

# **A Trial on the Mechanotransductional Influence of ESWT on Pig Skin and Fibroblastic Activity under the Aspect of Energy Flux Density and Frequency**

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The fundamental assumption for the mechanical effect applying extracorporeal generated shockwaves was in the common opinion replaced by a microbiological working mechanism. Hereafter the effect of shockwave is explained in the formation of new blood-vessels while a number of growth-factors are released.

How this mechanism is transformed and where the borders are, is subject of a number of basic-research studies performed in the society of shockwave application. Referring to the microbiological working mechanism of ESW the following knowledge is state of the art.

The application of shockwaves induces the release of biologically active substances as NO, VEGF, BMP and further growth-factors. Research work has shown these substances increased during and after shockwave-treatment. This effect is named "bioengineering", meaning to induce the tissue to produce and release biological active substances by itself after stimulation by an outside trigger.

The process of transformation of a mechanic stimulus into a biologic answer is united in the collective name of mechanotransduction. The phenomenon of mechanotransduction is well known, yet not completely understood. It is part of our daily experience of hearing and touching. It also plays a crucial role in the regulation of cell-volume, -shape, -motility and -differentiation.

Cells in general may respond to mechanical stresses transmitted over cell surface receptors that physically couple the cytoskeleton to extra cellular matrix or to other cells. Molecular biological and electrophysiological investigations indicate that this rapid process of signal transduction is mediated by mechano-gated membrane ion channels.

Although the effects of mechanical stress could be mediated in part by activation of mechano-sensitive ion channels or by locally and systemically released growth factors, studies have demonstrated that mechanical input itself is able to trigger cellular signalling mechanisms through the process of mechanotransduction.

Sensitivity to mechanical forces appears in all adhesion-dependent cells. This gets evident in the mechano-cytes or cells routinely subjected to mechanical forces, such as skeletal muscle cells, osteocytes, chondrocytes, airway smooth muscle cells, cardiomyocytes, vascular endothelial and smooth muscle cells.

Trying to understand these effects and the mode of action we started a number of clinical trials showing the effect of ESW.

In order to show mechanical influence affecting organic-tissue this trial was performed in Hamburg at Beiersdorf giving the opportunity to work with UPE and singulet-oxygen-detecting devices showing the Triboluminiszenz-Effect.

Triboluminiszenz is the emission of elektromagnetic radiation in UV-, VIS or IR-spectrum appearing if activated atoms or molecules rearrange to there former status. This can be detected by UPE - ultraweak Photoemission - quantifying the measure of physical stress.

The stimulation of the pig-skin is performed with the Orthowave by MTS using a regular focussed and a defocused application-head and the Piezason by Wolf.

ESW as a form of mechanical stress will rise the biosynthetic activity of cells by mechanotransduction. Is the mechanical stress too high this will lead to a reduction of biosynthesis and damage might be caused to treated tissue. The variables in this trial are the Frequency and the Energy Flux Density of different devices.

Aim is to show a gradient for the highest stimulation of the treated tissue regarding that different tissues will react in different ways and it seems as if every indication will need its own

curve. Knowing these curves a dose-effect-relationship could be realized and therapeutic application could be regulated for the highest induction of cell-proliferation and -regeneration. Of course this will only give a little step in this direction but once understanding the working mechanism of ESW and calculating the biologic answer research will be even more transparent and aimed.