INTRODUCTION

Lumbar spinal stenosis (LSS) is a disease inducing low back pain, leg pain, or neurogenic claudication from compression of neural structures generated by soft tissues (disc bulging and ligament flavum bucking) [1]. There are several treatment techniques for LSS as decompression (laminectomy, foraminectomy) and posterior-lateral fusion using pedicle screws and rods. However, surgical fusion is often too rigid that may change biomechanical behaviors (load bearing and motion) at the adjacent discs that could induce disc degenerations [2, 3]. Recently, a new surgical technique of inserting a spacer made of PMMA between interspinous processes has been introduced. This spacer, called interspinous spinal spacer (ISP), has been designed to keep the spine in a slightly-flexed posture to reduce narrowing of the spinal canal and intervertebral foramen. However, there are few studies that attempted to evaluate the biomechanical efficacies or effectiveness of this ISP technique. In this study using calf lumbar spine, effectiveness of the PMMA ISP was assessed by conducting in vitro biomechanical tests measuring the intervertebral disc pressures at the level of surgery as well as at the adjacent levels.

METHODS

Six calf spine specimens (less than 2 weeks of age, L1-L5) were divided into two groups: the intact and the operated (n=3 each). On the operated specimens, ISP made of PMMA (φ=12-mm) was inserted into the space between the spinous processes of L3-L4. To quantify pressures within the intervertebral discs (L2-L3, L3-L4, L4-L5), four strain-type pressure transducers (060s Precision Measurement Co. USA) was inserted at various regions of the annulus (anterior, posterior, and posterolateral locations) and at the nucleus pulposus. These transducers were attached on stainless steel rod (φ=2.3mm) for easy insertion into the discs (Fig. 1). These transducers were connected with strain scanner (AI 1600 Strain Measurement System, CAS Co., Korea) and strain scanning software. Biomechanical tests were done with MTS 858 (MTS system Corp., Minneapolis, MN, USA) by imparting pure compression (700N) and extension loads (700N+7.5Nm) and resultant disc pressures were measured. Statistical analysis (one-way ANOVA test) was performed to estimate the effectiveness of ISP insertion.

RESULTS

Changes in internal disc pressures before and after ISP insertion are shown under pure compression and extension in Figs 2 and 3, respectively. Under pure compression load, internal pressure was slightly decreased, but there was no statistical significance. Under extension, on the other hand, the disc pressures decreased significantly at the nucleus, the posterior and posterolateral portions of the annulus (P and S<0.05). The respective percent decreases were 25%, 31.7%, and 36.8%. However, changes in pressure at the adjacent disc levels (L2-L3, L4-L5) between intact and surgical group insertion ISP were negligible regardless of loading conditions (P and S>0.05).

DISCUSSION

During standing and walking, the lumbar spine is in slight extension, which may cause disc bulging in posterior direction and narrowing of spinal canal. This may be aggravated further in case of LSS since the compression of neural structure are related with posture, especially extension of the spine. Our initial finding suggested that insertion of ISP could effectively decrease the internal disc pressure in the posterior region at the surgical level (L3-L4) and no pressure changes at the adjacent levels under extension load. This may effectively reduce amount of disc bulging and alleviate spinal stenosis by relieving the narrowed areas for the spinal cord and nerve roots. In addition, it is less likely to cause disc degeneration at the neighboring levels as opposed to the rigid fusion.

REFERENCES


AFFILIATED INSTITUTIONS FOR CO-AUTHOR

Cheil Orthopedic Hospital, Seoul, Korea

+ Dept. of Biomedical Engineering, Konkuk University, Chungju, Chungbuk, Korea

ACKNOWLEDGEMENT

This work was supported by the Korea Science and Engineering Foundation Grant (R01-2001-00500).