Errors in Shock Wave Theory Can Impact Clinical Outcomes

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Abstract

The mechanical waves that are used therapeutically are well defined from the point of view of physics. The differences between focused and radial waves are very important, however there is enormous confusion in the literature.

In the present bibliographic analysis we make a critical comment on a publication in which a pneumatic source is illustrated and presented as generating focused shock waves.

We believe that every effort should be made to be strict in definitions, not only because science is based on the search for truth, but also because errors in shock wave theory can impact clinical outcomes.

Commented article: "Extracorporeal shockwave treatment in knee osteoarthritis: Therapeutic effects and possible mechanism" [1] published in Bioscience Reports, Volume 40, Issue 11.

We appreciate the citation of our previous study by the authors [2]. However, we would like to clarify a point to prevent any confusion regarding the physics of shock waves.

In the article by An et al., there is a figure (Fig. 1) that shows a diagram of a pneumatic radial pressure wave source and an image showing the pressure variation produced by a focused shock wave, as emitted by other types of generators; however, the figure caption reads: "Illustrations of ESWT generated by radial pressure wave source (A) and its characteristics (B)".

Two types of pressure waves are used in ESWT—focused shock waves and radial pressure waves (RPWs), which are often referred to as radial shock waves [2], although strictly speaking radial devices generate RPWs, not shock waves [3].

The characteristics of these waves differ significantly (Fig. 1). Unlike focused shock wave generators that produce true shock

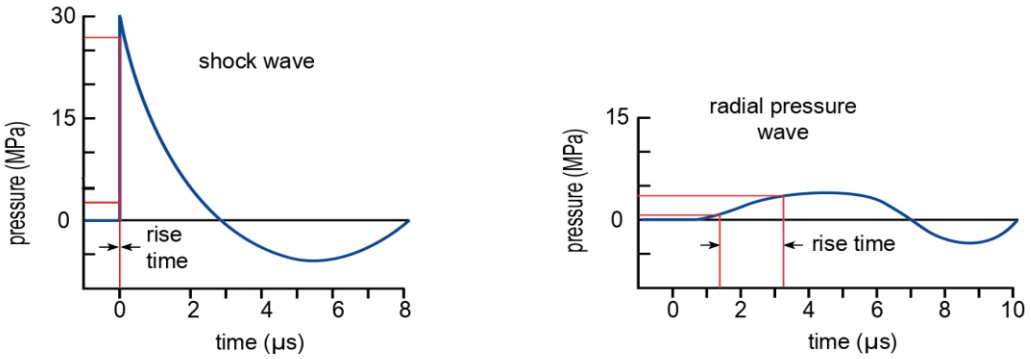

Figure 1: Differences in pressure waveforms between a shock wave and a radial pressure wave. The rise time is defined as the time taken for the positive pressure to rise from 10 to 90% of its maximum value.

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waves at the focus, radial "shock wave" generators emit "ordinary" acoustic waves [4] with peak pressures of up to 30 MPa and much higher rise times of up to 3 μs [5]. RPWs has a much longer rise time and a lower peak pressure than shock waves.

Unlike focused shock wave sources, ballistic therapy heads produce the highest pressure and energy flux density at the surface of the applicator, which decreases rapidly as the penetration depth increases, because the energy is not focused on a treatment target zone. Consequently, deep tissues are difficult or impossible to be efficiently treated with RPWs.

Because bioeffects are related to the pressure waveform, the therapeutic effects of RPWs may differ from those of focused shock waves [3].

Errors like the one noted here arise because even in user manuals of medical equipment and publications of clinical trial results, the term 'shock wave' is used instead of 'radial pressure wave', confusing the user.

The current consensus of the International Society for Medical Shockwave Treatment [6] and the Ibero-American Shock Wave and Tissue Engineering Federation (Onlat) [7] advocates the use of clear terminology to avoid confusion. Good clinical results are only obtained by understanding the characteristics of the used pressure field. Even the level of risk of focused generators is different from that of radial ones [7, 8].

Finally, we wish to draw attention to the references, because our study is cited twice (references 24 and 47).

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

Conflicts of Interest: Nil. **Source of Support:** None.

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