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EFFECT OF SHOCK WAVE ON LOWER BACK MUSCLE SPASM

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ABSTRACT

Background: A muscle spasm is a sudden violent involuntary contraction of a muscle or group of muscles. It is usually related to a localized skeletal muscle injury from acute trauma and may also stem from disorders such as hypocalcemia, hypokalemia or hyperkalemia, chronic pain syndromes, or epilepsy. Pain and interference with function attend muscle spasm, producing involuntary movement and distortion. When a muscle goes into spasm, it freezes in contraction and becomes a hard knotty mass, rather than normally contracting and relaxing in quick succession. ***Objective:*** The aim of the present study is to evaluate the role of shock wave on the treatment of patient with lower back muscle spasm. ***Methodology:*** After a verbal explanation of the study protocol, the selected 20 participants were randomly divided into two groups; control group (G1, $n = 8$) (receive ways to rest the back only) and treatment group (G2, $n = 12$). Each participant in G2 exposed to shock wave once weekly for 4 weeks along the period of the study (1×1×4). ***Results:*** The VAS readings indicated a significant difference at the 1% level (p = 0.003) between the two groups, while the ODQ readings showed no significant difference (p = 0.123). Results showed an improvement across two groups in pain and disability scores. In G1, the average VAS was 6.02cm upon entry to the program and the average ODQ score was 43% before treatment. Six weeks later, average scores were 3.87cm for the VAS and 36% for the ODQ. The average VAS score for G2 was 6.19cm upon entry to the program, and ODQ results showed that the average disability measure pre-intervention was 47%. Four weeks later, average scores stood at 4.07cm and 35.4% for the VAS and ODQ respectively. ***Conclusion:*** Exposure to shock wave once weekly has a better effect on improving pain and muscle spasm.

KEYWORDS: *muscle, spasm, chronic pain, shock wave, VAS.*

1. INTRODUCTION

The human body contains approximately 600 skeletal muscles. Skeletal muscle is voluntary, meaning a person can contract it at will. Seen under a microscope, skeletal muscle fibers show a pattern of cross-banding, which gives rise to its other name: striated muscle. The striations are caused by the alignment of bands, the most prominent of which are the A bands, I bands, and Z lines. The unit between two Z lines is called the sarcomere (Fig. 1).

Striated muscle is composed of two contractile proteins: actin and myosin. The thin filaments are made of actin, which is attached to the Z lines and is found in both A bands and I bands. The thick filaments, found in A bands, are made of myosin. In the process set forth in the sliding filament theory, the sarcomere shortens and the Z lines move closer together when muscle contracts. The filaments slide together because myosin attaches to, and pulls on, actin. The myosin head attaches to the actin filament, forming a crossbridge. After formation of the crossbridge, the myosin head bends, pulling on the actin filaments and causing them to slide. The result is that the Z lines move closer together, the I band becomes shorter, and the A band stays the same (Fig. 1). Muscle contraction is like climbing a rope. The crossbridge cycle is one of grabbing, pulling, and releasing, repeated over and over.

Muscle contraction is triggered by a sudden inflow of calcium ion (Ca2+). In the resting state, the protein tropomyosin winds around actin and covers the myosin-binding sites. The Ca2+ binds to a second protein, troponin; this action causes the tropomyosin to be pulled to the side, exposing the myosin-binding sites. With the sites exposed, muscle contracts in the presence of adenosine triphosphate (ATP). Muscle contraction stops when Ca2+ is removed from the immediate environment of the myofilaments.

A muscle spasm is a sudden violent involuntary contraction of a muscle or group of muscles. Spasm is usually related to a localized skeletal muscle injury from acute trauma. Spasms may also stem from disorders such as hypocalcemia, hypokalemia or hyperkalemia, chronic pain syndromes, or epilepsy. Pain and interference with function attend muscle spasm, producing involuntary movement and distortion. When a muscle goes into spasm, it freezes in contraction and becomes a hard knotty mass, rather than normally contracting and relaxing in quick succession.

During spasm, the blood vessels that normally feed the muscles and supply oxygen constrict, further compounding the problem. Tonic spasm, or cramp, is characterized by an unusually prolonged and strong muscular contraction, with relaxation occurring slowly. In the other form of spasm, called clonic spasm, contractions of the affected muscles occur repeatedly, forcibly and in quick succession, with equally sudden and frequent relaxations.

Shock waves, high-energy sound or pressure waves (like thunder following lightening or a small, focused explosion), have little to do with electric shock. Shock waves can be generated in many ways, but electrohydraulic devices have the greatest capacity to produce and project high energy to a deep focal depth. ESWT can be highly focused and can achieve a focal point beyond 10 cm into deeper tissues, depending on the treatment head used. ESWT differs from radial pressure wave therapy, which does not deliver focused energy at the target; instead, acoustic waves spread eccentrically from the applicator tip. ESWT is applied superficially, with waves entering tissue and being absorbed or reflected. Energy is released when a wave meets an area of high acoustic impedance (e.g., bone–tendon interface). Compressive and tensile forces cause cavitation and mechanical microstress in cells and tissues, resulting in modulation of inflammatory, angiogenic, and osteogenic proteins that assist the natural healing process. Shockwave therapy applied to an area of chronic, non-healing tissue (Fig. 2) may enable acute cytokines to be released and stimulate healing. The mechanism behind the pain-relieving function may result from increased serotonin activity in the dorsal horn and descending inhibition of pain signals.[3]

There are basically four different ways to produce the 'shock wave' (Fig. 2), which, without getting technical about it are: spark discharge; piezoelectric; electromagnetic and pneumatic (or electrohydrualic). The wave that is generated will vary in its energy content and also will have different penetration characteristics in human tissue. In therapy the most commonly employed generation method is based on the pneumatic system, and the key reason for this is that a radial (dispersive) wave results. The focussed waves are essential for 'surgical' interventions, but given their destructive nature, they are less appropriate for therapeutic uses. Focussed waves are sometimes also referred to as 'hard' shockwaves, the radial or dispersive wave sometimes called a 'soft' shockwave (another twist in the terminology).

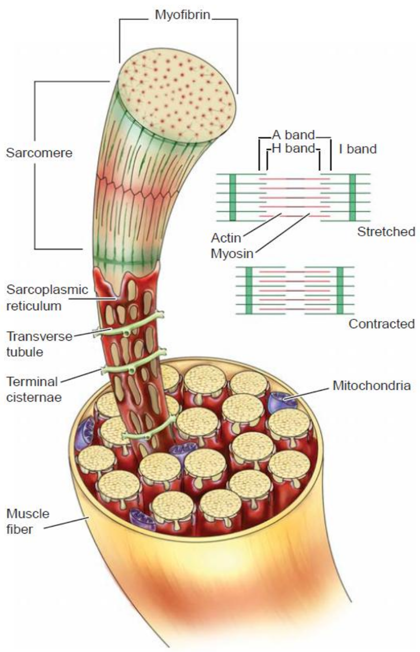

Fig. 1: Showing the muscle structure.

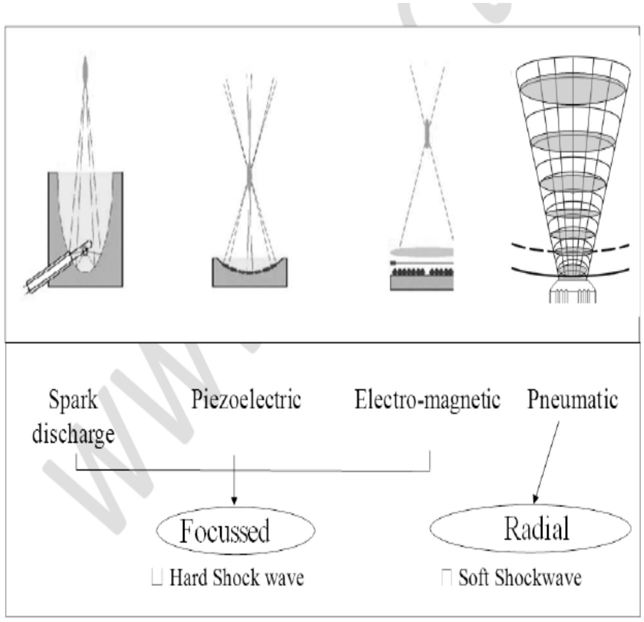

Fig.2: Showing the types of shock waves.

Since the late 1980s, focused shock waves therapy (SWT) has been widely and successfully used in the treatment of pain in various musculoskeletal disorders. SWT devices use pressure waves generated through electromagnetic, electrohydraulic and piezoelectric sources. These waves have their point of higher pressure in the focus, which is placed within the treated tissue; for this reason they are defined as focused shock waves.

In 1999, a new technology using a ballistic source to generate pressure waves was introduced. This technology is called radial shock wave therapy (RSWT). The ballistic source consists of a tube within which compressed air (1-4bar) is used to fire a bullet that strikes a metal applicator placed on the patient's skin. The applicator transforms the kinetic energy of the bullet into radially expanding pressure waves with a low penetration power (less than 3 cm). These unfocused shock waves have their point of highest pressure at the tip of the applicator, outside the treated tissue.

It has been shown that both focused (FSWT) and unfocused (RSWT) shock waves produce cavitation bubbles in the treated tissue. The cavitation is consequent to the negative phase of the wave propagation. The rapid collapse of the cavitation bubbles leads to secondary pressure waves. Cavitation-mediated mechanisms could have a central role in the action of both FSWT and RSWT for the musculoskeletal system.

From a theoretical point of view, shock waves could be useful to treat dystonia and muscle hypertonia in patients with UMNS. In accordance with the effects on tendon diseases, shock waves could have a direct effect on muscle fibrosis and other non-reflex components of muscle hypertonia, which are likely to be present also in some dystonic patients. Furthermore, shock waves acting at the muscular level could modify the sensory inflow from the treated muscle to the spinal cord, thus reducing spinal cord excitability and mitigating spasticity.

The aim of the present study is to evaluate the role of shock wave on the treatment of patient with lower back muscle spasm.

2. METHODS

Twenty Participants with a history of lower back muscle spasm prolonged more than 6 months ago, aged from 24 to 65 years, weight from 55 to 99 kg, and height from 159 to 188 Cm and body mass index (BMI) from 24.9 to 35.7, were selected from King Khalid Hospital, after they agreed to participate in the study and then receiving explanations regarding the purpose and procedures of the study, and signed an informed consent statement before participation. At the time of the study the participants were not receiving any medical or physical therapy.

After a verbal explanation of the study protocol, the selected 20 participants were randomly divided into two groups; control group (G1, $n = 8$) (receive ways to rest the back only) and treatment group (G2, $n = 12$). Each participant in G2 exposed to shock wave once weekly for 4 weeks along the period of the study (1×1×4).

Participants were excluded if they reported spinal, intra-abdominal or femoral surgery in the past year, a history of trauma or accidents or had been diagnosed with rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythymatosus or osteoporosis. Those who had any contraindications for physical tests, such as cardiovascular diseases or severe pulmonary diseases, were also excluded.

The outcome measures used in this study were the Oswestry Disability Questionnaire (ODQ) and the Visual Analogue Scale (VAS) both of which were scored by all participants who completed the four-week course.

Data analysis

Standard deviation and mean for the obtained data were calculated. Also, the data obtained were analyzed by SPSS 13.0 software test to compare the data before and after treatment within groups. The significant threshold set at $p < 0.05$, or non-significant set at $p > 0.05$.

3. RESULTS

The ODQ is used to score disability induced by lower back muscle spasm. It is a validated tool that is designed to assess a patient's level of function or disability, providing quantitative data that are suitable for quality assurance and research purposes. The VAS scale is a valid and reliable tool to rate pain intensities along a 10cm line. The patient is asked to put a mark along this line to reflect the intensity of the pain.

A total of 20 participants were eligible to take part in this study. These were divided into 2 groups; control group G1 ($n = 8$) and treated group G2 ($n = 12$).

The VAS readings indicated a significant difference at the 1% level (p = 0.003) between the two groups, while the ODQ readings showed no significant difference (p = 0.123). Results showed an improvement across two groups in pain and disability scores, as illustrated in Table 1 and Figures 3 & 4. In G1, the average VAS was 6.02cm upon entry to the programme and the average ODQ score was 43% before treatment. Six weeks later, average scores were 3.87cm for the VAS and 36% for the ODQ. The average VAS score for G2 was 6.19cm upon entry to the programme, and ODQ results showed that the average disability measure pre-intervention was 47%. Four weeks later, average scores stood at 4.07cm and 35.4% for the VAS and ODQ respectively (Table 1 and figures 3 & 4).

Although group G1 showed the best improvement in scores initially, group G2 scores continued to improve over time, with patients doing equally as well as participants in Group G1 after four weeks.

Age-related pre- and post-test differences were interesting. As shown in Figure 4, the 24-35-year-old age group improved by 70% on VAS scores and by 23% on ODQ scores. The 36-50-year-olds scored an average of 24% improvement on the VAS and 9% on the ODQ while the 51-65-year-olds improved by 35% and 16% on the VAS and ODQ respectively (Table 2 and figure 4).

Table 1: Showing the values of VAS and the percentage of ODQ before and after the treatment.

Groups	VAS (cm)		% of ODQ	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
A	6.02	3.87	43	36
B	6.19	4.07	47	35.4

Table 2: Showing the percentage of improvement for VAS and ODQ related to age of participants.

Age/year	% of improvement	
	For VAS	For ODQ
24-35	70	23
36-50	24	9
51-65	35	16

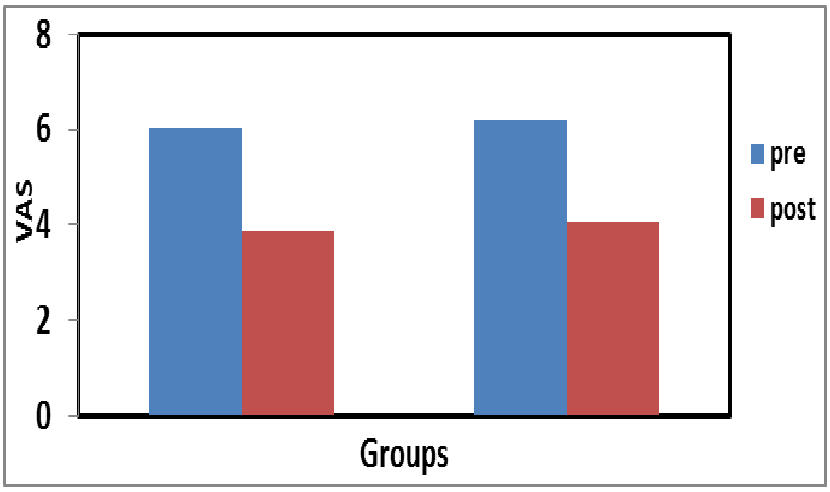

Fig. 3: Showing the values of VAS pre and post-treatment.

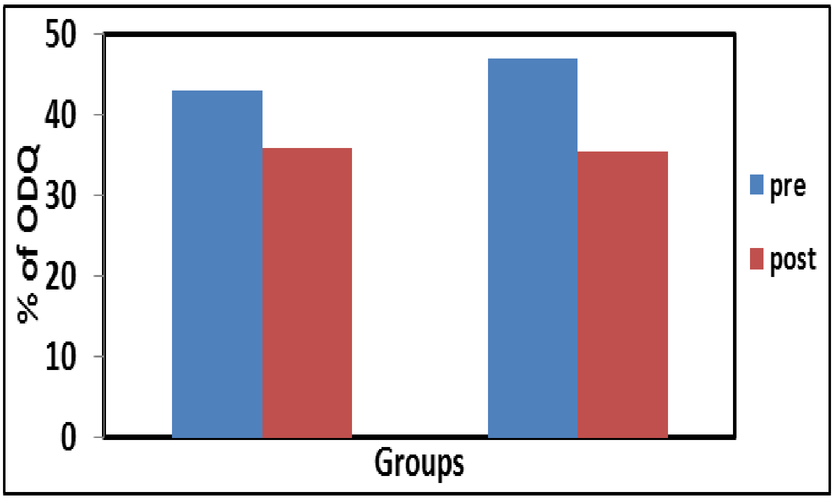

Fig. 4: Showing the percentage of ODQ pre and post-treatment.

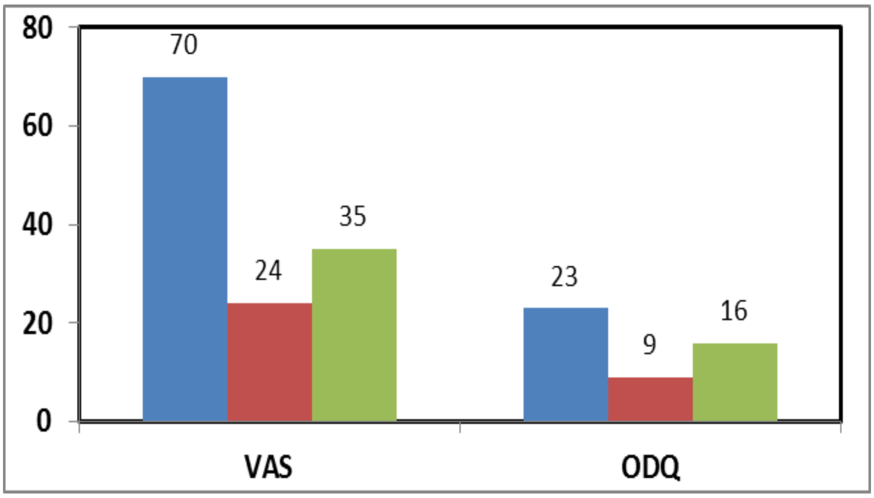

Fig. 6: Showing the percentage of improvement for VAS and ODQ related to age of participants.

4. DISCUSSION

The aim of this study was to evaluate the effect of shock wave on participants with lower back muscle spasm. A pre-test/post-test design was implemented over a period of four weeks. Outcome measures consisted of ODQ and VAS scores.

Four weeks after programme, pain and disability scores improved in treated group (G2) that received shock wave treatment once weekly for 4 weeks (1×1×4). At four weeks post-intervention, Group G2 showed the most significant improvements in both ODQ and VAS scores.

Participants in Group G2 who had exposed to shock wave had better VAS outcomes than those in Group G1 (received ways for resting back). The opposite was true with the ODQ results at 4 weeks. These findings are comparable to those of similar research studies in which the effects of shock wave were investigated. The evidence is inconclusive as to which skock wave is best and actually leans towards incorporating any general exercise programme to improve functions of muscles.

It is noteworthy that the participants had been randomly assigned to two groups without considering that age differences could affect outcomes. The distribution of ages between groups appears to relate to the initial results and may have introduced a bias in favour of Group G2 as age-related differences were striking. The 16-35-year-old participants showed the greatest improvement, which finding could be due to several factors such as healing occurring faster in younger populations. The youth are more body and movement aware, so they assimilate exercises more easily. Also, they were more likely to be cases of first incidence of lower back muscle spasm, which would be easier to treat than recurrent episodes, or chronic muscle spasm.

The 36-50-year-old participants showed the least improvement. This may be because the patients in this age group are likely to have had the greatest physical demands due to their lifestyles at work and at home, and also the least time for their own well-being. The 51-65-year age group had a better outcome than their younger counterparts, which may reflect the fact that they had more time for themselves and so were more likely to implement their home exercises program (HEP). It would have been a good idea to record compliance to the HEP with a diary. Another factor contributing to the results obtained for the older groups may have been chronicity of pain.

5. CONCLUSION

The results of this study imply that exposure to shock wave once weekly have a better effect on improving pain and muscle spasm. Interestingly, the control group G1 who had postural re-education did as well as the exposed group. Age was not considered to be a factor when allocating participants into groups. However, the younger age group showed marked improvement with posture re-education and exposure. These results are clinically significant. Further longitudinal studies in this area are called for, with a recommendation that participants are followed up for at least one year post-intervention in order to find out which approach has better long-term outcomes.

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