EVALUATION OF SPINE STABILITY FOLLOWING TREATMENT OF DEGENERATED INTERVERTEBRAL DISCS WITH DISCOPLASTY

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Introduction

Spinal nerve compression is often due to stenosis of the foramen, associated with intervertebral disc degeneration. In ageing population minimal invasive surgical (MIS) solutions can reduce the complication and provide good outcome. Percutaneous cement discoplasty (PCD) is a MIS procedure, that has been recently developed for the polymorbid ageing population with vacuum disc degeneration [1]. The mechanical impact of PCD on the spine stability and on the stress/strain in the surrounding tissues have not been investigated yet. A previous preliminary work on porcine spines demonstrated interesting trends and confirmed the potential benefits of discoplasty on degenerated discs. This study aimed at: (1) testing the stability of human spine segments after discoplasty by monitoring the disc height and the range of motion, (2) assessing the strains on the specimen surface for potentially dangerous peaks.

Methods

27 fresh-frozen human thoraco-lumbar FSUs were obtained from 15 cadaveric spines (35-86 y.o.). The soft tissues around the vertebral bodies were removed, leaving intact the ligaments. The specimens were aligned with the intervertebral disc horizontal; the extremities were potted with acrylic cement. In order to measure surface strains with Digital Image Correlation (DIC), a white water-based speckle pattern was sprayed on the specimens previously stained with methylene blue (Fig. 1). The specimens were tested in flexion and extension under 50% body weight axial load combined to an offset. Images were analysed by a 3D-DIC system (Q400, Dantec) using optimized parameters.

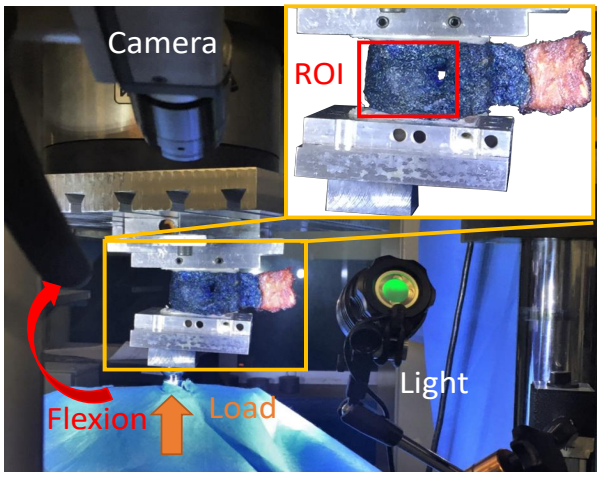

Figure 1: Experimental set-up in flexion. The Region of Interest (ROI) of DIC is located around the IVD.

The Range of Motion (ROM) and the Posterior Disc Height (PDH) were derived. The displacements and principal strains were also computed [2]. Each specimen was sequentially tested under two conditions:

- Simulated degeneration: the intervertebral disc was manually emptied through a hole in the annulus.
- after acrylic cement (Mendec Spine, Tecres) injection (discoplasty).

Results and Discussion

The PDH was significantly restored by discoplasty for both flexion and extension, increasing by 41% and 35% respectively. The ROM was significantly reduced in flexion due to the action of the posterior elements, but not significantly in extension. First and second principal strain concentrations were located on the disc surface for both motions (Fig. 2). Discoplasty decreased strain averages and concentrated first principal strain at the mid-height disc, while the second principal strain was clearly located along the endplates. Additionally, strain peaks were smaller after discoplasty, reducing the risk of local tissue damage.

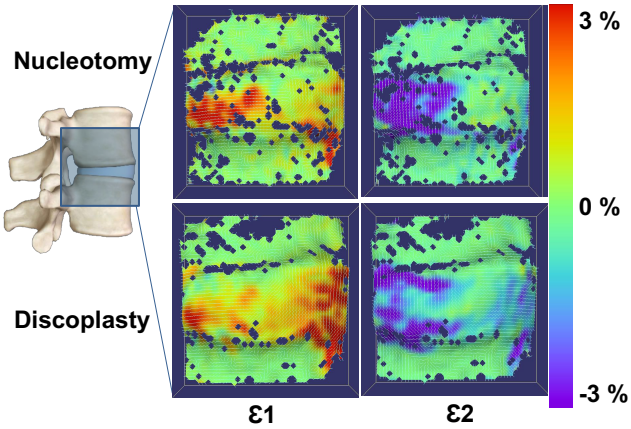

Figure 2: True principal strains (Ɛ1 and Ɛ2) at peak load in extension after nucleotomy, and discoplasty.

References

1. Varga *et al*, Der Ortho, 44:1-8,2015.
2. Palanca *et al*, MEP, 52: 76-83, 2018.

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Ethical approval

The study was approved by the bioethical committee of University of Bologna, prot. 76497, 1 June 2018. The specimens were obtained through an International donation program and the hospital of NCSD.