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Effect of extracorporeal shock waves on neuromuscular junctions versus carpal tunnel syndrome: A narrative review

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Abstract--Objective:to determine effectiveness of using extracorporeal shockwave therapy (ESWT) directly on the NMJ versus using it on injuries that exert pressure on the nerve such as (CTS). Background: The nervous system can be affected by many conditions and disorders that can disrupt its normal functioning and transmission of impulses, such as the destruction of neuromuscular junctions or pressure on nerves, such as carpal tunnel syndrome. Methods: The review was carried out by searching scientifically recognized medical databases, including PubMed, Scopus, Biomed, National Library of Medicine, Science direct library, Sage Journals and Spinger Link. Date restrictions were not applied. Conclusion: Preliminary research on extracorporeal shockwave therapy for carpal tunnel syndrome has shown encouraging results, leading to recommendations for its potential use as a treatment modality. However, the current literature examining shockwave therapy for neuromuscular junction dysfunction is limited. Further studies through high-quality human trials are still needed.

Keywords--low shockwave in nerve regeneration, shockwave in nerve regeneration, shockwave in nerve transmission, shock wave on neuromuscular junction, ESWT, shock wave.

Introduction

The nervous system is a complex network of cells and tissues that coordinates and regulates the activities of the body. It is responsible for receiving sensory information from the environment, processing and integrating that information, and generating appropriate responses. The nervous system consists of two main parts: the central nervous system (CNS) and the peripheral nervous system (PNS). [1]. The nervous system can be affected by many conditions and disorders that can disrupt its normal functioning and transmission of impulses [2], such as the destruction of neuromuscular junctions [3] or pressure on nerves, such as carpal tunnel syndrome. [4][5]

The neuromuscular junction (NMJ) is a specialized synapse formed between a motor neuron and a skeletal muscle fiber. [6] It is a crucial connection that allows for the transmission of electrical impulses from the nervous system to the muscle, leading to muscle contraction. [7]. Carpal tunnel syndrome (CTS) is a condition that involves compression or irritation of the median nerve as it passes through the carpal tunnel in the wrist. It often leads to symptoms such as pain, numbness, tingling, and weakness in the hand and fingers. [8] Shockwave therapy, also known as extracorporeal shockwave therapy (ESWT), is a medical treatment that involves the use of acoustic waves to deliver mechanical energy to tissues in the body. [9] It has been used for various therapeutic purposes, including the treatment of musculoskeletal conditions, such as tendinopathies, plantar fasciitis, and non-healing fractures. [10]

Aim of the study

In this narrative review, our primary focus was to collect relevant studies that examined the effects of shockwave therapy on the neuromuscular junction (NMJ) and carpal tunnel syndrome (CTS). Specifically, we aimed to compare the outcomes of using extracorporeal shockwave therapy (ESWT) directly on the NMJ versus using it on injuries that exert pressure on the nerve such as (CTS).

Material and Methods

The review was carried out by searching the scientifically recognized medical databases:

- PubMed Database.
- Scopus Database.
- Biomed Database.
- National Library of Medicine Database.
- Science direct library Database.
- Sage Journals Database.
- Springer Link Database.

After an initial search of the literature, the following search keywords were used: (low shockwave in nerve regeneration) and (shockwave in nerve regeneration without low) and (ESWT or shock wave) and (shockwave in nerve transmission) and (shock wave on neuromuscular junction). During the literature search no

date restrictions were applied. Articles written in a language other than English were excluded.

Criteria for considering studies for this review

Trials on humans and rats were included with English language and no time restriction.

Criteria for exclusion studies for this review

- Studies does not focus on effect of extracorporeal shockwave
- Studies does not focus on effect of extracorporeal shockwave
- Articles written in a language other than English were excluded

Results

As a result, a total of 1926 papers were identified. According to inclusion and exclusion criteria, 19 articles were finally screened. In total, 7 eligible (2 focused on effect of extracorporeal shockwave therapy on NMJ, and 5 focused on effect of extracorporeal shockwave therapy on CTS)

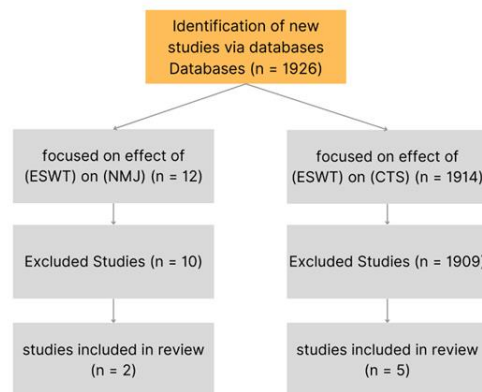


Figure 1. Flow graph represents the number of studies included in the review

Table 1
Represents the characteristics of studies focused on effect of (ESWT) on (CTS)

Study Name	Number of participants	Parameters	Findings	Number of sessions/durations
(R. Gholam et al., 2017) [11]	40	-	low-energy shock waves may represent an effective and non-invasive treatment in cases of nerve compression	-

(Vahdatpour et al., 2016) [12]	60	0.05, 0.07, 0.1, and 0.15 energy and shock numbers 800, 900, 1000, and 1100	It is recommended to use ESWT as a conservative treatment in patients with CTS	one session per week for 4 weeks
(Xu. Dingli et al., 2020) [13]	30	1000 shocks, 1.5 bar of pressure and a frequency of 6 Hz	ESWT is a useful noninvasive short-term treatment for mild to moderate carpal tunnel syndrome and elicits a better recovery	nine and 12-week
(P. Atthakomolet et al., 2018) [14]	13	4 Bar, 15 Hz frequency, 5000 shocks, BTL-6000 SWT, radial shockwave mode	single-dose radial extracorporeal shockwave therapy (rESWT) is appropriate for treatment of mild to moderate CTS	24 weeks
(UM. Rashad et al., 2020) [15]	60	2000 shocks at energy flux density (EFD) of 0.03 mJ/mm ² and 1.6 bar	It is recommended to use ESWT as a conservative treatment in patients with different severities of CTS, except patients with severe motor affection	one session per week for 6 weeks

(R. Gholam et al., 2017) [11] applied on (40) patients and showed that low-energy shock waves may represent an effective and non-invasive treatment in cases of nerve compression and It is recommended to use ESWT as a conservative treatment in patients with CTS. (Vahdatpour et al., 2016) [12] applied on (40) patients with parameters: 0.05, 0.07, 0.1, and 0.15 energy and shock numbers 800, 900, 1000, and 1100 and shows that it is recommended to use ESWT as a conservative treatment in patients with CTS. (Xu. Dingli et al., 2020) [13] applied on (30) patients with parameters: 1000 shocks, 1.5 bar of pressure and a frequency of 6 Hz and shows that ESWT is a useful noninvasive short-term treatment for mild to moderate carpal tunnel syndrome and elicits a better recovery.

(P. Atthakomole et al., 2018) [14] applied on (13) patients with parameters: 4 Bar, 15 Hz frequency, 5000 shocks, BTL-6000 SWT, radial shockwave mode and shows single-dose rESWT is appropriate for treatment of mild to moderate CTS.

(UM. Rashad et al., 2020) [15] applied on (60) patients with parameters: 2000 shocks at energy flux density (EFD) of 0.03 mJ/mm² and 1.6 bar and shows that it is recommended to use ESWT as a conservative treatment in patients with different severities of CTS, except patients with severe motor affection.

Table 2
Represents the characteristics of studies focused on effect of (ESWT) on (NMJ)

Study Name	Number of participants	Parameters	Findings	Number of sessions/durations
(T. Kenmoku et al., 2012) [16]	-	2,000 shock wave impulses at an energy flux density of 0.18 mJ/mm ²	The application of shock waves to muscle induced a transient dysfunction of nerve conduction at neuromuscular junctions	8 weeks
T. Kenmoku et al., 2018) [17]	20 rats	2,000 rESWs at 0.18 mJ/mm ² and a frequency of 15 Hz	there was no significant difference in compound muscle action potential (CMAP) latency between control and ESW-exposed muscles on the day of rESW application	-

(UM. Rashad et al., 2020) [16] applied on rats with parameters: 2,000 shock wave impulses at an energy flux density of 0.18 mJ/mm² and shows that the application of shock waves to muscle induced a transient dysfunction of nerve conduction at neuromuscular junctions. (T. Kenmoku et al., 2018) [17] applied on (20) rats with parameters: 2,000 shock wave impulses at an energy flux density of 0.18 mJ/mm² and a frequency of 15 Hz and shows that there was no significant difference in compound muscle action potential (CMAP) latency between control and ESW-exposed muscles on the day of rESW application.

Discussion

In general, the existing literature on the application of extracorporeal shockwave therapy for carpal tunnel syndrome (CTS) has demonstrated promising outcomes, particularly in studies involving human subjects. These studies have shown a notable interest in utilizing shockwave therapy as a potential treatment modality for CTS, with some studies even recommending its use. Conversely, limited research has been conducted on the use of extracorporeal shockwave therapy for

the neuromuscular junction (NMJ). The available studies in this area have predominantly focused on animal models, particularly rats. These studies have reported instances of transient dysfunction within the NMJ of rats following shockwave therapy. Consequently, based on the current body of evidence, the complete adoption of shockwave therapy for NMJ-related conditions is not recommended. It is important to note that further research is necessary to comprehensively evaluate the efficacy and safety of shockwave therapy for both CTS and NMJ-related conditions. Additional studies involving human subjects and a more extensive exploration of the underlying mechanisms are required to ascertain the full potential and limitations of shockwave therapy in these contexts.

Conclusions

Preliminary research on extracorporeal shockwave therapy for carpal tunnel syndrome has shown encouraging results, leading to recommendations for its potential use as a treatment modality. However, the current literature examining shockwave therapy for neuromuscular junction dysfunction is limited, with existing animal studies reporting possible transient issues. Further studies through high-quality human trials are still needed to fully characterize the therapeutic effects and safety profile of shockwave therapy for both carpal tunnel syndrome and neuromuscular junction-related conditions. While early findings for carpal tunnel treatment are promising, more research across contexts is warranted before widespread clinical implementation of this therapy.

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