Hip Capsular Closure: A Biomechanical Analysis of Failure Torque

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Objectives: Iatrogenic instability can result after hip arthroscopy due to capsular insufficiency, which can be avoided with an effective closure of the hip capsule. There is currently no consensus in the literature regarding the optimal quantity of sutures upon capsular closure to achieve maximal stability postoperatively. The objective of this study was to determine the strength of one-, two-, and three-suture constructs for hip capsular closure to resist external rotation and extension following a standard anterosuperior inter-portal capsulotomy (12 to 3 o'clock). Additionally, the degree of external rotation at which the suture constructs failed was recorded.

Methods: Nine pairs ($n = 18$) of fresh-frozen human cadaveric hemi-pelvises underwent anterosuperior inter-portal capsulotomies, which were repaired with one, two, or three side-to-side sutures. Each hip was secured in a dynamic, biaxial testing machine and underwent a cyclic external rotation preconditioning protocol followed by external rotation to failure (Figure 1). The non-parametric version of the BIBD ANOVA analysis (Durbin test) was used to assess the primary hypothesis that different suture numbers are associated with different torque capacities. When the omnibus Durbin test was statistically significant, post-hoc comparisons were made using Conover's method, and the Holm-Bonferroni method was used to control the type-1 error. Group medians and ranges were reported. Significance was set at $p < 0.05$.

Results: The failure torque of a one-suture hip capsular closure construct was significantly less than the three-suture construct. The failure torque for the one-suture construct was 67.4 N-m (range: 47.4 - 73.6 N-m). For two sutures, the failure torque was 85.7 N-m (range: 56.9 - 99.1 N-m) and for three sutures the failure torque was 91.7 N-m (range: 74.7 - 99.0 N-m). Repair constructs exhibited 36° (range: 22° - 64°) of external rotation at failure torque.

Conclusion: The most important finding of this study was that three sutures provided the strongest biomechanical construct, demonstrating a median maximum torque of nearly 91.7 N-m. A three-suture construct was significantly stronger than one suture; however, there was not a significant difference between two- and three-suture constructs. Additionally, constructs failed at approximately 35° of external rotation, providing an important guideline for appropriate rehabilitation to protect the capsular repair in the early postoperative period. Reestablishing the native anatomy of the hip capsule following hip arthroscopy has been reported to result in improved outcomes and reduce the risk of iatrogenic instability. Therefore, an adequate capsular closure is important to restore proper hip biomechanics, and postoperative precautions limiting external rotation should be utilized to protect the repair.

Figure 1. The hip was subjected to a cyclic external rotation preconditioning protocol, with the hip oriented in 10° of extension and under a constant axial compressive load of 5 N. Following cyclic loading, the hip was realigned to its starting position and was externally rotated to failure. Images 1 - 6 document the sequence of the failure mechanism of a two-suture capsular closure construct.

Figure 2. Boxplots of failure torques for the three different constructs (one, two, and three sutures). Dark horizontal lines represent the median, with the box representing the 25th and 75th percentiles.