BIOMECHANICAL COMPARISON OF FIXATION TECHNIQUES FOR DOUBLE PARS FRACTURES

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INTRODUCTION

Complete pars fracture is one of clinical conditions of spondylolysis and it can lead to spondylolisthesis or degenerative disc disease (DDD) [1]. Double pars fractures (DPF) commonly occur at L4-L5 due to traumatic in juvenile years, whilst occurring at L3-L4 in the elderly from degenerative change. Double pars fracture may decrease spinal stability and more so if complicated with DDD. Posterior instrumentation with cages may restore the biomechanical strength of the spine. Some studies biomechanically compared the spondylolysis fixation techniques [2, 3], but rare comprehensive biomechanical studies on DPF have been reported. The purpose of this study is to compare biomechanically the performance of fixation techniques for the repair of double spondylolytic defect in the pars interarticularis.

METHODS

Eighteen fresh-frozen and thawed porcine lumbar L2-L6 spines were used for mechanical testing. In addition to the control group, DPF group was created by making 2-mm wide defects in the pars interarticularis bilaterally at L3 and L4 using a power saw. Disectomy in combination with the DPF procedure resulted in a DPF&DDD group. The TPS group used transpedicular screw system (TPS) to stabilize DPF defects. The D2TPS group used TPS system to stabilize the spine of DPF&DDD. The D2TPSC group used TPS and interbody cages to stabilize the spine of DPF&DDD. The biomechanical properties were estimated and compared amongst six groups (Fig. 1). Motion segments were mounted and tested on a MTS machine. A series of loadings, including flexion, extension, lateral bending, torsion, and compression, were applied, respectively. The axial stiffness test for this study was 0-250 N compression at the displacement rate of 25 mm/min. In other rotational testing, the torque was 2.5 N-m and the load rate was 25 mm/min [4].

RESULTS AND DISCUSSION

In flexion, DPF had a significantly smaller stiffness (0.55 ± 0.02 N-m/deg) than the intact control group (0.68 ± 0.03 N-m/deg). With TPS fixation, the stiffness was increased significantly (Fig. 2). In extension, DPF had a significantly smaller stiffness than the intact group. With any kind of stabilization, stiffness was increased significantly. In lateral bending, DPF&DDD group had a less stiffness than controls. In compression, DPF and DPF&DDD gradually decreased the stiffness compared to controls. In torsion, DPF and DPF&DDD significantly reduced the intact stiffness. With fixation of TPS or cages, the stiffness was significantly greater than DPF group. In almost all testing, D2TPSC group had the higher stiffness than other groups.

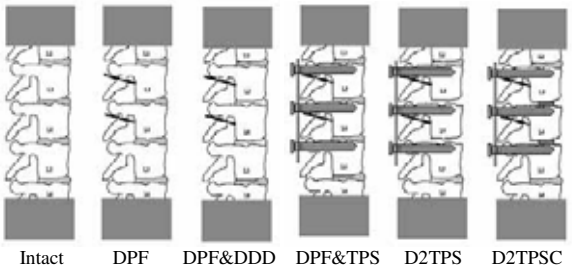

Figure 1: Diagram of 6 groups of device-spine constructs.

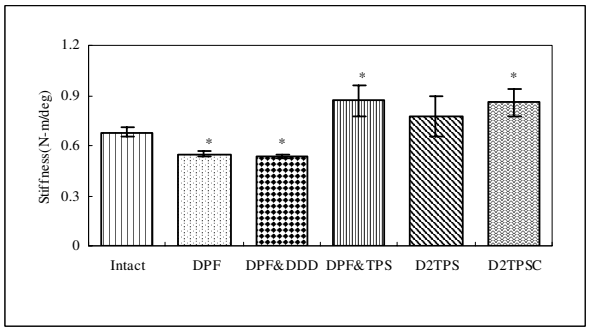

Figure 2: Comparison of flexion stiffness (N-m/deg).
* significantly different from data of Intact group ($p < 0.05$)

Double pars fracture is occasionally found in clinical practice. The treatment depends on the symptoms if DDD and stenosis is severe, decompression and posterior instrumentation is indicated. This study focused on the degenerative situation. Therefore, the facet screw or hook-screw system is not included.

CONCLUSIONS

Double pars fracture significantly reduced spinal stiffness. For spine with double pars fracture only, TPS could retain the intact stiffness. However, TPS seems not to stabilize spine with DPF and DDD. The cage possibly restored the stiffness decreased by the disc degenerative disease in all spinal motion.

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