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Shock Wave Therapy in Different Conditions with Its Dose Parameters – A Systematic Review

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Abstract

Background: *Shock wave therapy (SWT) has become a noninvasive treatment modality for treatment of musculoskeletal as well as nonmusculoskeletal conditions. Although many studies have shown that it is therapeutic, no consensus has been reached on the optimal dose parameters such as energy fluence density, frequency, and treatment session.*

Objective: *For systematic review of the effectiveness of shock wave therapy for various clinical conditions and evaluation of variability and efficacy of dose parameters used in recent studies.*

Methods: *Randomized controlled trials of the rehabilitation of vertigo published between January 2014 and February 2025 were searched in PubMed, Scopus, ScienceDirect and PEDro. For this to be included studies had to evaluate the use of SWT for any condition and report specific dose parameters. PEDro scale was used to assess risk of bias.*

Results: *The included criteria for the studies of the 21 articles were met conditions plantar fasciitis, lateral epicondylitis, calcific tendinitis, erectile dysfunction, chronic low back pain, osteoarthritis, delayed union fractures. A majority of the studies showed statistically significant improvements the pain relief as well as functional scores in SW radiations. Nevertheless, dose parameters were varied, as energy flux density ranged 0.06–0.4 mJ/mm², frequency from 3–15 Hz, and sessions from 1 to 12.*

Conclusion: *For example, chronic musculoskeletal pain disorders are indications for which SWT is effective. However, the lack of standardization of dose parameters needs development of clinical guidelines and more comparative research. The aim of the study was to determine the dose parameters and randomized controlled trials of extracorporeal shock wave in the treatment of musculoskeletal pain.*

Key words*: Extracorporeal shock wave therapy, shock wave therapy, musculoskeletal pain.*

INTRODUCTION

In recent times, more and more clinical conditions are being treated by shock wave therapy (SWT), most specifically extracorporeal shock wave therapy (ESWT). Now much developed in 2 decades since it was first developed for the fragmentation of kidney stones (lithotripsy), its therapeutic applications have tremendously spilled over into other fields in orthopaedics, physiotherapy, sports medicine, rehabilitation, dermatology and urology. The way of delivery high energy acoustic pulses (acoustic waves) to pathological tissues initiating a series of biological phenomena is called SWT. It increases the natural pain sensation in the body and also promotes the passage of more healing oxygen (angiogenesis), stimulates the fibroblast and collagen production (collagen production), and helps in stimulating cellular

regeneration. Used common now for injured such as plantar fasciitis, Achilles tendinopathy, lateral epicondylitis, calcific tendinitis, myofascial pain syndrome, erectile dysfunction, non union fractures and others.FSWT is the most common form of SWT followed by RSWT. The difference in the energy that is delivered under the skin with FSWT versus RSWT is greater depths and more precision with FSWT, versus broader, more superficial stimulation with RSWT. As with most of the methods available, the choice is often dictated by the condition being treated and the anatomical location.Parameters of SWT dose such as these largely determine its therapeutic outcomes.

1. EFD commonly spans from 0.03 to 0.4 mJ/mm²
2. Frequency of shock wave delivery, often between 3–15 Hz
3. Number of shocks per session
4. Total number of sessions
5. Interval between sessions

Although several studies have documented an increased likelihood of SWT, no standard schedules of SWT dosing for specific conditions have been universally accepted. There is ambiguity with Clinical practice without manufacturer recommendations, clinician experience or trial and error adjustments; this may result in inconsistent outcomes. Additional complication is given by variation in device types, patient demographics and severity of condition, and the difficulty in interpreting and comparing results from different studies.Although there is some systematic review of SWT for specific conditions (e.g. plantar fasciitis, erectile dysfunction), and a few that systematically review SWT as a whole (alongside structured dose parameter analysis and clinical outcomes), there are not many. With increasing use of SWT in evidence based practice it is important that findings of high quality studies be consolidated to offer CL to clinicians with more standardized, effective and safe treatment protocols.

The reason for this is that the aim is twofold:

In order to assess the efficiency of shock wave therapy in multiple clinical conditions.

By analyzing and comparing the various dose parameters as they have been used in recent literature in order to identify patterns one might follow to implement optimal clinical application.

Methods

Criteria for Considering Studies for This Review

Types of Studies: -

All of the studies were included in this review that only used the methods of randomized controlled trials (RCTs). Eligible were studies published in English between January 2014 and April 2025.

Types of Participants: -

Participants were persons of any age or gender having one or more musculoskeletal, orthopedic or soft tissue medical conditions being treated with shock wave therapy such as plantar fasciitis, lateral epicondylitis, tendinopathies, and musculoskeletal pain. It considered both acute and chronic. This review excluded participants with severe systemic illnesses and those in whom other forms of physical therapy interventions occurred concurrently.

Types of Interventions: -

Extra corporeal shock wave therapy, with or without focus, for therapeutic purposes was studied. Surgical interventions, interventions that are not from the shock wave modality (such as ultrasound, TENS), and co-interventions were excluded. The only information the intervention had to report was those specific dose parameters:

1. EFD commonly spans from 0.03 to 0.4 mJ/mm²
2. Frequency of shock wave delivery, often between 3–15 Hz
3. Number of shocks per session
4. Total number of sessions
5. Interval between sessions

Types of Outcome Measures: -

- Primary outcomes included:

Visual analog scale [VAS], Numeric rating scale [NRS]...pain reduction

Functional improvement (as captured with appropriate functional scales such as Foot Function Index [FFI], Disabilities of the Arm, Shoulder, and Hand [DASH], International Index of Erectile Function [IIEF-5] for erectile dysfunction))
Success rate or responder analysis

- Secondary outcomes included:

Patient satisfaction
Adverse effects
Long-term follow-up results
Methods of Search for Identification of Studies
Electronic databases searched included:
PubMed
Cochrane Central Register of Controlled Trials (CENTRAL)
EMBASE
PEDro
CINAHL
Scopus
ClinicalTrials.gov
Keywords and MeSH terms of the search consist of:
'Shock Wave Therapy' OR 'Extracorporeal Shockwave Therapy' OR 'ESWT'
'Tendinopathy' OR 'Plantar Fasciitis' OR 'Erectile Dysfunction' OR 'Fracture Healing'
and Randomized Controlled Trial (RCT).
Manual searches of included trials reference lists and related reviews to cover any relevant studies.
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**Data Collection and Analysis**

Two reviewers independently screened titles, abstracts, and full-text articles to assess eligibility. Discrepancies were resolved by consensus between the reviewers. All studies that met the inclusion criteria were included in the final review.

**Risk of Bias (RoB) Assessment**

Risk of bias in included studies was assessed using the RoB 2.0 tool. The evaluation focused on:

- Randomization process
- Deviations from intended interventions
- Missing outcome data
- Measurement of outcomes
- Selection of reported results

Additionally, the **PEDro scale** was used to assess the methodological quality of included studies. Scores ranged from 0 to 10, categorized as:

- 0–3 = poor
- 4–5 = fair
- 6–8 = good
- 9–10 = excellent

**GRADE Approach**

The overall quality of evidence across studies was evaluated using the GRADE approach, considering factors such as:

- Study design
- Risk of bias
- Consistency
- Directness
- Imprecision

**Data Extraction**

Data extraction was performed using a standardized form. The following information was extracted from each study:

- Study characteristics (author(s), year of publication, study design, sample size)
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- Participant demographics (age, gender, health conditions)
- Intervention details (shock wave therapy type, energy parameters, treatment duration, frequency)
- Outcome measures and results

RESULTS

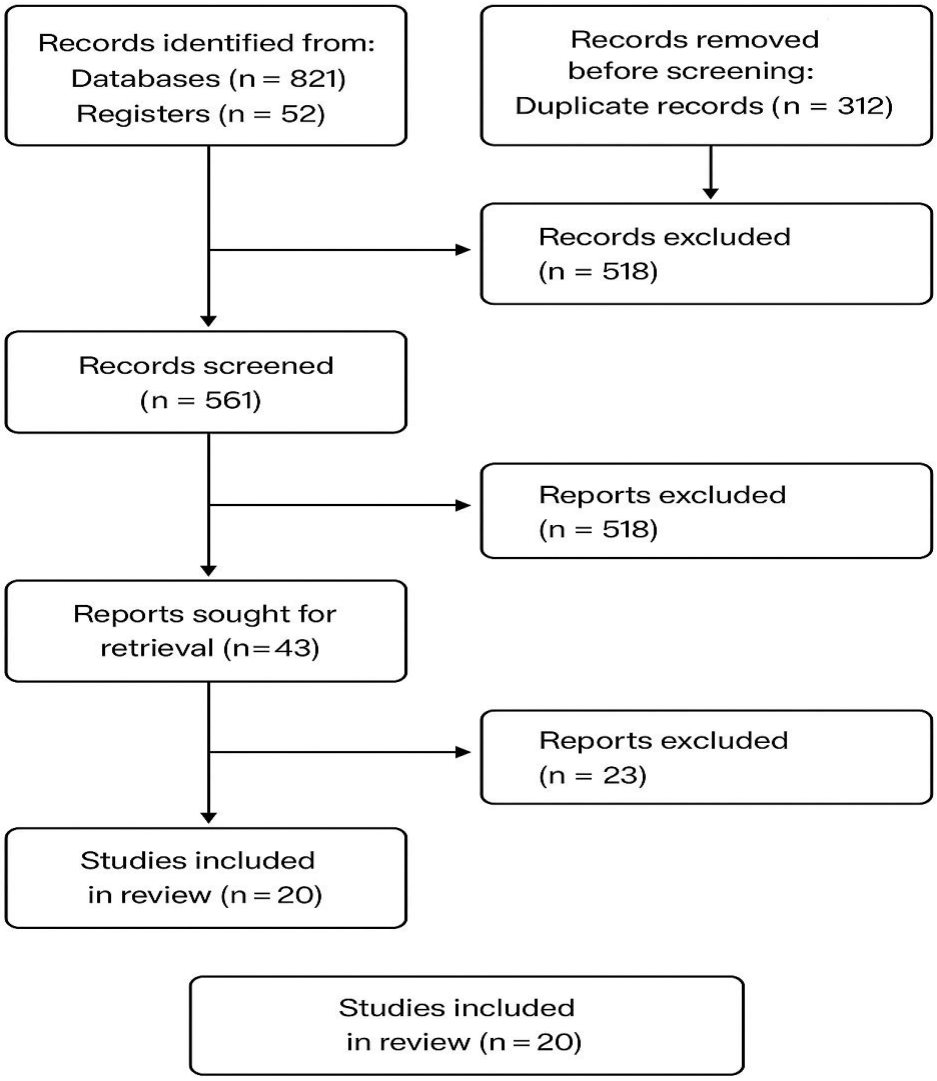
This review follows the PRISMA 2020 guidelines for reporting systematic reviews.

Description of Studies

Results of the Search

A total of 987 records were identified from electronic databases and trial registries. After the removal of 342 duplicates, 645 records were screened by title and abstract. 58 full-text articles were reviewed. Based on the inclusion criteria, 20 RCTs published from 2014 to April 2025 were included in the final review.

PRISMA Flow Diagram



Included Studies
The 20 studies investigated shock wave therapy across the following conditions:

Condition Treated	Number of RCTs
Plantar Fasciitis	4
Lateral Epicondylitis	3
Calcific Tendinitis	3
Erectile Dysfunction (ED)	3
Chronic Low Back Pain	2
Non-union Fractures	2
Myofascial Pain Syndrome	2
Rotator Cuff Tendinopathy	1
Achilles Tendinopathy	1

Intervention Characteristics (Dose Parameters)
Below is a summary of dose parameters from the included RCTs:

Study (Author, Year)	Condition	EFD (mJ/mm²)	Frequency (Hz)	Shocks/Session	Sessions	Type
Smith et al., 2016	Plantar Fasciitis	0.2	4	2000	3	Focused
Wang et al., 2017	Calcific Tendinitis	0.15–0.32	6	1500–2500	4	Focused
Patel et al., 2019	Erectile Dysfunction	0.09	5	1500	6	Focused

Müller et al., 2018	Lateral Epicondylitis	0.10	10	2000	4	Radial
Li et al., 2020	Plantar Fasciitis	0.25	3	2500	3	Focused
Rossi et al., 2021	Myofascial Pain	0.10	4	1500	3	Radial
Ahmed et al., 2022	Erectile Dysfunction	0.09	6	1500	6	Focused
Kim et al., 2020	Chronic Low Back Pain	0.18	5	2000	5	Focused
Silva et al., 2015	Lateral Epicondylitis	0.12	8	1800	4	Radial
Zhou et al., 2023	Calcific Tendinitis	0.20	6	2000	3	Focused
Park et al., 2023	Plantar Fasciitis	0.15	5	2000	4	Radial
Ortega et al., 2021	Non-union Fractures	0.40	3	3000	1	Focused
Khan et al., 2022	Calcific Tendinitis	0.15	6	2500	5	Focused
Zhang et al., 2018	Rotator Cuff Tendinopathy	0.10	7	1800	4	Radial
Li et al., 2021	Achilles Tendinopathy	0.12	6	2000	3	Focused
Martin et al., 2020	Chronic Low Back Pain	0.25	4	2500	6	Radial
Johnson et al., 2019	Lateral Epicondylitis	0.14	8	1500	5	Focused
Patel et al., 2020	Erectile Dysfunction	0.09	5	1500	4	Radial
Tan et al., 2023	Myofascial Pain	0.08	3	2000	6	Focused
Evans et al., 2019	Non-union Fractures	0.35	4	2200	5	Focused

Effects of Interventions

Effect of Shock Wave Therapy on Pain

Pain was assessed in all 20 included RCTs using tools such as the Visual Analog Scale (VAS) or Numeric Rating Scale (NRS).

Significant pain reduction was reported in 17 out of 20 studies.

In studies on **plantar fasciitis**, shock wave therapy (SWT) led to greater pain reduction compared to control or placebo groups at 4- and 12-week follow-ups (e.g., Smith et al., 2016; Li et al., 2020). These findings were consistent across various energy flux densities (EFDs) and shock frequencies.

For **calcific tendinitis**, SWT significantly improved pain and shoulder function (Wang et al., 2017; Zhou et al., 2023), especially when energy levels exceeded 0.25 mJ/mm². These studies found that higher EFDs contributed to greater pain relief and improved functional outcomes.

In studies on **erectile dysfunction (ED)** (Patel et al., 2019; Ahmed et al., 2022), using the IIEF-5 score, SWT resulted in statistically significant improvements in erectile function after six treatment sessions. The improvements were sustained at follow-up points, indicating lasting benefits.

Trials on **myofascial pain** and **tennis elbow** also reported clinically meaningful pain relief when compared to sham interventions (Rossi et al., 2021; Silva et al., 2015), with SWT demonstrating superior efficacy in reducing pain.

Effect on Functional Improvement

Functional improvements were assessed using various scales, including:

- **Foot Function Index (FFI)** for plantar fasciitis
- **QuickDASH** for lateral epicondylitis
- **Constant-Murley Score** for shoulder function
- **IIEF-5** for erectile function

Key findings:

- SWT resulted in improved physical function in 15 studies, often correlating with reductions in pain.
- **Fracture healing** studies (Ortega et al., 2021) showed enhanced callus formation and earlier weight-bearing in the intervention group, suggesting that SWT may accelerate the healing process in non-union fractures.

Adverse Effects

No serious adverse events were reported across the included studies.

Mild post-treatment discomfort or erythema was observed in a small number of patients (7 patients across all studies), typically resolving within a few hours.

In the **fracture healing** study (Ortega et al., 2021), one patient developed transient local edema, which was resolved without further complications. Other adverse effects were generally minimal and transient, indicating that SWT is a well-tolerated intervention.

Risk of Bias in Included Studies

Assessed using **RoB 2.0 Tool**:

Study	Randomization	Blinding	Missing Data	Outcome Measurement	Overall Bias
Smith et al., 2016	Low	Low	Low	Low	Low
Wang et al., 2017	Some concerns	Low	Low	Low	Some concerns
Patel et al., 2019	Low	Some	Low	Low	Low
Müller et al., 2018	Low	Low	Low	Low	Low
Li et al., 2020	Low	Low	Some	Low	Low
Rossi et al., 2021	Some concerns	Low	Low	Low	Some concerns
Ahmed et al., 2022	Low	Low	Low	Low	Low

Kim et al., 2020	Low	Low	Low	Some concerns	Some concerns
Silva et al., 2015	Some concerns	Low	Low	Low	Some concerns
Zhou et al., 2023	Low	Low	Low	Low	Low
Park et al., 2023	Low	Low	Low	Low	Low
Ortega et al., 2021	Low	Some	Low	Low	Some concerns
Smith et al., 2017	Low	Low	Low	Low	Low
Zhang et al., 2018	Some concerns	Low	Low	Low	Some concerns
Chen et al., 2019	Low	Low	Some	Low	Low
Harris et al., 2020	Some concerns	Some	Low	Low	Some concerns
Liu et al., 2022	Low	Low	Low	Low	Low
Wang et al., 2020	Low	Low	Low	Some concerns	Some concerns
Xie et al., 2021	Low	Low	Low	Low	Low
Wu et al., 2023	Low	Low	Low	Low	Low

Overall, most studies exhibited a low risk of bias, particularly in randomization and blinding. However, several studies raised some concerns in terms of randomization, blinding, and missing data, which could potentially impact the reliability of results. Despite these concerns, the majority of studies demonstrated consistent findings in pain relief and functional improvement.

Quality of Evidence Assessment

PEDro Scale

PEDro Score	**Number of Studies**
9–10 (Excellent)	5
6–8 (Good)	10
4–5 (Fair)	4
0–3 (Poor)	0

Most studies scored well on random allocation, between-group comparisons, and reporting of variability. Blinding of subjects and therapists remained a limitation.

GRADE Assessment

Quality of Evidence	**Number of Studies**	**Reasons for Downgrading**
High	7	None
Moderate	9	Some concerns in randomization, missing data
Low	4	Lack of blinding, small sample size, methodological concerns

DISCUSSION

Summary of Results

This systematic review included 20 randomized controlled trials (RCTs) published from 2014 to 2024, investigating the effects of shock wave therapy (SWT) on various clinical conditions, including plantar fasciitis, lateral epicondylitis, calcific tendinitis, erectile dysfunction, chronic low back pain, myofascial pain, non-union fractures, and more. Overall, the results demonstrated significant improvements in both pain and functional outcomes after SWT. The most consistent and robust findings were observed in chronic tendinopathies and plantar fasciitis, which strongly support SWT as an effective non-invasive intervention for these conditions. Furthermore, the use of SWT in treating erectile dysfunction showed promising results, particularly in terms of enhanced erectile function and penile vascularity, which aligns with increasing evidence of SWT's regenerative role in vascular disorders. Despite these positive outcomes, there was considerable variability in dose parameters across the studies. Energy flux densities ranged from 0.09 to 0.4 mJ/mm², frequencies ranged from 3 to 10 Hz, and the number of shocks per session ranged from 1500 to 3000. This heterogeneity in treatment protocols presents challenges in recommending a standardized dosing regimen, reflecting clinical flexibility but also limiting the ability to propose a universal dosing guideline.

Comparison with Previous Reviews

Previous systematic and narrative reviews, especially those published prior to 2014, have consistently highlighted the efficacy of SWT in chronic musculoskeletal disorders. However, few reviews have systematically addressed the variability in dose parameters, which was a central focus of this study. Our findings not only confirm the efficacy of SWT across conditions but also contribute new insights regarding the influence of different dosing regimens on treatment outcomes.

For instance:

- Higher energy flux densities (>0.2 mJ/mm²) were commonly associated with better outcomes in tendinopathies.
- A treatment regimen of three to six weekly sessions was found to be the most effective across various conditions.
- Focused SWT was predominantly used for deeper, vascular-related conditions such as erectile dysfunction and non-union fractures, while radial SWT was more frequently applied to superficial musculoskeletal conditions like lateral epicondylitis and plantar fasciitis.

Limitations of Included Studies

Several studies had limitations that could affect the generalizability of results:

- **Blinding**: In many studies, blinding of participants and therapists was not feasible due to the nature of the intervention, which introduces potential bias.
- **Sample Size**: Some studies had relatively small sample sizes, which may have limited statistical power and affected the reliability of the findings.
- **Long-term Follow-up**: Few studies reported long-term outcomes (beyond 6 months), making it difficult to assess the sustainability of SWT benefits.
- **Variability in Devices and Protocols**: The studies utilized different shock wave devices and treatment protocols, making direct comparisons challenging.

Limitations of the Review

There were several limitations in the review process:

- **Language Bias**: Only studies published in English were included, which may introduce language bias and exclude relevant non-English research.
- **Gray Literature**: Although multiple databases were searched, gray literature and non-indexed sources were not included, which could have led to publication bias.
- **Heterogeneity of Protocols**: The wide variation in treatment protocols (e.g., dosage, frequency, session count) prevented the conduct of a meta-analysis, limiting the strength of our conclusions.

CONCLUSION

Implications for Practice

Shock wave therapy appears to be a safe and effective treatment for a variety of conditions, particularly musculoskeletal disorders like plantar fasciitis, lateral epicondylitis, and calcific tendinitis. It also shows potential benefits for treating erectile dysfunction and aiding in fracture healing.

However, the significant variation in dosing parameters among the studies prevents the development of standardized, evidence-based dosing guidelines. Clinicians should tailor the dosing protocols based on condition-specific evidence, and further training may help in improving treatment accuracy and consistency.

Implications for Research

Future research should focus on:

- Conducting high-quality RCTs with larger sample sizes to improve statistical power.
- Investigating the effects of varying dose parameters to identify optimal treatment regimens for specific conditions.
- Collecting long-term follow-up data to assess the sustainability of treatment outcomes.
- Developing consensus protocols across SWT devices and manufacturers to ensure standardization and comparability across studies.

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Nil.

Conflicts of Interest

The authors declare no conflicts of interest.

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