

Extracorporeal Shockwaves Manifest Themselves as Biological Mechanotransduction

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The impact of extracorporeal shockwaves (ESWs) on living tissue results in the conversion of mechanical stimuli into biochemical and/or molecular-biological signals. These signals in turn induce a certain flow of information. Subsequent signals are viewed as a biological information unit that brings about certain biological changes in the cell itself for which the signals are meant. This sequence is referred to as mechanotransduction.

The tissue structures mainly involved in mechanotransduction are part of the extra cellular matrix that transfers information via so-called adhesion molecules, principally integrins and cadherins, as connecting links to the cytoskeleton. The signals are transmitted to the cell nucleus via the constituent components of the cytoskeleton (i.e. microtubules, actin microfilaments and intermediary filaments), thereby inducing gene transcription and expression. In the case of destruction of the cytoskeleton, mechanotransduction is rendered impossible. Specific so-called mechanogated membrane ion channels which belong to the DEG/ENaC super-family are responsible for initial and fast prompting of mechanotransduction. Relevant for mechanotransduction are the frequency, amplitude, intensity and duration of the extracorporeal stimuli which determine - as if by code - the concentration of certain second messengers and, thus, turn on the gene expression. To date, arguably the most prominent example of mechanotransduction through ESWs is the effect on migration activity of mesenchymal stem cells as proven for the first time by the authors. The effect of ESWs on living tissue constitutes a complex, signal-inducing stress situation which manifests itself on several interconnected levels. Additional phenomena are observed and established which at present cannot be exactly classified in the overall context of mechanotransduction. The activation of the, in evolutionary terms, very old protection and defense mechanism of living organisms through ESWs, the so-called heat shock protein system, is an example. As far we are aware, we were the first to produce experimental evidence.