Physical Principles of Shock Waves and Pressure Waves - Different Technical Solutions for Medical Applications

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Shock waves in medicine are utilized for different applications such as fragmentation of kidney stones, stimulation of healing processes and as treatment option for certain chronic pain diseases. Shock waves are generated mainly by three different physical principles: electro-hydraulic, electromagnetic and piezo-electric mechanisms. They are characterized by a high peak pressure (P+ = 5-100 MPa), steep rise of pressure amplitude (Tr<< 1 Microsecond), short time duration (Td< 1 Microsecond) and low tensile pressure amplitudes (P-<10% P+). Extracorporeally generated shock waves are generated within in a tissue like medium (usually water) to be transmitted into the body without significant reflection losses. Shock waves are distributed over a large surface area for gentle and lesion free transmission and are concentrated (focused) to ensure high treatment efficiency within the target zone. Whenever required, defined treatment zones may be selected within predetermined and localized regions of the body. As long as energy transmission is not obstructed by bony or gas filled organs remote tissue areas may be reached.

Although often mixed up, shock waves can be clearly differentiated from lower amplitude pressure waves, not featuring the above mentioned typical characteristics of shock waves. These types of pressure waves are usually generated by mechanical impact of colliding bodies resulting in extended pressure pulses (Td > 200 Microseconds) superposed by a small ultrasonic vibration in the range of 100 kHz containing only a small part of the applied energy.

In spite of being physically different from shock waves as defined above, pressure waves may also be efficiently used for stimulation of healing processes and pain therapy, but not for stone fragmentation in distant locations. Effective energy application is limited to superficial areas close to the point of skin contact.

Stone fragmentation is based on the disintegration power of shock waves. Stimulating effects and tissue engineering qualities of shock waves require a different mechanism. Reorganisation of pathological reflex patterns on a neuronal memory level may be an important mechanism involved and followed by biochemical reactions and improved metabolism. The hypothesis of modulation of reflex patterns by shock waves is briefly outlined.