BIOMECHANICAL EFFECT OF LUMBAR SPINE DECOMPRESSION: COMPARISON OF TWO DIFFERENT SURGICAL TECHNIQUES

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Introduction

Lumbar spinal stenosis causes the compression of neurovascular structures. Surgical decompression seems to have better outcomes compared to conservative treatments. The different decompression techniques, such as hemilaminectomy and the full laminectomy, remove parts of the posterior spinal elements increasing the space in the spinal canal. Removal of these structures could aggravate or create spinal instability [1]. In addition, changes in anatomy and in the load distribution could also alter the disc strains.
The aim of this work was to assess the biomechanical effect of hemilaminectomy and laminectomy in the lumbar spine, in terms of mechanical stability and strains on the intervertebral discs.

Materials and methods

Twelve L2-S1 spine cadaver segments were prepared leaving intact the anterior and all the posterior ligaments, removing the soft tissues around the discs and the vertebral bodies. A white speckle pattern was sprayed to measure surface strains with Digital Image Correlation (DIC). The specimens were mechanically tested in flexion, extension, right and left lateral bending under 2.5 Nm. Each specimen was tested:

i) in the intact condition;
ii) after hemilaminectomy;
iii) after full laminectomy.

The surgical procedures were performed at the L4-L5 vertebrae by a neurosurgeon, randomly choosing the side for the hemilaminectomy.
Surface images were acquired by a 3D-DIC system with two sensors (GOM Aramis 12M). Image correlation and analysis were performed using optimized parameters [2]. The range of motion (RoM) and the tensile (Ɛ1) and compressive (Ɛ2) principal strains distribution were computed for each loading configuration.

Results and discussions

Correlations and measurements were successfully performed for all the loading configurations and all conditions. Data were analyzed at the stage where the maximum moment of 2.5 Nm was reached. The statistically significant ($p<0.05$, Wilcoxon test) large increase in range of motion after hemilaminectomy suggests a loss of stability in flexion; different trend in the other loading configurations did not show significant changes. Tensile and compressive strains over the specimens showed similar distributions in each loading configuration before and after the hemilaminectomy (Figure 1).
Lateral bending on the side where the hemilaminectomy was performed (ipsilateral) was the most challenging loading configuration due to the statistically significant increase in minimum compressive strain on L4-L5 disc surface ($p<0.05$, Wilcoxon test).
Tests on the full laminectomy are currently being completed.

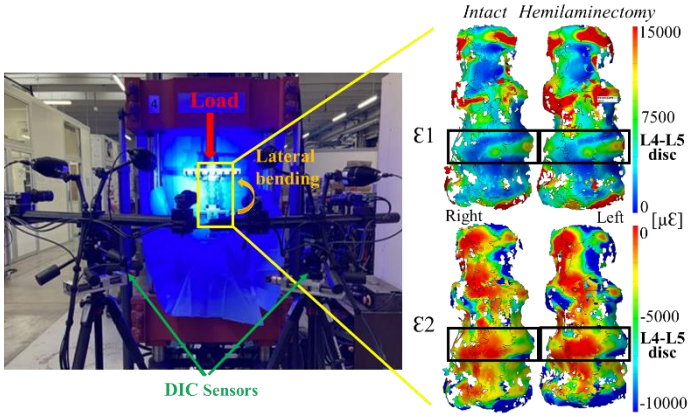

Figure 1: Left: set-up of mechanical tests, with the specimen in the middle and the two sensors of the DIC system with four cameras. Right: distribution of Ɛ1 (top) and Ɛ2 (bottom) on the surface of the specimen during left lateral bending in the intact and hemilaminectomy (ipsilateral scenario) conditions.

Conclusion

This study aimed to evaluate the risk of instability and changes in the strain distribution after lumbar spinal decompression performed by hemilaminectomy or laminectomy.
These preliminary results showed that the increased RoM in flexion, after hemilaminectomy, did not seem to damage the L4-L5 disc. Indeed, no significant increases in Ɛ1 or Ɛ2 were observed. Conversely, in the ipsilateral bending, the minimum compressive strains increased despite the RoM did not change.

References

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2. Palanca et al, MEP, 52: 76-83, 2018.

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Ethics

Bioethics Committee of UniBo (Prot. 113043 of 10 May 2021)