How to Read Radial Pressure Wave and Shock Wave Scientific Literature Without Perishing in the Attempt

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Abstract

Publications on shock wave therapy have experienced exponential growth since the beginning of the 21st century. While this has had a positive effect by providing a wealth of information, it has also generated confusion and misunderstandings. It is essential that readers be aware of the significant discrepancies and serious errors, even within the basic sciences related to this therapeutic tool.

In a literature review, we discuss examples of the most frequent errors.

Critical reading is the surest way to avoid adopting false concepts.

Keywords: Shock wave; Radial pressure waves; Literature review; Critical reading

Introduction

Mark Twain warned his readers to be cautious when making decisions based on health-related texts because they risked dying from a printing error [1]. As is often the case, the exaggerated irony of the famous author exposes a truth: Those of us who regularly read scientific publications are exposed to receiving inadequate or incorrect information.

At first glance, Twain's statement, made over 100 years ago, may seem out of place in an era of evidence-based medicine and peer review. However, he was not the only one to think this way, and more recent voices agree with his point of view. Richard Horton, editor of The Lancet, stated that 50% of published data was impossible to verify [2]. The title of McCann's publication is very explicit: "Don't believe everything you read, especially in medicine and wine (fake news)" [3]. Many have begun to increasingly question the reliability of what was believed to be one of the most important human creations, science.

Does this situation apply to the literature related to radial pressure waves and focused shock waves? Our hypothesis is that the field of mechanical waves applied to medical treatment is not exempt from this problem. This study discusses the findings of a literature review in search of the most frequent errors in publications related to the topic.

Material and Methods

Two independent observers with experience in the field of shock waves conducted a literature search including the words "shock + wave" in PubMed. Studies related to basic sciences and musculoskeletal applications were selected. The result yielded 8500 studies between 1987 and June 2025.

An analysis was performed to identify incorrect information, including possible errors, inadequate concepts, and misprintings. The findings were classified as errors in basic concepts, inclusion/exclusion criteria, treatment protocol, printing errors, and even unfounded accusations.

1-Basic concepts: The original sin:

Every branch of science is based on concrete and verifiable principles. Confusion or inaccuracies at this foundational level can lead to conceptual mistakes or worse still, to errors in practice.

The definition of a shock wave is very clear in the field of physics [4-7]. However, in certain situations, this definition has been used arbitrarily, extending it to other technologies that are not physically shock waves. The first reference we find in the literature is in a paper published in 2002 in which radial pressure waves are described as generated by a "ballistic source of shock waves" [8]. This is a misstatement, as radial waves do not possess the physical characteristics of shock waves. Unfortunately, as Loske clearly describes, "these misunderstandings have been passed down through the years, compromising clinical outcomes, limiting the reproducibility of treatment protocols, and hindering the optimization of therapeutic methodologies [7].

A simple example of the hundreds of misunderstandings that exist in

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the literature are two studies by Modena et al. [9, 10]. In articles published in 2021 and 2024, the authors studied the biological response in integumentary tissue after treatment with radial pressure wave therapy (RPWT); however, they describe the effects as generated by extracorporeal shockwave wave therapy (ESWT). The physical properties of RPWT and ESWT vary substantially, and thus the mechanistic effects on the integumentary system cannot be extrapolated this simply [4, 6, 7].

This error can only be noticed by reading the application parameters in the materials and methods section and requires a deeper understanding of shock waves to begin with. This confusion leads to a translocation of scientific evidence between the two types of treatment, generating false evidence.

Remarkably, even today, there are authors who defend the description of radial pressure waves as shock waves, persisting in a historical error.

In an excellent study on recommendations for the use of shock waves in sports medicine, with the participation of world experts seeking consensus, 4 out of 41 survey participants (9.8%) were still against ceasing to call radial waves as shock waves [11].

In some cases, the confusion has reached such an extreme that, for example, diagrams of a radial wave device as generating focused shock waves have been published [12]. This publication led to an open letter to the Editor highlighting the varying physical properties between RPWT and ESWT and urging better clarity and accountability in scientific literature [13].

In some cases, devices that do not meet the characteristics of shock waves generators have been described as shock wave sources. One example is the study published by Seco et al. [14]. The authors conducted a review that included 13 studies comparing the effect of transcutaneous electrical nerve stimulation with shock waves for the treatment of low back pain. They describe the effect of a treatment device that they consider to be shockwave therapy, but in reality, it did not meet any of the characteristics of a shockwave generator [15].

Foundational errors such as this have a trickle-through effect throughout literature and can cause discrepancies that limit the reliability of large systematic reviews or meta-analyses, two study designs that many consider to be of the highest scrutiny.

2-Methodology: Inclusion/exclusion criteria:

Those who administer shockwave therapy are not always experts in the pathology they are treating. This is a common situation when a method expands rapidly and has a low complication rate, which often leads to its inappropriate or excessive use, sometimes treating only symptoms and not a specific diagnosis.

In a letter to the Editor, Müller-Ehrenberg et al. [16] criticize the inclusion of patients with Achilles tendinopathies for shockwave therapy without performing complementary imaging studies that would rule out lesions and calcifications in a study by Lynen et al. [17].

Ramon et al. [18] criticize the inclusion/exclusion criteria of a study by Frizziero et al. [19], in which it is not clear whether partial tears and calcifications smaller than one centimeter were excluded in the treatment of a series of patients with rotator cuff tendinopaties.

In a study that compared the results of radial pressure waves with a supervised exercise program, Engebretsen et al. [20] included patients with "subacromial pain syndrome" as a study group. This definition is highly debatable since it can include anything from rotator cuff tendinopathy to tumor metastasis in the subacromial space [21]. The diagnostic criterion used by the authors was the finding of dysfunction or pain on abduction, normal passive glenohumeral range of motion, pain on two of three isometric tests (abduction at 0° or 30°, external or internal rotation), and a positive Hawkins-Kennedy sign [20]. A case of tumor metastasis in the subacromial space could meet these conditions. They admit to having included patients with rotator cuff rupture if they met the above criteria [20], which is another inclusion error.

The same authors make a very common mistake when conducting experimental studies on rotator cuff tendinopathies: The accepted age for inclusion was between 18 and 70 years [20]. This leads to the inclusion of completely different pathologies, since in young people the most frequent issue is underlying glenohumeral instability, while in older individuals it is tendon tissue degeneration.

Self-proclaimed "evidence-based medicine" is not always a guarantee of good inclusion criteria. Surace et al. [22] in a systematic review discussed the results of "shock wave therapy" in "rotator cuff disease" with or without calcification, with a similar misleading approach. Authors include as a study sample two differentiate clinical conditions, calcified and non-calcified tendinopathies of the rotator cuff, which have in common their anatomical location only. While a calcification settles by definition in a rotator cuff with regenerative capacities, non-calcified tendinopathy is a degenerative and progressive condition. As has been said, "it is like trying to compare the outcomes of treatments for pneumonia with lung cancer simply because both diseases are located in the lungs" [23].

3-Methodology: Treatment protocol:

The dose used during the application of focused shock waves and radial pressure waves has a great influence on the therapeutic outcome [24].

One of the main criticisms that have been made of the application of shock waves and radial pressure waves is the lack of uniformity in therapeutic protocols [6, 25, 26]. While it is very difficult to achieve uniform protocols due to the different types of generators and the variety of equipment models, there are basic principles that should be respected.

A very common mistake is to consider the treatment dose with radial waves expressed in bar; in reality, the pressure level in bar reflects the pressure inside the equipment's compressor and not the energy dose transmitted and administered to the patient.

Furthermore, the different devices have a different relationship between the internal pressure in the compressor (in bars) and the dose of energy administered.

This error is so widespread in practice and literature that the list of references would be endless. Another key factor in mechanical wave therapy is the type of equipment used. We have already established that radial waves are physically distinct from focused waves. However, there are also different focused shock wave generators (electrohydraulic, electromagnetic, or piezoelectric), and the effects of the generated focused waves are usually different according to the device [4-6]. The size of the focus and the energy level obtained determine that the results are not necessarily comparable [4-6].

In a multicenter study considered to be classic and foundational in the world of shock waves [27], the results of high-energy and low-energy

shock waves with sham treatment are compared in patients with rotator cuff calcifications. The authors mention utilizing "Extracorporeal Shockwave Treatment (ESWT)" without providing further details on the devices. It is difficult to completely rule out the use of radial pressure waves, as the lead author erroneously defined radial waves as shock waves in another study [8].

Even if readers assume that all equipment used in this study generated focused shock waves, it is unclear whether the equipment used at all centers employed the same type of generator (electrohydraulic, electromagnetic, or piezoelectric). It has always been said that the "Methods" section should be like a recipe that any other researcher can follow to replicate the experiment, but this study fails by not identifying the type of generator used.

A similar omission is found in the study by Kim et al. [28]. The authors intend to compare the effectiveness of ultrasound-guided needling with "extracorporeal shockwave treatment" in rotator cuff calcifications. They are very detailed in describing the puncture technique, but there is no information regarding the ESWT device or the physical parameters used [29]. It is unclear whether radial waves or focused waves were used. This is one of the most serious problems in literature stemming from that fateful decision to name radial waves as "shock waves" and the persistence of that error in many publications.

Furthermore, the authors report having applied the treatment at the point of maximum tenderness instead of focusing it on the area of the rotator cuff calcification; this is another serious flaw in this study. In the previously mentioned study by Frizziero [19], the same error is made: The application of the waves is performed in the area of greatest pain, which does not necessarily coincide with the location of the calcification. Standard recommendations stress focusing the application of shock waves on the calcific deposit [16].

In addition, the authors prescribed anti-inflammatory drugs for 7 days after the procedure, which may alter the mechanisms of action of shock waves in the inflammatory pathways, altering or possibly decreasing their effectiveness [30, 31].

In the area of application parameters, relying on evidence-based medicine studies is also not guarantee. Buchbinder et al. [32] published a literature review in which they analyze the results of the use of "shockwaves" in cases of lateral elbow pain. They included nine studies with more than 1000 cases. Their conclusions were that there was "Platinum" level evidence that shock wave therapy provided little or no benefit in terms of pain and function in lateral elbow pain. However, Rompe and Maffulli [33] conducted an in-depth methodological analysis of the studies included in the Buchbinder review. They found methodological errors in most of them related to the treatment protocol, such as prior application of anesthesia, insufficient doses, and complementary use of corticosteroids. The conclusion was that the information on which the meta-analysis study was based was inappropriate. This again further highlights how errors at the foundational level of research, many of which have stemmed from the incorrect generalization of radial pressure waves as true shockwave waves or a lack of understanding the procedural application of ESWT, can propagate through the literature and create false information at the level of a systematic review.

4-Printing errors

Printing errors are, of course, situations overlooked by authors and editors, but they are frequently present. None of us is exempt from this possibility of error, and perhaps some readers will find errors of this type in this very article.

In a randomized controlled trial, Mashaly and El Shiwi [34], when describing the treatment protocol, state that the dose per session was 21,000 shocks, which is clearly a printing error.

In the study already described by Kim et al. [28], the treatment doses written in the abstract do not match those in the main body of the article [29].

Sometimes, probably due to linguistic reasons, confusion arises. An example is the paper by Acar [35] in which the "rotator cuff" is called "rotator calf".

In a publication by Chan et al. [36] regarding calcifying tendinitis of the rotator cuff with cortical bone erosion, reference is made in the text to Fig. 3 and 4, but only Figs. 1 and 2 are published.

5- Unfounded accusations

All medical procedures are prone to complications, and shock waves are not the exception [37]. However, in some publications, secondary effects not clearly proven are attributed to the method through acts of correlation rather than true causation.

This is largely due to the belief that shock waves act at the musculoskeletal level as they do on kidney stones, causing a purely mechanical effect. A typical example is illustrated in a study on therapeutic options for the management of plantar fasciopathies refractory to conservative treatment, where the authors state that shock waves act through the production of micro-tears [38]. In this way, the phenomenon of mechanotransduction and the enormous number of biological responses determined by the mechanical stimulus are not acknowledged [6, 39].

This type of unfounded claim that falsifies the true mechanisms of action of ESWT can make it even easier for additional assumptions and extrapolations. Lin et al. [40] reported a case of spontaneous rupture of the Achilles tendon with a history of shockwave therapy, to which they attribute the injury. The authors state that risk factors for Achilles tendon rupture include previous surgery, steroid injection into the Achilles tendon, and possibly prolonged use of non-steroidal anti-inflammatory drug. The patient described presented all of these risk factors, yet the injury was attributed to shockwave therapy simply because the patient had received just one low-energy session 2 months prior [38]. Along the same line, a paper by Argyropoulou et al. [41] attributes the Achilles tendon injury to the application of shock waves. Beyond the fact that the study is riddled with conceptual and nomenclature errors, it ignores the natural evolution of Achilles tendinopathy, which is characterized by a high frequency of spontaneous rupture.

Perhaps the monument to the worst study in this line is that of Han et al. [42]. This study is riddled with inaccuracies, erroneous references, and misinterpretations, which are analyzed in an open letter to the Editor published by a group of international experts [43].

Conclusion

In this manuscript, we hope to clarify that radial pressure waves are mechanistically and physically distinct sound waves from true shock waves (focused shockwaves or ESWT). We have presented only a few examples of the studies present in the literature that can lead to an

unsuspecting reader to severe confusion in the interpretation of the basic concepts, the mechanisms of action, and therapeutic effects of shock waves. The application of critical thinking will be the responsibility of each reader.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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