Med. J. Cairo Univ., Vol. 85, No. 8, December: 2895-2901, 2017
www.medicaljournalofcairouniversity.net

Extracorpeal Shock Wave Therapy Versus Ultrasound for Carpal Tunnel Syndrome in Post Menopausal Women

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Abstract

Aim: To differentiate between the effect of extracopreal shock wave therapy and ultrasound therapy in the treatment of carpal tunnel syndrome in post-menopausal women.

Subjects: Forty women were selected from Damietta Specialist Hospital; their age ranged from 50-60 years and their body mass index (BMI) was than 30Kg/m^2. The participants were assigned into two groups of equal numbers, study and control groups 20 women each.

Methods: The study group (A) received shock wave therapy and wore cock-up splint which adjusted at neutral angle at night time, while the control group (B) pulsed ultrasound and wore cock-up splint which adjusted at neutral angle at night time. 3 days per week for a successive 4 weeks for both group.

Main measures: The measurement outcome was pressure pain intensity by visual analog scale and nerve study by EMG.

Results: Both group showed statistically significant improvement of the measured variables, but in favor of the group 1.

Conclusion: Both groups improved by the end of the program in nerve conduction study and visual analog scale. However shock wave therapy was effective improving pain intensity perception, increasing conduction velocity, decreasing sensory and motor nerve latency of median nerve.

Key Words: *Carpal tunnel syndrome – Menopause – Extracopreal shock wave therapy – Shock waves – Ultrasound – Phalen's maneuver – Tinel's sign – Durkan test – Latency – Nerve Conduction study and Nerve conduction velocity.*

Introduction

ALL women experience reduced ovarian hormone production in their 50s, which lead to the c essation of menstruation, but far from all women have difficulties in association with this vaginal mucosa [1].

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Menopause is the women's last spontaneous menstruation occurs on average around the age of 45-52, and a few years earlier in smokers.

This is caused by the ovarian estrogen production decreasing so much that the endometrium of the uterus is no longer stimulated and therefore does not need to be flushed out. Estrogen is produced in the ovarian follicles, which are already formed in the fetus and do not regenerate after that. The lower estrogen levels have been suggested to directly incite mood effects, through altered formation of signal substances in the brain [2]. When this stimulation subsides, the mucous membrane becomes thin and fragile and its blood supply is reduced. Urinary incontinence is more widespread among women than men; prolapse can like urinary incontinence, leading to discomfort during physical activity and can be an important factor in reduced physical activity among women. A reduced production of estrogen involves changes in several systems in the body. Hormonal changes that accompany menopause have a significant impact on the nervous and other physiological systems [3].

Carpal tunnel syndrome (CTS) is a clinical symptom complex characterized by numbness, pain in the part of the hand innervated by sensory fibers of median nerve and weakness of the muscles innervated by the motor fibers of median nerve. It the most well-known nerve entrapment mononeuropathy. Involving the median nerve, it is often described as an occupational disease and claimed as a basis for worker's compensation. It is a compression or pressure on the median nerve at the wrist level. Alignment at the wrist creates a tunnel through which the median nerve and tendon course [4].

Ultrasound therapy:

Therapeutic ultrasound is one of the most widely and frequently used in physical therapy. It is capable of causing temperature elevations in tissues to depth of three cm or more. Furthermore, it should also be noted that ultrasound is receiving increasingly widespread use for its non-thermal effect as well [5].

The waves are generated by a piezoelectric effect caused by the vibrations of crystals within the head of the ultrasound. The sound waves that pass through the skin cause a vibration of the local tissues. This vibration or cavitation can cause a deep heating locally through usually no sensation of heat will be felt by the patient [6].

Ultrasound can produce many effects other than just the potential heating effect. It has been shown to cause increase in tissue relaxation, local blood flow, and scar tissue breakdown. The effect of the increase in local blood flow can be used to reduce local swelling, chronic inflammation and according to some studies promote bone fracture healing. The intensity or power density of the ultrasound can be adjusted depending on the desired effect [7].

There is limited evidence on the effectiveness of ultrasound in relieving the symptoms of CTS. Ultrasonic therapy may be beneficial in the longer term management of CTS. A double-blind, randomized trial that compared with "sham ultrasonic" treatment (control), 20 sessions of carpal tunnel ultrasound therapy administrated over approximately seven weeks resulted in significantly greater improvement of symptoms at two weeks, seven weeks and six months. More studies are needed to confirm the usefulness of ultrasound therapy for CTS [8].

Ultrasound is commonly used in rehabilitation as an adjunct in the management of various soft tissue dysfunctions, including joint contracture, scar tissue, tendonitis, bursitis, skeletal muscle spasms and pain. In addition, ultrasound at therapeutic intensities has been included in treatment regimens for the management of pressure sores and as a noninvasive technique to enhance percutaneous absorption of topical medications (phonophoresis) [9].

Shock waves are high-energy acoustic waves with high voltage energy. Shock wave in urology is primarily used to disintegrate urolithiasis, whereas shock wave in orthopedics is not used to disintegrate tissues, rather to induce neo-vascularization, improve blood supply and tissue regeneration. The application of shock wave therapy in certain musculoskeletal has been around for approximately 15 years, and the success rate in non-union of long bone fracture, calcifying tendonitis of the shoulder, lateral epicondylitis of the elbow and proximal planter fasciitis ranged from 65% to 9 1%. The complication are low and negligible [10].

Recently, shock wave therapy was extended to treat other conditions including avascular necrosis of femoral head, patellar tendonitis (jumper's knee), osteochondrities dessicans and non-calcifying tendonitis of the shoulder. Shock wave therapy is a noval therapeutic modality without need of surgery and surgical risks as well as surgical pain. It is convenient and cost effective [11].

Subjects, Material and Methods

This study was carried out on forty female patients who diagnosed as having carpal tunnel syndrome during menopause clinically was diagnosed by neurologist or orthopedist. They selected randomly from Neurology and Orthopedic Department of Damietta Specialist Hospital, January 2017 to March 2017 and their age ranged from 50-60 years old, Additional inclusion criteria were their age was ranged from 50-60 years.

- All have subcutaneous painful swelling in the interthenar area.
- All have thenar discomfort pain.
- Their body mass index was than 30kg/m2.
- All have positive tinel's and phalen's sign.
- Stable health status.
- Consent form for all patients will be done. Appendix (I) [12].
- All patients had positive electrodiagnostic findings: Prolonged median nerve motor distal latency (MMDL) above msec and below 7msec with prolonged median sensory distal latency (MSDL) above 3.5msec Subjects with the following criteria were excluded from this study:
- Patients suffering from juvenile diabetes.
- Patients suffering from orthopedic deformities in the upper limb.
- Patients suffering from peripheral neuropathy.
- Patients with carpal bone fractures and joints injuries.
- Patient with rheumatoid arthritis.
- Patients with double crush syndrome.
- Presence of vascular disease at the wrist or hand.
- Cognitive or psychiatric disorders.
- Cervical spondylosis with radiculopathy.
- Osteoporosis [13].

- Anatomical abnormalities of the wrist or hand.
- Patients with history of steroid injection into the carpal tunnel. There was no significant difference in demographic data between both groups (Table 1). Women patients were divided randomly according to envolop into two groups:

Group (A) : Consist of 20 postmenopausal women who suffered from CTS received shock wave therapy three sessions per week day after day for four weeks and wore cock-up splint which adjusted at neutral angle at night time.

Group (B) : Consist of 20 postmenopausal women who suffered from CTS wore cock-up splint which adjusted at neutral angle at night time **[14]** and pulsed ultrasound 3 session per week, for 15 minute per session with frequency 1 MHz and at intensity of 1.0 W/cm 2 with duty cycle 1:4 **[15]** for four weeks.

Evaluation instrumentation:

A- *Height and weight scale:* A universal height and weight scale will used to determine the subjects height and weight in order to calculate body mass index (BMI) for all participants in the two groups.

B- *Electromyography (EMG) device:* Tonnies neuroscreen plus version 1 .59. It is used for measuring sensory and motor conduction velocity pre and post treatment program for two groups.

C- *VAS (Visual Analogue Scale):* Used to measure pain intensity of each patient in both group (A, B) pre and post treatment program for two groups.

Extracopreal shock wave therapy:

Forty female patients who diagnosed as having carpal tunnel syndrome during menopause clinically was diagnosed by neurologist or orthopedist. They selected randomly from neurology and orthopedic department of Damietta Specialist Hospital, and their age ranged from 50-60 years old.

In the current study, 20 postmenopausal women who suffered from CTS received shock wave therapy three sessions per week day after day for four weeks and wore cock-up splint which adjusted at neutral angle at night time. In this group received shock wave therapy for 2000 pulse per session for about 2min 3 sessions per week for one month.

Client guidelines for extracopreal shock wave therapy:

1- Explain how shock wave works to patient.
2- The patient in a sitting position wrist rested in comfortable position.
3- Gel application to minimize the loss of shock wave energy at the interface between the applicator tip and skin **[16]**.
4- Localization of painful.
5- Direct therapy after completion of preparation.

Procedure:

- Switch on the main switch on the rear panel beside the power connector.
- The screen turns on with a green light display.
- Select the operating mode pulsed.
- Select the frequency parameters. Start treatment at a pressure of (four bars).
- Remove the applicator from the holder and apply the coupling gel.
- Press the shock wave release button on the applicator to start treatment.
- Adjust the energy level 2000 pulses plus pressure from therapist.
- Press the shock wave release button to stop shock wave application **[16]**.

All patients in this group wear night cook-up splint at a neutral angle helps to decrease repetitive flexion and rotation, therapy relieving mild soft tissue swelling or tenosynovitis. It is used to prevent prolonged flexion or extension.

All the shock wave group patients, there were no significant complication noted, except for mild local erythematous changes over the shock wave application sites. No neurovascular complications were noted.

Treatment procedures for all participants in Group (B): The participant in group (B) who suffered from CTS wore cock-up splint which adjusted at neutral angle at night time **[14]** and pulsed ultrasound 3 session per week, for 15 minute per session with frequency 1MHz and at intensity of 1.0 W/cm 2 with duty cycle 1:4 **[15]** for four weeks.

Application of US:

Group (2) patients received pulsed ultrasound 3 sessions per week, for 15 minutes per session with frequency 1MHz and at intensity 1.0W/cm 2 with duty cycle 1 :4.

Preparation:

- The patient in sitting position.
- Gel application on ultrasound head.
- Direct therapy start after completion of preparations.

Procedure:

The ultrasound therapy session used ultrasound waves for five to seven minutes and intensities one MHz & one and half W/cm2 continuous wave used in the therapy sessions on the carpal tunnel portion anterior aspect of the wrist and hand. Then the patients in this group received the conventional physiotherapy program applied for the CTS [17].

Statistical analysis:

Statistical analysis was conducted using SPSS for windows, version 18 (SPSS, Inc., Chicago, IL). The current test involved two independent variables. The first one was the (tested group); between subjects factor which had three levels (group A receiving extra copreal Shock wave therapy and group B receiving ultrasound therapy). The second one was the (measuring periods); within subject factor which had two levels (pretreatment, post treatment). In addition, this test involved four tested dependent variables (distal motor latency, distal sensory latency, nerve conduction velocity of the median nerve, and VAS).

Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference.

Results

Statistical analysis using 2x2 mixed design MANOVA indicated that there were significant effects of the tested group (the first independent variable) on the all tested dependent variables; distal motor latency, distal sensory latency, nerve conduction velocity, and VAS (F=5.571, p=0.001*). In addition, there were significant effects of the measuring periods (the second independent variable) on the tested dependent variables (F=48.166, p= 0.0001*). Also, the interaction between the two independent variables was significant, which indicates that the effect of the tested group (first independent variable) on the dependant variables was influenced by the measuring periods (second independent variable) (F=19.587, p=0.0001*) (Table 2).

Table (1): Physical characteristics of patients in both groups (A&B).

Items	Group A Mean±SD	Group B Mean±SD	Comparison		S
			t-value	*p*-value	
Age (yrs)	54.55±2.3	54.5±3.44	0.054	0.957	NS
Weight (Kg)	88.5±7.12	89.25± 8.83	–0.295	0.769	NS
Height (cm)	163.7±3.49	162.4±3.31	1.207	0.235	NS
BMI (Kg/m2)	33.03±2.57	33.89±3.74	–0.854	0.399	NS

*SD: Standard deviation. p : Probability.
S : Significance. NS: Non-significant.

Table (2): The 2x2 mixed design Multivariate Analysis of Variance (MANOVA) for all dependent variables at different measuring periods between both groups.

Source of variation	F-value	*p*-value
Groups (Effect of treatment)	5.571	0.001*
Measuring periods (Effect of time)	48.166	0.0001*
Interaction	19.587	0.0001*

*Significant at alpha level <0.05.

Table (3): Mean±SD and p-values of distal motor latency pre treatment and post treatment test at both groups.

Distal motor latency	Pre treatment Mean±SD	Post treatment Mean±SD	MD	% of change	*p*-value
Group A	4.99±0.75	4.93±0.91	0.06	1.2↓	0.522
Group B	5.08±0.9	4.96±0.87	0.12	2.36↓	0.186
MD	–0.09	–0.025			
p-value	0.736	0.93			

*SD: Standard deviation. p : Probability.
S : Significance. NS: Non-significant.

Table (4): Mean±SD and p-values of distal sensory latency pre treatment and post treatment test at both groups.

Distal sensory latency	Pre treatment Mean±SD	Post treatment Mean±SD	MD	% of change	*p*-value
Group A	4.4±0.78	4.13±0.81	0.26	5.9↓	0.522
Group B	4.34±0.96	4.18±0.88	0.16	3.68↓	0.186
MD	0.06	–0.05			
p-value	0.844	0854			

*Significant level is set at alpha level <0.05.
SD :Standard deviation.
MD: Mean difference.
p-value: Probability value.

Table (5): Mean±SD and p-values of of nerve conduction velocity pre treatment and post treatment test at both groups.

Nerve conduction velocity	Pre treatment Mean±SD	Post treatment Mean±SD	MD	% of change	*p*-value
Group A	54.67±6.35	57.55±4.96	–2.8	5.1↑	0.0001*
Group B	53.7±5.77	54.45±5.24	–0.75	1.3↑	0.141
MD	0.97	3.1			
p-value	0.616	0.063			

*Significant level is set at alpha level <0.05.
SD :Standard deviation.
MD: Mean difference.
p-value: Probability value.

Discussion

The current study designed to investigate the effect of using shock wave therapy versus ultrasound therapy in treating carpal tunnel syndrome. While many forms of treating are employed for carpal tunnel syndrome evidence of efficacy of most intervention is lacking. Different methods of rehabilitation program are advocated for CTS patients; as physical therapy program, adverse neural tension techniques, LASER, transcutaneous electrice nerve stimulation (TENS), Magnatic Field, Ultrasound waves and recently the new scop of shock wave therapy.

The exact cause of carpal tunnel syndrome is unknown, although a degenerative process with an inflammatory reaction may play an important role. The goals of any treatment are to alleviate pain and restore function. The results from conservative treatment vary and there is no agreement on the best method of treatment. Likewise, the results of surgery with either an open or endoscopic transverse carpal ligament release are inconsistent **[18]**. In the present work we attempted to validate the therapeutic waves used in the management of CTS patients, using pain assessment with the use of objective way to prove such improvement that was nerve conduction study for median nerve. Comparing both shock wave group and ultrasound group pretreatment indicate that there was non-significant difference between both groups in all tested items (VAS, CV, SDL, and MDL). In other words, both groups were matched and if any effects will occur in post treatment test it can be attributed to the effects of the examined modalities. Comparing both the pre and post treatment values of VAS, CV, SDL and MDL of G1indicated that there is a highly significant difference in all the tested items ($p < 0.01$). The improvement of pain perception that was measured by VAS was noted in both ultrasound group and shock wave group. And this improvement was highly significant in both groups the shock wave therapy in the current study proved to give highly significant results in improving pain intensity perception, increasing conduction velocity, decreasing sensory and motor nerve latency of median nerve. The result of this study regarding the pain perception improvement seem to principally support the close association between application of extracorporeal shock waves and long term analgesia and this came in agreement with another study done by Hausdorf et al., **[19]** who examined selective loss of unmyelinated nerve fibers after extracorpeal shock wave application to the musculoskeletal system. The rational for the use of shock wave for these conditions is based on stimulation of soft tissue healing by local hyperemia, neovascularization, reduction of calcification, inhibition of pain and denervation to achieve pain relief and persistent healing of chronic inflammatory process **[20]**. Side effects are usually minimal **[21]**. It has been shown in vitro that high-energy shock waves can induce nerve action potential, and this enables substance P to be released from non-myelinated nerve fibers. Substance P can induce neurogenic inflammation, plasma extravasation and stimulation of proliferation of various types of cell **[16]**.Treatment is repeated up to 30 times at low intensity to create controlled local tissue injury that causes neovascularization, and is associated with increased amount of tissue growth factors within the locally injured structures. It is therefore hypothesized that ESWT stimulate healing by creating a wound environment at the site of shock wave delivery. Other hypothesized mechanism of action include the physical alteration of small axons, therapy inhibiting pain impulse conduction; chemical alteration of pain receptor neurotransmitter, thereby preventing pain perception; and hyperstimulation activation of the gate control mechanism, therapy affecting analgesia **[22]**. Shock waves stimulate the metabolic reaction of tissue, causing development of stress fibers and/or change in membrane permeability. Shock waves create cavitation bubbles, which breakdowns change the consistency of calcific deposite. Shock waves induce analgesic effect by over stimulating the axon (Gate-control Theory), thereby increasing a person's pain threshold **[23]**. The role of ultrasound therapy in decreasing pain of musculoskeletal system origin was examined in many preceding studies. In the current study; ultrasound therapy improved pain perception which was highly significant difference and conduction velocity which was significant difference but failed to provide a significant difference in sensory or motor distal latency of median nerve.

The decrease of pain associated with ultrasound in the current study may be due to increased pain threshold as reported by **[24]**. The author investigated the effect of ultrasound on mechanical pain threshold and concluded that continuous ultrasound on mechanical pan threshold and concluded that continuous ultrasound; on MHz applied at one w/cm^2 for five min increased the threshold of pressure induced pain **[25]** reported that ultrasound was able to increase pain threshold in human subjects similar to the level produced by raising tissue temperature by other means when US and infrared were applied to the area of the ulnar nerve at the elbow, an analgesic effect was found distally in the area supplied by this nerve. Treaster & Burr, (2004) found that ultrasound can significantly alter peripheral nerve propagation. Intensities on order of $0.5w/cm^2$ tend to increase motor nerve conduction velocity of the ulnar nerve. Intensities from one w/cm^2 to two w/cm^2 tend to decrease the conduction velocity; whereas intensities of three $watts/cm^2$ tend to increase it. This can be explained by mechanical forces of considerable magnitude as well as thermal effects may occur in tissue during ultrasonic irradiation. This also explains the results of the current study; ultrasound intensity used as 0.5 to one $watts/cm^2$. Statistically significant improvement was found in both subjective and objective criteria, with 60% of the patients reaching a normal value in their constant score.

Nearly three-quarter (72.5%) of the patients had no or only occasional discomfort, and six patients (15%) reported no improvement after 24 weeks. Some physicians have reported that treating patients with multiple application of low energy shock waves. They hypothesized that repeted exposure to shock waves would induce longer-lasting degeneration of free nerve endings than one application.

There are too few nerve fibers distributed to tendons to compare the degenerative effect of ESWT, therefore, they analyzed nerve endings could induce neurogenic inflammation in patients with tendinopathies. They presumed that degeneration of free nerve endings also might occur in a tendon with tendinopathies after application of shock waves **[26]**. They suggested that the initial application of shock waves causes degeneration of free nerve endings and consequent inflammatory changes, including synthesis of cytokines. The second application accentuates inflammatory change and prevents reinnervation.

Their results indicated specific cellular changes associated with repeated applications of low energy shock waves similar to those used for pain relief. They concluded that two applications of low energy shock waves might provide a longer acting antinocicptive effect than with one application **[27]**. There are no standardized guidelines for the using ESWT in soft tissue conditions. However, numerous clinical investigators have reported using two or three sessions for treating chronic tendinopathy, which may reflect their clinical experience that repeated shock wave applications benefit their patients. The implication is that one application is often insufficient for effective treatment, which is consistent with reports of degeneration of nerve fibers followed by regeneration. Although one application of shock waves induces the degeneration of free nerve endings, the effect of repeated application have not examined in previous studies **[28]**. It has been postulated that shock waves induce hyperstimulation analgesic by increasing the threshold of pain and promote bone healing as a result of microfracture. Recently, animal experiments demonstrated that shock waves treatment stimulate neovascularization in association with an increased expression of angiogenic growth markers including endothelial nitric oxide synthase (eNOS), vessel endothelial growth factor (VEGF), and proliferating cell nuclear antigen (PCNA) in tendon, bone and tendon-bone interfaces. In one study on regeneration of femoral head; they speculated that shockwave treatment may provide an analgesic effect by increasing pain threshold and may alter the pathophysiology of the condition by altering the vascularity of the affected parts of femoral head **[29]** In summary, extracopreal shock-wave treatment appeared to be more effective than core decompression and non-vascularized fibular grafting providing short-term pain relief for patients affected by early stages of osteoporosis of femoral head **[30]**.

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تاثير الموجات التصادمية مقابل الموجات الصوتية في علاج اختناق العصب الاوسط لدى الرسغ فترة ما بعد سن اليأس

هدف هذه الرسالة هو المقارنة بين العلاج بالموجات التصادمية والموجات الصوتية على متلازمة اختناق العصب الأوسط لدى الرسغ فترة ما بعد انقطاع الطمث وقد اشترك في هذه الدراسة أربعون شخصا من الإناث تتراوح أعمارهم ما بين ٥٠-٦٠ عام ولقد تم تقسيمهم عشوائيا إلى مجوعتين متساويتين فى العدد. المجموعة الأولى: والتى تشمل على عشرون شخصا من الإناث قاموا بإداء موجات تصادمية ثلاث أيام أسبوعيا لمدة اربع أسابيع مع ارتداء ساند رسغ أثناء النوم. المجموعة الثانية: والتى تشمل على عشرون شخصا من الإناث قاموا بإداء موجات صوتية ثلاث أيام أسبوعيا لمدة اربع أسابيع مع ارتداء ساند رسغ أثناء النوم.

وقد أظهرت النتائج ما يلى: ان كلا المجموعتين (١و٢) تحسنت في شدة الألم وسرعة التوصيل ولكن مجموعة الموجات التصادمية (١) أظهرت تحسننا كبيرا جدا فى التوصيل الحسى والحركى لدى العصب الأوسط فى الرسغ فى حين فشل مجموعة الموجات الصوتية فى الحصول على هذا التحسن. لذلك يجب الإشارة بان الموجات التصادمية بالإضافة الى ساند الرسغ فى الحصول على اقصى درجات التحسن فى اختناق العصب الأوسط لدى الرسغ.

\الاستنتاجات: وبمناقشة هذه النتائج وتحليلها يمكن القول بان استخدام الموجات التصادمية فى علاج اختناق العصب الأوسط لدى الرسغ له تأثير إيجابى فى علاج تلك المشكلة.