BIOMECHANICAL EFFECTS OF THE PEDICLE AUGMENTER FOR RECONSTRUCTION OF VERTEBRAL BODY

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INTRODUCTION

Posterior instrumentations alone are widely used to accomplish spinal reduction and provide stability for an injured spine, however, implant failure rates have been reported to be around 20% (McLain et al, 1993). Transpedicle disectomy and bone graft has reported only 32% fusion rates (Alanay et al, 2001). Combined anterior bony strut and posterior instrumentation was a challenge to geriatric patients with acceptable medical conditions and possible vascular and pulmonary complications. Therefore, a new design i.e. pedicle augmenter (Li et al, 2002) tries to reconstruct the vertebral body via internal mechanical support and also encourage bony fusion. However, the biomechanical effect of pedicle augmenters has not be studied previously. This study is to evaluate its initial mechanical effects.

METHODS

Biomechanical testing was performed on 14 adult porcine T11-L3 spines divided into 4 groups. The corpectomy over L1 vertebral body was to mimic the burst fractures. Trifix pedicle screws (TPS; 6.25 mm × 40 mm) were applied bilaterally into T11 and L2 for posterior fixation (PI group). The pedicle augmenter (PA) group was assigned to those combined posterior fixation with TPS and anterior support with pedicle augmenter. The pedicle augmenter is a titanium spinal block with porous surface. In DCP group, The DCP plates were impacted into place on the right anterolateral aspect of the T12 and L2 vertebral bodies. Each specimen was then potted in aluminium loading fixtures with low melting alloy (Fig. 1) The biomechanical properties were tested and compared among the intact, PI, PA and DCP groups (Fig. 2). Motion segments (T12-L2) were tested according to a biomechanical loading sequence (Volkman, 1996), which consisted of flexion, extension (5 N×m, 25 mm/min), and axial compression (250 N, 25mm/min). Five load-deformation curves were repeated from each specimen and from these curves stiffness values were calculated and averaged.

RESULTS AND DISCUSSION

The flexion stiffness of PA group (46.9 ± 7.8 N-m/deg) and DCP group (44.2 ± 5.7 N-m/deg) is greater than the intact (38.0 ± 2.4 N-m/deg) and PI group (37.7 ± 5.2 N-m/deg). The extension stiffness of PA group (54.5 ± 5.2 N-m/deg) is much higher than the intact group (34.6 ± 2.1N-m/deg) and DCP group (27.4 ± 2.0 N-m/deg), but same as PI group (48.6 ± 2.6 N-m/deg). The compression stiffness of PA group (359 ± 2 N/mm) is greater than PI group (268 ± 4 N/mm) and DCP group (330 ± 20 N/mm) but is lower than the intact group (419 ± 1 N/mm).

The primary purpose of this study was to evaluate the biomechanical effect of the pedicle augmenter for reconstruction of the collapsed vertebral body. This study showed pedicle augmenter can increase the stiffness of motion segment, particularly in the axial compression and flexion loadings. This findings support the clinical application of pedicle augmenter in the collapsed vertebral bodies, such as in burst fracture and compression fracture.

Figure 1: Left - The spinal segments with a pedicle augmenter and bilateral posterior fixation (PA group) was mounted on the testing machine. Right - A clinical case with burst fracture was reconstructed with a pedicle augmenter.

Figure 2: Diagram of 4 groups of device-spine.

SUMMARY

According to our results, applying the pedicle augmenter in collapsed vertebral body can increase axial compression and flexion stiffness, which means that applying pedicle augmenter in collapsed vertebral body can increase the initial strength and stability of spinal column.

REFERENCES