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Professional paper

Radial Extracorporeal Shock Wave Therapy in the Treatment of Shoulder Calcific Tendinitis

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A B S T R A C T

Shoulder calcific lesions of the rotator cuff are a common problem in physiatric and orthopedic practice. The lesions are mostly located in the supraspinatus tendon, close to the insertion area in the critical zone. Patients are usually treated conservatively by nonsteroid antiinflammatory drugs, analgesic drugs, local injections, physiotherapy and rarely by applying surgical procedures. Painful shoulder gives rise to functional disabilities and may sometimes lead to pharmacological overuse. In the last twenty years, extracorporeal shock wave therapy (ESWT) has been frequently used in the treatment of calcific tendinopathies. We have evaluated the effectiveness of radial ESWT on the group of 30 patients, aged between 28 and 58 years, with calcific tendinitis of the shoulder. Criotherapy, medical exercises and radial ESWT were applied. We used the radial ESWT device (BTL-5000 SWT®, Columbia, USA), 3 bars pressure, 10 Hz frequency, 2000 shocks. Patients were examined before the begining of the treatment, immediately after the treatment, and 6 months later. The treatment included measurement of the range of motion (ROM), measurement of voluntary isometric contraction of shoulder muscles with manual muscle test (MMT), and subjective assessment of pain intensity with visual analogue scale (VAS). X-ray was done before and 6 month after treatment. The study has shown the efficiency of the treatment with radial ESWT. The level of statistical significance was determined with student t-test. Radial ESWT applied to patients with shoulder calcific lesions of the rotator cuff resulted in pain relief, increase in the range of motion and increase in the muscular strength. As shown by X-ray, these results were followed by the decrease in the size of the rotator cuff calcifications.

Key words: *shoulder, callcific tendinopathies, extracorporeal shock wave therapy*

Introduction

Shoulder calcific lesions of the rotator cuff are a common problem that appears with accumulation of calcium hydroxyapatite in the tendon insertions of the rotator cuff on the bone. Lesions are often located in the supraspinatus tendon near the insertion in the so-called critical zone[1–3]. Etiology is unknown and it is more frequent in women. The incidence varies from 2.5 to 20% of asymptomatic patients and 50% of patients with painful shoulder. The average age of patients is between 40 and 50 years[3,4]. As a result of the outbreak of calcification, a partial rupture of the rotator cuff occurs on the bursal side, while complete rupture of the rotator cuff is a rarity. Pathogenesis of the disease is unknown. In the initial stage of the formation of calcium deposits the patient may be asymptomatic or may complain of local pain and tenderness. Calcium salt can be absorbed or can raise new deposits. Due to irritation of the surrounding tissue by increased deposits of calcium severe or less severe pains may develop. Pain often occurs suddenly after minimal trauma or stress. The pain propagates in the deltoid muscle insertion area. Shoulder mobility is reduced due to pain. During resorption of calcifications vascular proliferation occurs, with an increase of intratendon's pressure, which also causes pain. Additional pain develops due to increased volume of tendon that is colliding with the coracoacromial arch. X-ray examination shows deposits of calcium that has no contact with the bone, the calcificate having different intensity and sizes. Patients are usually treated conservatively using physical therapy, analgesics as well as local infiltration[3,4]. In the early

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nineties Extracorporeal Shock Wave Therapy (ESWT) began to be applied in the treatment of various chronic conditions in the soft tissues of the locomotor system. In 1992 Dahmen was the first who describe ESWT treatment of the calcified lesions of tendon[5]. ESWT is usually applied on painful shoulder (rotator cuff syndrome, calcific tendinitis), epicondylitis of the elbow, plantar fasciitis, heel spure and inflammation of Achilles tendon[6–11]. Pressure of high amplitude is generated outside the patient's body, and its energy is concentrated in the target area of the body. Penetration of shock waves varies, averaging 0–60 mm, and depends on the diameter of the applicator and frequency. Applicators can be focused or radial. Kinetic energy is converted into acoustic energy. Acoustic waves have a high positive amplitude, short duration and fast increase in pressure. Due to radial application energy is propagated divergently to the target tissue and weakens by the depth of penetration. The depth of penetration is up to 35 mm. Positive wave is responsible for the direct shock wave effects and is expressed in the tissues of different densities, such as soft tissues and mineralized tissues. Since calcifications do not have an organized structure like proteins-minerals, they are more fragile than bones. High pressure and its fast initial rise causes a high surface tension that breaks the structure of the material. The negative wave corresponds to the local reduction of pressure and creates cavitating bubbles. Pressure and energy inside the bubbles grow so strongly and in consequence, lead to splashing of the bubbles. These collapses generate new shock waves. The interaction between shock waves and the bubbles attached to the surface of tissues generates jets of fluid (called »water jets»). In contact with the surface of the tissue, such jets of liquid subsequently create holes in the surface[12,13]. The most frequently described biologic effects of ESWT are reactive hyperaemia, angiogenesis, stimulation of fibroblasts, tenocites, osteoblasts, chondrocites and mechanical destruction of calcifications[14,15]. Due to hyperaemia and neoangiogenesis reabsorption of calcification is facilitated. Except mechanical destruction, hyperemia and microcirculation increases by the application of radial ESWT which facilitates the natural wash-out of the body[12]. Analgetic effect of the shock wave is explained by hiperstimulated analgesia. In recent years, there have been studies proving a positive effect of shock waves on bone healing, though mostly with experimental animals[16–18].

Patients and Methods

We have studied a group of 30 patients (10 males/ 20 females) with calcific tendinitis of the shoulder (18 right shoulders/12 left shoulders), aged between 28–58 years, with mean age of 52.2 years. They were treated by radial ESWT device (BTL-5000®, Columbia, USA, ISO and CE certified, approved by the US FDA) with the frequency of 10 Hz, 3 bar pressure, 2000 shocks, applied once a week, with a maximum of 3–5 treatments. Beside radial ESWT, medical exercises and shoulder cryotherapy had also been applied. Patients were examined before the beginning of the treatment, after the treatment and 6 months later. Measurements of the shoulder range of motion (ROM) were taken: anteflexion, retroflexion, abduction as well as external/internal rotation. In addition, measurements of voluntary isometric contractions of shoulder muscles were taken with manual muscle test (MMT)[19], according to the following grading scale: patient can hold the position against maximum resistance and through complete range of motion (grade 5); patient can hold the position against strong to moderate resistance and has a full active range of motion (grade 4); patient can tolerate no resistance but can perform the movement through the full range of motion (grade 3); patient has all or partial range of motion in the gravity eliminated position (grade 2); the muscles can be palpated while the patient is performing the action in the gravity eliminated position (grade 1); no contractile activity can be felt in the gravity eliminated position (grade 0)[19].

Furthermore, the subjective assessment of pain intensity was analyzed applying visual analogue scale (VAS). The VAS is used to measure pain on a 100 mm horizontal axis between the extreme left endpoint of no shoulder pain and the extreme right endpoint of the worst pain. The distance is then measured and pain is recorded on a 100-point scale[20,21]. X-ray was done before the radial ESWT and 6 months after the treatment. The calcification size and density were analysed. The size of calcification was assessed according to Bosworth[22], such as: small diameter <0.5 cm (a=1), medium diameter 0.5–1.5 cm (b=2), large diameter > 1.5 cm (c=3). The density of calcification was assessed by the Gaertner[22] grading scale: sharp/dense contours (a=1), poorly defined dense or sharp contours (b=2), poorly defined/transparent (c=3).

Statistical analysis

The Student *t*-test was performed to determine significant differences between dependent samples of a previously mentioned group before and after the radial ESWT treatment ($p < 0.001$ was used as the cut-off value for significance).

Results

The mean age of thirty patients with shoulder calcific tendinitis who participated in this study was 52.2±10.3 years, while the age range was 28–58 years. 67% of the patients were female and 60% of all of them had affected right shoulder. All the previously mentioned parameters such as pain VAS, measurements of the shoulder ROM as well as the shoulder muscle strength measured by MMT, which are described in detail in the section žPatients and Methods', were tested before the begining of the radial ESWT application as well as immediately after the treatment and 6 months later.

The results have shown a statistically significant regression of VAS pain from an average of 47 mm before treatment, to 26 m after treatment and 24 mm six months after the treatment that is statistically significant at the level $p<0.001$, (Figure 1).

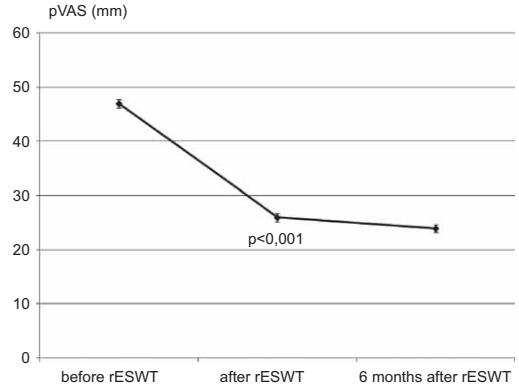

Fig. 1. Pain Visual Analogue Scale (pVAS, mm) before and after the radial Extracorporeal Shock Wave Therapy (rESWT), with statistically significant decrease (p<0.001).

The results have also shown statistically significant improvement in shoulder ROM, measured in degrees, (p<0.001). Anteflexion as well as external and internal rotation have been improved. Abduction and retroflexion showed a tendency to increase immediately after radial ESWT application and even 6 months after, (Figure 2).

Furthermore, a statistically significant increase was noticed in the shoulder muscle strength measured by MMT, immediately after finishing radial ESWT and also with further increase of muscle strength during the next 6 months (statistically significant at the level p<0.001) (Figure 3).

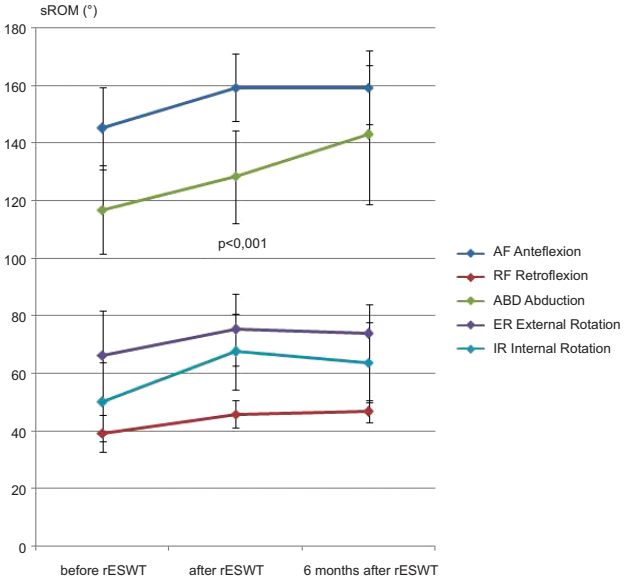

Fig. 2. Shoulder Range of Motion (sROM, °) before and after the radial Extracorporeal Shock Wave Therapy (rESWT), with statistically significant increase (p<0.001).

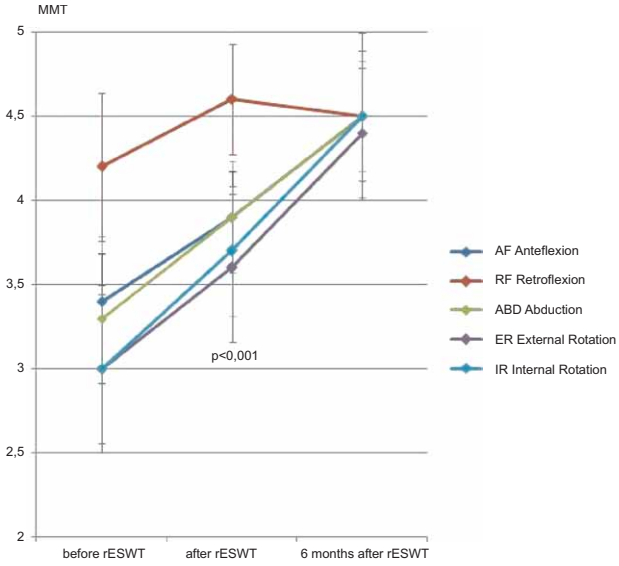

Fig. 3. Shoulder muscle strength measured by Manual Muscle Test (MMT), according to Daniels, before and after radial Extracorporeal Shock Wave Therapy (rESWT), with statistically significant increase (p<0.001).

Finally, the size of shoulder calcification resulted in a statistically significant reduction of the mean value from medium diameter 2(b), before therapy to mean value of small diameter 1(a), after 6 months (statistically significant at the level p<0.001), (Figure 4). The density of calcification has shown that poorly defined dense or sharp contours (b=2) subsequently become sharp/dense contours (a=1), but without any statistical significance (p=0.037) (Figure 4).

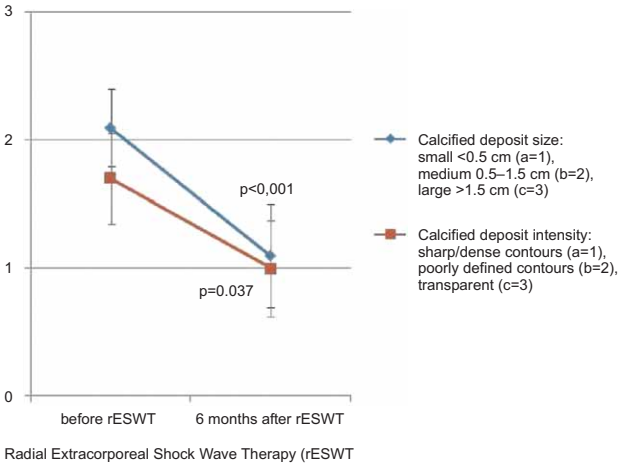

Fig. 4. The size of calcification, according to Bosworth, before and after radial Extracorporeal Shock Wave Therapy (rESWT), with statistically significant decrease (p<0.001), and the density of calcification, according to Gaertner, with increase in intensity but without statistical significance (p=0.037).

Discussion and Conclusion

The treatment of patients with shoulder calcific tendinitis is typically conservative, including phisiotherapy, sonophoresis, deep friction, local or systemic application of non inflammatory drugs and subacromial bursal steroid injection. If the pain becomes chronic or intermittent after several months of conservative treatment, arthroscopic and open procedures are available to cure the calcium deposit and additional subacromial decompression can be performed if necessary. As an alternative, extracorporeal shock wave therapy (ESWT) has been postulated to be an effective treatment option for treating calcific tendinitis of the shoulder, before surgery[23]. The mechanism of action of shock waves is not fully uderstood. Some authors have suggested that it has a centrally modulated effect on nociception via stimulation of peripheral nerves (the gating theory)[24]. In vitro studies have confirmed that energy densities as low as 0.12 mJ/mm^2 produce intracellular damage resulting in increased membrane permeability[25]. This may cause nerve depolarisation. It has also been shown to affect other cells such as neurtophils[26]. Local cell damage leads to a phased, cytokine-mediated increased vascularity[27]. There also is histologic evidence of a direct effect of shock waves on vascular endothelium[28]. The most recent review combines much of this work, suggesting that there may be a short-term analgesic effect followed by a longer-term microtrauma-mediated healing response[29]. Furthermore, since 1992, when Dahmen first described ESWT treatment of the calcified lesions of tendon[5], many studies have proved the occurrence of mechanical destruction of shoulder tendinitis calcifications[14,15,30,31] with facilitation of reabsorbtion due to hyperaemia and neoangiogenesis[12].

However, to our knowledge, to date very few studies have been conducted on the possible short and long-term effects of radial ESWT in the shoulder calcified tendinitis. In the present study, the results were obtained after 3 to 5 radial ESWT treatment sessions, applied once a week, over a period of 3–5 consecutive weeks. The patients were tested before the begining of the radial ESWT application as well as immediately after the treatment and 6 months later. The patients treated with radial ESWT showed a great and statisticaly significant reduction in pain. Therefore, radial ESWT demonstrates to have a very good and quick analgesic effect in patients with shoulder calcific tendinitis. Furthermore, no complications and adverse effects, during or after treatment, were observed. In addition, because of the previously mentioned analgesic effect, shoulder ROM and muscle strength measured by MMT had a statistically significant increase, not only immediately after the treatment but also 6 months after. The results remained the same, which confirms the long term effect of radial ESWT. At the same time, in terms of statistics, the size of shoulder calcification was reduced significantly, although the calcification densitiy became sharp/dense contours but without statistical significance. The meaning of the latter result proves mechanical destruction of shoulder tendinitis calcifications with reabsorbtion of poorly defined calcificat contours, but further research in this field needs to be conducted. Finally, the range of tendinous calcium deposits pre versus post radial ESWT application has a great influence on the pain and clinical results.

In conclusion, success can be noticed immediately after the treatment as an approved short term effect. Furthermore, the benefit effect has remained the same after 6 months as a long term result. Application of radial ESWT in cases of shoulder calcific tendinitis proves to be successful and therefore represents a reliable therapeutic method producing good functional short and long term results.

Although the results of the present study are encouraging, there is a need for conducting further studies, with larger samples, obtaining much more long-term findings and possible comparisons with other conservative and operative interventions or placebo control groups. For this reason prospective studies on the efficacy of radial ESWT should be conducted, introducing different dosages. Finally, continued research in this area is therefore of great importance because radial ESWT appeared to be effective for providing short and long-term pain relief. Also, on the basis of radiographic findings, ESWT may have been an advantageous treatment option, possibly better than operative treatment.

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RADIJALNI IZVANTJELESNI UDARNI VAL U LIJEČENJU KALCIFICIRAJUĆEG TENDINITISA RAMENA

S A Ž E T A K

Kalcificirajući tendinitis rotatorne manžete ramena je čest problem u fizijatriji i ortopediji. Lezija se često nalazi u tetivi supraspinatusa blizu inzercije u tzv. kritičnoj zoni. Bolesnici su uglavnom liječeni konzervativno nesteroidnim antireumaticima i analgeticima, lokalnim infiltracijama, fizikalnom terapijom, a rjeđe kirurškim zahvatom. Bolno rame dovodi do funkcijske onesposobljenosti, te ponekad do nekontroliranog uzimanja lijekova. Zadnjih dvadesetak godina u fizikalnoj terapiji sve se češće upotrebljava udarni val u liječenju tendinopatija zone. Ispitali smo djelovanje radijalnog izvantjelesnog udarnog vala na grupi od 30 bolesnika u dobi od 28 do 58 godina sa kalcificirajućim tendinitisom ramena. Primjenjena je krioterapija, medicinske vježbe i radijalni izvantjelesni udarni val. Korišten je uređaj radijalnog generatora koji proizvodi izvantjelesni udarni val (BTL-5000 SWT®, Columbia, USA), tlaka 3 bara, frekvencije 10 Hz, 2000 udara. Bolesnici su pregledani prije početka terapije, po završenoj terapiji i nakon 6 mjeseci. Uzete su mjere opsega pokreta (MOP), mjerenje maksimalne voljne izometričke kontrakcije mišića ramena pomoću manuelnog mišićnog testa (MMT) i subjektivna procjena osjećaja boli prema tzv. Vizualno analognom stupnjevanju (VAS). Radiološko snimanje učinjeno je prije provođenja terapije i 6 mjeseci nakon terapije. Studija je pokazala efikasnost terapije udarnim valom. Razina statističke značajnosti određena je student's t-testom. Liječenje udarnim valom u bolesnika sa kalcificirajućim tendinitisom rotatorne manžete dovodi do povećanja opsega pokreta, jačanja mišićne snage, smanjenja boli te radiološki dokazanog smanjena veličine kalcifikacija.