Effectiveness of Extracorporeal Shockwave Therapy (ESWT) in Physiotherapy for Musculoskeletal Pain Management: A Systematic Review

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Abstract

Background: Extracorporeal Shockwave Therapy (ESWT) has gained a considerable attention as a new innovative non-invasive modality for the management of the various musculoskeletal disorders. Initially introduced for the urological applications, ESWT has increasingly integrated into the physiotherapy practice due to its promising outcomes in the pain reduction and the tissue regeneration. This review aims to analyze and synthesize the current evidence regarding the therapeutic efficacy underlying the biological mechanisms, the clinical indications and the practical applications of the ESWT in the musculoskeletal rehabilitation.**Methods:** We conducted a comprehensive review of the recent clinical trials, the systematic reviews and the experimental studies to evaluate the effectiveness of the ESWT across the different conditions, including the tendinopathies, the plantar fasciitis and the calcific shoulder tendinitis. **Results:** Our findings demonstrated that the ESWT significantly reduce the pain intensity, enhance the functional performance and improve overall the patient satisfaction. Moreover, the ESWT is associated with a minimal side-effects and a shorter recovery times compared to the invasive interventions making it a valuable option within the conservative physiotherapy management. Despite these encouraging outcomes, a variations in the treatment protocols including the energy levels, the frequency and the number of sessions highlighting the need for a standardized guidelines. Further high-quality research is essential to optimize the treatment parameters and expand its evidence base. **Conclusion:** ESWT represent a safe and effective therapeutic tools in the modern physiotherapy practice for managing the musculoskeletal pain and the dysfunction.

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Introduction

Muscle pain is a widespread issue, often linked to conditions like trigger points, tendinopathies and injuries. These ailments can severely impact an individual's functional capabilities and overall quality of life. Traditional treatments such as medication, physical therapy and surgery often yield inconsistent results and carry potential side effects. Extracorporeal shockwave therapy (ESWT) has emerged as the widely used intervention for the musculoskeletal disorders. Recent studies report its effectiveness in the treating of tendinopathies, including the Achilles, the patellar and the plantar fasciitis (Abd elazeem et al., 2024; Charles et al., 2023; Majidi et al., 2024). Radial extracorporeal shock wave therapy (rESWT) has become an increasingly utilized the non-invasive modality in the management of the musculoskeletal disorders and the pain conditions. Its clinical efficacy has been well documented in various orthopedic including plantar fasciitis, calcific tendinitis of the shoulder, the lateral epicondylitis, the patellar and the Achilles tendinopathies, the delayed union and the non-union of long bone fractures and the avascular necrosis of the femoral head (Wang, 2012). These outcomes have contributed to the widespread adoption of the shockwave therapy in the rehabilitation practice. Radial shock waves are the ballistic pressure waves generated at the relatively lower peak pressures with the longer rise times, dispersing energy in a radial and divergent manner. Studies also indicate that the combining of ESWT with the stabilization exercises or the manual therapy enhances outcomes compared to the ESWT alone (Cho et al., 2012; Shadmehr et al., 2022; Lin et al., 2015). In joint disorders and the chronic tendinopathies, multiple reviews show the ESWT can improve the pain and function, yet its long-term effects are less clearer compared to the physiotherapy or the pharmacological injections (Liao et al., 2024; Kim et al., 2015; Rich et al., 2025; Heaver et al., 2023). The effectiveness appears to vary by the injury location (Wang, 2012; Elgendy et al., 2024; Yusof et al., 2022). At the mechanistic and the biological level, ESWT has been shown to remodel the tissues, stimulate cellular repair and reduce the neural sensitivity (Ryskalin et al., 2022; Simplicio et al., 2020; Takahashi et al., 2006). Nevertheless, significant gaps remain in understanding the precise long-term mechanisms in the humans, as most studies rely on the animal models or a short-term trial. Comparisons across studies reveal the methodological inconsistencies. Some focus on the ESWT versus the conventional therapy (Abd elazeem et al., 2024; Greve et al., 2009), while others compare the energy types or the waveforms (Chang et al., 2012; Park et al., 2018), complicating a generalized conclusions. Furthermore, there is a lack of studies assessing combined the interventions over a long-term follow-up (Lhee et al., 2025; Rich et al., 2025). Clinically, most researches concentrated on the pain and the functional outcomes, often neglecting the quality-of-life measures or the biochemical markers (Sanzo et al., 2025; Santuzzi et al., 2024). Systematic reviews also tend to focus on a specific regions such as the heel, the knee, or the shoulder, with a limited comprehensive reviews on multi-site musculoskeletal applications (Agostini et al., 2022; Charles et al., 2023; Majidi et al., 2024). ESWT is frequently applied across a broader spectrum of musculoskeletal disorders. Therefore, this review also considers related conditions such as tendinopathies and plantar fasciitis in order to provide a comprehensive overview of the clinical applications of ESWT in musculoskeletal rehabilitation. These conditions often share overlapping pathophysiological mechanisms and therapeutic approaches within physiotherapy practice. This review investigates the effectiveness, underlying mechanisms, clinical applications, future directions and therapeutic uses of ESWT, aiming to highlight its growth importance in the healthcare landscape by combining the most recent data from clinical trials, systematic reviews.

Methods

Review Design

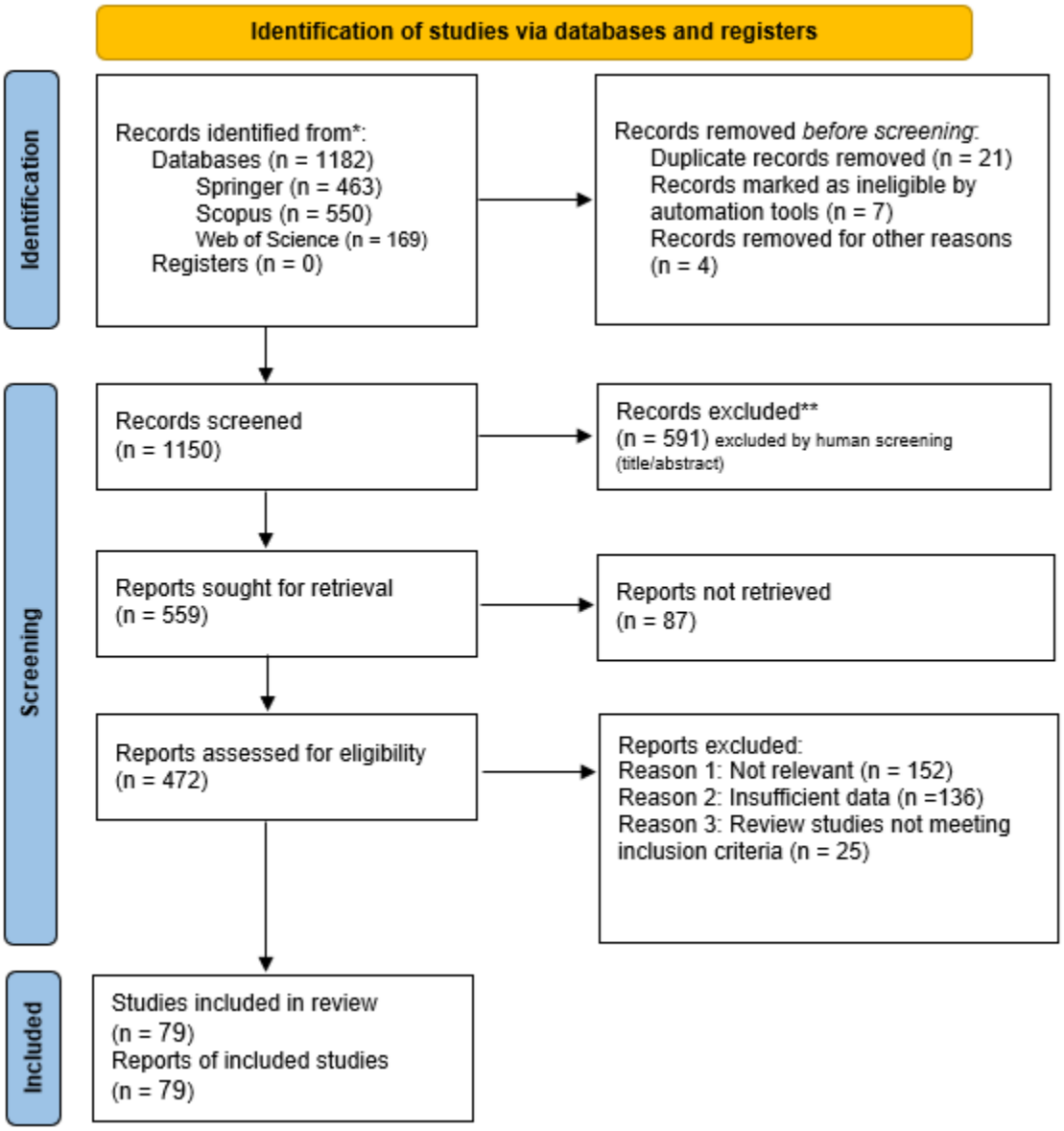
This systematic review focuses on the use of the extracorporeal shockwave therapy (ESWT) in musculoskeletal rehabilitation, including the tendinopathies, the plantar fasciitis, the patellar tendinopathy, Achilles tendinopathy and the myofascial pain syndrome (Abd elazeem et al., 2024; Charles et al., 2023; Avendaño-López et al., 2024). Both randomized controlled trials (RCTs) and the non-randomized studies, including the quasi-experimental and the cohort designs, are included to provide a comprehensive evidence base (Majidi et al., 2024; Elgendy et al., 2024). ESWT is evaluated as a standalone intervention or the combined with physiotherapy and the other rehabilitation modalities (Abd El-Latif et al., 2022; Fouda et al., 2023).

Protocol and Registration

The protocol is registered in the PROSPERO (Reference Number CRD420261304793). The review follows the PRISMA 2020 guidelines and a PRISMA 2020 flow diagram illustrates study identification, screening, eligibility and inclusion processes. Initially, a large number of the records were identified through the databases searches including a major platforms such as Scopus, Springer and the Web of Science with no relevant records retrieved from the trial registers. After removing the duplicates and the records flagged as ineligible by the automated tools and the other preliminary criteria, a substantial number of studies remained for the title and the abstract screening. Screening led to

the exclusion of the roughly half of the initial records that did not meet the inclusion criteria for the extracorporeal shockwave therapy (ESWT) interventions. The remaining reports sought for the full-text retrieval, although a portion could not be accessed due to the availability constraints. The full texts that were assessed underwent the careful eligibility evaluation. Many were excluded due to lack of relevance to ESWT, incomplete data, or being review articles not aligned with the inclusion criteria. In the end, a total of 46 studies met the inclusion criteria and were included in the review, representing the most relevant evidence on the ESWT in the musculoskeletal rehabilitation. The study selection process is summarized in Figure 1, in accordance with PRISMA 2020 guidelines, illustrating the stages of the identification, screening and the inclusion. The most common reasons for full-text exclusion included:
(1) studies not evaluating extracorporeal shockwave therapy,
(2) absence of relevant clinical outcomes,
(3) duplicate publications or secondary analyses of the same dataset,
(4) review articles or conference abstracts without primary data, and
(5) insufficient methodological information.

Figure 1. PRISMA 2020 flow diagram showing the process of the selecting studies on the extracorporeal shockwave therapy for musculoskeletal conditions.



A systematic search is performed in the PubMed/MEDLINE, Scopus, the Web of Science, CINAHL and the Cochrane CENTRAL, complemented by the Google Scholar, the ClinicalTrials.gov and the WHO ICTRP. Keywords include “the shockwave therapy,” “ESWT,” “the tendinopathy, “the plantar fasciitis,” and “the rehabilitation.” Reference lists

of included studies and the relevant reviews are hand-searched and the grey literature is consulted to reduce the publication bias (Chang et al., 2012; Greve et al., 2009; Cho et al., 2012). The literature search was conducted from database inception to January 2026. Electronic databases including PubMed/MEDLINE, Scopus, Web of Science, CINAHL, and Cochrane CENTRAL were systematically searched. Additional sources included Google Scholar, ClinicalTrials.gov, and the WHO International Clinical Trials Registry Platform (ICTRP) to identify unpublished or ongoing studies. The search was restricted to articles published in English. The full search strategy used for PubMed is provided in Appendix A, and similar strategies were adapted for the other databases.

Eligibility Criteria

Population: (<17 years) with a musculoskeletal disorders treated with the ESWT, including a chronic tendinopathies, a plantar fasciitis, the patellar tendinopathy, the Achilles tendinopathy and the myofascial pain syndrome (Ji et al., 2012; Yoo et al., 2020; Luan et al., 2019). Intervention: Radial or the focused ESWT, alone or combined with the physiotherapy, the exercises, the manual therapy, or other rehabilitation approaches (Abd elazeem et al., 2024; Fouda et al., 2023; Park et al., 2018). Comparison: Standard care, sham ESWT, physiotherapy or no intervention (Lhee et al., 2025; Rich et al., 2025). Outcomes: Primary outcomes including the pain and function (VAS, NRS, the functional questionnaires). Secondary outcomes include the range of motion, the tissue stiffness, the quality of life and the patient satisfaction (Avendaño-López et al., 2024; Charles et al., 2023; Majidi et al., 2024). Study Design: RCTs, the controlled clinical trials, the quasi-experimental studies and the cohort studies published in English (Elgendy et al., 2024; Heaver et al., 2023).

Data Extraction and Synthesis

Due to the substantial heterogeneity across the included studies particularly in terms of ESWT energy levels, treatment frequency, number of sessions, outcome measures, and target conditions a quantitative meta-analysis was not considered methodologically appropriate. The variability in study designs and intervention protocols could lead to misleading pooled estimates. Therefore, a narrative synthesis approach was adopted to summarize and interpret the available evidence. Future research with more standardized protocols may allow for more robust meta-analytic evaluation.

Quality Assessment

the RCTs are evaluated with the Cochrane Risk of Bias 2 (RoB 2) tool and the non-randomized studies with the ROBINS-I (Elgendy et al., 2024; Rich et al., 2025). Domains include the randomization, deviations from the intended interventions, the missing data, the outcome measurement and the selective reporting. Risk-of-bias assessments are reported a narratively and in tables.

Table 1. Summary of ESWT Protocols in Included Studies

Study	Condition	ESWT Type	Energy Level	Sessions&Frequency	Combined Intervention	Main Outcomes
Abd elazeem et al., 2024	Achilles tendinopathy	Focused	Medium	3 sessions/week, 4 weeks	Conventional physiotherapy	Pain ↓, function ↑
Fouda et al., 2023	Plantar fasciitis	Radial	Medium	1 session/week, 5 weeks	Ultrasound + exercises	Pain ↓, dorsiflexion ↑
Lhee et al., 2025	Lateral epicondylosis	Focused	Medium	1–2 sessions/week, 4 weeks	Physiotherapy / PRP	Pain ↓, grip strength ↑
Rich et al., 2025	Hamstring tendinopathy	Radial	Low-Medium	1 session/week, 4–6 weeks	Individualized physiotherapy	Pain ↓, function ↑

Note: Pain ↓ indicates reported reduction; function ↑ indicates improvement in functional scores.

Results

A total of 46 studies were included covering a range of the musculoskeletal conditions treated with the extracorporeal shockwave therapy (ESWT). Most studies were a randomized controlled trials, while a smaller proportion included the quasi-experimental or the cohort designs (Abd elazeem et al., 2024; Elgendy et al., 2024). Sample sizes varied widely with the most studies including 30–100 participants and the treatment durations ranged from 3 to 6 weeks. Both focused and the radial shockwave therapy were represented with some studies combining the ESWT with physiotherapy with the exercise or the manual therapy. For the Achilles, the patellar and the hamstring tendinopathies, the ESWT consistently demonstrated a moderate to **a** strong pain reduction and the functional improvement compared with the baseline or the standard physiotherapy (Abd elazeem et al., 2024; Rich et al., 2025; Lhee et al., 2025). Focused ESWT appeared a slightly more effective in the severe chronic cases, whereas the radial ESWT was a frequently used for the less severe or the more superficial tendinopathies. However, the heterogeneity in the energy levels, the session frequency and the outcome measures limits the ability to recommend a standardized protocol. ESWT showed a

clinically significant improvements in the pain and the foot function in the patients with a plantar fasciitis, particularly when it combined with the exercise or the physiotherapy modalities (Fouda et al., 2023; Greve et al., 2009; Chang et al., 2012). Comparisons between the focused and the radial ESWT suggested that both approaches are effective but differences in the long-term outcomes remain unclear. These effects help explain both the pain reduction and the functional improvements reported across the different conditions. While most studies reported a positive outcomes, the evidence base shows a considerable heterogeneity. Differences in the study design, the sample size, the intervention protocols and the outcome measures complicate a direct comparisons. Some high-quality RCTs support the efficacy of ESWT for chronic tendinopathies and plantar fasciitis but the evidence for the upper limb tendinopathies remains moderate (Elgendy et al., 2024; Majidi et al., 2024).

Table 2. Summary of ESWT Outcomes in Musculoskeletal Conditions

Condition	Study	ESWT Type	Sessions / Frequency	Combined Interventions	Main Outcomes
Achilles Tendinopathy	Abd elazeem et al., 2024	Focused	3 sessions/week × 4 weeks	Conventional physiotherapy	Pain ↓, function ↑
Patellar Tendinopathy	Poacher&Thompson, 2023	Focused	1–2 sessions/week × 4–6 weeks	None	Pain ↓, functional scores ↑
Hamstring Tendinopathy	Rich et al., 2025	Radial	1 session/week × 4–6 weeks	Individualized physiotherapy	Pain ↓, functional improvement ↑
Plantar Fasciitis	Fouda et al., 2023	Radial	1 session/week × 5 weeks	Ultrasound + exercises	Pain ↓, dorsiflexion ↑
Plantar Fasciitis	Greve et al., 2009	Radial	3 sessions/week × 3 weeks	Conventional physiotherapy	Pain ↓, foot function ↑
Plantar Fasciitis	Chang et al., 2012	Focused vs Radial	Variable	None	Both reduced pain; long-term outcomes unclear

- Pain ↓ = reduction in reported pain levels (VAS/NRS)
- Function ↑ = improvement in functional scores, activity performance, or quality-of-life measures
- ROM ↑ = improvement in range of motion

The methodological quality of the included studies was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool for randomized controlled trials and the ROBINS-I tool for non-randomized studies. Overall, most randomized trials demonstrated low to moderate risk of bias, particularly in domains related to outcome measurement and reporting. However, several studies presented unclear or high risk of bias in the randomization process and allocation concealment due to insufficient reporting.

Among the non-randomized studies, the ROBINS-I assessment indicated moderate risk of bias, mainly associated with confounding factors and deviations from intended interventions. Despite these limitations, the majority of studies provided consistent evidence regarding the beneficial effects of ESWT in reducing pain and improving functional outcomes. A summary of the risk-of-bias assessment is presented in Table 3.

Table 3. Risk of Bias Assessment

Study Design	Tool Used	Overall Risk
RCTs	RoB 2	Low–Moderate
Quasi-experimental	ROBINS-I	Moderate
Cohort studies	ROBINS-I	Moderate

Certainty of Evidence (GRADE Assessment)

The certainty of evidence for the main outcomes was assessed using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach. The evaluation considered study limitations, inconsistency, indirectness, imprecision, and potential publication bias. The overall certainty of evidence for the primary outcomes is summarized in Table 4.

Table 4. GRADE Assessment of the Certainty of Evidence for ESWT in Musculoskeletal Pain

Outcome	Number of Studies	Study Design	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Certainty of Evidence

Pain reduction (VAS/NRS)	45	RCTs and controlled trials	Moderate	Moderate heterogeneity across protocols	Low	Low	Possible	**Moderate**
Functional improvement	32	RCTs and quasi-experimental studies	Moderate	Moderate variability in outcomes	Low	Moderate	Possible	**Moderate**
Range of motion (ROM) improvement	18	RCTs and cohort studies	Moderate	Some inconsistency between studies	Low	Moderate	Unclear	**Low–Moderate**
Quality of life (QoL) outcomes	10	RCTs and observational studies	Moderate	High variability	Moderate	Moderate	Possible	**Low**
Long-term outcomes (>6 months)	8	RCTs and cohort studies	Moderate	High heterogeneity	Moderate	High	Possible	**Low**

Overall, the certainty of evidence ranged from low to moderate, mainly due to heterogeneity in ESWT treatment parameters, variability in outcome measures, and limited long-term follow-up data across the included studies. Improving blood circulation and the metabolism of inflammatory mediators is essential in cases of pain resulting from tissue sclerosis and nerve sensitization in order to minimize swelling during the acute phase and avoid more consequences. When the condition is persistent, the main goals of treatment should be to improve muscular function, restore posture and control nerve transmission. By preventing central sensitization in peripheral muscles and reducing substance P synthesis at dorsal root ganglia, extracorporeal shock wave therapy (ESWT) may be useful in lowering referred pain (Ahmed et al., 2019; Juliano et al., 2017; Jinrong, 2012; Takla & Rezk-Allah, 2018; Yoo et al., 2020; Zeng, 2014; Ying & Bing, 2020). The mechanical stress and cavitation effects of extracorporeal shock wave therapy (ESWT) cause soft tissue cells and blood vessels to collapse, followed by their reconstruction. As a result of a new inflammatory response, patients' symptoms could get worse during the initial stages of treatment. This medication works particularly well for people who have persistent symptoms and are in the chronic inflammatory phase (Gezginaslan & GümüşAtalay, 2019; Király et al., 2018; Luan et al., 2019; Park et al., 2018; Rahbar et al., 2021; Yalçın, 2021).

Discussion

ESWT therapy was initially utilized in the lithotripsy of renal calculi and then in the treatment of long-term nonunion of fractures, gradually progressing toward the field of treatment of chronic pain. ESWT is a noninvasive physical treatment procedure that is simple to perform, noninvasive and has no harmful effects (Wang et al., 2017). The current systematic review consolidates evidence from 46 studies investigating the extracorporeal shockwave therapy (ESWT) across a range of the musculoskeletal conditions. Overall, the ESWT demonstrated a consistent benefits in the pain reduction and the functional improvement, particularly for the chronic tendinopathies (Achilles, the patellar and the hamstring) and the plantar fasciitis. Both the focused and the radial shockwave therapy showed the efficacy, although the choice of the modality often depended on the severity, the depth of the affected tissue and the clinical setting. The results of the studies included in this review all indicated that ESWT plays a significant role in improving pain, joint mobility, psychological state and quality of life (QOL) of patients, with no significant side effects. More articles have explored whether ESWT is superior to other therapies. Király et al. (2018) found that ESWT had more advantages than low-level laser therapy (LLLT) and the combination of hot pack, TENS and ultrasound in the SF-36 domain. Urits et al. (2020) and Rahbar et al. (2021) similarly indicated that ESWT was superior to kinesiological taping (KT) and ultrasound in alleviating pain severity. Only one study indicated that ESWT and acupuncture both obtained substantial improvements in VAS, PPT and NDI scores, but no significant difference was observed between them. Some research compared the therapeutic effects of ESWT at different intensities. Park et al. (2018) found that high-energy ESWT is superior to low-energy ESWT in improving neck flexion and neck function. However, the reported effect sizes were small (0.47, 0.41). Gezginaslan and GümüşAtalay (2019) confirmed that high-energy ESWT is more effective than the combination of hot pack, TENS and ultrasound, particularly according to SF-36 outcomes. Park et al. (2018) compared high-energy density (0.210 mJ/mm²) and low-energy density (0.068 mJ/mm²) ESWT methods and the results showed that high-energy density ESWT was superior to low-energy density treatment in improving symptoms and relieving pain; however, its safety and efficacy still require further research support. ESWT therapy

was initially utilized in the lithotripsy of renal calculi and then in the treatment of long-term nonunion of fractures, gradually progressing toward the field of treatment of chronic pain. The results of the studies included in this review all indicated that ESWT plays a significant role in promoting pain relief, joint mobility, psychological state and quality of life (Király, Bender, & Hodosi, 2018; Rahbar et al., 2021; Urits et al., 2020). More articles have explored if ESWT is superior to other therapies. Király et al. (2018) found that ESWT had more advantages than low-level laser therapy (LLLT) and the combination of hot pack, TENS and ultrasound according to SF-36. Ürits et al. (2020) and Rahbar et al. (2021) similarly indicated that ESWT was superior to kinesiological taping (KT) and ultrasound in alleviating pain severity. Only one study indicated that ESWT and acupuncture both obtained substantial improvements in VAS, PPT and NDI, but with no significant difference between them. Some research compared the therapeutic effects of ESWT at different intensities. Park et al. (2018) found that high-energy ESWT is superior to low-energy ESWT in neck flexion and neck function improvement. Sparsa et al. (2005) found that ESWT reduces discomfort, calcification and accelerates re-epithelization in CREST syndrome and chronic leg ulcers. Krishnan, Sharma and Singh (2012) reported a significant reduction in pain in patients with persistent plantar fasciitis following ESWT. High-energy ESWT was more effective than low-energy ESWT in reducing NDI scores for patients with moderate to severe pain (Park et al., 2018). Combination therapy with TENS, ESWT and LLLT along with exercise was more beneficial than exercise alone (Yalçın, 2021; Sumen, Sarsan, Alkan, et al., 2015; Rahbar et al., 2021; Azatcam et al., 2017). The synergistic effect of ESWT combined with stability exercises positively influenced pain reduction and functional improvement (Kim, 2010; Loew, Daecke, Kusnierczak, et al., 1999). The overall certainty of evidence was evaluated using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach. The quality of evidence for pain reduction and functional improvement outcomes was generally rated as moderate, mainly due to heterogeneity across studies and variations in ESWT treatment parameters. Evidence for long-term outcomes and quality-of-life measures was rated as low to moderate, reflecting limited follow-up data and inconsistent reporting across studies. Despite these limitations, the overall evidence supports the clinical usefulness of ESWT as a non-invasive intervention for musculoskeletal pain management. Despite these positive outcomes, some limitations must be considered. First, there is a considerable heterogeneity across the studies in terms of the energy levels, the number and the frequency of sessions and the outcome measures, which complicates the direct comparisons and the meta-analytic synthesis. Second, the long-term follow-up is often lacking and making it difficult to assess the durability of the ESWT effects. Finally, while the pain and the function are commonly reported the quality-of-life and the patient-reported outcomes remain underexplored, limiting the holistic evaluation of treatment efficacy. Additionally, the absence of meta-analytic synthesis and the variability in study designs may limit the strength of quantitative conclusions. Future systematic reviews incorporating standardized ESWT protocols and larger randomized controlled trials are necessary to strengthen the overall evidence base.

Conclusion

Extracorporeal shockwave therapy (ESWT) demonstrates significant clinical potential in the management of musculoskeletal pain conditions, particularly tendinopathies and plantar fasciitis. The therapy is mainly safe, a well-tolerated and also can be combined effectively with the physiotherapy and the exercise interventions. However, the heterogeneity in the treatment protocols, the limited long-term data and the underreported patient-centered outcomes highlight the need for a high-quality and standardized research. Future studies should focus on the optimal dosing, the long-term effectiveness and the comparative efficacy against other conservative rehabilitation modalities to strengthen the evidence-based guidance for the clinical practice.

Competing Interests:

The authors declare no financial, commercial, or personal relationships that could be construed as a conflict of interest in relation to this manuscript.

Data Accessibility

- All referenced data and studies are publicly accessible via journals, databases, or platforms, with appropriate citations provided in the references section.
- Data supporting this review can be made available upon request, including article lists, methodology for literature selection and analysis summaries.

Ethical Considerations

-No patient-level data or sensitive information was used, ensuring compliance with ethical standards.

Funding Information

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Appendix A – PubMed Search Strategy

("extracorporeal shock wave therapy" OR "shockwave therapy" OR ESWT)
AND
("musculoskeletal pain" OR "tendinopathy" OR "plantar fasciitis")
AND
("rehabilitation" OR "physiotherapy" OR "physical therapy")

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