Hip Capsule Biomechanics:
The Effect of Capsulotomy and Repair on Resistive Capsular Torque

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Disclosures

- Ryan Mlynarek, MD – None
- Amanda Wach, MS – None
- Suzanne Maher, PhD
  - Co-Founder: Agelity Biomechanics LLC
  - Co-Founder: Hydro-Gen LLC
  - Board of Directors Member: Orthopaedic Research Society
- Anil Ranawat, MD
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- Bryan Kelly, MD
  - Paid Consultant: Arthrex, Inc.
  - Unpaid Consultant, Owns Stock: A3 Surgical
Clinical Questions

- What effect do different patterns of hip capsulotomy and repair have on hip capsule biomechanics?
  - Is there a significant difference in biomechanical effects between Interportal and Short-T or Long-T capsulotomies?
  - Does the repair of capsulotomies restore native biomechanics?
  - Does the change in biomechanical properties depend on hip flexion angles?
Limitations in Current Literature

- Abrams et al. *Arthroscopy* 2015
  - 7 cadavers, no radiographic data, IP and long T-capsulotomy repair only (no IP repair alone); non-randomized; neutral and 40 deg flexion only; measured degrees of external rotation after 10-Nm torque (change in ROM <5 deg +/- 20 deg)

- Philippon et al. *AJSM* 2017
  - 7 cadavers, no radiographic data; IP, T, Capsulectomy, repairs; non-randomized; 10 deg extension, neutral, 60 deg flexion; measured degrees IR/ER with 5-Nm torques (Results found differences of 0.4-1.5 deg)
Purpose

- To evaluate the biomechanical effect (change in resistive torque on hip for given internal/external rotation) of several variations of hip capsulotomies and their subsequent repairs

Hypotheses:

- Interportal Capsulotomy alone would have minimal effect (no significant difference in hip resistive torque) compared to intact capsule

- Short and Long T-Capsulotomies would have significant difference in hip resistive torque compared to intact capsule
  - Long-T would have greater effect than Short-T capsulotomy

- No significant difference between repaired capsulotomies and intact capsule
Methods

- 10 Cadavers (age 35-65, no OA 6M, 4F)
- CT Scans to evaluate for bony limits of ROM;
- MTS Bionix System to measure resistive torque for given IR/ER in neutral ABd/Add
- Hips are fixed in randomized flexion angle (90, 40 and -20 degrees)
- Hips are randomized to different testing states
Methods (cont.)

- Femur is IR/ER at rate of 15 degrees/s with 100N of axial compression

- The intact capsule condition is tested to determine IR/ER values to reach 5-Nm of resistive torque to determine baseline for conditional testing
Capsule States Tested

Intact
Interportal
IP Repair
Short T
Short T 1-Rep
Short T 3-Rep
Long T
Long T Repair
Results

Angle-Torque Curve for External Rotation in 20 Deg Extension

- intact
- IP Cut
- Short T Cut
- Long T Cut
- IP Repair
- Short T Repair x1
- Short T Repair x3
- Long T Repair
Results – Effects of Capsulotomy Alone (ER)

- All capsulotomies significantly different than intact capsule in all hip flexion positions
- NO significant difference between IP, ST, LT at all hip positions

Pairwise Comparisons P-values

<table>
<thead>
<tr>
<th>Flexion Position</th>
<th>Intact</th>
<th>IP</th>
<th>ST</th>
<th>LT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full extension</td>
<td></td>
<td>0.010</td>
<td>0.358</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Intact</td>
<td>&gt;0.999</td>
<td>0.985</td>
<td>&gt;0.999</td>
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<tr>
<td>40 deg</td>
<td>Intact</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td>IP</td>
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<td></td>
<td>ST</td>
<td>0.998</td>
<td>0.998</td>
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<tr>
<td>90 deg</td>
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<td>&lt;0.001</td>
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<tr>
<td></td>
<td>IP</td>
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<td>&gt;0.999</td>
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<tr>
<td></td>
<td>ST</td>
<td></td>
<td>&gt;0.999</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LT</td>
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</tbody>
</table>
Results – Effects of Capsulotomy Alone (IR)

- Significant difference for full extension, 40 deg flexion for all 3 states
- NO significant diff at 90 deg flexion
- NO significant diff between IP/ST/LT
Results – Capsulotomy Repairs (ER)

External Rotation

- NO sig diff in extension between repairs/intact
- In 40 deg, significant diff in ST, LT repairs
- In 90 deg flexion, sig diff in ST-repair alone

Pairwise Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Intact</th>
<th>IP Repair</th>
<th>ST Repair (1)</th>
<th>ST Repair (3)</th>
<th>LT Repair</th>
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</thead>
<tbody>
<tr>
<td>Full extension Intact</td>
<td>0.988</td>
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<tr>
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<td>90 deg Intact</td>
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</table>
Results – Capsulotomy Repairs (IR)

Internal Rotation

- NO sig diff in extension or 90 deg flexion between repairs/intact
- In 40 deg flexion, sig diff in STR-1, Long-T Repairs

Pairwise Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Intact</th>
<th>IP Repair</th>
<th>ST Repair (1)</th>
<th>ST Repair (3)</th>
<th>LT Repair</th>
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<tbody>
<tr>
<td>Full extension</td>
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<td>0.997</td>
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<td>LT Repair</td>
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<td>40 deg</td>
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<td></td>
<td>LT Repair</td>
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Conclusions

- No significant difference in biomechanical effect between interportal capsulotomy alone versus Short-T or Long-T capsulotomy, however, there is a trend that indicates increased rotation for a given force with extension of the capsulotomy.

- Repair of the capsule in all conditions has a significant effect to improve rotational stability, but does not reach native pre-capsulotomy stability.

- All capsulotomy patterns have greatest effect on rotation of the hip in 40-degrees of flexion and least effect in 90-degrees of flexion.

- Encourage surgeons to perform the necessary capsulotomy required for adequate peripheral cam resection and to repair the capsule to restore native hip biomechanics.
References

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Philippou M1,2, Trindade CAG1, Goldsmit MT1, Rasmussen MT1, Saroki AT1, Loken S1, LaPrade RF1,2.


Khair MM1, Grzybowski JS1, Kuhns BD1, Wuerz TH2, Shewman E1, Nho SJ3.


Capsulotomy Size Affects Hip Joint Kinematic Stability.


Biomechanical Evaluation of Capsulotomy, Capsulectomy, and Capsular Repair on Hip Rotation.