Effect of Shock Wave Therapy in Patients Affected by Stroke with Upper Limb Spasticity: Neurophysiologic and Clinical Study

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Summary

Aim of the study is to investigate the effect and the duration of extracorporeal shock wave therapy (ESWT) on the muscle spasticity of the hand and the wrist.

We studied 15 patients affected by stroke associated to severe spasticity in upper limb.

Clinical examination, neurological scales (NIH scale and Ashworth scales) and a video were performed before and immediately after the placebo and real stimulation. The placebo stimulation was performed before the real stimulation in each stimulation. The patients were monitored after one, four, twelve weeks from the real treatment. After four weeks needle EMG was studied.

After real ESWT the patients had greater improvement in flexor tone of wrist and fingers than after placebo stimulation. After 12 weeks from the therapy ten of the fifteen patients showed persistent reduction in muscle tone. No sign of muscle denervation was recorded in all patients. There were no adverse events associated with ESWT. ESWT reduce spasticity of the wrist and finger muscles lasting at least 12 weeks from the treatment.

Key words: Extracorporeal Shock Wave, ESWT, Stroke, Spasticity, Botulinum Toxin

Introduction

Shock waves are defined as a sequence of single sonic pulses characterised by high peak pressure (100 MPa), fast pressure rise (< 10 ns) and short duration (10 µs).Different studies and clinical experiments have showed the effectiveness of shock waves in the treatment of bone and tendon diseases pseudoarthrosis [15,16,17] tendinitis calcarea of the shoulder [5,12,] epicondylitis [11], plantar fasciitis[13] and several tendon diseases, especially in athletes [10,14].The persistent clinical effect of shock wave treatment of muscular contractures in athletes and the preliminary data reported on neurological patients [6] has suggested a possible effect of shock wave treatment on patients suffering from muscular spasticity. Spasticity in the hands and wrists is one of the major problems in the management of hemiparetic patients and may seriously impair dressing, washing and other activities of daily living [7]. A recent review has demonstrated that injections of botulinum toxin type A decreases muscle tone in spastic muscles of the hand with improvment in the use of the upper limb[1]. Spasticity, however, is a complex syndrome and more extensive and complete treatment is required. Rehabilitation and different non-invasive treatments should be also considered. The aim of this study is to examine the effect of shock wave treatment on spastic muscles in the hand and wrist in a group of patients affected by stroke.

Materials and Methods

Fifteen patients, with upper limb spasticity post stroke were enrolled in the study. Eligible subjects had to be at least 9 months post stroke and had focal spasticity of wrist and fingers and forearm, as demonstrated by a score of 3 or 4 for wrist flexor tone and a score of 2 or higher for finger flexor tone on the Ashworth Scale, with 0 indicating normal muscle tone and 4 rigid flexion.

Patients with prior or planned treatment of the limb with any botulinum toxin serotype or with phenol, alcohol, or surgery were excluded. All patients provided informed consent.

A video polygraphy EMG system was used: Micromed System Brainquick (Mogliano Veneto, Italy). A digital goniometer was used to measure passive range of motion of the wrist. The goniometer was synchronized with video.

Standard needle EMG was performed after four weeks from the ESWT in all patients on the first interosseus muscle, which was one of the treated muscles of the hand.

Shock wave Therapy Instrumentation

An electromagnetic coil lithotriptor (Modulith SLK® by Storz Medical AG) provided with in-line ultrasound, radiographic and computerized aiming (Lithotrack® system) was used. The pressure pulses were focused in the flexor spastic muscles of the forearm and in the interosseus muscles of the hand: 1500 shots were used to treat flexor muscles of the forearm, and 3200 shots for interosseus muscles of the hand (800 for each muscles). The energy applied was 0.030 mj|mm^2. Different points of application were used in order to treat several areas in the spastic muscles. Because low energy is used, the therapy is painless and does not require any kind of anaesthesia or the consumption of analgesic drugs. A placebo treatment without shock wave energy was applied with the same instrumentation and the same sound was utilized in all patients.

Study procedure

The study was an open study in which each patient served as their own control.

The protocol consisted of one placebo treatment session in which no shock waves were applied, followed one week later by one active shock wave treatment session.

This was done to ensure homogeneity in both active and placebo groups so that the true effect of shock wave could be compared in each patient. To avoid possible crossover effect, the study included a one week interval between placebo "treatment" and active shock wave therapy.

In each subject the clinical measures were performed before and immediately after placebo and one week later identical clinical measures were performed before and immediately after and after one, four and twelve weeks from the active shock wave treatment. The Ashworth values of each patients recorded over time were submitted to two analyses of variance (ANOVAs) with repeated measures. Post-hoc comparisons were performed with paired t-tests adjusted with the Bonferroni method. The alpha level chosen for all analyses was 0.05.

Results

The average baseline evaluation Ashworth results for the wrist flexor were 3,2 (Sd 0,7). Ashworth score was 3 for the hand muscles. Immediately after the treatment, the Ashworth for the wrist flexor dropped to 0,8 (Fig. 1). The hand muscles and finger flexion especially showed a marked reduction of spasticity with an Ashworth change from 3 to 0. The same findings were observed after one month for all subject. After three months we noted a persistent changes in Ashworth (level 2-1) only for the hand and the finger flexors while for the wrist flexor tone returned to the level of 3.0 (Fig 2). The range of passive motion of the wrist increased from a mean of 20° before the ESWT to 50° immediately after the treatment. The range of movement showed a mean of 40° after four weeks.

After four weeks, needle EMG recording did not show any sign of spontaneous activity in the first interosseus muscle, which was one of the treated muscles of the hand.

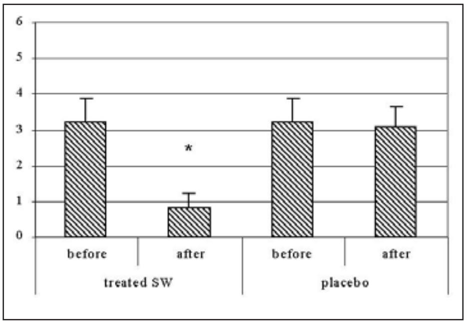

Fig. 1 Ashworth scale before and after real treatment on the left and before and after placebo on the right. Mean and standard deviation. P<0.001 with Bonferroni correction

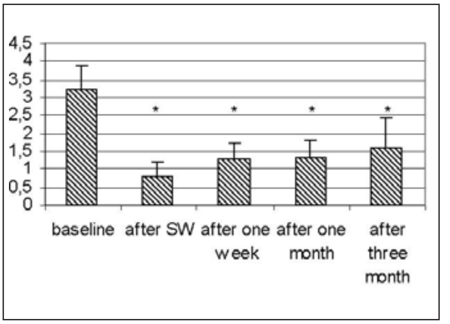

Fig. 2: Ashworth scale before and immediately after the ESWT, and after one, four and twelve weeks from the ESWT. Mean and standard deviation. * P<0.001 with Bonferroni correction

Video score showed a changes immediately after the real treatment. The changes were persistent in all patients after four weeks and in 10 of fifteen patients after twelve weeks from the shock wave therapy. NIH neurological examination score did not change before and after the treatment.

Conclusions

The main finding of this preliminary study is that a single treatment of shock wave therapy on spastic muscles in a patient affected by stroke resulted in a significant reduction in muscle tone. The persistence of this effect was not short but was observed at least 12 weeks after the therapy. In particular, we noted a significant effect on the muscle tone of the hand and finger flexors. No side effects were observed in all patients. After one month from the shock wave therapy no sign of denervation was recorded from the hand muscles. The mechanism of shock wave therapy on spastic muscles is still unknown.

We know that shock waves induces enzymatic[8] and non-enzymatic nitric oxide (NO) synthesis[2]. Nitric oxide is involved in important physiological functions of the CNS, including neurotransmission, memory and synaptic plasticity.[9]

NO synthesis has been suggested to be one of the most important mechanism to explain the effectiveness of shock waves in the treatment of different tendon diseases,

The effect of mechanical stimuli of shock waves on the muscle fibers next to the tendon cannot be excluded [4]. However in this patient group the clinical changes lasted at least for three months excluding a major effect of mechanical vibratory stimulation of this kind of therapy.

In addition because no sign of denervation was noted in the treated muscles we can exclude any kind of chemical or physical neuromuscular denervation in this patient cohort.

Shock wave therapy appeared to be safe, non invasive and without complications. Our findings suggest that shock wave therapy may be useful in decreasing flexor tone and functional disability in patients with spasticity of the hand.

This therapy could open a new field of research in the treatment of spasticity. Further studies with a larger group of patients are therefore, necessary.

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