Introduction: Lumbar spinal canal stenosis is prevalent in the elderly population. Minimally invasive posterior decompression using a microscope (Weiner and McCulloch et al) or endoscope (Khoo and Fessler et al) is becoming popular for those patients. An advantage of minimally invasive decompression is that the cauda equina and nerve root are in clear view and the facet joints, paravertebral muscles and spinous process are well preserved. By preserving the facet joints during the decompression, an abundant fusion may be avoided, plus there would be less concern with postoperative instability. Although there are some reports related to biomechanical studies of graded facetectomies (Absumi et al.) there are no reports of cadaver studies that have focused on minimally invasive decompression.

The purpose of this biomechanical cadaver study was to investigate the biomechanical effect of minimally invasive decompression at upper and lower lumbar levels.

Materials and Methods: Cadaveric specimen

Eight human lumbar motion segments (4: L2-3 and 4: L4-5) were harvested from fresh cadavers: Mean age was 71.4 years (range from 48 to 82 years); 6 females and 2 males. All specimens were frozen at -20 C and stored until tested. The specimens were examined grossly and radiologically to rule out malignancy or fractures that could have interfered with the results. The specimens were thawed, divided into motion segments, and stripped of excess soft tissues. The end of each motion segment was then potted up to its midbody in a 10-cm diameter polyvinylchloride end-cap using dental cement.

Biomechanical test

The specimen with the two end-caps was positioned and clamped in a materials testing machine (MTS 858 Mini-Bionix). First, the center of rotation for flexion-extension and lateral bending was established. Then the specimen was tested according to a biomechanical loading sequence consisting of: 1) compression; 2) flexion; 3) extension; 4) lateral bending; 5) axial rotation. The loads applied were 1000 N compression, 2 Nm flexion, extension, lateral bending and 15 Nm axial rotation where applicable (Minamide et al). 1000 N compression was always applied even when superimposed by bending or torsional moments. The specimen was tested according to this loading sequence: 1) intact; 2) after left fenestration (LF); 3) after bilateral decompression via left unilateral approach (BD); 4) after medial facetectomy (MF). In all conditions, the supra- and inter-spinous ligaments were preserved (Figure 1).

The stiffness of the motion segment was determined each time from the slope of the load-displacement curve obtained. To adjust for variations in stiffness between motion segments, a normalized stiffness was obtained; this was based on the corresponding result for the intact specimen. Statistical analysis consisted of paired t tests, and the statistical significance was defined at the p < 0.05.

Results: Biomechanical test

The ratio of stiffness for both LF and BD against to the corresponding value for the intact specimen was more than 80% in all motions, with no significant differences. On the other hand, BD is significantly stiffer than MF in extension and axial rotation.

Discussion: Bilateral decompression via unilateral approach and medial facetectomy may both be achieved with cauda equina symptom and bilateral nerve root symptom. The spine after bilateral decompression (BD) is greater than 80% as stiff as the spine when intact and the spine after left fenestration, and significantly stiffer than in extension and axial rotation after medial facetectomy. So it would seem that the risk of postoperative instability after bilateral decompression could be small, and the postoperative course may not be far from the natural course when intact.

Differences between the upper and lower spine were not clearly apparent. At L2-3 the spine after bilateral decompression was stiffer in axial rotation than the spine after medial facetectomy, but there are no significant differences at L4-5.

Conclusion: The main results to come from this experiment are: 1) Bilateral decompression produces less biomechanical instability (as measured by changes in stiffness) than medial facetectomy, 2) Bilateral decompression leaves the spine more than 80% as stiff as the intact spine, and 3) As compared to bilateral decompression L2-3 seems more affected than L4-5 by the medial facetectomy. These results go towards supporting a minimally invasive bilateral decompression. Minimally invasive bilateral decompression, as opposed to medial facetectomy, preserves the paravertebral muscles, the spinous process and the facet joints as much as possible. By preserving the facet joints during the decompression there is less concern with postoperative instability.