

Extracorporeal Shockwave Therapy as an Adjunct to Physiotherapy for Tendinopathies: A Scoping Review of Dosage, Modality, Clinical Outcomes, and Treatment Response

Prasanth K¹, M. Premkumar^{2*}, Madhuripu P³, K B Riyas Basheer⁴

¹PhD Research Scholar, Institute of Physiotherapy, Srinivas University, City Campus, Pandeshwar, Mangaluru, Karnataka-575001. Assistant Professor, AKG Cooperative Institute of Health Sciences, Mavilayi, Kannur, Kerala, India

^{2*} Corresponding Author: Professor cum HOD, Institute of Physiotherapy, Srinivas University, City Campus, Pandeshwar, Mangaluru, Karnataka-575001, India

^{3*} Associate Professor, Institute of Physiotherapy, Srinivas University, Mangaluru, Karnataka – 575001, India

⁴Vice Principal & Professor, Tejasvini Physiotherapy College, Kudupu, Mangalore, Karnataka – 575028, India

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ABSTRACT

Background: Tendinopathy is a common musculoskeletal disorder characterized by pain, reduced load tolerance, and functional limitation. Extracorporeal shockwave therapy (ESWT) is increasingly used as an adjunct to physiotherapy, but differences in treatment parameters and rehabilitation programs complicate interpretation of its effectiveness. **Objective of this study:** To map the available evidence on ESWT combined with physiotherapy for tendinopathies, focusing on treatment modality, dosage, rehabilitation co-interventions, clinical and structural outcomes, adverse events, and factors associated with treatment response. **Methods:** This scoping review follows the Arksey and O'Malley framework, Levac et al.'s methodological enhancements, Joanna Briggs Institute guidance, and PRISMA-ScR recommendations. The review examines adults with tendinopathy receiving ESWT alongside physiotherapy. Evidence is charted according to tendon site, ESWT modality, treatment parameters, co-interventions, outcome domains, follow-up, and treatment response. **Results:** The evidence demonstrates substantial clinical and methodological heterogeneity. Achilles and lateral elbow tendinopathies are prominent evidence clusters. Focused, point-focused, line-focused, and radial protocols differ considerably in physical dose. Some lateral elbow studies report favorable pain and functional responses, whereas sham-controlled Achilles trials do not consistently demonstrate additional benefit beyond exercise and education. Structural outcomes are less frequently reported and do not always parallel clinical improvement. **Conclusion:** ESWT may be a useful adjunct for selected patients, but current evidence does not support a universal protocol or universal superiority over high-quality rehabilitation. Future research should standardize dose reporting, physiotherapy co-interventions, clinically meaningful outcomes, structural measures, and long-term follow-up.

Keywords: extracorporeal shockwave therapy; ESWT; tendinopathy; physiotherapy; radial shockwave; focused shockwave; dosage; rehabilitation; clinical outcomes; treatment response

INTRODUCTION

Tendinopathy is a prevalent and clinically important musculoskeletal disorder characterized by pain, impaired function, reduced tolerance to mechanical loading, and variable alterations in tendon structure. Commonly affected sites include the Achilles, patellar, lateral elbow, and rotator cuff tendons, although tendinopathy may

occur throughout the peripheral musculoskeletal system. The condition can interfere with occupational activities, sports participation, recreation, sleep, and general physical activity, creating a substantial individual and societal burden. Contemporary management increasingly emphasizes patient education, activity modification, progressive tendon-loading exercise, and individualized rehabilitation rather than passive symptom management. Nevertheless, recovery is often variable, and a subgroup of patients remains symptomatic despite appropriately dosed physiotherapy. This persistent symptom burden has encouraged interest in adjunctive interventions that may reduce pain, improve load tolerance, and facilitate participation in rehabilitation.

Extracorporeal shockwave therapy (ESWT) has become an established non-invasive modality in musculoskeletal rehabilitation. It delivers mechanical acoustic energy to biological tissues and is commonly categorized as focused or radial ESWT. Focused systems concentrate acoustic energy within a focal region, whereas radial systems generate pressure waves that propagate from an applicator across a broader superficial area. Focused treatment may also involve point-focused and line-focused applicators, producing further variation in the spatial distribution of the stimulus. These distinctions are clinically important because ESWT is not a single standardized intervention. The physical stimulus delivered to the tendon depends on the combination of energy flux density or pressure, frequency, number of impulses, treatment duration, number of sessions, treatment interval, applicator characteristics, and anatomical targeting.

Several biological mechanisms have been proposed to explain the effects of ESWT, including mechanotransduction, modulation of local cellular activity, vascular responses, changes in pain-processing pathways, and potential effects on tissue remodelling. However, the clinical importance of these mechanisms remains incompletely established. In addition, symptoms and tendon structure do not necessarily change in parallel. In the placebo-controlled Achilles tendinopathy trial by Gatz et al. (2021), patients receiving point-focused ESWT, line-focused ESWT, or placebo demonstrated clinical improvement, but neither active ESWT approach was significantly superior to placebo. Conventional B-mode ultrasound, power Doppler ultrasound, and ultrasound tissue characterization did not demonstrate clear treatment-specific structural changes, although shear-wave elastography suggested alterations in tendon elastic properties. These findings indicate that treatment response cannot be understood solely through pain scores or conventional structural imaging.

Recent systematic reviews have produced inconsistent findings regarding the effectiveness of ESWT. Elgendy et al. (2024) reported that ESWT did not consistently outperform comparators for pain across all follow-up periods, although effects appeared more favourable in selected lower-limb and calcific conditions. Majidi et al. (2024) identified pain-reducing effects across several tendinopathies but emphasized substantial heterogeneity. Similarly, Xiong et al. (2024) found evidence of benefit for selected pain and functional outcomes in upper-limb tendon disorders. However, Xue et al. (2024) identified critically low methodological quality among systematic reviews and meta-analyses of ESWT, together with suboptimal reporting and considerable risk-of-bias concerns. More recently, Stania et al. (2026) found no clear overall superiority of radial over focused shockwave therapy for pain or function, with much of the available evidence characterized by low or very low certainty.

Evidence from individual studies further illustrates the complexity of treatment response. In lateral elbow tendinopathy, Perveen et al. (2024) reported greater improvement following ESWT than therapeutic ultrasound combined with deep friction massage. Król et al. (2024) also demonstrated clinically relevant improvements following focused shockwave therapy compared with ultrasound. Nevertheless, findings from these studies should not be generalized automatically to other tendons because tissue loading, pathology phenotype, symptom duration, anatomical depth, and rehabilitation demand differ. Achilles tendinopathy provides an important counterexample. In a randomized trial, Alsulaimani et al. (2025) found that radial ESWT combined with standardized exercise and education did not provide additional benefits over sham treatment for pain, VISA-A function, physical activity, psychological outcomes, or health-related quality of life. A subsequent meta-analysis by Ni et al. (2026) similarly found no clear overall advantage of ESWT over sham treatment for chronic Achilles tendinopathy, although exploratory findings suggested that symptom duration may influence short-term pain response.

Treatment dosage represents another major unresolved issue. ESWT protocols vary considerably in energy flux density, pressure, frequency, number of shocks per session, number of treatment sessions, session spacing,

treatment duration, and targeting technique. These differences may represent meaningful variations in the mechanical stimulus delivered to the tendon rather than simple reporting inconsistencies. For example, the 2025 Achilles trial used radial ESWT at 10 Hz, 3,000 shocks per session, and 2–4 bar, whereas Gatz et al. (2021) used 2,000 shocks at 5 Hz with different energy densities for point-focused and line-focused treatment. Consequently, interventions described using the same term may produce substantially different biological effects. Incomplete reporting of treatment parameters limits comparison between studies and prevents reliable conclusions regarding dose–response relationships.

Physiotherapy integration is also an important explanatory factor. Tendinopathy rehabilitation is fundamentally load-based, and exercise can independently improve pain, function, strength, and physical capacity. Therefore, studies in which ESWT is added to an identical exercise and education program in both active and control groups provide the clearest estimate of its incremental effect. Evidence from hip and pelvic tendinopathies also demonstrates variation in modality and dosage, despite reported improvements in pain and function (Rau et al., 2025).

These observations identify a specific research gap. Existing reviews have largely focused on whether ESWT reduces pain or improves function, while comparatively less attention has been given to how modality, complete dosage parameters, treatment targeting, physiotherapy co-interventions, structural outcomes, and patient characteristics interact to influence treatment response. A scoping review is therefore appropriate for mapping the breadth and characteristics of this heterogeneous literature without assuming that one protocol is universally effective. The present review examines ESWT as an adjunct to physiotherapy for tendinopathies, focusing on modality, dosage, rehabilitation co-interventions, clinical and functional outcomes, structural responses, adverse events, and factors associated with favourable or unfavourable treatment response.

METHODS

Review design and reporting

A scoping review design was selected to map the extent, nature, and characteristics of evidence concerning extracorporeal shockwave therapy (ESWT) as an adjunct to physiotherapy for tendinopathies. The methodology followed the framework of Arksey and O'Malley (2005), refined by Levac et al. (2010), and updated in Joanna Briggs Institute guidance (Peters et al., 2020). Reporting was structured according to the PRISMA extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). The review aimed to provide an evidence map and identify research gaps rather than generate a pooled estimate of treatment efficacy.

Review question and PCC framework

The review question was: What is known about ESWT as an adjunct to physiotherapy for adult tendinopathies, particularly regarding ESWT modality and dosage, physiotherapy co-interventions, clinical and structural outcomes, adverse events, and treatment response? The Population–Concept–Context framework included adults with clinically, functionally, or imaging-confirmed tendinopathy; ESWT delivered through radial, focused, point-focused, or line-focused approaches; and physiotherapy-based management and rehabilitation.

Eligibility criteria

Studies involving adults aged 18 years or older with Achilles, patellar, lateral elbow, rotator cuff, or other peripheral tendinopathies were eligible. Acute, subacute, and chronic presentations were included because symptom duration may influence treatment response. ESWT could be administered alone or with physiotherapy, exercise, education, manual therapy, stretching, activity modification, or related rehabilitation. Comparators included sham ESWT, exercise alone, physiotherapy, ultrasound, deep friction massage, usual care, or other active interventions. Studies involving tendon rupture, postoperative rehabilitation without established tendinopathy, non-tendinopathic pain, fractures, animal or in-vitro models, editorials, letters, commentaries, and protocols without results were excluded. Participant characteristics were considered in accordance with tendinopathy research recommendations, including age, sex, symptom duration, tendon location, athletic status, activity level, diagnostic criteria, and phenotype (Rio et al., 2020).

Information sources and search strategy

The planned search included PubMed/MEDLINE, Scopus, Web of Science Core Collection, PEDro, CINAHL, SPORTDiscus, Embase, and Cochrane CENTRAL. Reference lists of eligible studies and relevant systematic reviews were also screened. Search terms combined tendinopathy, ESWT, and rehabilitation concepts, including “tendinopathy,” “Achilles tendinopathy,” “patellar tendinopathy,” “tennis elbow,” “rotator cuff tendinopathy,” “extracorporeal shockwave therapy,” “radial shockwave,” “focused shockwave,” “physiotherapy,” “exercise therapy,” and “rehabilitation.” Database-specific controlled vocabulary, truncation, field tags, and Boolean operators were applied. Complete database-specific search strings and exact search dates should be reported in the final submission to ensure reproducibility. (see table 1)

Table 1: Proposed Database Search Strategy

Database	Search strategy / search terms	Limits
PubMed/MEDLINE	("Tendinopathy"[MeSH] OR tendinop*[tiab] OR tendinosis[tiab] OR "Achilles tendinopathy"[tiab] OR "patellar tendinopathy"[tiab] OR "lateral epicondylitis"[tiab] OR "tennis elbow"[tiab] OR "rotator cuff tendinopathy"[tiab]) AND ("Extracorporeal Shockwave Therapy"[MeSH] OR "extracorporeal shockwave therapy"[tiab] OR ESWT[tiab] OR "radial shockwave"[tiab] OR "radial pressure wave"[tiab] OR "focused shockwave"[tiab] OR "focused shock wave"[tiab] OR "pressure wave therapy"[tiab]) AND ("Physical Therapy Modalities"[MeSH] OR physiotherap*[tiab] OR "physical therap*" [tiab] OR rehabilitation[tiab] OR "exercise therap*" [tiab] OR exercise[tiab] OR "therapeutic exercise"[tiab])	No date restriction; adults
Scopus	TITLE-ABS-KEY (tendinop* OR tendinosis OR "Achilles tendinopathy" OR "patellar tendinopathy" OR "lateral epicondylitis" OR "tennis elbow" OR "rotator cuff tendinopathy") AND TITLE-ABS-KEY ("extracorporeal shockwave therap*" OR ESWT OR "radial shockwave" OR "radial pressure wave" OR "focused shockwave" OR "focused shock wave" OR "pressure wave therap*") AND TITLE-ABS-KEY (physiotherap* OR "physical therap*" OR rehabilitation OR "exercise therap*" OR exercise)	No date restriction
Web of Science Core Collection	TS=(tendinop* OR tendinosis OR "Achilles tendinopathy" OR "patellar tendinopathy" OR "lateral epicondylitis" OR "tennis elbow" OR "rotator cuff tendinopathy") AND TS=("extracorporeal shockwave therap*" OR ESWT OR "radial shockwave" OR "radial pressure wave" OR "focused shockwave" OR "focused shock wave" OR "pressure wave therap*") AND TS=(physiotherap* OR "physical therap*" OR rehabilitation OR "exercise therap*" OR exercise)	No date restriction
Embase	('tendinopathy'/exp OR tendinop*:ti,ab OR tendinosis:ti,ab OR 'Achilles tendinopathy':ti,ab OR 'patellar tendinopathy':ti,ab OR 'lateral epicondylitis':ti,ab OR 'tennis elbow':ti,ab OR 'rotator cuff tendinopathy':ti,ab) AND ('extracorporeal shock wave therapy'/exp OR 'extracorporeal shockwave therap*':ti,ab OR ESWT:ti,ab OR 'radial shockwave':ti,ab OR 'radial pressure wave':ti,ab OR 'focused shockwave':ti,ab OR 'pressure wave therap*':ti,ab) AND ('physiotherapy'/exp OR physiotherap*:ti,ab OR 'physical therap*':ti,ab OR rehabilitation:ti,ab OR 'exercise therap*':ti,ab OR exercise:ti,ab)	No date restriction

CINAHL	(MH "Tendinopathy+" OR TI tendinop* OR AB tendinop* OR TI tendinosis OR AB tendinosis OR TI "Achilles tendinopathy" OR AB "Achilles tendinopathy" OR TI "lateral epicondylitis" OR AB "lateral epicondylitis") AND (MH "Extracorporeal Shock Wave Therapy" OR TI "extracorporeal shockwave therap*" OR AB "extracorporeal shockwave therap*" OR TI ESWT OR AB ESWT OR TI "radial shockwave" OR AB "radial shockwave" OR TI "focused shockwave" OR AB "focused shockwave") AND (MH "Physical Therapy+" OR MH "Exercise Therapy+" OR TI physiotherap* OR AB physiotherap* OR TI rehabilitation OR AB rehabilitation OR TI "exercise therap*" OR AB "exercise therap*")	No date restriction
SPORTDiscus	(DE "Tendinopathy" OR tendinop* OR tendinosis OR "Achilles tendinopathy" OR "patellar tendinopathy" OR "lateral epicondylitis" OR "tennis elbow" OR "rotator cuff tendinopathy") AND ("extracorporeal shockwave therap*" OR ESWT OR "radial shockwave" OR "radial pressure wave" OR "focused shockwave" OR "focused shock wave" OR "pressure wave therap*") AND (physiotherap* OR "physical therap*" OR rehabilitation OR "exercise therap*" OR exercise)	No date restriction
PEDro	tendinopathy shockwave physiotherapy	Search terms entered separately using PEDro's search interface
Cochrane CENTRAL	(tendinop* OR tendinosis OR "Achilles tendinopathy" OR "patellar tendinopathy" OR "lateral epicondylitis" OR "tennis elbow" OR "rotator cuff tendinopathy") AND ("extracorporeal shockwave therap*" OR ESWT OR "radial shockwave" OR "radial pressure wave" OR "focused shockwave" OR "focused shock wave") AND (physiotherap* OR "physical therap*" OR rehabilitation OR "exercise therap*" OR exercise)	No date restriction

Data charting

A standardized charting form was developed to capture publication characteristics, participant characteristics, diagnosis, symptom duration, ESWT modality, complete treatment parameters, physiotherapy co-intervention, comparator, outcomes, follow-up, adverse events, and principal findings. Two reviewers should independently screen titles and abstracts and subsequently assess potentially eligible full texts. Disagreements should be resolved by discussion or consultation with a third reviewer. The charting form should be piloted before full extraction. Intervention reporting was conceptually aligned with the TIDieR checklist (Hoffmann et al., 2014).

ESWT parameter extraction

ESWT was treated as a multidimensional intervention rather than a binary treatment label. Extracted variables included radial/focused/point/line modality; device manufacturer and model; energy flux density in mJ/mm²; pressure in bar or MPa; frequency in Hz; shocks per session; total number of sessions; interval between sessions; total treatment duration; anatomical target; targeting method; intensity progression; applicator characteristics; coupling medium; anesthesia; patient/tendon position; and dose escalation. Where different units were reported, the original unit was retained and conversion was performed only when scientifically valid. Missing information was coded as "not reported" rather than inferred.

Physiotherapy co-intervention

Because the review addresses ESWT as an adjunct, the concurrent rehabilitation program was extracted separately. Variables included exercise type, eccentric/concentric/isometric or heavy-slow resistance training, frequency, sets, repetitions, intensity or load, progression criteria, stretching, education, activity modification, manual therapy, orthoses, home exercise, supervision, and duration. This distinction is essential because improvement following ESWT may partly reflect the rehabilitation program itself. In the Gatz et al. (2021) trial, for example, participants across active and placebo groups received physiotherapy for an extended period, making the incremental contribution of ESWT the key comparison.

Outcome domains

Outcomes were categorized into clinical pain, function/disability, patient-reported outcomes, physical performance, structural/biological outcomes, and safety. Pain outcomes included VAS, NRS, resting pain, loading pain, movement-evoked pain, and pressure pain threshold. Functional measures included VISA-A, VISA-P, PRTEE, DASH/QuickDASH, return to work or sport, physical activity, and functional performance. Physical measures included muscle strength, grip strength, calf strength, range of motion, load tolerance, and tendon-specific performance. Structural outcomes included tendon thickness, echogenicity, Doppler vascularity, neovascularization, ultrasound tissue characterization, shear-wave elastography, stiffness, and elasticity.

Follow-up and treatment response

Treatment response was grouped as immediate (within one week), short term (up to six weeks), intermediate term (>6–12 weeks), medium term (>12–24 weeks), and long term (>24 weeks). Both statistical significance and clinically meaningful change were considered where reported. Established minimal clinically important differences were preferred over p-values alone; for example, clinically meaningful change thresholds have been reported for VISA-A (McCormack et al., 2015). Response categories were favorable, no additional response versus comparator, mixed, uncertain, or insufficient evidence. These categories are descriptive and are not intended to constitute a formal hierarchy of effectiveness.

Quality appraisal and synthesis

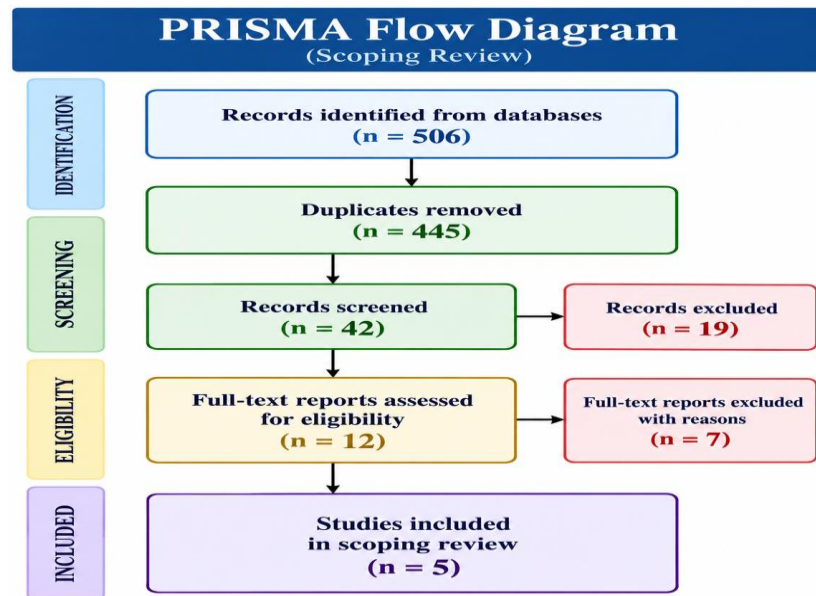
Critical appraisal is not mandatory for all scoping reviews, but methodological quality should be considered when interpreting the mapped evidence. Randomized trials may be assessed using RoB 2 and non-randomized comparative studies using an appropriate ROBINS-I framework. Appraisal is not intended to exclude evidence. Given anticipated clinical and methodological heterogeneity, synthesis is descriptive rather than a meta-analysis. Studies are grouped by tendon, modality, dose, comparator, physiotherapy co-intervention, outcome domain, and follow-up. Descriptive statistics may include study counts, tendon distribution, modality distribution, completeness of dose reporting, outcome frequency, follow-up distribution, physiotherapy integration, adverse-event reporting, and structural outcome reporting. Evidence-gap mapping is used to identify underrepresented populations, modalities, doses, comparators, outcomes, structural measures, follow-up periods, methodological domains, and implementation questions.

RESULTS

Study identification and selection

The final PRISMA-ScR flow diagram should report the exact number of records retrieved from each database, duplicates removed, records screened, full texts assessed, full texts excluded with reasons, and studies included. Because the current manuscript file does not contain a verified database-level search log, these numerical fields are intentionally left as placeholders rather than being fabricated. The final manuscript should replace each placeholder with the audited search and screening counts. This is particularly important because PRISMA-ScR requires transparent reporting of the selection process (Tricco et al., 2018). (see figure 1)

Figure 1: PRISMA Flow Diagram



Characteristics of the currently charted evidence

The evidence currently charted in the manuscript contains five clearly identifiable randomized or comparative clinical studies spanning Achilles and lateral elbow tendinopathies. Gatz et al. (2021) investigated point-focused and line-focused ESWT versus placebo in Achilles tendinopathy, with 66 participants randomized across three groups. Perveen et al. (2024) randomized 80 individuals with lateral epicondylitis to ESWT or ultrasound plus deep friction massage. Król et al. (2024) randomized 60 participants to focused shockwave, ultrasound, or sham ultrasound. Alsulaimani et al. (2025) randomized 76 participants with insertional Achilles tendinopathy to radial ESWT plus standardized exercise and education or sham plus the same rehabilitation. Alsulaimani et al. (2026) examined immediate movement-evoked pain following radial ESWT versus sham within a related insertional Achilles research program. (see table 2)

Table 2. Characteristics of studies

Study	Condition	Design	Sample	Modality	Comparator/co-intervention	Main outcomes	Principal response
Gatz et al. (2021)	Achilles	Placebo-controlled RCT	66	Point- and line-focused	Placebo physiotherapy +	VISA-A; AOFAS; B-US; PD-US; SWE; UTC	Improvement in all groups; no ESWT-specific superiority
Perveen et al. (2024)	Lateral elbow	Double-blind RCT	80	ESWT	US + deep friction massage	NPRS; PRTEE	Greater pain/function improvement with ESWT
Król et al. (2024)	Lateral elbow	RCT	60	Focused ESWT	US; sham US	NRS; PRTEE; strength	Favorable pain/function response; strength superiority uncertain

Alsulaimani et al. (2025)	Insertional Achilles	RCT	76	Radial	Sham exercise/education +	VISA-A; pain; function; secondary outcomes	No incremental benefit over sham
Alsulaimani et al. (2026)	Insertional Achilles	RCT	76	Radial	Sham	Movement-evoked pain	No immediate analgesic superiority

ESWT modality and dosage

The mapped studies demonstrate marked protocol variation. Gatz et al. (2021) used two focused approaches with 2,000 shocks at 5 Hz per session, but the point-focused and line-focused applicators produced substantially different energy densities. Perveen et al. (2024) used a pressure-based ESWT protocol, whereas Król et al. (2024) used focused ESWT at 0.2 mJ/mm², 4 Hz, and 2,000 shocks per session. Alsulaimani et al. (2025) used radial ESWT at 10 Hz, 3,000 shocks, and 2–4 bar. These differences illustrate why “ESWT” cannot be interpreted as one uniform dose. (see table 3)

Table 3. ESWT modality and dosage characteristics.

Study	Modality	Energy/pressure	Frequency	Shocks/session	Sessions	Interval	Target
Gatz 2021 – point	Point-focused	~0.60 mJ/mm ² ; pmax ~50.3 MPa	5 Hz	2,000	4	~2 weeks initially	Painful Achilles region
Gatz 2021 – line	Line-focused	~0.126 mJ/mm ² ; pmax ~9.5 MPa	5 Hz	2,000	4	~2 weeks initially	Painful Achilles region
Perveen 2024	ESWT	Energy level 2.0; 2 bar	1 Hz	NR	7	4 days	Lateral elbow
Król 2024	Focused	0.2 mJ/mm ²	4 Hz	2,000	3	1 week	Most painful lateral epicondyle
Alsulaimani 2025	Radial	2–4 bar; estimated EFD ~0.63 mJ/mm ²	10 Hz	3,000	3	Protocol-defined	Insertional Achilles

Physiotherapy co-interventions

Physiotherapy co-intervention varied from structured exercise and education to comparator-based modalities. In the Gatz et al. (2021) study, all groups received physiotherapy over a substantially longer period than the six-week ESWT/placebo treatment period. In Alsulaimani et al. (2025), exercise and education were standardized across active and sham groups, creating a stronger test of the incremental contribution of ESWT. In Perveen et al. (2024), the comparison was ESWT versus ultrasound plus deep friction massage, illustrating a different clinical question: whether ESWT produces greater benefit than another passive physiotherapy strategy. These differences make cross-study comparisons challenging. (see table 4)

Table 4. Physiotherapy co-intervention characteristics.

Study	Exercise/rehabilitation	Education	Manual therapy	Home/supervised	Interpretive issue
Gatz 2021	Physiotherapy exercises	NR	NR	Physiotherapy provided	Improvement cannot be attributed to ESWT alone
Perveen 2024	Comparator physiotherapy	NR	Deep friction massage in comparator	Supervised	Tests ESWT versus passive modality
Król 2024	Physiotherapy context	NR	Deep friction massage/context	Supervised	Co-intervention details require careful interpretation
Alsulaimani 2025	Structured progressive exercise	Yes	NR	Home supervised +	Strong test of incremental ESWT effect
Alsulaimani 2026	Structured exercise framework	Yes	NR	Rehabilitation framework	Immediate response may not reflect long-term rehabilitation

Clinical and functional outcomes

Pain and function were the most consistently assessed outcomes. In lateral elbow tendinopathy, Perveen et al. (2024) reported greater improvements following ESWT compared with ultrasound and deep friction massage, while Król et al. (2024) also found favorable pain and function outcomes with focused shockwave therapy. In contrast, the Achilles evidence was less supportive of an incremental ESWT effect. Gatz et al. (2021) observed improvement across active and placebo groups, while Alsulaimani et al. (2025) found no additional benefit from radial ESWT when standardized exercise and education were provided. The 2026 Achilles meta-analysis similarly found no overall superiority of ESWT over sham, although symptom-duration subgroup findings suggest that treatment timing may warrant further study (Ni et al., 2026).

Structural and biomechanical outcomes

Structural outcomes were less frequently reported than pain and function. Gatz et al. (2021) provides an important example because the study incorporated B-mode ultrasound, power Doppler, ultrasound tissue characterization, and shear-wave elastography. Clinical VISA-A improvement occurred without a corresponding clear treatment-specific change in conventional structural measures. Some changes in tendon elastic properties were detected with shear-wave elastography. This pattern supports the separation of clinical and structural response domains and suggests that future studies should avoid assuming that pain reduction necessarily indicates normalization of tendon structure.

Safety and treatment tolerability

Available evidence suggests that ESWT is generally well tolerated, although transient treatment-related pain, symptom exacerbation, erythema, swelling, and skin irritation may occur. The hip/pelvis systematic review by Rau et al. (2025) reported adverse events in six of 18 studies, with an overall rate of approximately 12% among participants in studies reporting adverse events; no serious adverse events were reported. The 2025 insertional Achilles randomized trial also reported few minor adverse events and no serious adverse events. Safety should

nevertheless be reported systematically in future trials because tolerability may influence adherence and clinical implementation.

Evidence-gap synthesis

The evidence map indicates several recurring gaps. First, Achilles and lateral elbow tendinopathies are more extensively represented than several other tendon sites. Second, radial and focused modalities are represented, but direct head-to-head evidence remains limited. Third, dose reporting is inconsistent, particularly when pressure-based and energy-flux-density-based protocols are compared. Fourth, physiotherapy co-interventions are frequently incompletely described. Fifth, structural outcomes and advanced imaging are much less common than pain and disability measures. Sixth, long-term follow-up, return to sport/work, quality of life, and clinically important change are inconsistently reported. Finally, the literature does not yet establish a reliable dose-response relationship. (see figure 2)

Figure 2: Evidence-Gap Heat Map

Evidence domain	Achilles	Lateral elbow	Patellar	Rotator cuff	Other
Radial ESWT	3	2	1	1	0
Focused ESWT	3	3	0	1	0
Dose reporting	2	3	0	2	0
Physiotherapy standardization	3	2	0	2	0
Sham-controlled evidence	3	2	1	2	0
Pain outcomes	3	3	2	3	1
Functional outcomes	3	3	2	3	1
Structural imaging	3	0	0	2	0
Advanced imaging	3	0	0	1	0
Long-term follow-up	3	2	0	2	0
Dose-response	1	1	0	0	0

Figure 2 note. Preliminary evidence-gap map: 0 = major gap; 1 = limited evidence; 2 = moderate/heterogeneous evidence; 3 = relatively well represented.

DISCUSSION

The central finding of this scoping review is that ESWT for tendinopathy is best understood as a heterogeneous family of interventions rather than a single treatment. Clinical response appears to depend on tendon location, symptom duration, ESWT modality, physical dose, comparator, and the quality and content of the concurrent rehabilitation program. This interpretation is consistent with recent systematic reviews demonstrating wide variation in ESWT parameters and with the 2026 radial-versus-focused meta-analysis, which did not establish a clear overall superiority of one modality for pain or function (Stania et al., 2026).

The clinical evidence is most convincing for selected upper-limb and some hip/pelvic tendinopathies, but even these findings should be interpreted within the context of heterogeneity. Xiong et al. (2024) synthesized 18 randomized trials of upper-limb tendon disorders and found evidence of benefit for selected pain and functional

outcomes. Perveen et al. (2024) provided recent randomized evidence favoring ESWT over ultrasound plus deep friction massage for lateral epicondylitis. Król et al. (2024) similarly adds contemporary evidence for focused shockwave therapy. However, these studies compare ESWT with different interventions and therefore address different clinical questions. A positive result against a passive modality does not necessarily establish superiority over progressive exercise rehabilitation.

The Achilles evidence illustrates this distinction particularly clearly. Gatz et al. (2021) showed that point-focused and line-focused ESWT, when embedded within physiotherapy, did not produce statistically significant advantages over placebo despite improvement in VISA-A scores across groups. Alsulaimani et al. (2025) subsequently tested radial ESWT in a stronger adjunctive design in which exercise and education were provided to both active and sham groups. The absence of additional benefit across pain, VISA-A function, physical activity, psychological outcomes, and health-related quality of life suggests that the value of ESWT cannot be assumed when a structured rehabilitation program is already present. Ni et al. (2026) reached a similar overall conclusion in a meta-analysis of eight sham-controlled randomized trials involving 458 participants, although exploratory subgroup findings suggested that shorter symptom duration may be associated with a modest short-term pain response.

The role of dose remains one of the most important unresolved questions. The reviewed protocols differ in energy flux density, pressure, frequency, shock number, number of sessions, and session spacing. This heterogeneity is not merely a reporting inconvenience; it may represent true differences in the biological stimulus delivered to the tendon. Rau et al. (2025) found that most hip/pelvic tendinopathy studies used three to four weekly sessions and 2,000–3,000 pulses per session, but both radial and focused technologies were represented. The absence of standardized dose definitions makes it difficult to determine whether negative studies reflect ineffective modalities, inadequate doses, inappropriate treatment targets, or populations unlikely to respond.

Physiotherapy integration is another major explanatory factor. Tendinopathy rehabilitation is fundamentally load-based, and exercise can improve pain, function, strength, and capacity independently of adjunctive modalities. Therefore, trials in which ESWT is added to identical exercise in both active and control groups provide the clearest estimate of incremental treatment effect. Conversely, trials comparing ESWT with a passive modality may demonstrate the relative effectiveness of ESWT without establishing whether ESWT adds value to contemporary exercise-based care. This distinction should be explicit in both clinical interpretation and future trial design.

Structural outcomes deserve greater attention, but they should not replace patient-centered outcomes. The Gatz et al. (2021) findings illustrate that clinical improvement may occur without clear changes in conventional ultrasound measures. Advanced techniques such as shear-wave elastography may capture biomechanical changes that conventional imaging misses, but these measures require standardized acquisition and interpretation. Future studies should therefore integrate pain, validated function, physical performance, and appropriately selected structural or biomechanical outcomes rather than assuming that one domain is a surrogate for another.

The current evidence also highlights the importance of treatment phenotype. Tendon location, insertional versus midportion pathology, symptom duration, activity level, and baseline severity may modify response. The 2026 Achilles meta-analysis provides a hypothesis-generating example in which participants with symptoms of less than 12 months showed short-term pain reduction, whereas the overall chronic Achilles population did not. Such findings should not yet be interpreted as definitive patient-selection rules, but they support stratification in future trials and more precise clinical characterization.

Safety appears favorable, but systematic reporting remains necessary. ESWT can produce transient treatment discomfort and local reactions. Rau et al. (2025) found no serious adverse events in the hip/pelvic literature and reported generally limited minor adverse effects. The absence of serious events in available studies is reassuring, but adverse-event definitions and reporting completeness vary. Standardized safety reporting should therefore accompany standardized dose reporting.

Finally, the methodological quality of the review literature itself warrants caution. Shahabi et al. (2024) found critically low methodological quality among 18 ESWT systematic reviews and meta-analyses, with substantial concerns regarding reporting and risk of bias. This finding strengthens the rationale for a parameter-focused scoping review. Rather than producing another broad efficacy estimate that may be distorted by heterogeneity, the present approach maps the intervention characteristics that may explain divergent results and identifies specific priorities for controlled trials.

LIMITATIONS AND FUTURE RECOMMENDATIONS

This review has several limitations. The evidence base is clinically and methodologically heterogeneous, including different tendinopathy sites, disease phenotypes, ESWT technologies, dose units, treatment schedules, comparators, and rehabilitation programs. Several studies incompletely report key treatment parameters, limiting direct comparison and preventing robust dose-response inference. Outcome measures and follow-up periods also vary, and structural measures are inconsistently applied. In addition, the current manuscript file did not contain a final audited database search log; therefore, PRISMA numerical fields remain placeholders and should not be interpreted as final study-selection counts. Future randomized trials should use adequately powered samples, standardized ESWT reporting, transparent physiotherapy protocols, sham or exercise-controlled designs where appropriate, and clinically meaningful follow-up. Direct radial-versus-focused comparisons, dose-ranging studies, phenotype-stratified trials, return-to-activity outcomes, and standardized structural/biomechanical assessments are particularly warranted (Peters et al., 2020; Stania et al., 2026).

Clinical Implications

Clinically, ESWT should be considered an adjunct rather than a replacement for evidence-based physiotherapy and progressive tendon-loading rehabilitation. Treatment selection should consider tendon site, chronicity, symptom severity, patient tolerance, and the evidence supporting the specific modality and dose. Clinicians should document the ESWT modality, energy or pressure, frequency, shocks per session, total sessions, treatment interval, targeting technique, and the concurrent physiotherapy program. The present evidence does not justify routine use of one universal ESWT protocol across all tendinopathies. An individualized, exercise-centered rehabilitation strategy with selective ESWT may be more defensible than modality-driven treatment selection.

CONCLUSION

This scoping review indicates that ESWT may provide clinically useful adjunctive effects in selected tendinopathies, but responses are heterogeneous and cannot be separated from modality, dosage, tendon phenotype, and physiotherapy context. Evidence is more favorable in some upper-limb conditions than in sham-controlled Achilles trials. Substantial variation in treatment parameters and rehabilitation protocols limits comparison and prevents identification of a universal optimal dose. Future research should prioritize standardized ESWT reporting, dose-response studies, direct modality comparisons, structured exercise controls, clinically meaningful outcomes, long-term follow-up, and integrated structural or biomechanical assessment.

Highlights of this study

- ESWT is a potentially useful adjunct to physiotherapy for selected tendinopathies.
- Treatment response varies with tendon pathology, modality, dosage, and rehabilitation context.
- Pain and function are more consistently reported than structural or biomechanical outcomes.
- Radial and focused ESWT cannot currently be considered universally superior.
- ESWT dosage and physiotherapy co-interventions are inconsistently standardized.
- Dose-response relationships remain a major research gap.

- Future trials should integrate standardized ESWT protocols with progressive exercise rehabilitation.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT:

Author 1: Conceptualization, Formal Analysis, Methodology, Writing – Original Draft, Project Administration.

Author 2: Conceptualization, Investigation, Writing – Original Draft, Writing – Review and Editing, Investigation, Project Supervision.

Author 3: Formal Analysis, Data Collection, Methodology, Investigation.

Author 4: Formal Analysis, Data Collection, Methodology, Investigation.

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