Radial Extracorporeal Shock Wave Therapy (ESWT) Induces Bone Formation in Vivo

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Extracorporeal shock wave therapy (ESWT) is presently applied to a variety of bone and soft tissue pathologies in orthopaedics. Compared to the commonly used focused shock waves, radial ESWT (ESWT) is characterized by a larger treatment area, which simplifies application and reflects the pathology zone rather than a point. Therefore, ESWT is expected to be at least as effective as focused ESWT. The purpose of the study was to evaluate if ESWT can induce new bone formation at low energy flux densities and to study the time course of ESWT-induced osteogenesis.
New Zealand white rabbits (n=13) were used for the animal model after approval by the responsible ethics committee. After the adaptation phase, radial extracorporeal shock waves (ESW) were applied with the Swiss Dolorclast shock wave device (EMS Electro Medical Systems, Nyon, Switzerland) to one randomized femur of each animal, while the contralateral side served as an intraindividual control. Four thousand pulses of ESW with an energy flux density of 0.16mJ/mm2 were applied twice with standard parameters (8Hz, 4 bar, 7-day interval). Animals were sacrificed at 1 week (n=4), 3 weeks (n=4) and 5 weeks (n=5) after the second ESWT. Sections of all femora (thickness ~75 microm) were investigated with broad-band fluorescence microscopy (H3 filter, JUST filter) and contact micro radiography for new periosteal and endosteal bone and callus formation, periosteal detachment and cortical and trabecular fractures.
Integration of the fluorescent dyes into bands of newly deposited bone could be observed under fluorescence microscopy and were significantly increased after ESWT. Shock wave-induced osteogenesis was already visible at week 1 however, new bone formation was even more pronounced and significantly different to the control group after 3 and 5 weeks.
Furthermore we could demonstrate both endosteal and periosteal new bone formation at the dorsal femoral cortex after ESWT, but not in the control. No calcified bone remodelling, resorption or callus formation could be shown in contact micro radiography. Furthermore, neither trabecular nor cortical fractures were observed. No side effect was found but there was some haematoma at the application site.
ESWT offers new perspectives in the therapy of bone pathologies as larger tissue areas could be effectively treated. The osteogenetic effect is a shock wave induced biochemical response resulting from the total energy applied per area rather than high energy-related local mechanical effects found in focused ESWT.