A Method to Characterize the Sealing Capacity of the Acetabular Labrum

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DISCLOSURE
None of the authors has a conflict related to this presentation
Introduction

• Field et al. have demonstrated that the acetabular labrum regulates the transport of synovial fluid between the central and peripheral compartments during hip motion.¹
• They hypothesized that the flow of synovial fluid was necessary to provide nutrition to the articular cartilage.
• Others have reported that the labrum facilitates lubrication and load distribution by containing synovial fluid within the central compartment.²,³,⁴
• To evaluate these conclusions, we developed an experimental method to quantify the potential role of the labrum in regulating the flow of synovial fluid.
Methods: Specimen Preparation

- Six human hemi-pelves and femurs were dissected down to the joint capsule and potted in casting resin.
- Rigid tubing was inserted into the ilium and the intra-capsular space through sealed portals.
- Fluid pressures within both the central and peripheral compartments was continuously monitored with electronic pressure transducers.

Specimen outfitted with pressure sensors and a gate valve
Methods

- The 3D positions of the femur and pelvis were continuously measured with a motion analysis system.
- Computer models were generated by reconstruction of CT scans of each specimen.
- Reference geometries were created to allow precisely describe intra-articular displacement of the femur vs. the acetabulum during pressurization of the central compartment.
Methods

• The specimens were fixed in a neutral position in an adjustable loading apparatus which allowed ML and AP displacement of the pelvis during loading.
• A 400N axial load was applied to the femur.
• Phosphate-buffered saline was injected into the central compartment at 0.75cc/sec via a syringe pump.
• Fluid pressures within both of the compartments were continuously monitored and each bone was tracked with the motion analysis system.
Results

• The sealing ability of the labrum was defined by the maximum pressure reached within the central compartment at a given rate of infusion.

• Initially, the intra-articular pressure increased in an approximately linear manner until fluid leakage into the peripheral compartment was detected. Soon after, pressure within the central compartment reached a maximum value.

• The average compartment pressure at initiation of leakage from the central compartment was $28.7 \pm 7.9$ kPa and the ultimate pressure resistance of the labrum was $30.7 \pm 8.9$ kPa.

![Typical pressure curves of the central and peripheral compartments](image)
Registration of the motion analysis data and CT based models revealed that during pressurization the femoral head was displaced by approx. 0.8mm in a posterior-lateral direction.

3D distance of femoral head center from acetabulum center:

Unpressurized
1.13 mm (.38i - .14j + 1.05k)
Pressurized
1.89 mm (.49i - .31j + 1.80k)
Discussion

• Our results confirm that the labrum performs a sealing function and so is expected to regulate fluid flow within the joint.

• Further studies should assist us in defining the sealing capacity of the labrum during functional activities.

• This method will also help develop increased understanding of the pathomechanics of joint disease and the efficacy of alternative labral refixation techniques.

