Anatomically Contoured Dual Mobility Insert Mitigates Soft-tissue Impingement and Insert Entrapment: A Cadaver Verification Study

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Introduction: Dual Mobility (DM) implants have gained popularity for the treatment and prevention of hip dislocation, with increased stability provided by a large diameter mobile insert. However, distal regions of the insert may impinge on soft tissues like the iliopsoas, leading to groin pain. Additionally, soft-tissue impingement may trap the mobile insert, leading to excessive loading of the insert rim from engagement with the femoral neck and subsequent intra-prosthetic dislocation. To address this, an Anatomically Contoured Dual Mobility (ACDM) insert with a soft-tissue friendly distal geometry was developed (Fig.1). Previously, the ACDM insert was shown to maintain the femoroacetabular contact area and joint stability of a conventional DM insert [1,2]. The goal of this study was to utilize cadaver specimens to verify whether the ACDM insert could reduce soft-tissue impingement relative to a conventional DM insert.

Methods: Fluoroscopic imaging was used to evaluate soft-tissue interaction with ACDM and conventional DM inserts in four cadaver hips. A metal wire was sutured to the deep fibers of the iliopsoas muscle/tendon, and metal wires were embedded in the inner head and the mobile insert for fluoroscopic visualization (Fig. 2). All soft tissue except the anterior hip capsule and iliopsoas were removed, and a rope was attached to the iliopsoas to apply tension along its native orientation. A femoral stem and a DM acetabular shell were implanted so that the ACDM or conventional DM inserts, together with the inner heads, could be inserted. Fluoroscopic images of the hip joint were taken at maximum hyperextension, 0°, 15° and 30° hip flexion with the insert positioned in neutral and anteverted orientations. Neutral orientation corresponded to the insert axis parallel to the femoral neck, while anteverted orientation corresponded to a flexed insert that contacted the femoral neck posteriorly.

Results: In all hips, fluoroscopic images revealed iliopsoas tenting with the conventional DM insert, and impingement of the iliopsoas occurred at low hip flexion angles (hyperextension, 0°, 15°) with the insert in neutral and anteverted orientations (Fig. 2A). Further, at certain low flexion positions during dynamic motion, the movement of the conventional DM insert was blocked due to trapping of the insert by the anterior soft tissue and the femoral stem (Fig. 2B). At flexion angles above 30°, the iliopsoas moved
away from the mobile insert and no impingement was seen. In all hips, the soft-tissue impingement and insert trapping was significantly reduced with the ACDM insert (Fig. 2). The reduction in impingement occurred with the insert in both neutral and anteverted orientations, although it was more evident for the latter.

**Discussion:** This study showed that conventional DM inserts impinge against the iliopsoas in low flexion, and their motion can be blocked by soft-tissue impingement. The Anatomically Contoured Dual Mobility (ACDM) insert significantly reduced this undesirable soft-tissue impingement. Thus, the ACDM insert may reduce the risk of groin pain and intra-prosthetic dislocation resulting from soft-tissue impingement and entrapment of the mobile insert.

**Significance:** This biomechanical study demonstrated the mechanism of soft-tissue impingement and entrapment of the mobile insert in conventional DM implant. This undesirable soft-tissue impingement was also shown to be reduced dramatically with a novel mobile insert design.

**Figure 1:** Conventional Dual Mobility (DM) and Anatomically Contoured Dual Mobility (ACDM) inserts
Figure 2: (A) Iliopsoas impingement and tenting with Conventional DM insert relieved with use of ACDM insert. (B) Conventional DM insert trapped between iliopsoas and stem, while ACDM insert is free to move.