Unfocused Extracorporeal Shock Waves Induce Anabolic Effects in Rat Bones.

OP Van der Jagt¹, TM Piskaer¹, JH Waarsing¹, M De Jong¹, H Weinans¹
¹Erasmus Medical Center, Rotterdam, The Netherlands

Aims: It has been shown previously that extracorporeal shock waves (ESW) can influence the differentiation and expression profiles of bone cells (1). ESW treatment might thus affect bone remodeling and lead to changes in bone architecture and mechanical properties. To examine this and subsequently evaluate if ESW might be a potential treatment for osteoporosis we investigated the effects of unfocused shock waves using in vivo SPECT scanning and in vivo microCT scanning.

Method. The tibiae of 6 male wistar rats were exposed to 1000 unfocused shock waves at day 0 (0.3 mJ/mm). The large focal zone of 3.8 cm allowed treatment of the whole tibia. The contra-lateral tibia served as untreated control.
To analyze bone turnover multipinhole-SPECT scans were made with a spatial resolution less than 1 mm at 2, 7, 21 and 49 days. Intravenously injected radioactive technetium labeled methylenediphosphonat was used as a marker of bone turnover. In-vivo micro-CT scans of both tibiae were made at week 0 and week 49 (18 um voxelsize). The resulting scans were segmented using a local thresholding algorithm and morphometric parameters were calculated at the metaphysis.

Results. Shock waves increased bone turnover in the treated tibia (fig.1). The increase in the metaphysis at 7 days and in the diaphysis at day 7 and 21 days was more than twofold. In the diaphysis bone turnover remained elevated longer than in the metaphysis. Micro-CT analysis showed that shockwave treatment increased trabecular volume fraction from 20.9 to 25.3% in the treated leg (fig. 2a). The cortical volume increased with 16.8% on average, while in the control legs a decrease of 7.2% was observed (fig2b).

Further examination of the micro-CT scans showed the presence of trabecular structures and mineralizations in the bone marrow (fig.3a). On histology these mineralizations were
present around fibrotic tissue and had a bony morphology with osteocytes and osteoblasts (fig.3c). Further, histology showed the presence of hemosiderin, indicative of bleeding, and an increase in adipocytes in the marrow of treated legs.

Conclusion: We have shown that a single treatment with unfocused ESW can induce anabolic effects on bone, but ESW also induced bleedings in the marrow and affected the adipose tissue there. Though the anabolic effects show the potential of ESW for treating osteoporosis, more research is needed into the long-term consequences of ESW on bone.

References