WELCOME

ESWT & Physics
MTS – Who Are We?

• MTS is represented by appointed distributors on all five continents
• MTS products are approved in more than 30 countries worldwide, eg. EU, United States, Canada, Russia etc.
• MTS therapy systems are operated worldwide
MTS – Who Are We?
What Are Shock Waves?

Shock waves are acoustic waves characterised by:

• High pressure amplitudes (steepening effect)
• High peak pressure (up to 100MPa)
• Fast pressure rise (<10ns)
• Short lifecycle (<10ms)
• Positive and negative pressure phase
• Shock wave parameters:
  – -6dB shock wave focus
  – 5MPa treatment zone
  – Total energy (mJ)
  – Energy flux density (ED) (mJ/mm²)
How To Create Shock Waves?

**Electro hydraulic principle**

- High-energy spark discharge in water quench
- Explosive water evaporation produces „spark“ shock wave, which is spherically spreading out into surrounding medium
How To Create Shock Waves?

Electro magnetic principle

• **FLAT COIL/ LENSE**
  – Flat diaphragm is moved impulsively by electromagnetic forces and produces a flat wave
  – Wave is focused by means of an acoustic lense
  – Shock wave is generated by a steepening effect in focus centre

• **CYLINDER COIL/ REFLECTOR**
  – Production of cylinder wave that is focused by means of a parabolic reflector
  – Shock wave is generated by a steepening effect in focus zone
How To Create Shock Waves?

Piezo electrical principle

- Layer of piezoelements on a spherical surface is stimulated to emit a pressure wave towards the centre of the sphere via voltage pulses
- Shock wave is generated by steepening effect close to the centre of the sphere
How To Create Shock Waves?

Comparison of three different acoustic waves

Source:
- MTS Europe GmbH, measurement orthog K100, focused applicator
- diagnostic ultrasound: wire wave, calculated with 1 MHz peak pressure at 2 MHz
- radial pressure wave: R. D. Clewes et al., Acoustic field of a ballistic shock wave therapy device. Ultrasound Med Biol, 2008; 34:1127–1303, 2007, Figure 1b.
Shock Wave vs. Pressure Wave

Difference SW / PW

- Pressure waves are acoustic waves
- Differ from shock waves by physical features
- No focusing
- No steepening effect
- Only superficial therapeutical effect

![Graph showing comparison between Shock Wave and Pressure Wave](image-url)
Shock Wave vs. Pressure Wave

Ballistic generating principle

- Pressure wave are generated by the impact of a projectile on an impact absorbing body
- Projectile is accelerated with compressed air to a speed of several metres per second and then abruptly slowed down by hitting an impact body
MTS Spark Wave Technology

AEHT Advanced Electro Hydraulic Technology

- Intelligent electrode SmartTrode
- Improved effectiveness
- Constant & efficient operation
- Up-to-date spark gap design
- Unique range of energy
- Short rise time
- Unique positive pressure (>90%)
- Low tensile pressure (<10% = less cavitation, less tissue damages, less haematoma)
MTS Spark Wave Technology
MTS Spark Wave Technology

AEHT Advanced Electro Hydraulic Technology

- Positive pressure
- Tensile pressure $P_c \approx 1 - 5$ MPa
- Rise time $t_r$ approx. 20 ns
Effects of Spark Waves

Mechanical effect

• Very fast pressure transition causes high tension at tissue interface and cracks structure of material
• Cavitation
Effects of Spark Waves

Biological effect

- Dilution of substance p (neurotransmitter)
- Release of angiogenic growth factors (VEGF, eNOS etc.)
- Improved blood supply
- Neovascularisation
- Cell proliferation
- Bactericidal effect
- Mobilization and migration of stem cells
Thank You Very Much For Your Attention!

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