THE SHEEP AS ANIMAL MODEL FOR THE HUMAN SPINE? – IN VIVO STUDY

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Introduction

During the past 20 years, advancements in the field of tissue engineering have resulted in numerous strategies to replace or regenerate the intervertebral disc (IVD). Yet before any of these strategies can be introduced into the clinic, extensive preclinical tests are required. Elaborate *in vitro* data suggest the suitability of sheep as representative models for the human spine. However, no studies exist, which attest the validity of the ovine IVD as an adequate biomechanical *in vivo* model. The present study aimed to gain insight into loads within the ovine disc *in vivo* in comparison with human data.

Methods

The intradiscal nucleus pressure (IDP) was measured for 24 hours within the IVD L2-L3 and L4-L5 via a piezo-resistive pressure sensor in one merino sheep (Fig. 1).

The entire data set was divided into an active and a recovery phase and the resultant average pressure values of both phases were determined. Additionally, IDPs for different *static* and *dynamic* activities of the animal were analyzed. After sacrificing the sheep, the axial forces corresponding to the measured IDPs were examined *ex vivo*.

Figure 1: a) Instrumented laboratory animal and b) experimental test set-up for monitoring.

Results

Plotting continuous records during activity and rest visualizes the creep and relaxation behavior of the ovine IVD in comparison to humans (Fig. 2). Similarities between both species can be seen in the disc long-term response; trends of pressure decrease during activity and increase during recovery are comparable. Large differences, however, were observed for different *dynamic* activities, e.g. standing up or walking, where IDP are, with 3.73 MPa and 1.60 MPa approx. two to four times higher within the ovine compared to the human IVD. Further differences are seen *ex vivo*. While non-degenerate human discs yield IDPs of ~0.1 MPa without external loads, ovine discs show ~0.25 MPa. Axial compressive forces corresponding to the *in vivo* IDPs for activity and recovery were, with 130 N and 58 N, much lower than forces estimated from *in vivo* measurements on humans, with 500-600 N and 100 N, respectively.

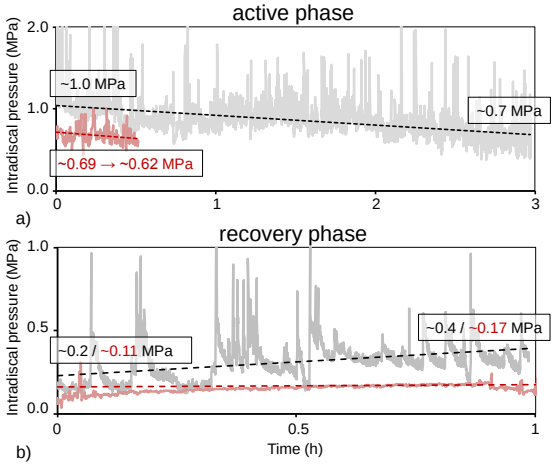

Figure 2: Temporal IDP response for active (a) and recovery phases (b) within the ovine (grey) and human (red) intervertebral disc.

Discussion

The high ovine IDPs in comparison to humans need to be considered when using sheep for preclinical tests. Due to similarities in the disc long-term behaviour, current results still suggest that despite the differences in IDP magnitude, the general mechanical function of the disc seems to be preserved across both species. Further investigations, including more animals, are recommended to more closely characterize the validity of the sheep as an animal model for intervertebral disc research.

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