Hip Instability

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Not all hip instability is the same...

Laxity

Asymptomatic passive translation of the femoral head relative to the acetabulum

Beighton criteria:
- Placing flat hands on the floor with straight legs
- Left knee bending backward
- Right knee bending backward
- Left elbow bending backward
- Right elbow bending backward
- Left thumb touching the forearm
- Right thumb touching the forearm
- Left little finger bending backward past 90 degrees
- Right little finger bending backward past 90 degrees
Instability
Symptomatic pathologic translation of the femoral head

Spectrum of Hip Instability
Traumatic → Microtrauma → Atraumatic
Laxity → No Laxity

Hip Biomechanics
Static Factors
- Stabilize femoral head in acetabulum

Dynamic Factors
Traumatic Hip Instability

High energy: motor vehicle accident

Lower energy: athletic competition with fall on flexed hip
  - Football, rugby, soccer, gymnastics, basketball, biking


Management of Acute Hip Dislocations

History and physical exam
  - Hip fixed in flexion, adduction, internal rotation
  - Neurovascular exam

Radiographs: AP & lateral views & Judet views

Acute management: closed reduction < 6 hrs
  - AVN 7-25%
  - CT scan after reduction
  - Operative
    - Acute arthroscopy for retained fragment
    - ORIF: Fracture - Dislocations

Traumatic Hip Instability

Moorman et al. (JBJS 2003)

Traumatic posterior hip subluxation have triad of posterior acetabular lip fracture, iliofemoral ligament disruption, and hemarthrosis
  - Fluoroscopic aspiration to decrease intracapsular pressure
  - PWB for 6 wks
  - Posterior hip precautions
  - Repeat MRI to determine presence of AVN
FAI Induced Hip Instability

Traumatic Hip Dislocations (Philippon et al. Arthroscopy 2009)
- All 14 RTP in professional athletes
- 9 of 14 with FAI

FAI – Induced Hip Instability (Krych et al. CORR 2012.)
- 20 of 22 patients RTP
- 18 of 22 with FAI

MOI
- No FAI: posterior directed force with hip in flexion – adduction (ie, dashboard)
- FAI: torsion and hyperflexion

Krych et al. CORR 2012.

Systematic Review

Does Femoroacetabular Impingement Cause Hip Instability? A Systematic Review
Colin D. Canham, M.D., Yi-Meng Yen, M.D., Ph.D., and Brian D. Giordano, M.D.

Atraumatic Hip Instability

Capsular laxity
- Etiology: repetitive microtrauma, generalized lig laxity, connective tissue disorders, etc.
- Symptoms: groin pain and associated snapping iliopsoas tendon in setting of hypermobility
- MOI: increased translation may cause labral injury
- Surgery: controversial
**Ehlers-Danlos Syndrome: Arthroscopic Management for Extreme Soft-Tissue Hip Instability**

Christopher M. Larsen, M.D., Rebecca M. Storie, M.S., A.T.C., Emma P. Grossi, B.S., M. Russell Giovann, P.h.D., and Geoffrey D. Correlle, D.O.

EDS hypermobility type
- Giving way and pain
- Easily distractible hip with manual traction with fluoro
- Patulous capsule intra-op
16 patients with 44.6 months follow-up (LCEA 31°, AA 63.6°, Tonnis 3.6°)
13 cases primary HA
3 cases revision HA

Hip Function Outcomes
MHHS 45.6 → 88.5
No dislocations
1 revision for continued pain
Larsen et al. Arthroscopy 2015.

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**Atraumatic Hip Instability**

**Imaging Studies**
- Radiographs / CT scan: Osseous anatomy to identify dysplasia/FAI
- MRI: attenuation of lateral insertion of PFL with max ER (60°)

**Pathomechanics**
- Normal osseous morphology
- Trends towards increased abduction and ER (ie, turnout) and decreased IR
- Femoral head subluxation of 2.05mm – 5.14mm in dancers when in splits position

**Treatment:**
- Hip arthroscopy labral refixation, capsular plication ± FAI

Charbonnier et al. AJSM 2011.
Iatrogenic Hip Instability

11 reported cases of macroinstability after hip arthroscopy

• Benali & Katthagen, Arthroscopy 2009.
• Matsuda, Arthroscopy 2009.
• Ranawat et al. JBJS 2009.
• Mei-Dan et al. Arthroscopy 2012.
• Sansone et al. KSSTA 2013.

Evidence of capsular defect following hip arthroscopy

McCormick et al. KSSTA 2013.
Why do I close the capsule?

20 yr old woman
- Oct 2011: femoral osteochondroplasty
- Oct 2012: iliopsoas lengthening

She cannot participate in any recreational activities
Groin pain worse with sitting, shoes and socks, walking on her toes

Why?

Rationale for Capsular Closure

- Understand Anatomy: Structure and Function of the IFL
- Capsulotomy
  - Size & location of interportal
  - T-Capsulotomy
- Rationale for capsular closure: anatomic repair of the IFL should restore the biomechanical characteristics of the IFL.
  1. Axial strain
  2. Translation
  3. Rotation
Thirteen fresh-frozen cadaveric specimens
Six reflective infrared markers (Eagle 4, Motion Analysis, Santa Rosa, CA)
4 conditions:
  Intact-Neutral, Intact-Flexion, Capsulotomy-Neutral, Capsulotomy-Flexion
ER torque 0.588 Nm
Bayne et al. AJO 2014.

Bayne et al. AJO 2014.

Prior cadavaric studies in our lab have demonstrated that an interportal capsulotomy increases hip rotation and translation compared to an intact hip
Increasing the size of the interportal capsulotomy has a dose dependent effect on rotation
The Effect of Capsulotomy and Capsular Repair on Hip Distraction

- The primary outcome measure was force required for 6mm of hip distraction tested at a distraction rate of 0.5 mm/sec normalized to the intact state.
- The intact state and 2cm, 4cm, 6cm, and 8cm capsulotomy conditions were tested.
- The capsule was then repaired using either the SS (Left) or SA (Right) technique.

Khair et al. Arthroscopy 2016 (Submitted).

Both SS and SA repair techniques increase the distraction force

Both SS and SA repair techniques increased distraction force to a level consistent with the intact hip.
- SS repair required a higher distraction force to 6mm (104%) than SA repair (87%).

Axial Strain

Video courtesy of Stephen Aoki, MD
Out of 1100 cases, 33 patients developed symptomatic instability after HA.
- 2 of 33 with hip dislocations
- 31 of 33 with microinstability
- All underwent index HA for treatment of FAI with interportal capsulotomy
- Revision surgery for capsular repair

Wylie et al. AJSM 2015.
Clinical Signs of Iatrogenic Microinstability

History: Pain with ADL
- Pain worse than prior to index surgery

Physical Exam
- Instability Test
- Apprehension
- Hypermobility


Capsular Adhesions


Drive Through Sign

Is Capsular Closure Necessary?

The Use of Double-Loaded Suture Anchors for Labral Repair and Capsular Repair During Hip Arthroscopy

William Slikker III, M.D., Geoffrey S. Van Thiel, M.D., M.B.A.,
Jaskarnish Chahal, M.D., F.R.C.S.C., and Shane J. Nho, M.D., M.S.

Arthroscopy Techniques 2012

Routine Complete Capsular Closure During Hip Arthroscopy

Joshua D. Gentry, M.D., William Slikker III, M.D., Anil K. Gupta, M.D., M.B.A.,
Frank M. McCormick, M.D., and Shane J. Nho, M.D., M.S.

Arthroscopy Techniques 2013
Improved Outcomes After Hip Arthroscopic Surgery in Patients Undergoing T-Capsulotomy With Complete Repair Versus Partial Repair for Femoroacetabular Impingement

A Comparative Matched-Pair Analysis

<table>
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<th>Partial Closure</th>
<th>Complete Closure</th>
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<td>Patients</td>
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<td>Gender</td>
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<td>Female</td>
<td>20</td>
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<td>20</td>
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<tr>
<td>Right</td>
<td>19</td>
<td>12</td>
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<tr>
<td>Center Edge Angle</td>
<td>33.27±5.51</td>
<td>34.15±5.57</td>
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<tr>
<td>Alpha Angle</td>
<td>56.91±11.15</td>
<td>59.43±8.27</td>
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<td>Follow-up (min-max)</td>
<td>20.63 (12-1.31.73)</td>
<td>15.08 (12-10-19.04)</td>
</tr>
</tbody>
</table>

Frank et al. AJSM 2014.
Surgical Approach

1. T-capsulotomy with closure of vertical limb only (Partial Closure)
2. T-capsulotomy with complete capsular closure (Complete Closure)

HOS ADL-SS at Pre-Op/6M/1Y

- *4 Partial Closure Patients Required Revision Surgery

Partial Closure vs. Complete Closure HOS ADL
Partial Closure vs. Complete Closure HOS SS

Survivorship of Hip Arthroscopy for Treatment of FAI and Capsular Mgt


Arthroscopic Capsular Closure

Principles for capsular closure
- Routine interportal capsulotomy in line with the joint
- Central compartment procedures can be performed
- Peripheral compartment
  - T capsulotomy between medial and lateral IFL
  - Tensioning
  - Plication stitches
- Restore biomechanical properties of the hip capsule
  - Restrain distraction, extension, ER
Is the hip an unstable joint?

Hip joint is inherently stable but is dependent on static and dynamic stabilizers:
- Identify osseous morphology
- Capsuloligamentous support
- Labrum

There are several sub-types of hip instability:
- Traumatic hip instability
- FAI-Induced instability
- Atraumatic hip instability
- Iatrogenic hip instability

Conclusions

Capsular management is an important aspect of hip arthroscopy:
- Improper management can lead to micro- or macro-instability

Capsulotomy is required for visualization and proper treatment of FAI:
- Understand the structure and function of IFL: Axial Strain, Translation, Rotation
- Clinical studies may suggest that complete capsular closure can lead to improved functional outcomes

Thank You!

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I (and/or my co-authors) have something to disclose.

Detailed disclosure information is available via:

Printed Final Agenda
AANA Education App
or
AAOS Orthopaedic Disclosure Program on the AAOS website at http://www.aaos.org/disclosure

**Disclosures**

Consultant: Stryker, Ossur
Research Support: Arthroscopy Association of North America, Stryker, Allosource

**Hip Joint Stability**

Hip joint stability

Static stabilizers
- Osseous morphology & version
- Labrum
- Capsuloligamentous
- Suction seal: negative intraarticular pressure / adhesion-cohesion

Dynamic stabilizers
- Gluteus medius and minimus
- Short external rotators
- Iliopsoas
- Neuromuscular control
- Propioception
Osseous Morphology

Radiographic Appearance of Hips
Impingement (Deep) --> Normal --> Dysplasia (Shallow)

Dysplasia

Peri-Acetabular Osteotomy
Is there a role for hip arthroscopy in dysplasia?

- 36 Hips for dysplasia (DDH in 30; Retroversion in 6) and FAI underwent HA labral debridement and osteoplasty
  • Improvement at 6 wks then deteriorated over time
  • 13 Femoral head migration
  • 14 Accelerated OA

Matsuda at el. Arthroscopy 2012.
- 2 cases of rapid acceleration of hip OA

Mei-Dan et al. Catastrophic Failure in Hip Arthroscopy Due to Iatrogenic Instability: Can Partial Division of Lig Tertis and Iliofemoral Ligament Cause Subluxation? Arthroscopy 2012.

Dysplastic Variants

- Borderline dysplasia
  - Domb et al. AJSM 2013.
    • 26 patients with CEA 22.2° (range, 18-25°) underwent HA with labral repair and capsular plication
    • 77% (17/22) G/E outcome
    • 14% (3/22) Tonnis 0 → 1
    • 9% (2/22) Revision

Dysplasia Variants

- Excessive femoral anteversion/Femoral valgus
  - Femoral anteversion > 25°
    • Iliopsoas lengthening with femoral anteversion > 25° have inferior clinical outcomes (Fabricant et al. Arthroscopy 2012.)
    • Recent studies do not show a difference in outcome and femoral version (Ferro et al. Arthroscopy 2015)
Acetabular Labrum

Deepens the socket allowing for greater coverage of the femoral head
- Maintain stability
- Decrease contact pressure

Provides a fluid seal for the hip joint

**Most common area of injury is at the capsulolabral junction**


Labral Function

Labrum maintains intra-articular fluid pressure
- Decreases with labral tear / resection
- Through-type labral repair > looped-type labral repair
- Labral reconstruction normalized IAP

Labrum stabilizes hip by maintaining suction seal at small displacement (1-2mm) but capsule has a greater role at larger displacement
- May explain microinstability in the setting of labral injury.

Neppe et al. KSSTA 2014.

Labrum Contact Mechanics

Findings: Compared to normal hips, the labrum in dysplastic hips supported a larger percentage of total load transferred to the hip

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

An in Vitro Biplane Fluoroscopy Study

Casey A. Myers, MD, Bradley C. Register, MD, Past Lettsom, MD, Leonard Episcopo, MD, W. Wex, Pennington, MD, J. K. Gharib, PhD, Robert F. LaPrade, MD, PhD, and Marc J. Prillipon, PhD

Investigation performed at the Biomechanics Research Institute of the St. Louis University Medical Center, St. Louis, Missouri.

ER and translation increased when IFL and labrum sectioned
- IFL has a significant role in limiting ER and anterior translation
- Labrum has a secondary role

Myers et al. AJSM 2011.

Quantification and correlation of hip capsular volume to demographic and radiographic predictors

Frank et al. KSSTA 2014.

Anterior Hip Capsule and Ligamentous Support

Anterior Static Stabilizers: restrains extension & external rotation
- Iliofemoral ligament (Y Ligament of Bigelow): strongest hip ligament
  - Originates from AIIS and inserts on the intertrochanteric line of femur.
  - Terminal fibers form zona orbicularis
  - “Screw home” mechanism with hip extension / ER
- Pubofemoral ligament
  - Originates from the pubic rami and inserts on the intertrochanteric crest

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Anterior Hip Capsule and Ligamentous Support
Posterior Hip Capsule and Ligamentous Support

Posterior Static Stabilizers: restrains internal rotation in flexion and extension
- Ischiofemoral ligament: originates from the ischial rim and inserts on the posterosuperior base of the GT
  - Blends with zona orbicularis posteriorly

Zona Orbicularis
- Encircles entire femoral neck
- Functions as locking ring around the femoral neck and provides stability with distraction

Ligamentum Teres
- Travels from the inferior aspect of the acetabulum at the transverse acetabular ligament to fovea of the femoral head (fovea capitis).
- Tension with adduction and ER
- May serve as a secondary stabilizing structure
- Torn LT has been described as a source of hip pain (Byrd & Jones. Arthroscopy 2004).
  - Some have recommended debridement (Hein & O’Connell. KSSTA 2011)
  - Some have recommended LT reconstruction (Amendub et al. Arth Tech 2012; Lindner Arth Tech 2012; Philippon et al. JBJS Br 2013)

Negative Intra-Articular Pressure

Pre-Capsular Venting  Post-Capsular Venting
Aim: use a cadaveric model to determine hip rotational motion differences in 5 capsular conditions
- Intact
- Interportal capsulotomy
- T-capsulotomy
- Repaired T-capsulotomy
- Capsulectomy

Methods

Seven fresh-frozen cadaveric specimens – 5M, 2F, 62 years
Muscle and soft tissue removed – capsule left intact
CT scan for morphology/motion tracking
Six reflective infrared markers (Eagle 4, Motion Analysis, Santa Rosa, CA)

Capsular interventions were performed in a single specimen sequentially:
  • Intact
  • Interportal capsulotomy (4 cm)
  • T-capsulotomy
  • Repaired T-capsulotomy
  • Capsulectomy

Results

Neutral

83.2 87.7 91.1 87.4 91.9
Intact Interportal T-Capsulotomy Repair Capsulectomy