Biomechanical eveluation of tranpedicularly placed intravetebral support for the management of osteoporotic vertebral compression fractures

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Abstract

This in vitro biomechanical study reports on a new implant, called an intravertebral expandable pillar (IVEP). The implant is aimed at restoring the height and strength of collapsed vertebra after fracture in an osteoporotic patient. The hypothesis is that the IVEP can effectively restore the body height of the compressed vertebra and provide proper stiffness for the collapsed vertebra. Although the reported complication rate of percutaneous vertebroplasty by injection of polymethylmethacrylate (PMMA) is low, the sequelae are severe; other potential adverse effects of PMMA injection into the vertebral body include thermal necrosis of the surrounding tissue caused by a high polymerization temperature, and lack of long-term biocompatibility. We test the mechanical properties before and after fracture of 14 human cadaver lumbar vertebrae by a material testing system. The fractured vertebra was implanted with the IVEP, and its mechanical properties tested. The vertebral body height at each stage was evaluated by a digital caliper and radiographic films. After IVEP implantation, the vertebral body height restoration rate was 97.8%. The vertebral body height lost 12.7% after the same loading to create fracture. The vertebra lost half of its strength after compressed fracture, while IVEP implantation restored 86.4% of intact vertebra strength. The stiffness of intact vertebrae was significantly greater than that of untreated vertebrae after fracture and fractured vertebrae with IVEP treatment, while the stiffness of fractured vertebrae after IVEP treatment was significantly greater than that of untreated vertebrae after fracture. The bipedicularly implanted IVEP restores the initial height and strength of the vertebral body following an induced compression fracture, and could be used by a minimally invasive procedure to treat lumbar vertebra compression factures and avoid the disadvantage of using bone cement in vertebroplasty or kyphoplasty.