantly after 6 months; however, SNAP latency did not enter the normal range (lower than 3.6), but CMAP latency was placed in a normal range (lower than 4.2),[14] according to electro-diagnostic CTS grading, improvement from moderate to mild was observed during 3 months and remained in this range after 6 months, but there was no significant reduction in SNAP and CMAP distal latency after 1 and 3 months after treatment in Seok's survey.[13] One of these reasons can be the difference between the applied methods.

Finally, it is assumed that the pressure on median nerve decreased, due to the application of hand splint and restriction of wrist movement. Therefore pain severity, function, and nerve conduction study (NCS) parameters got better in the control group until they used splint, but the symptoms returned after second 3 months with discontinuing splint usage. Hence, its effect is temperate and subject to permanent use of it.

One of the hypotheses that are present for ESWT's effects is producing nitric oxide (NO) due to the stimulation of neuronal NO synthase in the tissue around median nerve and it reduces topical inflammation, so reduces pressure on median nerve.[15] Another mechanism, stated in ESWT studies, is to increase NO level due to increasing neuronal NO synthase can reduce pain transformation in the nervous system. In this hypothesis, NO effects on nerve cell membrane causes opens potassium channels and reduces the entrance of calcium, resulting hyperpolarization of the cell membrane and controls pain transmission.[16,17] In addition, it is possible that produced NO by neuronal NO synthase acts as opioids and reduces pain.[18] One of the reasons for symptoms generation in CTS is malnutrition and reduction of median nerve perfusion causing by pressure on feeder vessels in wrist like what is made in ischemic compression in other nerves, and this produce pain and paresthesia.[19] On the other hand, we know that NO has a vasodilation effect, so producing NO can dilate tiny feeder vessels of median nerve, hence perfusion and feeding of nerve improvement and this can reduce patient symptoms via improving transmission impulse.

Regarding vascular dilation, speed and volume of blood circulation increase and can be result to facilitate washout of inflammatory mediators.

CONCLUSION

Considering the impact of ESWT in the improvement of clinical symptoms and EDX findings, without series effects, ESWT can be applied in the conservative treatment of patient with mild to moderate CTS.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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