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A Narrative Review of Extracorporeal Shock Wave Therapy for Rotator Cuff Tendinopathy: Clinical Effectiveness, Treatment Parameters, and Safety

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Abstract

Rotator cuff tendinopathy is a common cause of shoulder pain and functional limitation. Extracorporeal shock wave therapy (ESWT) is a non-invasive treatment option for rotator cuff tendinopathy, although its effects appear to differ between calcific and non-calcific presentations. A narrative literature search was conducted using PubMed (National Institutes of Health (NIH), Bethesda, Maryland, USA) and Google Scholar (Google LLC, Mountain View, California, USA) to identify studies evaluating the clinical effectiveness, treatment parameters, safety, and therapeutic positioning of ESWT in rotator cuff tendinopathy. Current evidence suggests that ESWT may improve pain and functional outcomes, with more supportive evidence in calcific than non-calcific rotator cuff tendinopathy. In calcific disease, ESWT may promote fragmentation and resorption of calcific deposits, although radiological improvement does not necessarily correspond to clinical improvement. Evidence in non-calcific rotator cuff tendinopathy remains heterogeneous, with variable effects across studies and follow-up periods. Differences in ESWT modality, treatment parameters, patient characteristics, and outcome measures may contribute to this heterogeneity. Overall, the available evidence supports a more established role for ESWT in calcific rotator cuff tendinopathy, whereas its effectiveness in non-calcific disease remains less certain. Further research using standardized treatment protocols, including clearly defined modality, energy flux density, number of pulses, treatment frequency, and number and interval of sessions, is needed to better define the clinical role of ESWT in rotator cuff tendinopathy.

Categories: Physical Medicine & Rehabilitation
Keywords: calcific tendinitis, eswt, extracorporeal shock wave therapy, rotator cuff, rotator cuff tendinopathy, shoulder pain

Introduction And Background

Shoulder pain is the third most common musculoskeletal complaint at physician office visits, with rotator cuff tendinopathy (RCT) presenting as one of the primary causes of shoulder pain and functional impairment [1,2]. A careful clinical assessment is essential because other conditions, including adhesive capsulitis, bursitis, glenohumeral disorders, and cervical radiculopathy, may present with overlapping symptoms and functional limitations [3]. The etiology and pathogenesis of this condition are still controversial: aging, overuse, mechanical stress, smoking, genetic predisposition, degenerative changes, previous injuries, hypovascularization of the cuff, metabolic disorders, and functional overload have been cited over time as possible causes of RCT [1,4].

Rotator cuff tendinopathy is characterized by a combination of degenerative and mechanical processes rather than a purely inflammatory condition. Repetitive microtrauma and chronic overload contribute to tendon degeneration, collagen disorganization, and a reduced capacity for healing. Its pathogenesis involves both intrinsic and extrinsic pathways [5]. Intrinsic factors include alterations in tendon structure, mechanical properties, and vascularity, while extrinsic factors are mainly related to abnormal scapular and glenohumeral kinematics, resulting in subacromial or internal impingement. These mechanisms often coexist and interact, contributing to the complexity of the disease. In some cases, calcific deposits may develop within the tendon, further exacerbating pain and functional limitation.

The management of rotator cuff tendinopathy includes both surgical and conservative treatment. Conservative management generally constitutes the first-line approach and emphasizes patient education, activity modification, and exercise-based rehabilitation [6]. Oral non-steroidal anti-inflammatory drugs (NSAIDs) may be considered for short-term pain relief, while subacromial corticosteroid injections may provide short-term symptom relief in selected patients [1]. However, no single treatment has proven to be consistently effective, simple, and non-invasive. Surgery may be considered in selected patients with persistent symptoms despite appropriate conservative management, depending on the underlying lesion and clinical context.

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Extracorporeal shock wave therapy (ESWT) has emerged as a non-invasive treatment option for several tendon and musculoskeletal disorders, including rotator cuff tendinopathy [4]. Proposed biological mechanisms of ESWT include modulation of angiogenic and inflammatory pathways and effects on tissue remodeling. However, the extent to which these mechanisms translate into structural tendon repair or clinically meaningful benefits in rotator cuff tendinopathy remains uncertain [7]. These mechanisms have primarily been investigated in experimental models and across different musculoskeletal conditions. ESWT is used in rehabilitation for various musculoskeletal conditions, including chronic pain and tendinopathies. Its clinical effectiveness in rotator cuff tendinopathy remains debated. Some studies report improvements in pain and function, whereas others have found limited or no benefit [4,7]. The aim of this narrative review is to evaluate the clinical effectiveness of extracorporeal shock wave therapy (ESWT) in rotator cuff tendinopathy, distinguishing between calcific and non-calcific disease. This review also examines the influence of treatment parameters, compares ESWT with other conservative and procedural interventions, and summarizes its safety profile and reported adverse events.

Review

Literature search strategy

A narrative literature search was conducted using PubMed (National Institutes of Health (NIH), Bethesda, Maryland, USA) and Google Scholar (Google LLC, Mountain View, California, USA) to identify publications evaluating extracorporeal shock wave therapy (ESWT) for rotator cuff tendinopathy. The search covered publications available from database inception through March 2026. Search terms included combinations of “rotator cuff tendinopathy,” “rotator cuff disease,” “calcific tendinitis,” “calcific tendinopathy,” “extracorporeal shock wave therapy,” “ESWT,” “focused shock wave,” and “radial shock wave.” The exact search strings and the date on which the final search was performed were not recorded.

Eligibility criteria

Publications were considered eligible if they investigated ESWT in human participants with rotator cuff tendinopathy, including calcific and non-calcific presentations. Relevant topics included clinical effectiveness, treatment parameters, safety, mechanisms of action, and the comparative role of ESWT. Clinical outcomes of interest included pain, shoulder function, clinical improvement, treatment-related adverse events, and imaging findings when reported. Studies comparing ESWT with placebo or sham treatment, other conservative treatments, or other therapeutic interventions were considered, as were studies evaluating ESWT without a comparator.

Eligible publication types included randomized controlled trials, systematic reviews, meta-analyses, clinical practice guidelines, and other relevant clinical studies conducted in humans. Studies involving mixed shoulder tendinopathy populations were considered only when rotator cuff-specific data could be separately identified. Studies in which findings specific to rotator cuff tendinopathy could not be distinguished from those of other shoulder conditions were excluded from the clinical effectiveness synthesis. Publications were excluded if they focused on conditions unrelated to rotator cuff tendinopathy, did not evaluate ESWT as a therapeutic intervention, or did not provide information relevant to the objectives of the review. Animal studies, in vitro studies, case reports, conference abstracts, and publications primarily addressing surgical management without relevant evaluation of ESWT were excluded.

Study selection

Study selection was performed by the first author based on the relevance of the retrieved records to the scope of this narrative review. Duplicate records identified across the databases were removed manually. Full-text articles were sought through institutional access, publisher platforms, or publicly available sources. Only publications for which the full text could be accessed and reviewed were included in the narrative synthesis. The number of publications for which full-text access could not be obtained was not recorded; therefore, their potential impact on the completeness of the review cannot be determined. No formal language filter was applied, although English-language publications were prioritized. As this was a narrative review, the search and selection process was not designed as a systematic review. No formal risk-of-bias assessment or quantitative synthesis was undertaken.

Pathophysiology of rotator cuff tendinopathy

Rotator cuff tendinopathy is a multifactorial disorder involving interactions between tendon-related changes, mechanical loading, and biological processes, including inflammatory signaling. Age-related alterations in tendon structure and composition may affect its mechanical properties and capacity to adapt to repetitive loading. Intrinsic tendon factors and extrinsic biomechanical factors, including scapular and glenohumeral kinematics, have both been proposed as contributors to tendon dysfunction [4]. Repetitive loading may contribute to collagen disorganization and changes in tendon structure, while inflammatory signaling may also participate in the pathophysiological process. The relative contribution and interaction of these mechanisms remain incompletely understood. Calcific deposits may occur in a subset of patients and represent a distinct clinical presentation that should be differentiated from non-calcific tendinopathy [5].

Mechanisms of ESWT

Extracorporeal shock wave therapy (ESWT) delivers acoustic pressure waves to targeted tissues, producing mechanical stimuli that may trigger biological responses. Two main modalities are used in clinical practice: focused ESWT, which concentrates energy within a focal zone at a selected depth, and radial pressure wave therapy, in which pressure waves diverge from the applicator and reach their highest pressure near the treatment surface [7-10]. Although these modalities differ in their physical characteristics and energy distribution, tissue depth alone does not determine treatment selection. The choice of modality and treatment protocol also depends on the location and nature of the target lesion, device characteristics, and relevant treatment parameters [10,11]. The relationship between these physical differences and comparative clinical effectiveness remains incompletely established [10].

Several mechanisms have been proposed to explain the effects of ESWT, including modulation of nociceptive signaling, changes in local tissue vascularity, and stimulation of cellular responses involved in tissue remodeling [7,8,12]. Much of the mechanistic evidence derives from experimental studies and research involving different musculoskeletal conditions. Although clinical studies have investigated the effects of ESWT in rotator cuff tendinopathy, the extent to which these proposed mechanisms explain the observed clinical outcomes in this specific condition remains uncertain. These mechanisms should therefore not be interpreted as proof that ESWT directly repairs damaged tendon tissue.

In calcific rotator cuff tendinopathy, ESWT may influence calcific deposits through mechanical effects that may facilitate their fragmentation or resorption. Clinical studies have reported reductions in calcific deposit size or complete resorption following ESWT, as well as improvements in pain and shoulder function [13,14]. However, radiographic changes in calcific deposits and clinical improvements are distinct outcomes, and the extent to which changes in calcific deposits contribute to symptomatic improvement remains uncertain. The relative contributions of mechanical effects on deposits, biological responses, and other pain-modulating mechanisms to the overall clinical benefit also remain incompletely understood. Overall, ESWT appears to involve multiple mechanisms rather than a single established pathway. Further research is needed to clarify how these mechanisms relate to clinical outcomes in calcific and non-calcific rotator cuff tendinopathy.

Clinical effectiveness

ESWT has been investigated for the treatment of rotator cuff tendinopathy, with evidence suggesting variable effects on pain and shoulder function according to the presence or absence of calcific deposits. Recent systematic reviews and meta-analyses indicate more supportive evidence for calcific rotator cuff tendinopathy, whereas findings in non-calcific disease are more heterogeneous (Table *1*) [15,16].

Study	Study design	Population	Type of tendinopathy	ESWT protocol	Comparator	Main outcomes	Main conclusion
Gerdesmeyer et al. (2003) [13]	**RCT**	**Patients with chronic calcific rotator cuff tendinopathy**	**Calcific**	**High-energy ESWT, low-energy ESWT**	**Placebo**	**Improvement in Constant-Murley score, pain, and radiographic calcification**	**Both energy levels improved clinical outcomes compared with placebo; high-energy ESWT showed greater improvement than low-energy ESWT.**
Cacchio et al. (2006) [14]	Randomized clinical trial	Patients with calcific tendinitis of the shoulder	Calcific	Radial ESWT	Sham treatment	Improvement in pain and shoulder function	ESWT improved clinical outcomes compared with sham treatment.
Xue et al. (2024) [15]	Systematic review and meta-analysis	Patients with rotator cuff tendinopathy from 18 studies	Calcific and non-calcific	Radial and focused ESWT; various protocols	Various comparators	Pain and shoulder function	More supportive evidence for calcific disease; evidence for non-calcific disease was more heterogeneous.
Kamonseki et al. (2024) [16]	Systematic review and meta-analysis (9 RCTs; n = 543)	Patients with non-calcific rotator cuff tendinopathy	Non-calcific	Various ESWT protocols	Sham ESWT and other treatments	Pain and shoulder function at short-, intermediate-, and long-term follow-up	Moderate-certainty evidence indicated a small improvement in pain with ESWT compared with sham at short-term follow-up. No significant superiority was found for pain at intermediate- or long-term follow-up, or for shoulder function at any follow-up period.
Louwerens et al. (2020) [17]	RCT (n = 82)	Patients with symptomatic calcific tendinitis of the rotator cuff refractory to conservative treatment	Calcific	High-energy ESWT, 4 sessions, 2,000 impulses per session	Ultrasound-guided needling combined with subacromial corticosteroid injection	Pain (VAS), function (CMS and DASH), and radiographic calcification at 6 weeks, 3, 6, and 12 months	Both groups improved clinically. No statistically significant between-group differences were found in changes in CMS, DASH, or VAS at 12 months. Needling resulted in greater reduction in calcific deposit size and fewer additional treatments.
Frassanito et al. (2018) [18]	RCT	Patients with calcific tendinopathy of the shoulder	Calcific	ESWT + kinesio taping	ESWT alone	Functional and clinical outcomes	Addition of kinesio taping was associated with improved clinical outcomes compared with ESWT alone.

TABLE 1: Summary of the Main Clinical Studies Evaluating ESWT for Rotator Cuff Tendinopathy

ESWT, extracorporeal shock wave therapy; RCT, randomized controlled trial; VAS, Visual Analog Scale; CMS, Constant-Murley Score; DASH, Disabilities of the Arm, Shoulder and Hand.

However, differences in study populations, comparators, treatment protocols, and follow-up periods limit direct comparisons across studies. Furthermore, statistically significant improvements do not necessarily indicate that clinically important thresholds have been reached.

Calcific vs non-calcific tendinopathy

In calcific rotator cuff tendinopathy, clinical studies and systematic reviews have reported relatively consistent benefits of ESWT, particularly for pain and shoulder function [13-15,19]. Several studies have also reported reductions in the size or radiographic appearance of calcific deposits following ESWT [13,14]. However, radiographic changes should be distinguished from clinical outcomes, as reduction or resorption of calcific deposits does not necessarily correspond directly to improvement in pain or function. Mechanical effects on calcific deposits and associated biological responses have been proposed as potential mechanisms underlying the clinical effects of ESWT. However, these mechanisms have not been established as mediators of clinical improvement, and their relative contributions to treatment outcomes remain uncertain.

In non-calcific rotator cuff tendinopathy, the evidence is more heterogeneous. A systematic review and meta-analysis including nine randomized controlled trials (n = 543) found a small short-term reduction in pain with ESWT compared with sham treatment (standardized mean difference (SMD): -0.28; 95% CI: -0.55 to -0.01), with moderate certainty of evidence. However, no significant superiority was demonstrated for pain at intermediate- or long-term follow-up. ESWT was also not superior to sham treatment or other interventions for shoulder function at short-, intermediate-, or long-term follow-up [16]. These findings suggest that the potential benefit of ESWT in non-calcific rotator cuff tendinopathy may be limited to a

small short-term reduction in pain, without consistent evidence of improved shoulder function or sustained pain relief.

Differences between studies may be related to variations in ESWT modality and treatment parameters, patient characteristics, comparator interventions, and outcome assessment. However, these factors represent possible explanations for the observed heterogeneity rather than established causes. Overall, the available evidence provides greater support for ESWT in calcific rotator cuff tendinopathy than in non-calcific disease, for which the magnitude and durability of clinical benefit remain less certain [15,16].

Treatment parameters

The clinical effects of ESWT may vary according to treatment parameters, including energy level, number of sessions, treatment interval, number of impulses, and shock wave modality. Evidence from randomized trials and systematic reviews suggests that treatment energy may influence clinical outcomes, particularly in calcific rotator cuff tendinopathy. However, direct comparisons between high- and low-energy protocols are limited, and comparisons across studies may be confounded by differences in patient populations, treatment devices, and other protocol characteristics. Therefore, the available evidence does not establish a universally superior energy level [13,20,21].

Both radial and focused ESWT have been used in the treatment of rotator cuff tendinopathy. Available evidence does not establish a consistent superiority of one modality over the other, and radial and focused ESWT should not be considered synonymous with low- and high-energy treatment, respectively [20,21]. Treatment protocols vary substantially across studies with respect to energy flux density, number of impulses, number of sessions, and treatment intervals. This heterogeneity limits the ability to define a single standardized treatment regimen [21,22].

Selected treatment parameters reported in clinical studies are summarized in Table *2*. Because treatment protocols vary substantially according to ESWT modality, device, and study design, these parameters should be interpreted as examples of published protocols rather than standardized recommendations.

Parameter	Examples reported in clinical studies	Clinical considerations
Indication	ESWT has been investigated in calcific and non-calcific rotator cuff tendinopathy.	Evidence is more supportive for calcific tendinopathy, whereas findings in non-calcific disease remain heterogeneous.
ESWT modality	Both focused and radial ESWT were compared in Li et al.[20].	Available evidence does not establish consistent superiority of one modality across all clinical presentations.
Energy and dose	Energy parameters varied according to the modality and device. (Specific values reported in the included studies are presented below.)	These values represent study-specific treatment settings, not maximum device capacities or universally recommended doses.
Energy flux density (EFD)	Focused ESWT: mean EFD of 0.09 ± 0.018 mJ/mm² in Li et al.[20]; 0.35 mJ/mm² in Louwerens et al. [17].	These values represent different published protocols and should not be interpreted as equivalent doses or universal treatment targets.
Radial pressure	Mean radial pressure of 4.0 ± 0.35 bar reported by Li et al.[20].	Pressure in bar and EFD in mJ/mm² are different parameters and should not be considered interchangeable.
Pulses per session	Li et al. [20]: 3,000 shocks per session. Louwerens et al.[17]: 2,000 pulses per session.	The number of shocks varied between protocols and should be interpreted alongside other treatment parameters.
Treatment frequency	Li et al. [20]: 5.1 ± 0.5 Hz for focused ESWT and 3.2 ± 0.0 Hz for radial ESWT. Louwerens et al. [17]: 4 Hz for focused ESWT.	Frequency varies by device and protocol. The frequency reported by Li et al. should not be attributed to Louwerens et al. without confirmation.
Number of sessions	Four sessions in Li et al. [20] and Louwerens et al. [17].	These examples do not establish a universally optimal number of sessions.
Interval between sessions	Weekly sessions in Li et al. [20] and Louwerens et al. [17].	The optimal interval has not been established for all clinical presentations and devices.
Local anesthesia and analgesia	Li et al. [20] reported that no local anesthesia, analgesics, or NSAIDs were used during the procedure. Local anesthesia and analgesia details were not reported in the cited publication by Louwerens et al. [17].	Anesthesia and analgesia protocols should be reported when documented; these findings do not support a universal recommendation.
Overall interpretation	Published protocols differ in modality, intensity, frequency, number of shocks, and treatment schedule.	Standardized reporting is needed to improve reproducibility and comparison across clinical studies.

TABLE 2: Treatment Parameters Reported in Clinical Studies of Extracorporeal Shock Wave Therapy for Rotator Cuff Tendinopathy

ESWT, extracorporeal shock wave therapy; EFD, energy flux density; Hz, hertz; NSAIDs, non-steroidal anti-inflammatory drugs. Reported values are examples of published protocols and should not be interpreted as standardized treatment recommendations.

Comparison with other treatments

ESWT has been compared with other conservative and interventional treatments for calcific rotator cuff tendinopathy. In the randomized trial by Louwerens et al., both high-energy ESWT and ultrasound-guided needling combined with a subacromial corticosteroid injection were associated with improvements in pain and shoulder function over follow-up [17]. However, ultrasound-guided needling resulted in greater radiographic reduction of calcific deposits and a lower need for additional treatment. These findings indicate differences in radiological and treatment-related outcomes but do not establish overall clinical superiority of one intervention over the other.

Compared with surgery, ESWT is less invasive and may represent an option before operative treatment in selected patients with persistent symptoms despite conservative management. However, direct evidence demonstrating that ESWT reduces or prevents the need for surgery remains limited. Therefore, any potential role of ESWT in delaying or avoiding surgery should be considered a possible clinical implication rather than

an established treatment effect. A proposed clinical algorithm for the use of ESWT in rotator cuff tendinopathy is presented in Figure *1*.

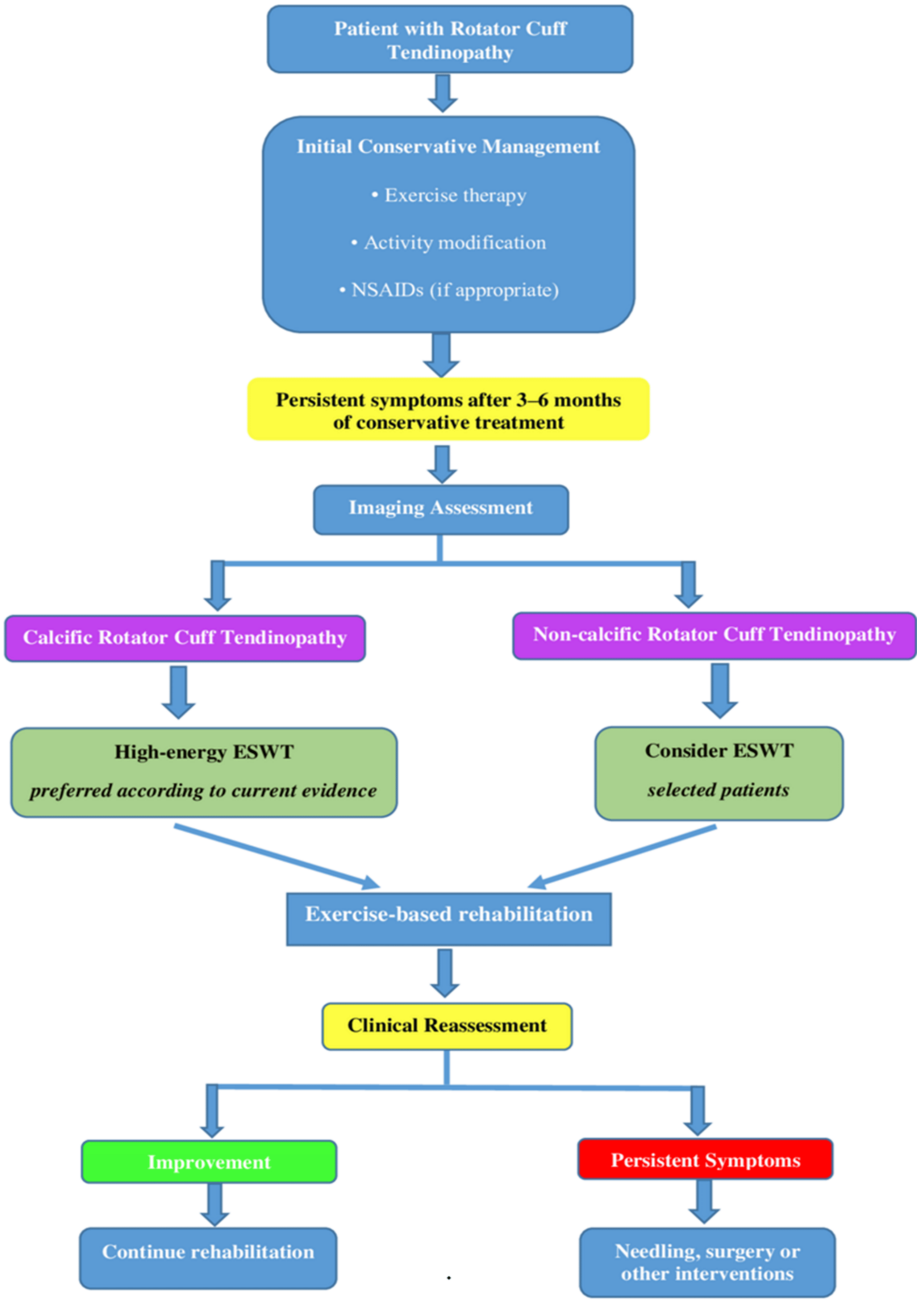


FIGURE 1: Proposed clinical algorithm for the use of extracorporeal shock wave therapy (ESWT) in the management of rotator cuff tendinopathy.

The algorithm summarizes the proposed place of ESWT within the management pathway, highlighting its preferential role in calcific rotator cuff tendinopathy, its selective use in non-calcific disease, and the importance of exercise-based rehabilitation and clinical reassessment. ESWT, extracorporeal shock wave therapy; NSAIDs, non-steroidal anti-inflammatory drugs.

Clinical implications

Based on the available evidence, ESWT may be considered as a treatment option for patients with persistent rotator cuff tendinopathy following an appropriate course of conservative management, including exercise-based rehabilitation [23]. The available evidence provides greater support for its use in calcific rotator cuff tendinopathy than in non-calcific disease [15,16]. Although some studies have reported favorable outcomes with high-energy protocols, the available evidence does not establish the superiority of focused high-energy

ESWT over other ESWT modalities. In non-calcific tendinopathy, ESWT should be considered within a broader rehabilitation strategy rather than as a stand-alone intervention.

Safety and tolerance

ESWT is generally well tolerated, with commonly reported adverse effects including transient local pain, erythema, bruising, and swelling at the treatment site [11,24,25]. The frequency and severity of adverse events may vary according to treatment modality, energy level, and protocol. Although reviews have generally described a low incidence of complications, serious adverse events, including tendon rupture, have been reported. The available evidence does not establish the absence of serious adverse events, and their frequency remains difficult to quantify because of differences in study protocols and adverse-event reporting [11,24,25]. Overall, ESWT may be considered a non-invasive treatment option when appropriately selected and administered, with due consideration of treatment parameters and potential risks [11].

Discussion

This narrative review examined the clinical role of extracorporeal shock wave therapy (ESWT) in calcific and non-calcific rotator cuff tendinopathy, with particular consideration of clinical effectiveness, treatment parameters, comparative treatments, and safety. Overall, the available evidence provides greater support for ESWT in calcific rotator cuff tendinopathy, particularly for improvements in pain and shoulder function, whereas evidence in non-calcific disease remains more heterogeneous [15,16].

The more favorable clinical evidence in calcific tendinopathy may partly be related to the mechanical effects of shock waves on calcific deposits, as well as to associated biological responses described in the literature. However, radiographic reduction of calcific deposits should be distinguished from clinical improvement, as changes in calcification do not necessarily correspond directly to changes in pain or function [13,14]. The relative contribution of these mechanical and biological mechanisms to clinical outcomes remains uncertain.

The heterogeneity of findings across studies may be related to differences in patient characteristics, symptom duration, calcification characteristics, ESWT modality, treatment dose, number and interval of sessions, comparator interventions, and outcome measures [15,16,24]. These factors represent possible explanations for the variability in treatment response rather than established causes. In particular, the available evidence does not establish a consistent superiority of focused over radial ESWT, or of high-energy over low-energy treatment across all clinical settings.

Another important finding is the substantial variability in ESWT treatment protocols. Differences in energy flux density, number of impulses, treatment frequency, number and interval of sessions, and treatment modality make direct comparisons between studies difficult. This variability limits the ability to define a standardized treatment regimen and highlights the need for greater protocol standardization in future clinical trials.

From a clinical perspective, the available evidence supports considering ESWT as a treatment option for selected patients with persistent rotator cuff tendinopathy despite conservative management, particularly in calcific disease. In non-calcific tendinopathy, the more heterogeneous evidence suggests that ESWT should be considered within a broader rehabilitation strategy rather than as a stand-alone intervention. Exercise-based rehabilitation remains an important component of conservative management.

The available evidence should also be interpreted in light of methodological limitations across the included studies. Several randomized trials and systematic reviews included relatively small samples, heterogeneous eligibility criteria, variable treatment protocols, and different outcome measures and follow-up periods. Blinding may also be challenging in ESWT trials because of the nature of the intervention, which may introduce performance or detection bias. These factors should be considered when interpreting the magnitude and consistency of reported treatment effects.

Important knowledge gaps remain regarding the optimal selection of patients and treatment parameters. Future randomized controlled trials should use clearly defined and standardized ESWT protocols, including modality, energy flux density, number of impulses, treatment frequency, number and interval of sessions, targeting method, and outcome assessment. Longer follow-up and standardized clinical and radiological outcomes may also help clarify the durability of treatment effects and the relationship between radiographic changes and clinical improvement. Further research should also investigate predictors of treatment response to improve patient selection.

Limitations of this review

This review has several limitations. As a narrative review, it did not include a formal risk-of-bias assessment, a formal assessment of the certainty of the evidence, or a quantitative synthesis. The literature search was limited to PubMed and Google Scholar, which may have resulted in the omission of relevant studies indexed in other databases. Study selection and screening were performed by the first author based on the relevance

of each publication to the objectives of the review, which may have introduced selection bias. The emphasis on English-language publications may also have limited the inclusion of relevant studies published in other languages. These methodological limitations should be considered when interpreting the findings and may affect the comprehensiveness and reproducibility of the review.

Conclusions

Extracorporeal shock wave therapy (ESWT) appears to have a more established clinical role in calcific rotator cuff tendinopathy, with evidence supporting improvements in pain and shoulder function and, in some studies, reductions in calcific deposits. In non-calcific rotator cuff tendinopathy, the available evidence is more heterogeneous, with less consistent evidence for sustained clinical benefit. The current literature is also characterized by substantial variability in treatment parameters, patient populations, and outcome assessment, limiting the ability to define a standardized ESWT protocol. Further high-quality studies using clearly defined treatment parameters, including ESWT modality, energy flux density, number of impulses, treatment frequency, number and interval of sessions, and targeting method, together with standardized clinical and radiological outcome measures and adequate follow-up, are needed to clarify the clinical role of ESWT and optimize patient selection and treatment protocols.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Supervision: Siham Elmir

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