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THE USE OF PIEZOELECTRIC SHOCKWAVE THERAPY IN THE TREATMENT OF BODY DISHARMONY AND TISSUE FLACIDITY: A CASE STUDY

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INTRODUCTION

Currently, shock waves have been used more and more with emphasis on body aesthetic treatments, due to their mechanism of tissue mechanical stimulation and increased cellular activity, as well as to other inflammatory cytokines and due to their potent recalcitrant action on calcified deposits and dense tissues and fibroses. The objective of this case study was to verify the comparative tissue response of Piezoelectric Shockwave Therapy (TOC), at different frequencies of pulse cuts in the treatment of body disharmony and in the treatment of tissue flaccidity.

HISTORY

The discovery of the piezoelectric effect was fundamental for the development of ultrasound and currently for the advancement of shock wave technologies. Discovered by Pierre and Jacques Currie in 1880, it consists of a physical phenomenon of certain crystals that are capable of producing electric fields from mechanical compressions, that is, transforming mechanical energy into electrical energy and its reverse, electrical into mechanical 8. When crystals piezoelectric crystals were subjected to mechanical loads generated electrical charges on their surface, and the reverse is also true, applying electrical charges to the surface of piezoelectric crystals produced deformations in the crystals [4,5.]

Sound waves are generated by ultrasonic transducers, also simply called transducers or heads. Generally speaking, a transducer is a device that converts one type of energy into another, in this case electrical energy into mechanical energy. These transducers have piezoelectric materials in their constitution. The piezoelectric material to be used as a transducer must be precisely designed and constructed to reach its maximum vibration in front of an electric field and, therefore, promote changes in its thickness. These changes generate movements on the face of the crystal, originating sound waves at the same frequency as the current.[15]

A shock wave is essentially a pressure disturbance that propagates rapidly through a medium. It can be defined as a compression wave of great amplitude, such as that produced by an explosion or by the supersonic movement of a body in a medium. Obvious examples of shock waves are the "ultrasonic boom" of an aircraft, thunder, or the sound after an explosion. Simply put, a shock wave is an acoustic wave capable of transmitting energy to a medium, which differentiates it from an ultrasound. (Figure 01).

Shock waves were initially employed as a non-invasive treatment for kidney stones since the early 1970s and have become a first-line intervention for such conditions. In the animal experimentation process associated with this work, it was identified that the shock waves could have an (initially adverse) effect on the bone.[8] This led to a series of experimental investigations looking at the effect of shockwaves on bone, cartilage and associated soft tissues (tendon, ligament, fascia) resulting in what is now becoming an increasingly popular intervention, especially for recalcitrant injuries to these tissues, although clinical uses are expanding and now include wound management, fracture treatment, and numerous additional applications. The use of shockwaves to treat bone problems was researched in the early 1980s. In the early 1990s, some periodical reports and conferences began to appear where shockwaves began to be used to deal with soft tissue problems, more commonly calcific tendonitis, and then for a variety of other long-term problems in the tendon, ligaments and similar tissues.4 Currently,

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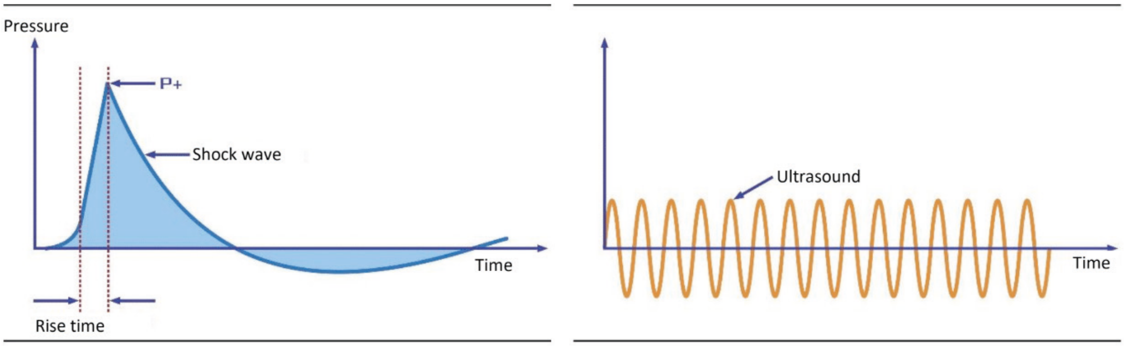

Figure 01 - Comparative scheme of propagation of shock waves x ultrasound in the medium.

Figure 02 - Photo documentation of the clinical evolution before and after the 3 sessions of MAXISHAPE PSW.

shock waves have been used more and more with emphasis on body aesthetic treatments, due to their tissue mechanical stimulation mechanism, increased local blood flow for increased cellular activity - release of substance P, prostaglandin E2, NO, TGFβ, VEGF and other inflammatory cytokines and for its potent recalcitrant action on calcified deposits and dense tissues and fibrosis. [12,13]

The treatment has several names, the most popular being SHOCKWAVE THERAPY or EXTRACORPORAL SHOCKWAVE THERAPY, although there are several variations, which are often linked to the names of particular machines. Some have recently suggested that the therapeutic version of shock wave treatment could usefully be called RADIAL SHOCKWAVE THERAPY, to distinguish the wave nature from the focused versions employed in other parts of medical practice.[6,8,9.]

PHYSIOLOGICAL EFFECTS AND MECHANISM OF ACTION

Shock waves can be associated with different types of emission sources such as: an electro-hydraulic system, an electromagnetic system or a piezoelectric system. The electro-hydraulic principle refers to high energy acoustic waves generated by underwater explosion with spark discharge from high voltage electrode. These waves are focused with an elliptical reflector and directed towards the area that needs repair in order to produce a therapeutic effect. The electromagnetic principle involves electric current passing through a coil to produce a strong magnetic field, a lens is used to focus the waves, and its focal point is defined by the length of the lens. [1,3]

The piezoelectric principle involves a large number of piezocrystals mounted in a sphere, usually larger than a thousand crystals, and receiving a rapid electrical discharge that induces a pressure pulse in the surrounding water slope for a shock wave. The combination of crystals causes the waves to self-focus towards the target tissue and lead to extremely precise, high-energy centering within a defined focal volume. Thus, the piezoelectric equipment promotes energy focusing, so that if applied to the subcutaneous tissue, it is believed that this stimulus would promote a response at the level of adipose tissue, which would favor metabolic alterations in this tissue.17,18 Focused waves are called "intense or hard" shock waves, and deliver their energy at a focal point, while the radial or dispersive wave are called "light or soft" shock waves, which admit a specific acting area. [14,15]

The shock wave causes direct effects as well as "indirect" effects associated with the subsequent low-pressure part of the cycle (often also referred to as the rarefaction phase), and during this phase ultrasonic cavitation will occur. The collapse of these cavitations (blisters) is, at least in part, responsible for the effectiveness of the therapy. The waves are focused to achieve the effects in a zone of tissue limited by volume, although the focus does not reach a "spot" in therapy devices, but as a zone or small volume typically several millimeters in diameter, and so the effects destructive ones are eliminated. No evidence of tissue destructive effects at therapeutic doses.[19]

As the shock wave travels through a medium and reaches an interface, part of the wave will be reflected and part transmitted. Some of the effects relate to an increase in local blood flow that was clearly evident even in relatively avascular tissues. It is suggested that the beneficial effects are due, in part, to the stimulation of an inflammatory response, therefore increasing tissue repair responses, which is especially relevant when dealing with recalcitrant tissues, such as some chronic and non-bonded tendinopathies. [1,12,13]

One of the strongest arguments for the use of shock waves in therapy is that it effectively takes tissue from a more chronic state to a more acute state, and in doing so, provides a stimulus (trigger) for a "stuck" repair sequence. ". This is consistent with other approaches employed in therapy – such as some manual therapies (for example: transverse rubs), some exercise-based approaches (for example: eccentric loading) and some electrotherapy interventions (for example: ultracavitation or laser treatments). The most strongly established treatment effects on shockwave therapy levels are by ranges of their energy content and, although there is some controversy, it is generally accepted, according to Watson: LOW (up to 0.08mJ/mm2) – anti-inflammatory effects. – inflammatory and regenerative (inflammatory and postoperative cellulitis.); MEDIUM (up to 0.28mJ / mm2) – harmful and destructive effect (sagging - collagen induction); HIGH (more than 0.6mJ / mm2) - harmful and destructive effect (adiposity – lipolysis). [10, 11, 12]

Shock waves trigger a cascade of effects, which begin with the application of physical energy in the form of acoustic waves and, ultimately, lead to the neoformation of vessels and the improvement of metabolic activity through various physiological mechanisms. As for the number of pulses to be used, there is no predetermined specific number of pulses. However, according to some studies, the application of piezoelectric shock waves with an average variation applied between 1500 and 2000 pulses, cause positive effects in the treated tissues. [7, 9, 10]

Some current studies relate evidence that shock waves can be used as a safe form of therapy and can be indicated to approach skin rejuvenation and sagging.5, 6 Observing the beneficial effects of acoustic waves on oxidative stress and products of lipid oxidation, an indirect increase in antioxidants was noted. However, the positive effects of reducing oxidative stress and increasing antioxidants, including ascorbic acid (vitamin C) on collagen biosynthesis, have been directly demonstrated in some studies with the use of Shockwaves.[4,8]

MATERIALS AND METHODS

Three (3) sessions were performed with weekly intervals of Piezoelectric Shock Waves, with the MAXISHAPE equipment from Bioset ® Indústria de Tecnologia Eletrônica, in the trochanteric region on the left side, carrier frequency 38Khz, pulse cut of 5Hz and 20Hz on the left side left and right side 20Hz and both with 12W output power. The sensory limits of the volunteer were respected during the application, exposed area of the quadrant of 10 x 15 cm (150 cm2) for a period of time of 10 minutes, with the transducer in motion. Data were recorded with the Iphone 6 ® Camera (Apple Inc.) of 3264x2448 pixels and a thermographic camera model FLIR ONE®, at a distance of 1.20 m, with a black background of matte material and at room temperature ± 27º C (figure 03), adipometer and measuring tape from the RMC® brand. The female volunteer, 37 years old, nulliparous, denies hormone treatments or medications, normal BMI, with localized trochanteric lipodystrophy, associated with a flaccid component, reports physical activity 3 to 4 times a week, denies previous aesthetic treatments. The study was carried out in the scientific research department of the company ``Bioset Bioequipamentos``, in the city of Rio Claro - SP, from March to April 2019. Measurements were taken with the volunteer in an orthostatic position and plyometrics was based on the average of the values obtained in the three measurements and were performed by the same evaluator. After the interview, no contraindications were found that would prevent the volunteer from receiving the treatment and after verifying the absence of the exclusion criteria, the volunteer was informed of the purpose of the study and agreed to the research's free and informed consent form (TCLE).

RESULTS AND DISCUSSION

According to this case study and through the images collected by photodocumentation and photothermography and local perimetry, it was possible to verify that there was a decrease in the aspect of localized lipodystrophy and aspect of tissue flaccidity in the trochanteric region. (table 01).

Evaluation and Measurement of Measures	D1	D7	D15
Trochanteric Circumference Below the gluteal fold (left side)	52 cm	51 cm	50,5 cm
Trochanteric Circumference Below the gluteal fold (right side)	52,5 cm	52,0cm	52,0 cm
Adipometry (left side)	24,0mm	20,0 mm	20,0mm
Adipometry (right side)	24,0 mm	24,0 mm	24,0 mm

Table 01 - Anthropometric data of the volunteer.

In this study, a slight decrease in anthropometric data (perimetry) was observed in relation to the loss of fat volume (adipometry) in the trochanteric region, which can be related to the fact that the volunteer initially had a flaccid component and the left side was treated with waves of shock with pulse cutting frequency at 5Hz, while the right side was treated with pulse cutting frequency at 20Hz; therefore, in the evaluation of the photos, a considerable symmetric alteration of the latero-gluteal region was observed, which is related to a reduction in the body perimeter measurement.

The result suggests that the unilateral

application at cut-off frequencies of different pulses has promoted the reduction of this measure. Associated with this answer, body weight measurements were not verified, since the treated volunteer was informed to maintain her body weight during the three weeks of the experiment and to continue her life habits and physical activity in the same previous conditions, only this corroborates the objective of the study, which was to identify only changes in localized adiposity. (figure 02)

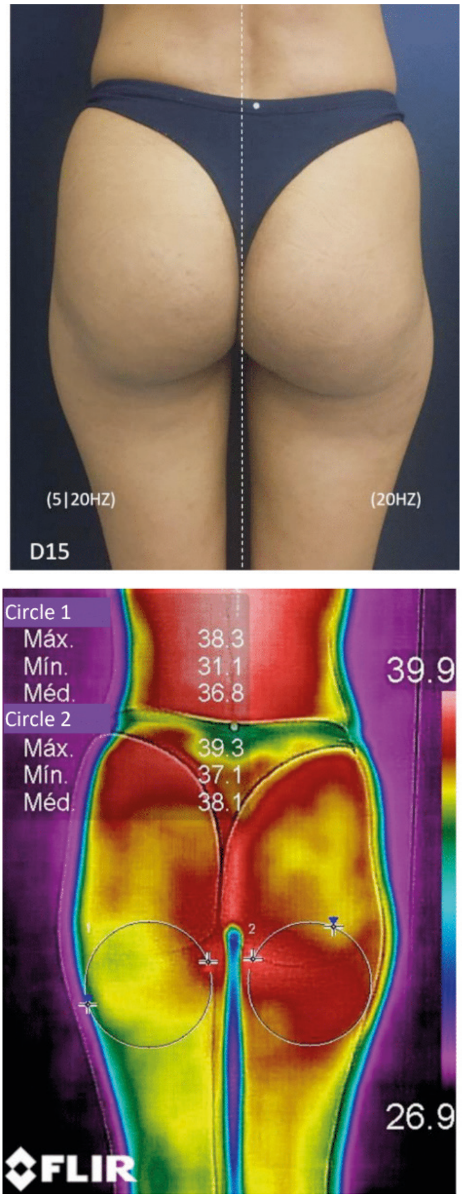

Figure 02- photothermography of the clinical evolution after the 3 sessions of MAXISHAPE PSW performed on the left side.

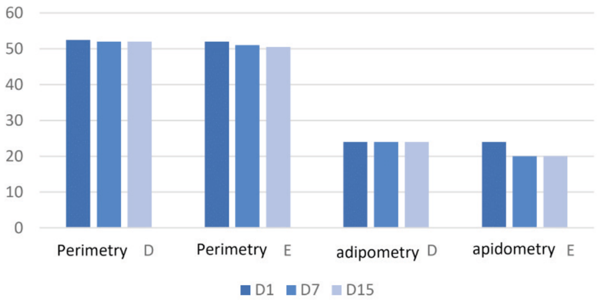

Table 02 - Comparative results of anthropometric findings.

CONCLUSION

Piezoelectric shock wave therapy with the equipment model and therapeutic dose chosen in this study, promoted a greater reduction in the volume of fat in the trochanteric region on the left side and on the right side a visible improvement in tissue tone and demonstrating asymmetric images of photothermography, which also suggest and demonstrate the same. Therefore, it is suggested that higher frequency pulse cutting cycles (20Hz) promote a more intense and selective acoustic disturbance in adipose tissue, whereas lower cycles (5Hz) seem to interfere with connective tissue and collagen, corroborating with Watson's theory of dose-effect relationship in the treatment of body disharmony.

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