EX VIVO MODEL FOR PERCUTANEOUS VERTEBROPLASTY

OLIVEIRA MT1, LUCENA S1,2, POTES J1,2, QUEIROGA MC1,2, REHMAN S1,2, DALGARNO K1,2, RAMOS A1,2, REIS JC1,2

1Veterinary Medicine Department, School of Science and Technology, University of Évora, Aparado 94, 7002-554 Évora, Portugal
2Institute of Mediterranean Agricultural and Environmental Sciences (CIARA), University of Évora, Aparado 94, 7002-554 Évora, Portugal
3UFI Orthopaedics, Sheffield, United Kingdom
4School of Mechanical and Systems Engineering, Newcastle University, United Kingdom
5Biomechanics Research Group, TEMA, University of Aveiro, Portugal

Abstract. The testing of novel biomaterials for percutaneous vertebroplasty depends on suitable animal models. The aim of this study was to develop an ex vivo reproducible and feasible model of percutaneous vertebroplasty for further application in vivo. A large animal model was used (Merino sheep) due to its translational properties. Vertebroplasty was performed under tactile and fluoroscopic control through a bilateral modified paramedian access in lumbar vertebrae. Care was taken in order to avoid disruption of the vertebral foramen. The average defect volume was 1234±240 mm³, which enables practical defects to test novel injectable biomaterials. Six vertebrae were injected with a commercial cement (Cerament®, Bone Support, Sweden) and adequate defect filling was observed in all vertebrae. All vertebrae were assessed by microCT, prior to and post defect creation, and after biomaterial injection. No mechanical failure was observed under loads higher than the physiological ones. Ultimately, this model is considered suitable for pre-clinical studies, mimicking clinical application.

Introduction. Percutaneous vertebroplasty (PVP) and kyphoplasty (KP) are minimally invasive techniques used for effective vertebral augmentation in humans when conservative treatment for vertebral compression fractures is not possible or insufficient. Their purpose is to augment and stabilize the defective vertebral body by injecting percutaneously a material that will fill the bone defect. This will allow to achieve immediate pain relief and function [1-3]. In PVP small entry points for needle placement are made through the soft tissues (skin and muscles) to access the vertebrae, under fluoroscopic guidance, as an alternative to the conventional “open” approach techniques wherein an incision along the soft tissues is made. To test biomaterials for PVP, the availability of a feasible animal model close to the human conditions is vital. Sheep is considered a suitable model for biomedical research due to its availability, low animal cost, easy handling and housing, and good homogeneity, when selected for age, breed, and sex [4]. Moreover, due to its anatomical similarities when compared to human bones, regarding weight, size, bone structure, bone remodelling process and biomechanical behaviour [7-9], it is also considered a good model for orthopaedic research, as these enables the use of the same prosthetic devices [4,5].