SHOCKWAVE THERAPY TO TREAT CELLULITE

Pablo Naranjo García discusses cellulite treatment of a unique instance with high energy radial shockwave therapy from Zimmer MedizinSysteme (Z*Wave*®).

ABSTRACT

In this case study of a unique instance, the effects of non-invasive generated shockwaves onto the skin and the underlying fat tissue of a cellulite-afflicted, 52-year-old woman were investigated. The treatment was applied at the lateral thighs once per week for a period of 10 weeks. Diagnostic high-resolution ultrasound (Esaote 25 Gold® device with 15–18 MHz linear probe), thermography (Thermo-Cell) and photography (Canon® camera) were performed before and after treatment. Changes to the subcutaneous fat were demonstrated using ultrasonography and thermography.

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Zimmer MedizinSysteme

CELLULITE IS A common topographical alteration in which the skin acquires an orange-peel or mattress appearance. In this condition, alterations occur to the adipose tissue and microcirculation that result from blood and lymphatic disturbances causing fibrosclerosis of the connective tissue. It is considered a non-inflammatory, degenerative phenomenon that provokes alterations to the hypodermis producing irregular undulations on the skin overlying affected areas.

Cellulite is certainly not a serious condition from the medical point of view, but it does represent the most widespread and least tolerated aesthetic complaint among women. The condition is well-known as a result of intense publicity campaigns in the mass media and cosmetics industry, targeted at increasing the market for cosmetic creams, electro-medical equipment, and therapeutic fantasies that often lack a scientific basis, although they do sometimes improve the aesthetic aspect of the problem. A few treatments supported by some evidence are available today, such as mechanical therapy with suction, bipolar radiofrequency, carboxytherapy, mesotherapy, and recommendation of exercise and weight-loss, for example. Shockwaves applied locally to the skin with cellulite may be an effective non-invasive therapy combined with any of the other treatments.

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High Energy Radial Shockwave Therapy (HERST)

Shockwaves transmit mechanical energy from the place of generation to distant areas. They display a single, mainly positive pressure pulse of large amplitude that is followed by comparatively small tensile wave components[1]. When using shockwaves for therapy, effects that make the pressure pulse even steeper as a result of non-linearities in the propagation medium, as well as phenomena such as refraction and diffraction at acoustic interfaces, must be taken into consideration. The fact that shockwaves selectively effect acoustical interfaces (connecting two media, each with a different density; e.g. oil/water) and pass through homogenous elastic tissue without damage to the majority of the area is medically important. Unfocused extracorporeal shockwaves radially spread with an energy flow density per pulse smaller than 0.1 mJ/mm^2 [2,3], which decrease the power by one third for every centimeter that penetrates into the tissue.

Biological effects of HERST

The stimulating effect of defocused extracorporeal-generated shockwaves on biological processes within the tissues reached has increasingly become the centre of interest over the last few years. The biological mechanism of action after a shockwave is still unknown to a large extent. Biological reactions of liberation of different agents (measured by immunohistochemistry) such as vascular endothelial growth factor (VEGF), endothelial nitric oxide synthase (ENOS), and proliferating cell nuclear antigen (PCNA) have been reported[4,5].

On the subcellular level, the damages are the increase of permeability of the cell membrane[6], lesions of the cytoskeleton[7], and changes to the mitochondria, endoplasmatic reticulum, and nuclear membrane of the cell that may lead to apoptosis[8]. Shockwaves are also effective as a means of increasing local blood circulation and metabolism, as well as having a high antibacterial effect.

Pathophysiology of cellulite

Nobody can deny that the term 'cellulitis' has been misused, because in medicine the suffix 'itis' refers to an inflammation or infection. Therefore, 'cellulitis' might refer to any inflammation of the cells involved. In cellulite, there is no inflammation or infection, but perhaps an alteration of interstitial tissues. There was a time when cellulite was thought to be a mere increase of fat in subcutaneous tissues associated with an altered lymphatic and venous flow, and lymphatic stasis. Furthermore, there was a deeply rooted notion that cellulite was closely related to the specific stasis subsequent to hypotonia or venous and lymphatic disease. It was therefore assumed that a previous varicose disease should exist for cellulite to appear.

In fact, this is infrequently true. Most often, the interstitial ▷

Figure 1 Treatment of the left thigh with shockwave therapy (Z*Wave*®)

Figure 2 Shockwave therapy from Zimmer MedizinSysteme (Z*Wave*®)

▷ alterations of cellulite disease appear first and the varicose or lymphatic pathology manifests itself only later. Regardless, the characteristic 'peau d'orange' appearance of cellulite is either caused by an increase in the fat or interstitial liquid content, or to the alteration and retraction of connective tissue layers occurring at different times and in different manners.

Venous-lymphatic stasis is the outward expression of malfunctioning in the endocrine-metabolic regulation of the interstitium. However, this definition does not include all stages of the disease as far as their evolution in time is concerned and furthermore, it does not consider its aetiological and physiopathological variants.

There are clearly three stages of development—oedema, fibrosis, and sclerosis. However, the initial oedema is not always the first pathological manifestation as an alteration to the interstitial matrix, the connective structure, or the adipose tissue often precedes its appearance. In some cases, such as lipoedema and lipo-lymphoedema, the oedema (characterised by the presence of free water rather than lymph) results from an alteration of the interstitial or adipocytic metabolic mechanisms. Based on inspection of the skin, Nürnberger and Müller[9,10] formulated a simple grading-score of cellulite. Up to the 7th or 8th foetal month in both sexes, the upper part of the subcutaneous tissue just below the corium consists of standing fat-cell chambers and septa running radially similar to those of the adult woman. At birth, gender-typical differences are clearly manifest: in male newborns, small, polygonal fat-cell chambers and septa of netted, angled and parallel to the surface, criss-crossing connective tissue are distinctly those of adult males in addition to the corium being thicker and coarser in fibrous structure. These gender-typical structural differences possibly the result of the proliferative effect of androgens on the mesenchyme (fibroblast activity) during the last third of foetal life.

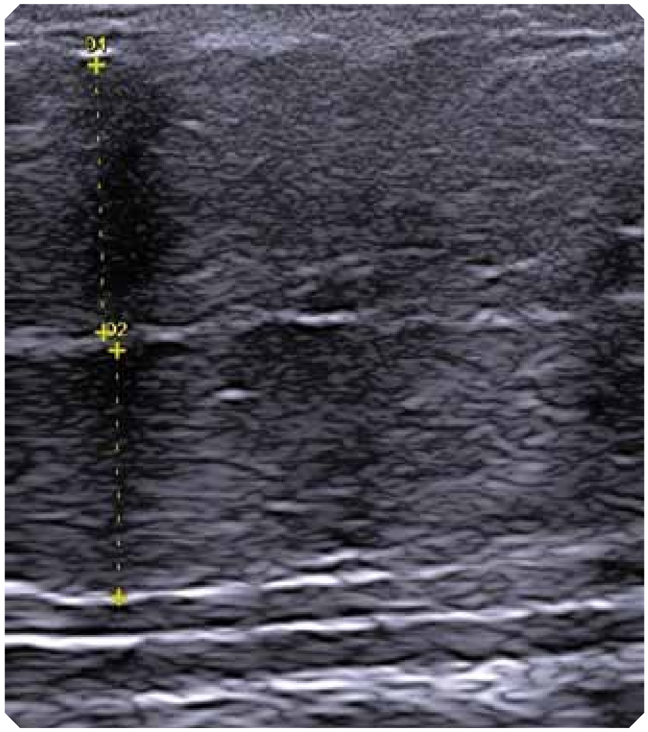

Figure 3 High-frequency high-resolution ultrasound of right thigh before first HERST treatment, corresponding to cellulite degree III

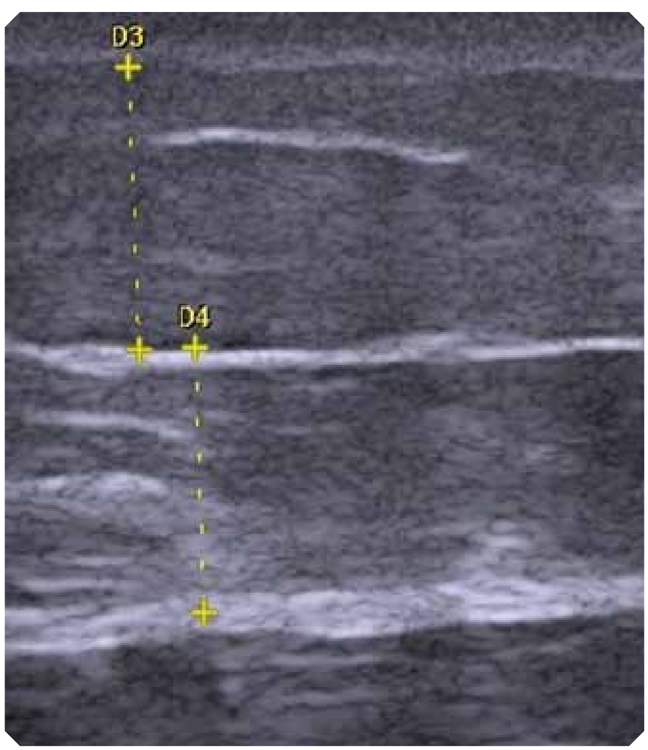

Figure 4 High-frequency high-resolution ultrasound of right thigh after 10th HERST treatment, corresponding to cellulite degree 0–I.

Incipient cellulite, recognised by an orange peel appearance, represents focally enlarged fibro-sclerotic strands partitioning the hypodermis and limiting the out-pouching of fat lobules. In contrast, fully developed cellulite recognised by a dimpled skin surface represents subjugation of the hypertrophic response of the hypodermal connective tissue strands when the resistance is overcome by progressive fat accumulation (in subjects with high body mass indices) forming papillae adiposae that protrude into the lower reticular dermis[11].

Materials and methods

A healthy woman, aged 52 years with Fitzpatrick skin type III and cellulite degree III agreed to have the skin at her right thigh treated with HERST over 10 sessions (*Figure 1*), and with no treatment at the contra-lateral thigh. The giving of informed consent was required to perform the treatment. The patient was asked to continue with her usual daily routine, without undergoing a specific exercise regimen. Changes in subcutaneous fat where evaluated using diagnostic high-resolution ultrasound (Esaote 25 Gold® device with 15–18 MHz linear probe) and liquid crystal contact thermography (LCCT) (Thermo-Cell).

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Exclusion criteria related to health status included:

- Disease of the skin

- Thrombosis or post-thrombosis syndrome
- Known melanoma or chemotherapy
- Anti-coagulation therapy
- Cortisone-therapy
- Known metabolic disorder (e.g. diabetes mellitus, hypercholesterolaemia)
- Inflammation within treatment area
- Other simultaneous treatment of cellulite.

High-resolution ultrasound

The high-resolution ultrasound was carried out at the beginning and at the end of the study. It is an image-producing and non-invasive diagnostic tool[12], which is able to give an exact representation of the structure and quality of the subcutis, and therefore the result of cellulite therapy can be evaluated precisely[13].

Liquid crystal contact thermography

LCCT measures minor differences in skin temperature[14]. In this study, LCCT was used to detect a change in micro-perfusion of the surrounding tissue treated with HERST.

Application technique and device parameters

The low-energy defocused HERST was produced by electromagnetic means with the *ZWave*® device (*Figure 2*), with the energy flow density per shot set at 0.02 mJ/mm^2. The treatment was applied to the right lateral thigh, once per week for a period of 10 weeks. Over a surface area of 120 cm^2 of skin, 3700 shots where applied homogeneously at 16 Hz and 120 mJ. The control area was the left thigh. At the end of the treatment period (equivalent to 37 000 shots), a questionnaire was completed with regard to tolerance (pain and side-effects) and the subjective outcomes of cellulite.

Results and discussion

Impact of HERST on remodelling subcutaneous fat

In addition to tightening the skin and improving its quality, an ideal therapy of cellulite should ensure a reduction to the subcutaneous fat. In one study[15], the hypothesis was stated that low-energy defocused HERST treatment (12 sessions) is effective in treating cellulite through the remodelling of subcutaneous adipose tissue. This effect can be corroborated by the subjective comments of the patient (in which improvement as a result of treatment may have a latent period of 2–6 months), as well as studying the superficial adipose tissue using high-frequency ultrasound (indirect signs of subcutaneous remodelling) and LCCT (indirect signs of increased perfusion). The present prospective design study (low-energy, HERST, 10 therapy sessions) supports this hypothesis.

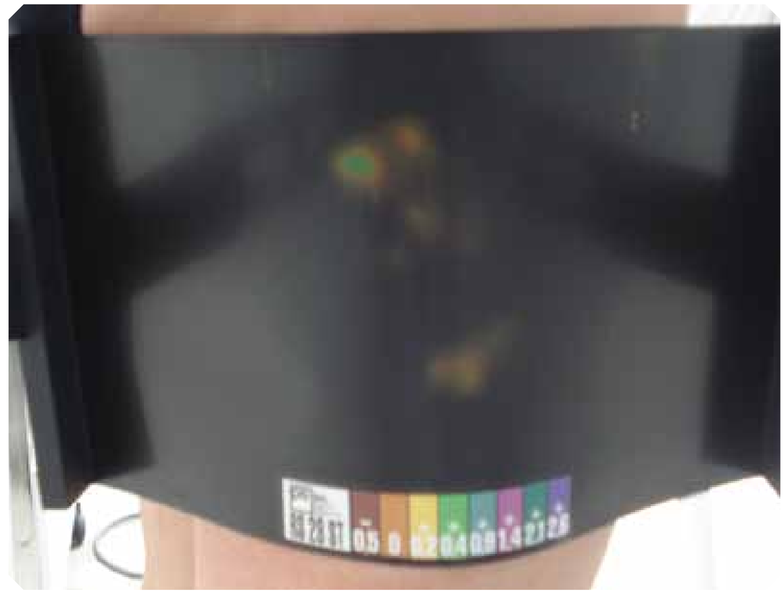


Figure 5 Liquid crystal contact thermography (LCCT), RW28ST with colours corresponding to temperature steps of 0.50 Celsius) of right lateral thigh, before first HERST treatment

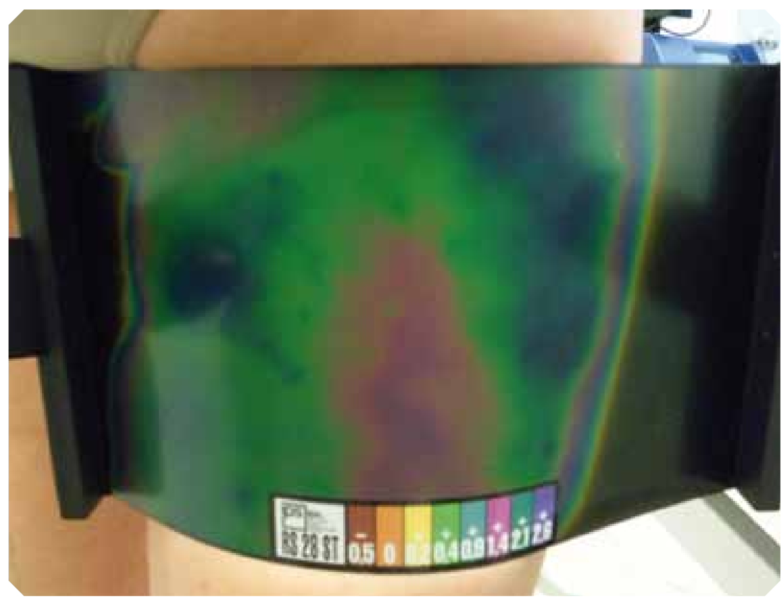
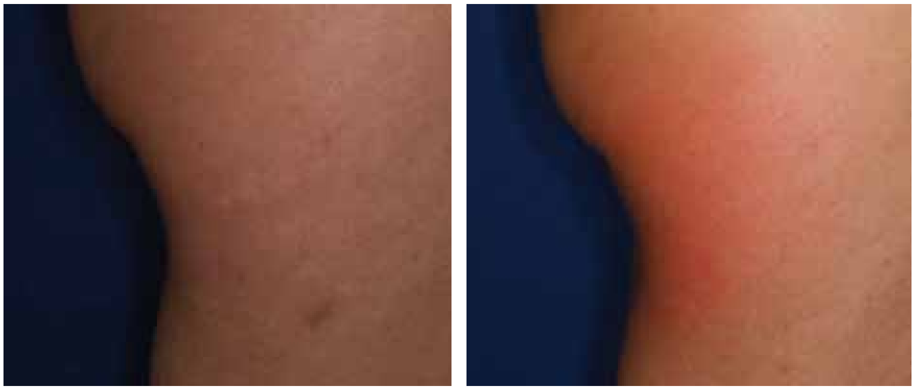


Figure 6 Liquid crystal contact thermography (LCCT), RW27ST with colours corresponding to temperature steps of 0.50 Celsius) of right lateral thigh, after 10th HERST treatment

A remodelling in the subcutis can be seen using high-resolution ultrasound. In the pre-treatment echography it is possible to see typical macro-nodules of cellulite degree III, in both the areolar and lamellar layers of the subcutaneous adipose tissue (*Figure 3*). The superficial fascia is unfolded and hyperechogenicity of the subcutis is shown. In the post-treatment echography, an improvement to the area (without nodules), increased homogenisation of the echogenicity and linear superficial fascia can be seen, all of which are typical of ▷



Before (left) and after (right) treatment with HERST therapy

▷ cellulite degree I (*Figure 4*).

Hyperaemia was clearly visible with LCCT at the site of HERST treatment, starting immediately thereafter and lasting for a number of days. In the pre-treated thigh, it is possible to see areas with a low perfusion (black in colour) typical of macro-nodular cellulite degree III (*Figure 5*). In the post-treated thigh, one can clearly see an improvement to the area without nodules and increased homogenisation of light colours corresponding with well-perfused areas, all typical proof of cellulite degree I (*Figure 6*).

> "In the pre-treated thigh, it is possible to see areas with a low perfusion (black in colour) typical of macro-nodular cellulite degree III."

Conclusions

The encouraging results obtained in this study reveal that HERST is an interesting non-invasive therapy for cellulite, not only by strengthening the skin's scaffolding fabric[16], but also by remodelling the subcutaneous fat tissue. Further studies should investigate whether parameters such as the patient's age (adolescent, adult or elderly females), body-composition (obesity), and the stage of cellulite have an influence on the outcomes of HERST.

▶ ***Figures*** *© Dr Pablo Naranjo García*

References

1. Wess O. Physics and technology of shock wave and pressure wave therapy. 9th International Congress of the International Society for Musculoskeletal Shockwave Therapy (ISMST) News Letter ISMST. 2006;2:2-12.
2. Roupe et al 1997
3. Urhahne 2005
4. Siems W, Grune T, Voss P, et al. Anti-fibrosclerotic effects of shock wave therapy in lipedema and cellulite. BioFactors. 2005;24:275-82.
5. Wang et al 2006
6. Koshiyama K, Kodama T, Yano T, et al. Structural change in lipid bilayers and water penetration induced by shock waves: Molecular dynamics simulations. Biophys J. 2006;91:2198-205.
7. Moosavi-Nejad 2006
8. Kato K, Fujimura M, Nakagawa A, et al. Pressure-dependent effect of shock waves on rat brain: induction of neuronal apoptosis mediated by a caspase-dependent pathway. J Neurosurg. 2007;106:667-76.
9. Müller G, Nürnberger F. Anatomical principles of the so-called "cellulite" Arch Dematol Forsch. 1972;244:171-2.
10. Nürnberger F, Müller G. So-called cellulite: an invented disease. J Dermatol Surg Oncol. 1978;4:221-9.
11. Quatresooz P, Xhauflaire-Uhoda E, Piérard-Franchimont C, et al. Cellulite histopathology and related mechanobiology. Int J Cosmetic Sci. 2006;28:207-10.
12. Tikjob et al 1984
13. Mole B, Blanchemaison P, Elia D, et al. High frequency ultrasonography and celluscore: an improvement in the objective evaluation of cellulite phenomenon. Annales de chirurgie plastique esthétique. 2004;49:387-95.
14. Hoffman et al 1989
15. Angehrn F, Kuhn C, Voss A. Can cellulite be treated with low-energy extracorporeal shock wave therapy? Clin Interv Aging. 2007;2:623-30.
16. Kippenberger S, Loitsch S, Guschel M, et al. Mechanical stretch stimulates PKB/Akt phosphorylation in epidermal cells via angiotensin II type 1 receptor and epidermal growth factor receptor. J Biol Chem. 2005;280:3060-7.

Further reading

- Alster TS, Tehrani M. Treatment of cellulite with optical devices: an overview with practical considerations. Lasers Surg Med. 2006;38:727-30.
- Bereiter-Hahn J, Blasé C. Ultrasonic characterisation of biological cells. In: Kundu T, editor. Ultrasonic Nondestructive Evaluation: Engeneering and Biological Material Characterisation. Boca Raton: CRC Pr; 2003. pp. 725-59.
- Brodmann M, Ramschak H, Schreiber F, et al. Venous thrombosis after extracorporeal shock-wave lithotripsy in a patient with heterozygous APC-resistance. Thromb Haemost. 1998;80:861.
- Delius M, Draenert K, Al Diek Y, et al. Biological effect of shock waves: In vivo effect of high energy pulses on rabbit bone. Ultrasound Med Biol. 1995;21:1219-25.
- Gerdersmeyer L, Maier M, Haake M, et al. Physikalisch-technische Grundlagen der extrakorporalen Stoßwellentherapie (ESWT) Der Orthopäde. 2002;31:610-17.
- Gerdesmeyer L, von Eiff C, Horn C, et al. Antibacterial effects of extracorporeal shock waves. Ultrasound in Med and Biol. 2005;31:115-19.
- Haeussler E, Kiefer W. Anregung von Stoßwellen in Flüssigkeiten durch Hochgeschwindigkeits-Wassertropfen. Verhandlungen Dtsch Phys Gesellschaft (VI) 1971;6:786-9.
- Neuland H, Kesselman-Evans Z, Duchstein H-J, et al. Outline of the Molecular and biological effects of the Extracorporal Shockwaves (ESW) on the Human Organism. Orthopädische Praxis. 2004;9:488-92.
- Nishida T, Shimokawa H, Oi K, et al. Extracorporeal cardiac shock wave therapy markedly ameliorates ischemia-induced myocardial dysfunction in pigs in vivo. Circulation. 2004;110:3055-61.
- Sapozhnikov OA, Khokhlova VA, Baileya MR, et al. Effect of overpressure and pulse repetition frequency on cavitation in shock wave lithotripsy. J Acoust Soc Am. 2002;112:1183-95.
- Schaden W, Thiele R, Kölpl C, et al. Extracorporeal shock wave therapy (ESWT) in skin lesions. 9th International Congress of the International Society for Musculoskeletal Shockwave Therapy (ISMST) News Letter ISMST. 2006;2:13-14.
- Wilbert DM. A comparative review of extracorporeal shock wave generation. BJU Int. 2002;90:507-11.
- Wolfrum B, Ohl C-D, Mettin R, et al. 2003. Die Bedeutung von Kavitationsblasen für transiente Membranpermeabilisierung und Zellschädigung Fortschritte der Akustik—DAGA 2003Aachen, 826-7.7M. Vorländer, Deutsche Gesellschaft für Akustik e.V. (DEGA) Oldenburg.

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