

Shock-wave Treatment Enhances Mechanical Strength during Early Fracture Healing: An Animal Study

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ABSTRACT

Purpose To evaluate the effect of shock-wave treatment on the mechanical strength and the bone mineral density of tibial diaphyseal osteotomy in a rabbit model.

Material and Method 18 adult New Zealand rabbits received right tibial diaphyseal transverse osteotomy and external fixation at Day 0. In the experimental group, the 12 rabbits received 5000 impulses, 0.32mJ/mm^2 shock-wave treatment by Orthospec™ at the osteotomy site at Day 7 and Day 21. In the control group, the 6 rabbits did not receive any treatment on the osteotomy site. Serial plain X-ray examinations and measurements of bone mineral density by dual-energy X-ray absorptiometry (DEXA) on bilateral tibiae were performed at Day-7, Day 0, Day 14, Day 21, and Day 28. At Day 28, rabbits of the control group and 6 rabbits of the experimental group were sacrificed. The remaining 6 rabbits were sacrificed at Day 42. The bilateral tibiae were sent for torsional test by using Material Testing System (MTS) machine. Histologic examination of the osteotomy site was performed after the mechanical tests were completed.

Result On plain X-ray film, the osteotomy gaps at Day 28 completely healed in 3 of the control group (50%) and 8 of the experimental group (66.7%). Lower limb alignment of the two groups are both normal. There is no difference on the change of

percentage of bone mineral density of bilateral tibial diaphysis of the two groups from Day 0 to Day 28. The percentage of maximum torque of bilateral tibial diaphysis of experimental group at Day 28 is significantly higher than that of control group (55.9% versus 31.0%, $P < 0.05$). The percentage of maximum torque of bilateral tibial diaphysis of experimental group at Day 42 is significantly higher than that at Day 28 (74.3% versus 55.9%, $P < 0.05$). There is no significant correlation between values of maximum torque and values of bone mineral density (correlation coefficient = 0.56, $P = 0.055$). Histologic examination is in progressing.

Conclusion Shock-wave treatment has positive effect on early healing of bone fracture by demonstrating superior mechanical torsional strength and higher union rate of fracture healing, but is ineffective in increasing bone mineral density.

Long-term effect of shock-wave treatment on fracture healing is deserved to be studied. The influence of shock-wave treatment on bone metabolism is in need of further investigations.

Key word shock-wave treatment, diaphyseal osteotomy, bone mineral density, biomechanical testing

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