The Effect of Capsulotomy and Capsular Repair on Hip Distraction: A Cadaveric Investigation

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Purpose: To quantify how increasing interportal capsulotomy size affects the force required to distract the hip and to biomechanically compare simple side-to-side suture repair to acetabular-based suture anchors as capsular repair techniques. **Methods:** Twelve fresh-frozen cadaveric hip specimens were dissected to the capsuloligamentous complex of the hip joint and fixed in a material testing system, such that a pure axial distraction of the iliofemoral ligament could be achieved. After each hip in was tested an intact state, sequential distraction was tested with 2, 4, 6, and 8 cm capsulotomies. Specimens were assigned randomly to be repaired with either 4 side-to-side suture repair (n = 6) or 2 double-loaded all-suture anchors (n = 6). The distraction force as well as the relative distraction force percentage normalized to the intact capsule were compared between suture repair and suture anchor repair groups. **Results:** Increasing the size of the capsulotomy resulted in less force required to distract the hip to 6 mm. The force decreased as the capsulotomy was extended with statistical significance in distraction force seen between the intact state and the 4 cm ($P = .003$), 6 cm ($P < .001$), and 8 cm ($P \leq .001$) capsulotomy but not for the intact state compared to the 2 cm capsulotomy ($P = .28$). Statistical significance in relative distraction force was seen for each of the capsulotomy conditions ($P < .001$ for all conditions compared with the intact state). The side-to-side suture repair construct (104.3% of intact force) required greater force to distraction to 6 mm compared with the suture anchor repair (87.1% of intact force) ($P = .008$). **Conclusions:** An interportal capsulotomy significantly affected the force required to distract the hip in a cadaveric model, with the larger the size of capsulotomy resulting in less force required to distract the hip. When we performed an interportal capsulotomy, the iliofemoral ligament strength was altered significantly but capsular repair with either side-to-side sutures or suture anchor-based repair was able to restore the capsular strength to a native intact hip. We found, however, that the side-to-side suture repair was better able to restore the distraction force compared with suture anchor repair. **Clinical Relevance:** Capsular management during hip arthroscopy remains a debated topic, with multiple techniques involving both capsulotomy and capsular closure published in the literature. This study provides insight into capsular stability against axial stress under capsulotomy and capsular repair conditions.

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During the past decade, hip arthroscopy has been used increasingly to manage intra-articular hip joint disease in both pediatric and adult populations.[1] Hip capsular management during arthroscopic procedures is receiving increasing attention, with multiple techniques for both capsulotomy and capsular repair published in the literature.[2-8] Currently, controversy exists regarding capsulotomy extent, given the delicate balance between obtaining sufficient exposure while simultaneously preventing iatrogenic instability. There also is little agreement regarding the decision to repair the capsule, which is based largely on surgeon preference.[2,9-11] At present, hip capsular management remains an important field of inquiry, given our evolving understanding of capsular contributions to overall joint stability coupled with the diversity of technical options for both capsulotomy and repair.[7,12-14]

Previous cadaveric biomechanical studies have demonstrated that capsular violation alters the rotational and translational profile of the hip joint, which can be restored after repair.[15-17] There also are several reports documenting the importance of the labrum to distractive stability of the hip joint, but there is little in the literature describing the role of the capsule in stabilizing distractive forces across the joint.[18,19] Using a cadaveric hip distraction model, we sought to quantify how increasing interportal capsulotomy size affects the force required to distract the hip and to biomechanically compare simple side-to-side suture repair with acetabular-based suture anchors (SAs) as capsular repair techniques. We hypothesized that that increasing capsulotomy size would lower distraction force and that capsular repair would at least partially restore the distractive stability of the hip.

Methods

Specimen Preparation

Twelve fresh-frozen cadaveric hip specimens consisting of the hemipelvis and femur were dissected down to the level of the hip capsule. All specimens were screened by computed tomography to ensure adequate acetabular coverage (lateral center edge angle >25°), femoral version, and the absence of significant bony pathology. Although we did not formally evaluate the cadaveric labra, we did evaluate for bony pathology such as contractures, arthritis, and arthrosis on plain radiographs and computed tomography to rule out significant pathology. Arthritis severity was assessed based on joint space width and Tonnis grade. We excluded hips that had a joint space of less than 2 mm or Tonnis grade >2.

After the pelvis was thawed for 24 hours, 2 metals screws were placed—one superior and one inferior to the acetabulum—with care to avoid violating the bony acetabular wall and the hip capsule. A third screw was drilled into the greater trochanter aligned coaxially with the femoral neck. The exposed ends of these screws were then potted in poly(methyl methacrylate) cement within cylindrical polyvinylchloride molds. Potting was undertaken such that when the poly(methyl methacrylate)/polyvinylchloride pots were aligned, distracting them would create a resultant axial force across the iliofemoral ligament (ILFL; Fig 1 A and B). In this manner, displacement would not be constricted by bony acetabular obstruction, and the majority of the force would be taken up by the ILFL. In addition, a small drill hole was introduced into the center of the acetabulum to negate the suction seal force typically present due to an intact labrum.[20]

Distraction Testing

After potting, each specimen was mounted on a materials testing system (Insight 5; MTS, Eden Prairie, MN) with the use of custom-made jigs (Fig 1 A and B). To standardize the test conditions, a baseline level of distraction was established for each specimen generated from preconditioning trials in which no excessive toe-in regions (over 1 mm) existed on a force-versus-displacement graph. From this starting position, the specimens were tested to 6 mm of distraction at a rate of 0.5 mm/s, with the force required to distract the hip 6 mm as the primary outcome measure. Distraction of 6 mm was chosen based on a model used previously by Crawford et al.[18]

For each specimen, the "zero position" of the test sequence was determined during a pretesting phase whereby the toe-in region of the stress-strain curve

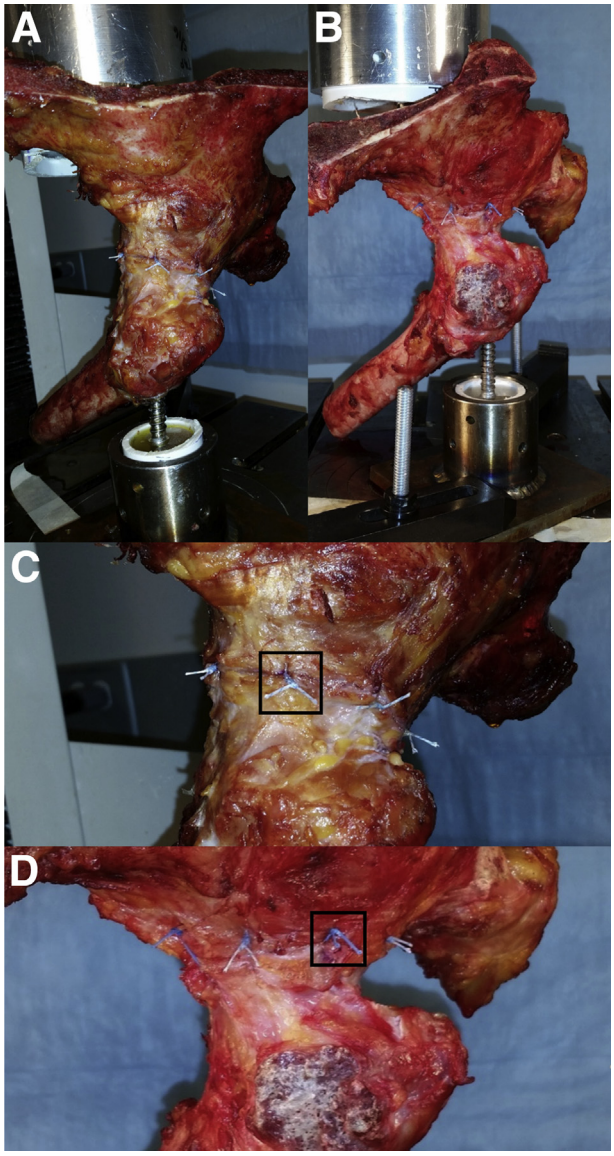

Fig 1. Experimental setup for distraction testing with the suture (A) and SA (B) repairs. Magnified views of the SS (C) and SA (D) groups to highlight suture orientation. (SA, suture anchor; SS, simple suture.)