Contributions of the Iliofemoral Ligament and the Acetabular Labrum in Hip Stability

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INTRODUCTION

A variety of pathologic conditions have been associated with hip instability in recent years. Serving as frequent and debilitating causes of pain and discomfort, such conditions have been reported to affect the soft tissues surrounding the hip. Specifically, injuries to the capsular (iliofemoral- IF) ligaments and acetabular labrum have gained interest because they are thought to serve as primary contributors to joint stability. It has been reported that repair of a torn labrum yields excellent outcomes compared with debridement alone [1]. Moreover, IF ligament plication or shrinkage has also yielded good outcomes in various reports [1]. The improved patient outcomes with these procedures are thought to be a direct result of the restoration of hip stability provided by labral and/or IF ligament repair. However, the relative role of each of these structures in maintaining hip stability has not been shown.

The purpose of this study was to determine the relative contributions of the acetabular labrum and IF ligaments in maintaining hip joint stability as measured by external rotation and anterior translation of the femur relative to the center of the acetabulum when performing the dial test. It was hypothesized that each of these structures are vital for the stability of the hip, with increased stability provided by the IF ligament compared to the labrum. Moreover, we hypothesized that once torn, these structures could be surgically repaired to restore the stability of the hip.

METHODS

Fifteen fresh-frozen cadaveric hips with no evidence of prior injury, arthritis, or other abnormalities were used for this study. Each specimen was selectively skeletonized by removing all musculature and soft tissue, leaving only the IF ligament and acetabular labrum intact. Four tantalum microbeads with a diameter of 1.0 mm were embedded into both the femoral head and pelvis of each hip. Each specimen was mounted into a custom built hip jig that securely positioned the pelvis laterally in the biplane fluoroscopy system. Described to simulate the dial test, the femoral shaft was centered and fixed in an apparatus that allowed for standardized 5 Nm external rotation torques to be applied.

The hips were sectioned and later repairing the acetabular labrum (LabTorn) and IF ligament (LigTorn) in a randomized order. IF ligament tears were created through the entire medial and lateral arms of the ligament at a level 1 cm distal to the edge of the acetabulum, mimicking the positioning of a capsulotomy performed arthroscopically. Labral tears were created from the 12 o’clock position on right hips and the corresponding anterior-superior location on left hips, which correlated with the most commonly reported labral tear locations [2]. In specimens where the labral tear was created prior to the IF ligament tear, a 5 mm longitudinal incision was made in the anterior capsule and this tissue was re-approximated with a single #0 suture. The labrum was repaired (LabRepaired) using two 2.3 mm suture anchors. IF ligament repairs (LigRepaired) were completed using interrupted #0 sutures with care taken to re-approximate the ligament and not to overconstrict it.

At each testing condition the hips were tested in the following positions: 10° extension, 0°, 10° flexion, and 40° flexion. In order to test the reliability of the testing apparatus, the BothTorn condition was repeated at each joint angle after a thirty minute time interval and values were compared to the respective conditions.

Hips were sectioned and debrided as described by Wu et al., 2002. Reconstructed from CT scans, the bone contours were detected semi-automatically from the fluoroscopy images using model based RSA (Medis Specials, Leiden, Netherlands). The beads were automatically detected in each image and matched to its respective location in each view by finding the intersections of the rays originating from the focus positions of the x-ray generators and extending to the centers of the detected beads in the imaging planes.

A 2-way ANOVA with independent factors of hip position and sectioned condition was used to analyze the degree of external and internal rotations as well as translations. Adjusted Bonferroni/Dunn post hoc analyses were applied where appropriate with significance set at p<0.05.

RESULTS

Significant main effects were found for both the sectioned condition and hip flexion angle with regards to external rotation, but there was no interaction between the two. Post hoc analysis of the effect of sectioned condition revealed that external rotation significantly increased from the intact condition to the LigTorn condition and both torn condition (Intact: 41.5 ± 7.4 deg vs. LigTorn: 54.4 ± 6.6; p<0.0001; Both Torn: 61.5 ± 5.7; p<0.0001), but there was not a significant increase in external rotation in the labral torn condition. This relationship was mirrored in the repair conditions. Only a slight non-significant reduction in external rotation was observed in the LabRepaired condition compared to the both torn condition, while the LigRepaired condition resulted in an average of 19.0 degrees less external rotation compared to the BothTorn condition (Both Torn: 61.5 deg ± 5.7 vs. LigRepaired 42.5 ± 6.1; p<0.0001).

Additionally, the Intact and BothRepaired conditions did not display any differences (Figure 1). For hip flexion angle, the average external rotation across all cuts significantly decreased by an average of 4.8 deg ± 1.5 for each position as hip flexion decreased from 40° flexion to 10° extension. The reliability test showed no differences between the repeated BothTear conditions at any of the flexion angles, validating the testing apparatus for repeatability.

DISCUSSION

The results of this study indicate that the IF ligaments significantly regulated hip joint stability by limiting external rotation and anterior/posterior translation at varying hip angles (10° extension, 0°, 10° flexion, and 40° flexion.) The acetabular labrum only has a minor role in the stabilization of the hip and was observed to be most effective at limiting external rotation and anterior translation when paired with an intact or repaired IF ligament. These findings have significant clinical implications as they showed that once torn, both the acetabular labrum and IF ligaments can be surgically repaired to restore the native stability observed in the hip.

REFERENCES


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