EFICÁCIA DA TERAPIA POR ONDAS DE CHOQUE EXTRACORPÓREA NO TRATAMENTO DA DOR OSTEOARTICULAR CRÔNICA: UMA REVISÃO SISTEMÁTICA

EFFICACY OF EXTRACORPOREAL SHOCK WAVE THERAPY IN THE TREATMENT OF CHRONIC OSTEOARTICULAR PAIN: A SYSTEMATIC REVIEW

EFICACIA DE LA TERAPIA DE ONDAS DE CHOQUE EXTRACORPÓREAS EN EL TRATAMIENTO DEL DOLOR OSTEOARTICULAR CRÓNICO: UNA REVISIÓN SISTEMÁTICA

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Carlos Henrique de Jesus Oliveira[1], André Pereira Silva Freitas[2], Danielle Fernandes de Araujo[3], Láysa Rodrigues de Lima Gomes[4], Lorena de Oliveira Tannus[5]

RESUMO

Introdução: A dor osteoarticular crônica é uma condição debilitante que compromete a qualidade de vida e exige abordagens terapêuticas eficazes e seguras. Objetivo: Avaliar a eficácia da Terapia por Ondas de Choque Extracorpórea (TOCE) no tratamento da dor osteoarticular crônica. Metodologia: Revisão sistemática baseada no protocolo PRISMA, registrada no PROSPERO. A busca foi realizada em março de 2025, nas bases PubMed e Cochrane, utilizando descritores MESH relacionados à TOCE e dor crônica. Foram incluídos ensaios clínicos randomizados publicados entre 2020 e 2024, com adultos ≥18 anos, em português, inglês ou espanhol. A seleção dos estudos, extração de dados e avaliação do risco de viés (ferramenta RoB 2) foram conduzidas por revisores independentes. Resultados: Foram selecionados 7 estudos, realizados em diferentes

[1] Medical Student
Faculty of Medical Sciences of Pará (FACIMPA)
E-mail: carloshdjo@hotmail.com
Lattes: http://lattes.cnpq.br/0757554450246415
Orcid: https://orcid.org/0000-0003-2263-4074
[2] Medical Student
Faculty of Medical Sciences of Pará (FACIMPA)
Email: andrefreitttas@hotmail.com
Lattes: http://lattes.cnpq.br/3361108529141934
Orcid: https://orcid.org/0000-0001-6498-0149
[3] Medical Student
Faculty of Medical Sciences of Pará (FACIMPA)
Email: danielle.araujo02@hotmail.com
Lattes: https://lattes.cnpq.br/5285113065862804
Orcid: https://orcid.org/0000-0003-0796-2782
[4] Medical Student
University of the State of Pará (UEPA)
E-mail: laysa.rdlgomes@aluno.uepa.br
Lattes: http://lattes.cnpq.br/7458187716195335
Orcid: https://orcid.org/0009-0005-8575-7479
[5] Master in Surgery and Experimental Research
University of the State of Pará (UEPA)
Email: lorena.otannus@uepa.br
Lattes: http://lattes.cnpq.br/3887621214342902
Orcid: https://orcid.org/0000-0002-1917-0267

países, todos em inglês. Todos os estudos demonstraram redução significativa da dor (EVA) e melhora funcional. Protocolos com maior frequência e menor intensidade energética mostraram resultados superiores a curto prazo. Apenas um estudo relatou efeitos adversos leves e autolimitados. A maioria dos estudos apresentou risco moderado de viés. Discussão: A TOCE mostrou-se eficaz em diferentes condições musculoesqueléticas, com destaque para sua segurança e potencial analgésico. A heterogeneidade nos protocolos reforça a necessidade de padronização. Conclusão: A TOCE é uma terapia promissora, segura e eficaz no manejo da dor osteoarticular crônica, sendo recomendada como alternativa aos tratamentos convencionais.

Palavras-chave: Dor Crônica. Tratamento por Ondas de Choque Extracorpóreas. Sistema Musculoesquelético. Reabilitação.

ABSTRACT

Introduction: Chronic osteoarticular pain is a debilitating condition that compromises quality of life and requires effective and safe therapeutic approaches. Objective: To evaluate the efficacy of Extracorporeal Shock Wave Therapy (ESWT) in the treatment of chronic osteoarticular pain. Methodology: Systematic review based on the PRISMA protocol, registered in PROSPERO. The search was carried out in March 2025, in the PubMed and Cochrane databases, using MESH descriptors related to ESWT and chronic pain. Randomized clinical trials published between 2020 and 2024, with adults ≥18 years old, in Portuguese, English or Spanish were included. Study selection, data extraction and assessment of risk of bias (RoB 2 tool) were conducted by independent reviewers. Results: Seven studies were selected, conducted in different countries, all in English. All studies demonstrated significant pain reduction (VAS) and functional improvement. Protocols with higher frequency and lower energy intensity showed superior short-term results. Only one study reported mild and self-limiting adverse effects. Most studies had a moderate risk of bias. Discussion: ESWT has been shown to be effective in different musculoskeletal conditions, with emphasis on its safety and analgesic potential. The heterogeneity in the protocols reinforces the need for standardization. Conclusion: ESWT is a promising, safe and effective therapy in the management of chronic osteoarticular pain, and is recommended as an alternative to conventional treatments.

Keywords: Chronic Pain. Extracorporeal Shock Wave Therapy. Musculoskeletal System. Rehabilitation.

RESUMEN

Introducción: El dolor osteoarticular crónico es una condición debilitante que compromete la calidad de vida y requiere enfoques terapéuticos efectivos y seguros. Objetivo: Evaluar la eficacia de la terapia de ondas de choque extracorpóreas (TOCE) en el tratamiento del dolor osteoarticular crónico. Metodología: Revisión sistemática basada en el protocolo PRISMA, registrado en PROSPERO. La búsqueda se realizó en marzo de 2025, en las bases de datos PubMed y Cochrane, utilizando descriptores MESH relacionados con TOCE y dolor crónico. Se incluyeron ensayos clínicos aleatorizados publicados entre 2020 y 2024, con adultos ≥18 años, en portugués, inglés o español. La selección de estudios, la extracción de datos y la evaluación del riesgo de sesgo (herramienta RoB 2) fueron realizadas por revisores independientes. Resultados: Se seleccionaron siete estudios, realizados en diferentes países, todos en inglés. Todos los estudios demostraron una reducción significativa del dolor (EVA) y una mejoría funcional. Los protocolos con mayor frecuencia y menor intensidad energética mostraron resultados superiores a corto plazo. Solo un estudio informó efectos adversos leves y autolimitados. La mayoría de los estudios tuvieron un riesgo moderado de sesgo. Discusión: La terapia por ondas de choque extracorpóreas (TEC) ha demostrado su eficacia en diversas afecciones

musculoesqueléticas, destacando su seguridad y potencial analgésico. La heterogeneidad de los protocolos refuerza la necesidad de estandarización. Conclusión: La TEC es una terapia prometedora, segura y eficaz en el manejo del dolor osteoarticular crónico, y se recomienda como alternativa a los tratamientos convencionales.

Palabras clave: Dolor crónico. Terapia de ondas de choque extracorpóreas. Sistema musculoesquelético. Rehabilitación.

INTRODUCTION

Chronic pain is defined as pain that persists for a period of more than three months, and may persist even after the resolution of the initial lesion or be associated with chronic clinical conditions that trigger continuous or recurrent episodes of pain. This condition can be classified as primary, when there is no identifiable underlying disease, or as secondary, when it results from previous comorbidities or traumas (MOURA et al., 2025). In this scenario, chronic pain is a relevant public health problem on a global scale, affecting about 60 million people worldwide (AGUIAR et al., 2021). It is a multifactorial phenomenon, with physical, emotional and social components, which require a comprehensive and integrated approach by health teams.

Among the main causes of this prolonged and recurrent pain are osteoarticular diseases, often associated with the natural aging process, mechanical wear and tear, or autoimmune diseases. In addition, some joints that suffer greater impact throughout life are particularly susceptible, such as the shoulder, knee, and spine (SANTOS et al., 2022). Consequently, the persistence of pain significantly compromises the quality of life of individuals, making them more dependent to perform daily activities, especially in more severe cases (SANTOS KANEMATSU et al., 2022). This context reinforces the need for effective and accessible therapeutic strategies, aimed at pain reduction and functional recovery.

Therefore, the main objective of chronic pain management is to improve the quality of life of patients, employing therapeutic approaches that go beyond the use of drugs. Non-pharmacological interventions, such as physiotherapy and complementary therapies, including acupuncture, chiropractic, massage, and shockwave therapy, have been widely studied due to their analgesic potential and positive impact on the functionality of individuals (MENDONÇA et al., 2023). In this sense, the expansion of the use of these therapies shows a trend towards valuing less invasive resources that are more focused on the patient's integral well-being.

Currently, shockwave therapy has stood out as a promising approach in the treatment of chronic pain, because, in addition to being non-invasive, it demonstrates sustained long-term efficacy in the rehabilitation of patients. This method uses electromagnetic waves, classified as focused (F-SWT) and radial (R-SWT), which act by stimulating angiogenesis and neovascularization of bone structures and soft tissues. As a result, there is a reduction in inflammation, a decrease in edema, and an improvement in the flexibility of the connective tissue. Furthermore, studies indicate that therapeutic protocols of three to five sessions, performed weekly, promote a significant reduction in the

visual analog scale (VAS), evidencing their effectiveness in relieving pain (CHAVES et al., 2024).

Therefore, it is inferred that chronic osteoarticular pain, in addition to compromising the functionality of individuals, represents a serious public health problem, as it entails high costs for health systems. However, despite the investments, most of the therapies offered demonstrate limited efficacy, presenting minimal or even non-existent benefits. In addition, some of these approaches can be harmful, such as the indiscriminate use of opioids and excessive imaging tests (PADILHA et al., 2024). Given this scenario, it is essential to evaluate the effectiveness of non-invasive therapeutic methods, such as Shockwave Therapy, since studies prove their safety and benefits in the management of this condition.

METHODOLOGY

A systematic review of the literature was carried out, which analyzed the efficacy of extracorporeal shock wave therapy in the treatment of chronic osteoarticular pain.

PROTOCOL REGISTRATION

The present systematic review is based on the *Preferred* Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline, used in the development of systematic reviews and meta-analyses. A protocol was created in the International Prospective Register of Ongoing Systematic Reviews (PROSPERO), with a "CRD420251018962" record, where it is possible to view the entire methodology for the creation of the present review.

RESEARCH QUESTION

The research question was defined based on the PICO methodology: P (participant or patient) = Adult patients with chronic osteoarticular pain; I (intervention) = Extracorporeal Shock Wave Therapy; C (comparator) = Conventional treatment or placebo (if applicable); O (*outcomes*/outcomes) = Reduction in the frequency and intensity of osteoarticular pain and improvement in the quality of life of chronic patients. The problem situation of this research is based on the knowledge that chronic osteoarticular pain is a debilitating condition that affects millions of people worldwide, negatively impacting quality of life and limiting daily activities. Conventional treatments often do not provide lasting relief, leading to the need for more effective therapeutic alternatives. Extracorporeal Shockwave Therapy (ECTO) has been proposed as a promising approach, promoting analgesic and

regenerative effects in affected tissues. Therefore, is extracorporeal shockwave therapy effective in the treatment of chronic osteoarticular pain?

SOURCES OF INFORMATION AND SEARCH STRATEGIES

Data collection took place in March 2025. Two databases focused on the health area were used: PubMed and Cochrane. Based on the PICO methodology and the Medical Subject Headings Terms (MESH), a search strategy was developed in PubMed using the following terms: (("Extracorporeal Shockwave Therapy"[Mesh]) AND ("Chronic Pain"[Mesh] OR "Musculoskeletal Pain"[Mesh] OR "Low Back Pain"[Mesh] OR "Back Pain"[Mesh] OR "Arthralgia"[Mesh] OR "Fibromyalgia"[Mesh] OR "Pain Management"[Mesh])) AND "Treatment Outcome"[Mesh]. The search strategy was adapted according to the vocabulary controlled in each database.

SELECTION PROCESS, DATA COLLECTION AND ELIGIBILITY CRITERIA

The articles found in the databases were exported to the Rayyan® software for the screening process. At this stage, two reviewers working independently (Oliveira CHJ and Gomes LRL) selected the studies based on the title and abstract, and then on the full text. Conflicts between the two reviewers were resolved by a third author (Freitas APS). Screening was done according to the eligibility criteria.

The inclusion criteria were: (i) original studies (randomized clinical trials - RCTs); (ii) in Portuguese, English or Spanish; (iii) published from the year 2020; (iv) adult patients (≥18 years old) diagnosed with chronic osteoarticular pain. Articles were excluded that: (i) Observational studies; (ii) articles published outside the stipulated time period; (iii) reviews, abstracts, monographs, dissertations and theses; (iv) patients under 18 years of age; (v) studies combining TOCE with other therapies without isolated analysis of the effect of ESWT; (vi) studies without objective assessment of pain and osteoarticular function; (vii) Articles without access to the full text.

Data extraction and synthesis were performed by the reviewers independently, using a previously established data collection form. The characteristics extracted from the studies included: General data of the articles (title, author and year), sample, location of pain, pain intensity, measured through scales, frequency and duration of treatment, durability of pain relief after sessions and adverse effects of therapy.

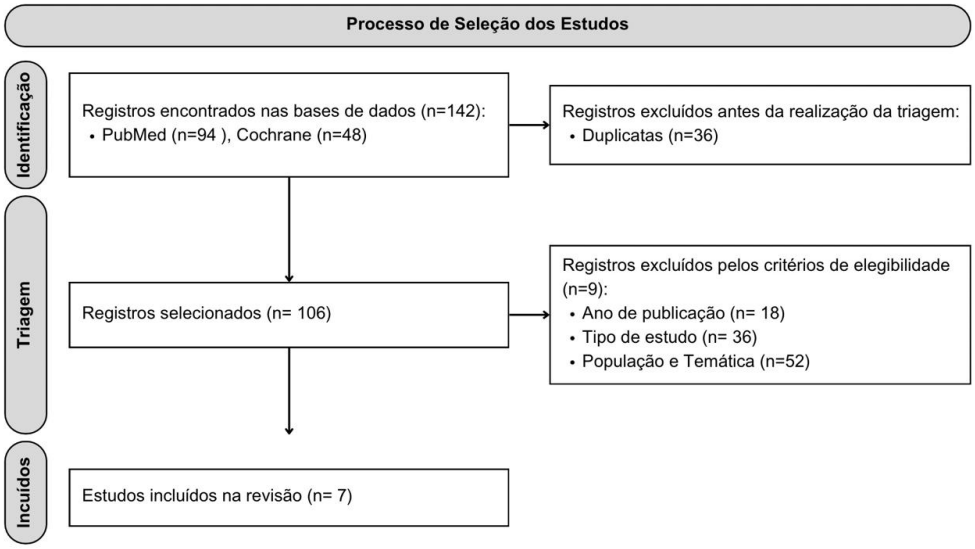
RISK OF BIAS ASSESSMENT

The quality of the selected studies was assessed using the Cochrane RoB 2 tool (revised tool for Risk of Bias in randomized trials). The tool allows a critical analysis of the review methodology, through the identification of possible methodological biases, analyzing the aspects: randomization process, intervention deviations, missed data, evaluation of results, selection of reported results, and overall risk. For each item, the risk of bias is classified as low risk, high risk, or moderate, ensuring greater reliability of the results presented.

RESULTS

A total of 142 articles were found in the databases. After the exclusion of 68 duplicates, the selection stage carried out by reading the title, abstract and full text, and according to the eligibility criteria, allowed the selection of 7 studies to compose the present review. The flowchart of the article selection process is illustrated in Figure 1.

Figure 1: Study selection process based on *the PRISMA* guideline.



Source: Authors, 2025

The selected research was developed mainly in Poland, with 2 articles (RAJFUR et al., 2022; WALEWICZ et al., 2019). The other countries studied were: China, Japan, Pakistan, and Turkey, each with 1 article (CHEN et al., 2022; YAN et al., 2020; HASHIMOTO et al., 2024; FATIMA et al., 2022; CIRCI et al., 2018). Regarding the language of publication, a prevalence of articles in English was found, with all 7 articles published in this language. Regarding the year of publication, the oldest study was published in 2018 (CIRCI et al., 2018) and the most recent was published in 2024 (HASHIMOTO et al., 2024).

The year with the highest number of publications was 2022, with a total of 2 papers (CHEN et al., 2022; FATIMA et al., 2022). The included studies are illustrated in Table 1.

Table 1 – Studies on the efficacy of Extracorporeal Shockwave Therapy (ECTO), Marabá, Pará, 2025

Author(s) and year	Study title	Sample	Objective of the study	Denouement
Rajfur et al., 2022	Efficacy of Focused Extracorporeal Shockwave Therapy in Chronic Low Back Pain: A Prospective Randomized Trial With 3-Month Follow-up	40 patients with discopathy	To evaluate the efficacy of focused TOCE in chronic low back pain	Reduction in pain (VAS: 7.2 → 1.5) after treatment, remaining at 2.0 after 3 months. No adverse effects.
Hashimoto et al., 2024	Extracorporeal Shockwave Therapy for Degenerative Meniscal Injuries	27 patients with meniscopathy	Assess pain relief and T2 relaxation time	Pain decreased from 3.4 → 1.2, remaining at 0.4 after 12 months. No adverse effects.
Fatima et al., 2022	Effects of High Energy Shockwave Therapy on Calcific Tendinopathy	40 patients with tendinopathy	Assess pain, function, and ultrasound imaging	Pain reduction (7.8 → 3.3 at 12 weeks). No adverse effects.
Chen et al., 2022	Comparison of TOCE Regimens in Chronic Low Back Pain	69 patients (34 LI, 35 MI)	Compare low and medium TOCE intensities	Group LI had greater pain reduction and functional improvement (ODI, HAS). No adverse effects.
Yan et al., 2020	TOCE for Chronic Achilles Tendinopathy	34 patients with tendinopathy	Compare long and short course of tendinopathy	Average pain reduction by 65%. Mild adverse effects (ecchymosis, numbness).
Circi et al., 2018	TOUCH in Subacromial Impingement Syndrome	30 patients (24 females, 6 males)	Assess pain and function in relation to acromion morphology	Reduction of SPADI pain scores (16.1 → 10.4), function, and total. No adverse effects.
Walewicz et al., 2019	Radial TOCE in Chronic Low Back Pain	40 patients (20 rESWT, 20 sham)	To evaluate the efficacy of radial TOCE	Reduction in VAS pain: 4.7 → 2.0 at 3 months in the rESWT group; In the SHAM group, pain increased. No adverse effects.

Source: The authors, 2025

The variables discussed among the articles analyzed were the type and location of pain, pain intensity before treatment, frequency and duration of treatment, treatment efficacy (pain intensity after treatment) and the main adverse effects of the use of Extracorporeal Shock Wave Therapy in the treatment of osteoarticular conditions with chronic pain. In general, the studies demonstrated significant improvement in pain intensity and functionality of patients, with a low rate of adverse effects and increasing evidence of clinical benefit in the short and medium term, as shown in Table 2.

Table 2 - Comparison of Studies on the Efficacy of Shockwave Therapy in Different Musculoskeletal Conditions. Marabá, Pará, 2025.

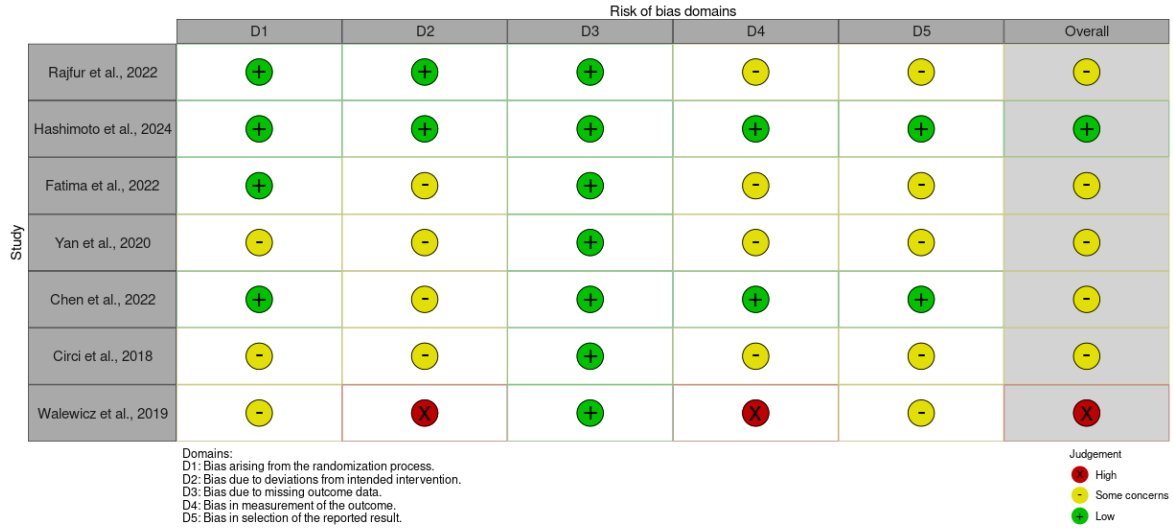
Study	Type of pain (location)	Pain intensity (VAS)	Frequency and duration of treatment	Therapeutic efficacy	Adverse effects
Rajfur et al., 2022	Chronic lumbosacral pain (L5-S1)	Mean of 7.2 (experimental) and 7.3 (control)	45-minute sessions, 5x/week for 5 weeks	VAS: 7.2 → 1.5 (experimental); 7.3 → 2.9 (control). Maintenance: 1.7 (1 month) and 2.0 (3 months) in the experimental group.	No adverse effects
Hashimoto et al., 2024	Chronic knee pain, degenerative injury of the medial posterior meniscus	Mean of 3.4 (experimental) and 4.3 (control)	3 sessions of 15-20 min, 1 per week	VAS: 3.4 → 1.2 (experimental); 4.3 → 4.1 (control). Pain maintained at 0.4 (experimental) after 12 months.	No adverse effects
Fatima et al., 2022	Chronic shoulder pain, calcific rotator cuff tendinopathy	Mean of 7.8 (experimental) and 7.9 (control)	12 sessions, 2x/week, for 6 weeks	Experimental: 7.8 → 5.0 (6 weeks) and 3.3 (12 weeks); Control: 7.9 → 6.0 (6 weeks) and 4.75 (12 weeks).	No adverse effects
Chen et al., 2022	Chronic low back pain (>12 weeks, no specific cause)	Significant reduction in the LI group (movement VAS, $p < 0.05$)	Group LI: 6 applications (3/week, 0.03 mJ/mm³, 4000 pulses); MI Group: 2 applications (1/week, 0.09 mJ/mm³, 4000 pulses), for 2 weeks	Significant pain reduction and functional improvement in the LI group (ODI and SAH)	No adverse effects
Yan et al., 2020	Chronic pain at Achilles tendon insertion	Average: 5.92 ± 1.12 (short course) and 5.87 ± 1.10 (long course)	1 session/week for 5 weeks	Average 65% reduction in pain in both groups after 3 months; no significant difference between courses ($p = 0.487$)	Ecchymosis and mild and transient numbness
Circi et al., 2018	Subacromial impingement syndrome (shoulder)	Pain reduction: 16.1 ± 5.1 → 10.4 ± 4.9 ($p < 0.001$). Function: 37.3 ± 19.8 → 26.7 ± 17.5 ($p < 0.001$). Total: 53.4 ± 24.5 → 37.1 ± 21.6 ($p < 0.001$).	3 sessions (1/week), 1500 pulses/session (0.12 mJ/mm²)	Improvement maintained at 12 weeks	No adverse effects
Walewicz et al., 2019	Chronic low back pain (non-radicular, pseudo-radicular)	EVA: 4.7 (pre); 4.4 (immediate post); 2.7 (1 month); 2.0 (3 months)	10 sessions: 2/week, 2000 pulses; 2.5 bars; 5 Hz; 7 min/session	Significant reduction maintained after 3 months; SHAM Group returned to 4.4 points	No adverse effects

Source: The authors, 2025

The risk of bias in randomized trials is shown in Figure 2. Most studies showed moderate risk of bias. Only 1 study had an overall dominance with a high risk of bias

(WALEWICZ et al., 2019). The criteria for the critical review were based on a practical guide for assessing the risks of bias in systematic reviews (STERNE et al., 2019). At this stage, two reviewers worked independently, and the conflicts were resolved by a third person. None of the studies evaluated with high risk of bias were excluded because they showed limitations related to this project.

Figure 2. Assessment of risk of bias by study included in the systematic review using the Rob tool. 2 Cochrane. Marabá, Pará, 2025



Source: The authors, 2025

The studies included in this systematic review evaluated the application of Extracorporeal Shock Wave Therapy (OCT) in different types of chronic musculoskeletal pain, all quantified using the Visual Analogue Scale (VAS). Rajfur et al. (2022) investigated chronic lumbosacral pain associated with L5-S1 discopathy, with an initial mean VAS score of 7.2 in the experimental group. Similarly, Chen et al. (2022) analyzed chronic nonspecific low back pain and observed significant relief of pain on movement, especially in the group that received a low-intensity protocol. Hashimoto et al. (2024) evaluated knee pain due to degenerative injury of the medial meniscus, with an initial mean VAS score of 3.4 in the experimental group. Regarding shoulder pain, Fatima et al. (2022) studied patients with calcified rotator cuff tendinopathy, whose average initial pain was 7.8 points in the VAS. Similarly, Circi et al. (2018) investigated subacromial impingement syndrome. In addition, Yan et al. (2020) addressed pain in the Achilles tendon region, with averages of 5.9 and 5.8 in the VAS for the short and long duration of symptoms groups, respectively. Finally, Walewicz et al. (2019) also looked at chronic non-specific low back pain, with initial pain scores ranging between 6 and 8 on the VAS.

Regarding the frequency and duration of treatment, relevant differences were observed between the studies, reflecting the diversity of protocols used. Rajfur et al. (2022) applied 45-minute sessions, five times a week for five weeks, always accompanied by stabilization exercises. In turn, Hashimoto et al. (2024) opted for three sessions of 15 to 20 minutes, with weekly application. Fatima et al. (2022) conducted 12 TOCE sessions over six weeks, with two applications per week. In the study by Chen et al. (2022), patients in the low-intensity group received six sessions (three per week), while the medium-intensity group performed only two sessions over two weeks. Yan et al. (2020), in turn, administered a weekly session for five weeks. The other studies included also showed similar variations, such as three weekly sessions (CIRCI et al., 2018) or five single sessions applied over five weeks (WALEWICZ et al., 2019).

Overall, all studies reported significant reduction in pain after treatment with TOCE. Rajfur et al. (2022) observed a drop in the mean VAS score from 7.2 to 1.5 in the experimental group, while in the control group the reduction was from 7.3 to 2.9. Hashimoto et al. (2024) found an improvement from 3.4 to 1.2 in VAS after treatment. Fatima et al. (2022) reported a reduction from 7.8 to 5.0 after six weeks, and to 3.3 after 12 weeks of follow-up. The study by Chen et al. (2022) pointed out that, although both groups improved, the group submitted to low application intensity showed superiority in pain reduction up to six weeks, although this difference was not maintained at three months. Yan et al. (2020) identified that patients with shorter symptom time had better functional outcomes, although pain measured by VAS decreased in both groups. It is important to highlight that, among the studies analyzed, none reported significant adverse effects related to the use of TOCE. Only Yan et al. (2020) mentioned mild and self-limiting effects, such as ecchymosis and local discomfort, which did not require treatment interruption or additional intervention.

DISCUSSION

The present study evaluated the efficacy of extracorporeal shockwave therapy in the treatment of chronic osteoarticular pain.

LOCATION AND TYPE OF PAIN

Extracorporeal shock wave therapy (OCT) has been widely studied in the treatment of tendinopathies and other chronic musculoskeletal disorders, with increasing evidence of its clinical efficacy. Thus, when comparing different studies, it is observed that there is a common tendency for improvement in pain and functional capacity of patients, even though

the results may be influenced by factors such as the site of application, the intensity of waves, the frequency of sessions, and the duration of symptoms.

In the study by Yan et al. (2020), for example, TOCE was applied to patients with chronic Achilles tendon tendinopathy, comparing groups with short-term (3 to 6 months) and long-term (>6 months) pain, in which both achieved improvement in pain and function, assessed by VAS and AOFAS, although the group with more recent symptoms had better functional performance. Thus, the study suggests that the chronicity of pain can interfere with the magnitude of therapeutic results. However, this conclusion is in line with what was pointed out by Stanias et al. (2019), who indicate the duration of tendinopathy as a limiting factor for the success of OCT, due to more resistant biological changes in chronically injured tissues.

On the other hand, Fatima et al. (2022), when treating patients with calcified rotator cuff tendinopathy using high-energy TOCE (0.32 mJ/mm², 120 Hz, 2000 pulses), reported a significant reduction in pain and improved function and quality of life compared to the control group that received only conventional physical therapy. Unlike Yan et al. (2020), pain duration was not a comparison variable, however, the improvement was also accompanied by favorable structural changes observed by ultrasound, which corroborates the morphological effects already described by Notarnicola et al (2017), reinforcing the regenerative mechanisms attributed to OCT.

Regarding subacromial impingement syndrome, Circi et al. (2018) showed that the application of TOCE was effective in reducing pain (SPADI), regardless of the anatomical type of acromion. Therefore, this result contrasts with the classical biomechanical hypothesis that certain acromion morphologies, such as type 3, would be associated with worse prognosis. Therefore, the idea that the action of TOCE can overcome predisposing anatomical barriers is reinforced, possibly due to its anti-inflammatory and tissue stimulation effects, also highlighted by Wang et al. (2012), who reported the induction of angiogenic and osteogenic factors with the use of the technique.

In the joint context, a clinical study with 27 patients explored the application of TOCE in the treatment of knee osteoarthritis, using focal waves of 0.25 mJ/mm² in three sessions. In this scenario, the results showed a significant reduction of T2 relaxation time on MRI, as well as pain relief, suggesting chondroprotective effects (HASHIMOTO et al., 2024). Such effects are in line with what had already been observed in animal models by Zhang et al (2022), who demonstrated cartilaginous regeneration and stimulation of the extracellular matrix after application of TOCE.

With regard to chronic low back pain, in a study carried out in Poland, focused extracorporeal shock wave therapy (0.15 mJ/mm², 1000 pulses, 4 Hz) associated with stabilization exercises was applied. In this approach, the combination therapy showed significant improvement in pain (VAS and LPS) and functionality (ODI), with maintenance of effects for up to three months (RAJFUR et al., 2022). Comparatively, the study by Chen et al. (2022) evaluated different intensities and distributions of therapeutic energy: a low-intensity protocol (0.03 mJ/mm² in 6 sessions) and a medium-intensity protocol (0.09 mJ/mm² in 2 sessions). Thus, both presented positive effects, but the low-intensity protocol with more frequent sessions demonstrated greater efficacy in the short term. Thus, this finding reinforces what was previously discussed by studies cited in the article itself (WANG et al., apud CHEN et al., 2022), which suggest that the higher frequency of stimuli can promote greater cell activation and tissue remodeling, even with a lower energy load per session.

PAIN INTENSITY (VAS): BEFORE AND AFTER TREATMENT

In the study conducted by Rajfur et al. (2022), the therapy was applied to patients with chronic low back pain, combining TOCE with spinal stabilization exercises. As a result, a significant reduction in pain intensity was observed, with VAS scores decreasing from 7.2 to 1.5 in the experimental group. In contrast, the control group, which performed only the exercises, showed a more modest reduction, from 7.3 to 2.9. Similarly, Stania et al. (2020), in a comparative study, found that the association between shockwave therapy and kinesiotherapy promoted a more significant reduction in low back pain levels when compared to the isolated application of kinesiotherapy, reinforcing the benefits of the combined approach in the management of chronic pain.

Chen et al. (2021) demonstrated that low-intensity protocols (0.03 mJ/mm²), applied in six sessions, were more effective in reducing chronic low back pain than medium-intensity protocols (0.09 mJ/mm²) administered in only two sessions, even though both had the same total energy dose. Specifically, there was a decrease in VAS from 6.8 to 2.4 in the low-intensity group, while patients in the medium-intensity group showed less significant improvement. Thus, these findings suggest that the higher frequency of application, even with lower intensity per session, can potentiate the therapeutic effects of OCT. Corroborating this idea, Walewicz et al. (2019) also highlighted the relevance of energy distribution over time, associating this strategy with more effective pain modulation and better clinical outcomes.

In cases of tendinopathies, Yan et al. (2020) demonstrated that the application of TOCE resulted in a significant reduction in pain both in patients with short-term pain (3 to 6 months) and in those with more prolonged pain (over 6 months), with the mean VAS decreasing from 6.6 to 2.2. Comparably, Fatima et al. (2021) reported a reduction in VAS from 7.1 to 2.0 in patients with calcified rotator cuff tendinopathy undergoing high-energy TOCE, associated with gains in functionality and quality of life. In addition, the study showed positive structural changes in the ultrasound examination, reinforcing the superiority of the intervention in relation to conventional physical therapy. Thus, both studies point to the effectiveness of TOCE, with emphasis on its clinical and structural benefits.

In joint conditions, such as knee osteoarthritis, Hashimoto et al. (2024) observed a reduction in VAS from 6.9 to 3.1 after three sessions of TOCE, evidencing its anti-inflammatory and chondroprotective effects. These findings corroborate the results of Zhao et al. (2017), who also reported significant improvement in pain and joint function with therapy. Similarly, Circi et al. (2016) found a decrease in VAS from 6.1 to 2.5 in patients with subacromial impingement syndrome, regardless of acromion morphology, which reinforces that the efficacy of TOCE is not restricted by predisposing structural changes. Thus, the studies converge in demonstrating the applicability of TOCE both in joint disorders and in musculoskeletal conditions with associated anatomical factors.

PARAMETERS FOR THE APPLICATION OF TOCE

Regarding the application parameters used, such as intensity, frequency, number of pulses and sessions, and intervals between applications, considerable heterogeneity was observed in the protocols employed. Regarding the intensity of application, the studies analyzed demonstrate a significant variation in the energy parameters. Chen et al. (2021) directly compared low-intensity (0.03 mJ/mm²) versus medium-intensity (0.09 mJ/mm²) protocols in the treatment of chronic low back pain while maintaining the same total energy dose. The results indicated superiority of the low-intensity protocol with a higher number of sessions (6 sessions in 2 weeks) compared to the medium-intensity protocol with a lower number of sessions (2 sessions in 2 weeks), suggesting that the distribution of energy over time may be more relevant than the intensity alone. On the other hand, the study by Fatima et al. (2021) used a high-energy protocol (0.32 mJ/mm²) in the treatment of calcified rotator cuff tendinopathies, with significantly superior results compared to conventional physical therapy.

Corroborating the findings of Chen et al. (2021), a recent meta-analysis involving patients with chronic low back pain also showed that protocols with lower energy intensity

(0.03 to 0.1 mJ/mm²), but applied with greater frequency and number of sessions, tend to produce better clinical outcomes in pain reduction and functional improvement, when compared to more intense applications with less frequency. These data reinforce the hypothesis that the distribution of energy over time, with repeated and less aggressive stimuli, can more efficiently modulate pain relief mechanisms (LIU et al., 2023). In a similar sense, a study with patients undergoing treatment for plantar fasciitis comparing different frequencies (10 vs. 15 Hz) with the same number of sessions demonstrated that both regimens promoted significant improvement, suggesting that flexibility in the parameters can be effective, as long as constancy and total volume of energy applied are maintained (KALBANI et al., 2024). These findings support the need for individualization of protocols, considering not only the intensity alone, but also their balance with the frequency and duration of treatment.

Regarding the number of pulses per session, in 3 of the 7 studies relative consistency was observed, with values predominantly between 1000 and 2000 pulses. Rajfur et al. (2022) applied 1000 pulses at 4 Hz to the lumbar and sacral region, while Hashimoto et al. (2024) used 2000 impulses in the treatment of degenerative meniscal tears. The application frequency also varied, with values between 4 Hz and 120 Hz, and lower frequencies are generally associated with higher intensity applications.

In a comparative study, a systematic review on TOCE for orthopedic conditions highlighted that among the randomized controlled trials analyzed, the average number of impulses per session ranged from 250 to 6000, with an average of approximately 2029 impulses. The frequency of the sessions ranged from 1 to 42 days, with a mean interval of 9.13 days between sessions. These data reinforce the lack of consensus on the ideal application parameters, highlighting the need for further research to determine optimized protocols (SCHIMITZ et al., 2015). Therefore, the variability in TOCE protocols, especially with regard to the number of pulses per session and the frequency of application, highlights the importance of further studies to establish standardized guidelines that maximize treatment efficacy.

The optimal number of sessions and intervals between applications represent another crucial aspect of TOCE protocols. In the study by Yan et al. (2020) compared short versus long treatment courses in patients with Achilles tendon tendinopathy, noting that both protocols resulted in significant improvement of clinical parameters, although with differences in satisfaction rates and recovery time. In the clinical trial with patients with calcified rotator cuff tendinopathy, a protocol of 12 sessions distributed over 6 weeks (2 sessions/week) for calcified tendinopathies was adopted, while 3 sessions with a weekly

break for the treatment of meniscal injuries were chosen (FATIMA et al., 2024; HASHIMOTO et al., 2024)

Under this bias, Schmitz et al. (2015) suggest that an ideal TOCE protocol consists of three weekly sessions, with 2000 impulses per session and the highest energy flux density tolerable by the patient. In addition, a study conducted with patients diagnosed with symptomatic calcifying tendinopathy demonstrated that an individualized rESWT protocol, tailored according to the patient's response, resulted in a 92% success rate after one year, with an average of 7 sessions. These findings indicate that both personalization and proper distribution of sessions can be crucial for treatment effectiveness, underscoring the need for flexible protocols that are adaptable to individual patient needs (MALLIAROPOULOS et al., 2017).

ADVERSE EFFECTS OF TOCE

Regarding adverse effects, TOCE is generally considered a safe therapeutic modality, with a low incidence of significant complications, with only 1 of the 7 articles presenting side effects after use. The study by Schimitz et al., (2015) reinforced this perspective, highlighting that, among the randomized controlled trials evaluated, there were no reports of serious adverse events related to OCD. The adverse reactions observed were generally mild, such as transient discomfort, skin erythema, and localized swelling.In addition, a multicenter study involving 272 patients treated with TOCE for lateral epicondylitis recorded mild adverse effects such as transient redness of the skin (21.1%), pain (4.8%), and minor bruising (3.0%). Rarer events included migraine and syncope, but no physical parameter of shock waves could be definitively identified as a cause of these effects (SILVA, COSTA, SILVA, 2024). The low incidence of adverse effects in TOCE can be attributed to several factors, including the controlled application of energy, the precise focusing of shock waves, and the absence of the need for invasive procedures. These characteristics make TOCE a safe and effective therapeutic option for various musculoskeletal conditions (LIU et al., 2023).

However, from the methodological point of view, the studies analyzed have limitations that should be considered when interpreting the results. One of the main limitations of the present study was the selection of studies evaluated with low risk of bias, most of which presented moderate risk. In addition, the heterogeneity of treatment protocols represents another significant limitation in the current literature on OCD. As previously discussed, the studies analyzed show considerable variability in application parameters, including intensity, frequency, number of pulses, number of sessions, and intervals between

applications. This heterogeneity makes it difficult to directly compare studies and establish universal guidelines for clinical practice. In addition, the absence of adequate placebo groups in some studies also represents a relevant methodological limitation. Finally, the variability in the outcome measures used in the different studies makes it difficult to quantitatively synthesize the results and perform robust meta-analyses. Although instruments such as the VAS pain scale and specific functional questionnaires are frequently used, the heterogeneity in the evaluation times and in the definition of therapeutic success limits the comparability between studies.

In addition, it is suggested that more studies be carried out that prioritize the standardization of treatment protocols, since the variability observed in the application parameters makes it difficult to compare studies and establish clear guidelines. The durability of the therapeutic effects of TOCE, especially in long-term treatments, also deserves further investigation, as well as the identification of predictors of therapeutic response, which could optimize treatment personalization. Finally, cost-effectiveness studies that consider the impact of TOCE on quality of life and the use of health resources could provide crucial information to support clinical decisions and health policies.

CONCLUSION

The present systematic review shows that Extracorporeal Shock Wave Therapy (ECOT) represents a promising and effective therapeutic alternative in the management of chronic osteoarticular pain, with benefits observed in different anatomical regions, such as the shoulder, knee, lumbar spine and Achilles tendon. The included studies consistently demonstrated a significant reduction in pain measured by the Visual Analogue Scale (VAS), functional improvement, and a low incidence of relevant adverse effects, reinforcing the safety profile of the method.

Despite the heterogeneity between the protocols used — with regard to wave intensity, number of sessions, and specific clinical conditions — the clinical efficacy of TOCE remained evident in most of the studies analyzed. In addition, factors such as the duration of symptoms, the type of condition treated, and the association with therapeutic exercises seem to positively influence clinical outcomes.

Therefore, although larger-scale randomized clinical trials and standardization of application protocols are still needed, the findings of this review contribute to the consolidation of TOCE as a non-invasive, safe, and effective intervention in the context of musculoskeletal rehabilitation, with significant impacts on the quality of life of patients affected by chronic pain.

REFERENCES

1. Aguiar, Débora Pinheiro Et Al. Prevalence Of Chronic Pain In Brazil: A Systematic Review. Brjp, São Paulo, V. 4, P. 257–267, Out. 2021.

2. Chaves, Camila Teixeira De Oliveira Penna Et Al. Evaluation Of The Efficacy Of Shock Waves In The Treatment Of Lateral Epicondylitis. Revista Delos, Rio De Janeiro, V. 17, N. 61, P. E2546, Jan. 2024.

3. Chen, Y. Et Al. Comparison Of Different Intensities Of Extracorporeal Shock Wave Therapy For Chronic Low Back Pain: A Randomized Controlled Trial. Pain Physician, Florida, Vol. 25, No. 8, P. E1211–E1218, Nov. 2022.

4. Circi, E. Et Al. The Effectiveness Of Extracorporeal Shockwave Treatment In Subacromial Impingement Syndrome And Its Relation With Acromion Morphology. Acta Orthopaedica Et Traumatologica Turcica, Istanbul, V. 51, N. 5, P. 393–397, Out. 2017. Available At: Https://Doi.Org/10.1016/J.Aott.2017.08.002. Accessed On: May 13, 2025.

5. Fatima, A. Et Al. Effects Of Extracorporeal High-Energy Shockwave Therapy On Pain, Functional Disability, Quality Of Life, And Sonographic Changes In Patients With Calcified Rotator Cuff Tendinopathy. Biomed Research International, Cairo, V. 2022, P. 1230857, Ago. 2022. Available At: Https://Doi.Org/10.1155/2022/1230857. Accessed On: May 13, 2025.

6. Hashimoto, S. Et Al. Extracorporeal Shockwave Therapy For Degenerative Meniscal Tears Results In A Decreased T2 Relaxation Time And Pain Relief: An Exploratory Randomized Clinical Trial. Knee Surgery, Sports Traumatology, Arthroscopy, Heidelberg, V. 32, P. 3141–3150, Jan. 2024. Available At: Https://Doi.Org/10.1002/Ksa.12384. Accessed On: May 13, 2025.

7. Kalbani, F. A. L. Et Al. Comparison Between Two Shockwave Therapy Protocols For Patients With Plantar Fasciitis: A Pilot Study. Plos One, San Francisco, V. 19, N. 5, P. E0302553, May 2024. Available At: Https://Doi.Org/10.1371/Journal.Pone.0302553. Accessed On: May 13, 2025.

8. Liu, K.; Zhang, Q.; Chen, L. Et Al. Efficacy And Safety Of Extracorporeal Shock Wave Therapy In Chronic Low Back Pain: A Systematic Review And Meta-Analysis Of 632 Patients. Journal Of Orthopaedic Surgery And Research, London, V. 18, P. 455, Set. 2023. Available At: Https://Doi.Org/10.1186/S13018-023-03943-X. Accessed On: May 13, 2025.

9. Malliaropoulos, N. Et Al. Individualized Radial Extracorporeal Shock Wave Therapy (Reswt) For Symptomatic Calcified Tendinopathy Of The Shoulder: A Retrospective Clinical Study. Bmc Musculoskeletal Disorders, London, V. 18, P. 513, Nov. 2017. Available At: Https://Doi.Org/10.1186/S12891-017-1873-X. Accessed On: May 13, 2025.

10. Mendonça, J. Et Al. Multidisciplinary Approaches To The Management Of Chronic Pain: A Review Of Integrative Therapies And Chronic Pain Management Strategies, Including Medications, Physical Therapy, And Alternative Therapies. Brazilian Journal Of Implantology And Health Sciences, São Paulo, V. 5, N. 5, P. 129–144, Dez. 2023.

11. Moura, Ana Laura Guimarães Et Al. Approach To Chronic Pain In Primary Care: A Review. Revista Contemporânea, Belo Horizonte, V. 4, N. 10, P. E5992, Mar. 2024.

12. Notarnicola, A.; Moretti, B. Extracorporeal Shockwave Therapy (Eswt) In Achilles Tendinopathy. British Medical Bulletin, Oxford, V. 124, N. 1, P. 83–95, June 2017. Available At: Https://Doi.Org/10.1093/Bmb/Ldx009. Accessed On: May 13, 2025.

13. Padilha, Grasiele Correa De Melo Et Al. Multidisciplinary Treatment Program For Pain And Disability Improvement Associated With Chronic Nonspecific Low Back Pain. Brjp, São Paulo, V. 7, P. E20240005, Jan. 2024.

14. Rajfur, K. Et Al. Efficacy Of Focused Extracorporeal Shockwave Therapy In Chronic Low Back Pain: A Prospective Randomized 3-Month Follow-Up Study. Medical Science Monitor, New York, V. 28, P. E936614, Ago. 2022. Available At: Https://Doi.Org/10.12659/Msm.936614. Accessed On: May 13, 2025.

15. Santos, Patricia Souza Et Al. Repercussions Of The Posture Group For Older Adults With Osteoarticular Diseases: An Experience In The Family Health Strategy. Brazilian Journal Of Development, Curitiba, V. 7, N. 5, P. 52483–52487, May 2021.

16. Santos Kanematsu, Jaqueline Dos Et Al. Impact Of Pain On The Quality Of Life Of Patients With Chronic Pain. Revista De Medicina, São Paulo, V. 101, N. 3, P. 1–9, Set. 2022.

17. Schmitz, C. Et Al. Efficacy And Safety Of Extracorporeal Shock Wave Therapy For Orthopedic Conditions: A Systematic Review On Studies Listed In The Pedro Database. British Medical Bulletin, Oxford, V. 116, N. 1, P. 115–138, Mar. 2015. Available At: Https://Doi.Org/10.1093/Bmb/Ldv047. Accessed On: May 13, 2025.

18. Silva, Beatriz Augusta; Costa, Raquel Alves Da; Silva, Ariane Émily Da. Side Effects Of Extracorporeal Shockwave Therapy (Eswt) In The Treatment Of Tennis Elbow. British Journal Of One Health, London, V. 1, N. 2, P. 50–56, Fev. 2024. Available At:Https://Www.Researchgate.Net/Publication/387680596 . Accessed On: May 13, 2025.

19. Stania, M. Et Al. Extracorporeal Shock Wave Therapy For Achilles Tendinopathy. Biomed Research International, Cairo, V. 2019, P. 3086910, Out. 2019. Available At: Https://Doi.Org/10.1155/2019/3086910. Accessed On: May 13, 2025.

20. Sterne, J. A. C. Et Al. Rob 2: A Revised Tool For Assessing Risk Of Bias In Randomised Trials. Bmj, London, V. 366, P. L4898, Ago. 2019. Available At: Https://Doi.Org/10.1136/Bmj.L4898. Accessed On: May 13, 2025.

21. Walewicz, K. Et Al. Effect Of Radial Extracorporeal Shock Wave Therapy On Pain Intensity, Functional Efficiency, And Postural Control Parameters In Patients With Chronic Low Back Pain: A Randomized Clinical Trial. Journal Of Clinical Medicine, Basel, V. 8, N. 9, P. 1376, Set. 2019. Available At: Https://Doi.Org/10.3390/Jcm8091376. Accessed On: May 13, 2025.

22. Wang, C. J. Et Al. Extracorporeal Shockwave Therapy In Musculoskeletal Disorders. Journal Of Orthopaedic Surgery And Research, London, V. 7, Art. 11, Mar. 2012. Available At: Https://Doi.Org/10.1186/1749-799x-7-11. Accessed On: May 13, 2025.

23. Yan, B. Et Al. Extracorporeal Shock Wave Therapy For Patients With Long- Or Short-Course Chronic Achilles Tendinopathy. Biomed Research International, Cairo, V. 2020, P. 7525096, Dec. 2020. 2020. Available At:Https://Doi.Org/10.1155/2020/7525096 . Accessed On: May 13, 2025.

24. Zhang, Y. Et Al. Biological Response Of Extracorporeal Shock Wave Therapy To Tendinopathy In Vivo: Review. Frontiers In Veterinary Science, Lausanne, V. 9, 2022. Available At: Https://Doi.Org/10.3389/Fvets.2022.851894. Accessed On: May 13, 2025.