Effectiveness of treatment rotator cuff tendinopathy using extracorporeal shock wave therapy – systematic review of randomized controlled trials

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Abstract

Background: Rotator cuff tendinopathy is otherwise known as rotator cuff inflammation, which usually occurs as a result of sudden trauma or degenerative changes. One of the physical therapies used to treat rotator cuff inflammation is extracorporeal shock wave therapy (ESWT). An increasing number of scientific studies of varying quality are emerging and need to be systematized on a regular basis.

Aims: The aim of this review was to analyze the scientific evidence on the effectiveness of treating rotator cuff tendinopathy using ESWT.

Material and methods: The systematic review was conducted in October 2023. After searching databases such as PubMed, PEDro, Cochrane Library, and applying eligibility criteria, out of 163 studies, 10 papers were included in the review. They were methodologically assessed using the PEDro scale. A total of 819 people with diagnosed rotator cuff tendinopathy were included in the study. The methodology of the study involved comparisons between groups applying different ESWT parameters or comparing ESWT with other treatments. Pain and shoulder function assessment scales were used to evaluate efficacy. Some studies were supported by radiological evaluation.

Results: The study showed that the use of ESWT in rotator cuff tendinopathy is an effective treatment method. A positive therapeutic effect was evident in both short- and long-term follow-up. High-energy ESWT had a higher treatment efficacy than low-energy ESWT.

Conclusions: The results of this review clearly indicate that ESWT is highly effective in the treatment of rotator cuff tendinopathy. However, more randomized clinical trials (RCTs) are needed to determine a specific management protocol, including establishing treatment parameters and determining the number of treatment sessions on a large group of subjects.

Key words

ESWT, rotator cuff tendonitis, calcific rotator cuff, pain shoulder.

Introduction

Rotator cuff tendinopathy, also known as rotator cuff inflammation, typically arises as a result of sudden injury or degenerative changes. The muscles whose tendons are prone to inflammation include the supraspinatus, infraspinatus, subscapularis, and teres minor [1]. The main symptoms include pain during active movement, tenderness, and limited range of motion. Tendinopathies can be divided into acute and chronic. The former primarily affects athletes engaged in contact sports or activities involving overhead throws, exposing them to direct damage within the upper limb's rotator cuff [2].

Chronic tendinopathy is usually caused by lifestyle factors. Micro-damages that occur in professional work or daily life, as well as pre-existing pathologies of the shoulder cuff, such as subacromial impingement syndrome, decentralization of the head of the humerus, or disruption of the scapulohumeral rhythm, left untreated over time, can lead to the development of inflammation [1,3]. Age is also a significant risk factor. The frequency of rotator cuff inflammation in patients aged 20 ranges from 5% to 10%, while in those aged 80, it exceeds 60%. Additional risk factors include obesity, the use of certain medications, and tobacco smoking [4]. Diagnosis is primarily based on clinical tests of the shoulder joint and imaging techniques such as X-rays, ultrasound, and magnetic resonance imaging (MRI) [1,5].

One of the physiotherapeutic methods used in the treatment of rotator cuff inflammation is a procedure using extracorporeal shock wave therapy (ESWT) [6]. Depending on the amount of emitted energy and the method of wave generation, shock wave therapy is divided into focused shock wave therapy (FSWT) and radially propagating shock wave therapy (RSWT) [7]. In focused shock wave therapy, the device applied to the treated area concentrates the highest amount of energy, which is only minimally dispersed beyond the intended treatment area. In radially propagating shock wave therapy, the energy is dispersed over a larger area. The maximum depth of wave absorption is approximately 6 cm, while the frequency of pulse generation ranges from 1 Hz to 8 Hz [6,7]. ESWT is applied in the case of orthopedic disorders because its properties have analgesic and tissue-stimulating effects. Literature suggests that one theory explaining the effectiveness of pain reduction is the increase in blood flow and reduction of inflammation. Another theory posits that the cell membrane is damaged, making the transmission of pain stimuli impossible [8, 9]. Researchers have noted that the action of shock waves can have broad applications, prompting studies on the treatment of rotator cuff tendinopathy using ESWT.

Aims

The aim of the study was to review and analyze scientific research on the effectiveness of treating rotator cuff tendinopathy using ESWT.

Material and methods

Sources and strategy search

A literature review was conducted on the treatment of rotator cuff tendinopathy using ESWT based on online medical databases: PubMed, Physiotherapy Evidence Database (PEDro), Cochrane Library. The review was carried out in October 2023. The search was performed using the following terms: "ESWT," "ESWT treatment," "tendinitis rotator cuff," "calcific rotator cuff," "non-calcific rotator cuff," "pain shoulder," "ESWT tendinitis."

Inclusion and exclusion criteria

Randomized clinical trials (RCTs) conducted in the English language were included in the review. All participants in the studies were diagnosed with rotator cuff tendinopathy. Studies that were excluded assessed conditions other than rotator cuff tendinopathy, contained only abstracts, or were duplicates of other works. Ultimately, 10 RCTs were qualified for the review, as depicted in **Figure 1**.

Quality assessment

The qualitative analysis was assessed using the PEDro scale of bias, which is an effective tool for evaluating research design [11]. Studies that were not assessed at the time of the review underwent evaluation using the PEDro scale by a single reviewer. Studies could be classified as having high methodological quality (8-10 PEDro), moderate quality (4-7 PEDro), or low quality (1-3 PEDro). Detailed data is provided in **Table 1**.

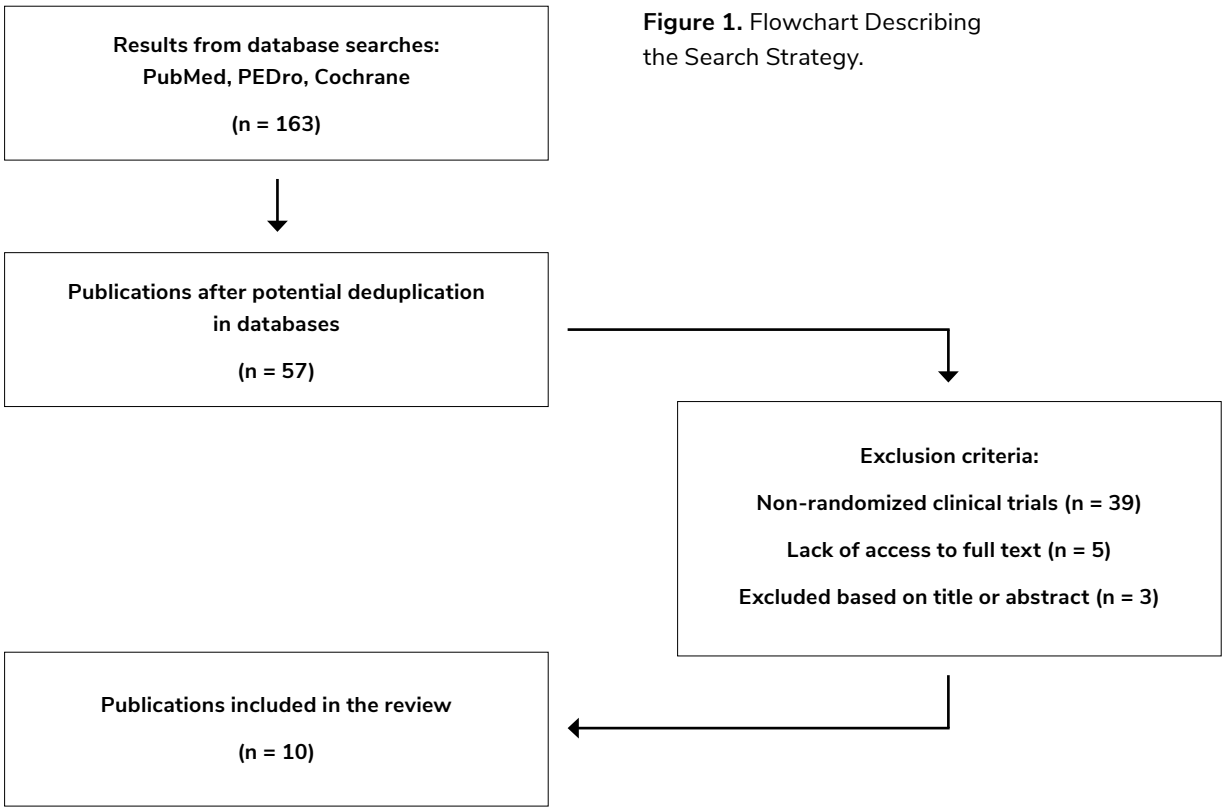

Figure 1. Flowchart Describing the Search Strategy.

Results

Search results

After searching the databases, 163 articles were identified, which were checked for duplication in the databases. There were 57 remaining articles, from which 3 were excluded based on the abstract or title, and 5 articles without access to the full text were excluded. Non-randomized clinical studies were further excluded from the remaining, resulting in a total of 10 articles included in the review (**Fig. 1**).

Characteristics of the included papers

The characteristics of the studies include the authors' names, publication year, the study's purpose, description of materials and methods, measurement tools employed, obtained results, and final conclusions (**Table 2**).

Table 1. Assessment of study quality according to PEDro.

Author PEDro	Wei Li [12]	A. Cacchio [13]	L. Gerdesmeyer [14]	A. Fatima [15]	F. Ioppolo [16]	J.-D. Albert [17]	O. Galasso [18]	P. Frasstanito [19]	F. Del Castillo--Gonzalez [20]	R. Cosentino [21]
Eligibility criteria were specified	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Eubjects were randomly allocated to groups	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Allocation was concealed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
The groups were similar at baseline regarding the most important prognostic indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
There was blinding of all subjects	Yes	Yes	Yes	No	No	Yes	Yes	No	No	Yes
There was blinding of all therapists who administered the therapy	Yes	No	No	No	No	No	No	No	No	No
There was blinding of all assessors who measured at least one key outcome	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by “intention to treat”	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
The results of between-group statistical comparisons are reported for at least one key outcome	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
The study provides both point measures and measures of variability for at least one key outcome	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Score	10	9	9	8	8	9	9	7	5	5

Table 2. Characteristics of the included papers.

Abbreviations: *ESWT – Extracorporeal shock wave therapy, RSWT – Radial shock wave therapy, CRCT – Chronic rotator cuff tendonitis, RCCT – Rotator cuff calcific tendinopathy, KT – Kinesiology Taping, NRS – Numerical pain rating scale, VAS – Visual Analogue Scale, ST – Simple Shoulder Test, UCLA – The University of California-Los Angeles Shoulder Scale, WORC – Western Ontario Rotator Cuff Index, CMS – Constant-Murley score, DASH – Disabilities of the Arm, Shoulder and Hand questionnaire, SSRQ – Subjective Shoulder Rating Questionnaire, OSS – Oxford Shoulder Scale.*

Authors	Outcomes	Material and methods	Measurement tools	Results	Conclusions
Wei Li et al. 2017 [12]	Evaluation of the efficacy and safety of CRCT treatment using ESWT.	The study involved 84 patients, assigned to a test group (n=42), and a control group (n=42). The study group received 3,000 pulses, with an energy of 0.11 mJ/mm^2. The control group received a placebo. Treatments in both groups were applied in 5 sessions, 3 days apart.	NRS, Constant-Murley score - shoulder function and pain rating scale, SST. Measurements were taken before, and 4 and 8 weeks after the study.	ESWT in the study group significantly reduced the intensity of shoulder pain as measured by the NRS scale and shoulder function as measured by CMS and SST, both at 4 and 8 weeks after the procedure. No adverse symptoms were reported in either group.	The study showed that ESWT is an effective, and safe physical therapy tool in CRCT.
A. Cacchio et al. 2006 [13]	Evaluation of the effectiveness of RSWT in the treatment of RCCT.	The group of 90 patients were divided into a test group (n=45), and a control group (n=45). The test group received 500 pulses with a pressure of 1.5 bar and a frequency of 4.5 Hz, and 2000 pulses with a pressure of 2.5 bar and a frequency of 10 Hz with an energy of 0.10 mJ/mm^2. The control group received a placebo. In both groups, 4 sessions were performed one week apart.	UCLA shoulder assessment, VAS pain score, Gartner and Simons calcification classification. Measurements were taken before and after the study, and after a 6-month follow-up.	Through the application of RSWT, all measured parameters in the study group improved significantly both after treatment and after a 6-month follow-up. A significant amount of atrophy of shoulder tendon calcification was demonstrated. No statistically significant differences were found in the control group.	RSWT is an effective tool in the treatment of RCCT.
L. Gerdesmeyer et al. 2003 [14]	Efficacy of ESWT treatment of RCCT under fluoroscopy.	The 144 patients were divided into 3 groups. The two study groups, which received high-energy ESWT (n=48): 1500 pulses, with an energy of 0.32 mJ/mm^2, low-energy ESWT (n=48): 6,000 pulses, with an energy of 0.08 mJ/mm^2, and a control group (n=48) that received placebo. All groups received 2 sessions approximately 14 days apart, followed by 10 sessions of physiotherapy.	Constant-Murley score - shoulder function and pain assessment scale, Pain assessment - VAS scale. Measurements were taken before the study, and at 3, 6 and 12 months after the study.	ESWT was found to be effective in the treatment of CRCT in both study groups, while high-energy ESWT therapy was more effective in the treatment of RCCT. No statistically significant differences were found in the control group. Efficacy was maintained at 3, 6 and 12 months after treatment.	The study showed significant benefits for both high- and low--energy ESWT, in the treatment of RCCT with significantly better results of high-energy ESWT.

A. Fatima et al. 2022 [15]	Effect of high--energy ESWT treatment on RCCT.	The 42 patients were assigned to two groups. The study group (n=21) received routine physiotherapy along with high-energy ESWT: 2000 pulses, with an energy of 0.32 mJ/mm^2. The control group (n=21) received only routine physiotherapy. In both groups, treatments were conducted twice a week for 6 weeks.	Pain assessment - NRS, Constant-Murley score - shoulder function and pain assessment scale, rotator cuff index - WORC. Measurements were taken before the study, and 6 and 12 weeks after the study.	While both groups showed significant improvements in treatment outcomes, there were statistically significant differences in favor of the study group with the NRS, and CMS scales.	While both groups successfully treated RCCT, high-energy ESWT proved more effective at long-term follow-up.
F. Ioppolo et al. 2012 [16]	Comparison of two different ESWT energies in the treatment of RCCT.	The study involved 46 patients assigned to two comparison groups. Group A (n=23) received 2400 pulses with an energy of 0.20 mJ/mm^2. Group B (n=23) received 2400 pulses with an energy of 0.10 mJ/mm^2. Both groups received a session once a week for a period of 4 weeks.	Constant-Murley score - shoulder function and pain assessment scale, Pain assessment - VAS scale, Numerical pain rating scale - NRS, Calcification classification according to Gartner and Simons. Measurements were taken before the study, and 3 and 6 months after the study. The NRS scale was measured after 12 months of follow-up, while radiographic calcium deposit size was assessed after 6 months of follow-up.	Significant improvements in patient outcomes were found in both groups, with a clear benefit for Group A. After comparing the results at 6-month follow-up between the groups, there was a greater effect on pain relief in Group A. NRS test results showed significantly lower levels of pain in Group A patients. Complete disappearance of calcification was observed in 12 subjects from group B, and 11 from group A.	The study found that an energy level of 0.20 mJ/mm^2 was more effective in treating RCCT.
J.-D. Albert et al. 2007 [17]	Efficacy of high--energy ESWT treatment in RCCT.	The 80 patients were divided into two comparison groups. The study group (n=40) received high-energy ESWT in the form of 2500 pulses, and increasing energy up to 0.45 mJ/mm^2. The control group (n=40) received low-energy ESWT in the form of 2500 pulses, and increasing energy from 0.02mJ/mm^2 to 0.06mJ/mm^2. Both groups received 2 sessions 14 days apart.	Scale for the assessment of shoulder function and pain - CMS, Assessment of pain - VAS scale, 5-grade scale of subjective assessment of the subject on the effectiveness of treatment, Radiological assessment of calcification. The CMS scale was measured at the beginning of the study, and 3 months after the end of the study. The VAS scale, and subjective evaluation of the subject were assessed 48h before each session.	The mean score for the CMS scale was significantly higher in favor of the study group. Measurements for the VAS scale, and the subjective evaluation of the subject also showed greater treatment efficacy in the study group. Complete or partial disappearance of calcification was observed in 9 subjects in the study group, and 7 subjects in the control group.	High-energy ESWT is an effective treatment option for RCCT.

O. Galasso et al. 2012 [18]	Efficacy of CRCT treatment with ESWT.	The 20 patients were assigned to a test group (n=11), and a control group (n=9). The study group received 3,000 pulses with an energy of 0.068mJ/mm^2. The control group received a placebo. Both groups received 2 sessions 7 days apart.	Scale for assessing shoulder function and pain - CMS. Measurements were taken before the study, and 6 and 12 weeks after the study.	The study group showed a significant improvement in performance compared to baseline values, with the exception of muscle strength, which did not change in a statistically significant way. The improvement in performance increased, along with the duration of observation. No significant differences were observed in the control group.	ESWT is highly effective in treating CRTC.
P. Frassanito et al. 2018 [19]	The effectiveness of treating RCCT with ESWT, and KT.	The study included 42 patients who were divided into two comparison groups. The ESWT group (n=21) received 1,800 pulses with energies ranging from 0.07 mJ/mm^2 to 0.15 mJ/mm^2. The ESWT + KT group (n=21) received the same shock wave parameters, plus KT application to the shoulder muscle. Both groups received 3 sessions once a week for the next 3 weeks.	Assessment of pain - VAS scale, Upper limb disability questionnaire - DASH, Subjective Shoulder Rating Questionnaire - SSRQ, Oxford Shoulder Scale - OSS. Measurements were taken before the study, and 1, 4 and 12 weeks after the study.	During the short-term follow-up period, the ESWT + KT group showed significantly greater improvement than the ESWT group on the VAS, DASH, SSRQ scales. The OSS scale showed no significant differences. In the long-term follow-up, progressive improvement in both groups was not significantly different.	KT is an effective adjunct to ESWT therapy in the course of RCCT.
F. D. Castillo--Gonzalez et al. 2016 [20]	Comparison of ESWT, and Barbotage in the course of RCCT treatment.	201 patients were assigned to two comparison groups. One group (n=80) received ESWT 2000 pulses of 0.20 J/mm^2 energy. The session was performed twice a week for 4 weeks. The opposite group (n=121) received Barbotage treatment.	Assessment of pain - VAS scale, Assessment of the size of the calcification. Measurements were taken before the study, and at 3, 6 and 12 months after the study.	Significant improvements in outcomes were observed in both study groups. At 12-month follow-up, a significant difference was noted in the disappearance of calcium deposits in favor of the group that received Barbotage. In addition, this group showed lower VAS scores than the opposite group.	Both methods have shown high efficacy in the treatment of RCCT, but the Barbotage method has greater effectiveness.
R. Cosentino et al. 2003 [21]	Clinical and radiological evaluation of ESWT in the treatment of RCCT.	The 70 patients were assigned to two groups. The test group (n=35) received 1200 pulses with an energy of 0.28 mJ/mm^2. The control group (n=35) received 1200 pulses with an energy of 0 mJ/mm^2. In both groups, 4 sessions were performed with a 4–7-day interval between sessions.	Shoulder function and pain assessment scale - CMS, Radiological assessment. CMS evaluation was done before and after the study, and at 1 and 6 months of follow-up. Radiological evaluation was done before the study and after one-month follow-up.	In the study group, there was a marked improvement in the results compared to the control group, in which the results worsened at distant follow-up. Radiological imaging after one-month follow--up noted complete or partial resorption of calcium deposits in 71% of the subjects.	ESWT is an effective treatment method for RCCT.

Discussion

Ten scientific studies were included in the systematic review. Two of the studies are not randomized clinical trials; however, due to their high methodological value assessed on the PEDro scale, the author decided to include these works in this review. The average score of the studies on the PEDro scale is 7.9 points. The results of the review suggest that ESWT is an effective tool in the treatment of rotator cuff tendinopathy; nevertheless, determining clear technical and procedural parameters still appears to be a challenge. The researchers [14,16,17] demonstrated the effectiveness of both high and low-energy ESWT, but the applied treatment parameters, the quantity, and the duration of the sessions were not consistent. A similar situation is observed in studies evaluating calcification resorption [13,14,16,17,21], where different ESWT parameters in both groups proved to be effective but with noticeable differences between them. Through the analysis of the studies, it can be observed that high-energy ESWT exhibits higher treatment efficacy.

Fatima et al. [15] conducted an analysis of the effectiveness of ESWT in combination with routine physiotherapy; however, there is a lack of studies comparing it with other physiotherapeutic methods. In the study by Castillo-Gonzalez et al. [20], the effectiveness of treatment between two different interventions was assessed, but they significantly differ in methodology.

Due to their objectives, not all studies applied a placebo in the control group. The methodology of the procedure proves to be problematic in terms of therapist blinding, as only one study [11] implemented therapist blinding. Another significant limitation of the studies was the observation period, as re-evaluations after 12 months of observation were only conducted in three studies [14,16,20].

Study limitations

The main weakness of this review is the lack of blinding during the analysis of included publications, due to its preparation by a single author. An additional limitation is the relatively small number of studies included in the analysis and the broad range of publication years. This is a result of the scarcity of high methodological quality randomized clinical trials, which could provide a robust analysis.

Conclusions

ESWT is an effective tool in the treatment of rotator cuff tendinopathy in both short-term and long-term observations. However, attention should be paid to the need for conducting a greater number of reliable randomized clinical trials to establish clear procedural parameters.

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