

Application of extracorporeal shock wave treatment to enhance spinal fusion: a rabbit experiment

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Introduction:

Besides the applications in urolithiasis, extracorporeal shock wave treatment (ESWT) has been further utilized for the treatment of many orthopedic disorders. Some studies demonstrated that ESWT causes subperiosteal callus formation by creating small fractures on the cortex (decortication). Others showed that ESWT stimulates expression of growth factors that in turn improve blood supply and cell proliferation and eventual tissue regeneration. To our knowledge, no study has reported the effect of ESWT on spinal fusion.

Methods:

Fifteen rabbits of 12 months old were used in this study. Spinal fusion was performed with decortication of bilateral L5 and L6 transverse processes, and placement of the bone chips onto the ipsilateral L5-6 intertransverse space. The right L5 and L6 transverse processes of all animals were treated with 1000 impulses of ESWT at 14 KV (equivalent to 0.18 mJ/mm²) at 3 and 6 weeks after surgery. The left transverse processes did not receive ESWT, and served as controls. Radiographic examinations of the spines were performed at 3, 6, and 12 weeks. Computed tomography (CT) was performed at 12 weeks. The rabbits were sacrificed at 12 weeks, and the spinal segments were harvested for histomorphological examination.

Results:

None of the rabbits developed neurological deficit throughout the course of this study. Radiographs of the tested rabbits taken at different post-ESWT stages demonstrated repairing effect of ESWT on the fusion gap of the treated (right) sides. Statistical analysis of the image studies indicated that 11 of 15 (73%) rabbits showed superior fusion mass on the ESWT (right) side than that of control (left) side ($p < 0.001$). The remaining 4 (27%) rabbits showed no discernable fusion difference between the ESWT side and the control side. Histomorphological examination showed good new bone formation in 9 fusion masses. All of these cases were noted on the ESWT (right) sides. Statistical analysis showed that ESWT sides had better new bone formation than the control sides ($p = 0.001$).

Discussion:

Our previous studies demonstrated that high-energy ESWT (0.47 mJ/mm² of EFD) may injure the femoral artery. Another recent study found that low-energy ESWT (0.18 mJ/mm² of EFD) causes no neurological symptoms (unpublished data). As ESWT of 0.12 to 0.16 mJ/mm² EFD induces bone formation, we therefore determined to utilize a safe and effective dose of 14 KV (equivalent to 0.18 mJ/mm² EFD) to induce new bone growth.

Conclusion:

The results of this study demonstrated that ESWT is effective in promoting spinal fusion in rabbits.