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Biomechanical Assessment of Hip Capsular Repair and Reconstruction Procedures Using a 6 Degree-Of-Freedom Robotic System

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Summary:
To evaluate the effects of arthroscopically relevant conditions of the capsule through a robotic study. The results suggest that common hip arthroscopic capsulotomy procedures resulted in increased hip rotations and capsular repair and reconstruction partially restored hip range of motion. Thus, capsular repair or reconstruction should be considered in cases with risk of residual instability.

Abstract:
Abstract: Background: Although acetabular labral repair has been biomechanically validated to improve stability, capsular management of the hip remains a topic of growing interest and controversy.

Purpose: The purpose of this study was to biomechanically evaluate the effects of several arthroscopically relevant conditions of the capsule through a robotic, sequential sectioning study.

Methods: Ten human cadaveric unilateral hip specimens (mean age: 51.3 years; range: 38-65 years) from full pelvises were used to test hip range of motion (ROM) for the intact capsule and for multiple capsular conditions including portal incisions, an inter-portal capsulotomy, an inter-portal capsulotomy repair, a T-capsulotomy, a T-capsulotomy repair, a large capsular defect, and capsular reconstruction. Hips were biomechanically tested using a 6 degree-of-freedom robotic system to assess ROM with applied 5 Nm internal, external, abduction, and adduction rotation torques throughout hip flexion and extension.

Results: All capsulotomy procedures-portals, inter-portal capsulotomy, and T-capsulotomy – created significant increases in external, internal, adduction, and abduction rotations compared to the intact state throughout the full tested range of motion (-10° to 90° of flexion). The reconstruction procedure significantly reduced rotation compared to the large capsular defect state for external rotation at 15° and 90° of flexion, internal rotation at -10°, 60° and 90° of flexion, abduction rotation at -10°, 15°, 30°, 60° and 90° of flexion and adduction rotation at 0°, 15°, 30°, and 90° of flexion. Repair of a T-capsulotomy resulted in significant reductions in rotation compared to the T-capsulotomy condition for abduction rotation at -10°, 15°, 30°, 60° and 90° of flexion, and internal rotation at -10°, 60°, and 90° of flexion. Similarly, inter-portal capsulotomy repair resulted in significant reductions in abduction and internal rotations compared to inter-portal capsulotomy at 90° of flexion.

Conclusion: The results of this study suggest that common hip arthroscopic capsulotomy procedures can result in significant increases in external, internal, abduction, and adduction rotations throughout a full range (-10° to 90°) of hip flexion. However, capsular repair and reconstruction partially succeeded in restoring hip range of motion. Thus consideration should be allotted towards capsular repair or reconstruction in cases with an increased risk of residual instability.

Clinical Relevance: Although complete restoration of joint stability may not be fully achieved at time-zero, capsular repair and reconstruction may lead to improved patient outcomes by bringing hip rotational movements to near normal values in the immediate postoperative period, especially in cases where extensive capsulotomies are performed.

Keywords: Hip arthroscopy, hip capsulotomy, capsular management, hip instability, T-capsulotomy