Imaging of the Elbow in the Throwing Athlete

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Faculty Disclosure

- Consultant – Stryker Endoscopy
- Consultant – Venture MD
- Research Support – Arthrex
- Board/Committee Membership –
  - Orthopaedic Learning Center BOD
  - MLB Elbow Research Study Group
  - AOSSM Fellowship Committee

History

- 21 y.o. RHD minor league baseball pitcher
- Acute R medial elbow pain while throwing
- Unable to throw
**Predictable Series of Events in Throwers**

- Progressive osseous changes
- Peri-elbow muscle weakness
- Peri-elbow Soft Tissue contracture
- Flexor-Pronator Strain in Late Cocking/Acceleration Phases of throwing
- **UCL** injury can occur
- Ulnar Nerve Irritation/symptomatic subluxation

*General population is not routinely exposed to this “cascade of events,” but throwers are!*

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**Elbow Injury in the Thrower**

- History
- Physical Examination
- Imaging

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**Elbow Injury in the Thrower - Imaging**

- Bony changes
  - Olecranon/Coronoid spurring
  - Radio-capitellar changes
  - Medial (UCL) ossification
- Flexor-Pronator changes
  - Tendon degeneration/fraying/tearing
- **UCL** changes
  - Ligament degeneration/fraying/tearing
- Ulnar Nerve changes
  - Nerve edema
  - Nerve subluxation

*Cohen, Arthroscopy 2011
Glocott, AJSM 2014
Gustas, RCNA 2016
Joyner, JSES 2016*
IS IT WHAT I THINK IT IS?

... Imaging

Imaging

- Plain X-Rays
  - AP (45 deg), Lat, Oblique, Axial

Plain X-Rays

- Calcifications
- Radiocapitellar chondrosis
- Posteromedial spurring

ASYMPTOMATIC ABNORMALITIES EXIST!
Sampath, Sports Health 2013
Gustas, RCNA 2016
Joyner, JSES 2016
Plain X-Rays
Stress X-Rays
• MANUAL
• TELOS
Joint space widening compared to contralateral side
> .5-2mm difference

ASYMPTOMATIC ABNORMALITIES EXIST!
Rijke, RAD, 1994
Ellenbecker, AJSM, 1998

Plain X-Rays
Stress X-Rays
MRI/MRA
• T1, T2, and specialized sequences
• Coronal, Sagittal, Axial
• Intra-Articular Gadolineum
• Systematically evaluate:
  • Cartilage, Bone, Ligaments, Muscles,
    Tendons, Neurovascular Structures

MR - Cartilage/Bone
Capitellar OCD
Olecranon Stress Fx
**UCL INJURY CLASSIFICATION**

- **MRA (Joyner et al, 2016)**
  - Type 1 – Low-grade partial UCL tear; edema in UCL only
  - Type 2 – High-grade partial UCL tear; no extravasation of contrast
  - Type 3 – Complete, full-thickness UCL tear; extravasation of contrast
  - Type 4 – Tear/pathology in >1 location (i.e.-ulna & humerus)

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**MR - Muscle/Tendon**

- Biceps Tendon Tear
- Triceps Tendon Tear
MR Imaging

- MRI
- Enhanced MRI

... not perfect
... asymptomatic abnormalities exist
... subtle injuries may be missed

Imaging

- Plain X-Rays
- Stress X-Rays
- MRI/MRA
- Stress Ultrasound
  - Multifrequency
  - 13-MHz linear-array transducer
  - Electronic calipers (.01mm resolution)
  - Allows functional/dynamic assessment
Ultrasound

- Medial Epicondyle of Humerus
- UCL
- Trochlea
- Coronoid Process

SUS - Ligament

- Normal UCL, Contralat. Arm
- Torn UCL, Pitching Arm

SUS - Muscle/Tendon

- Tendinosis with Partial Tear of Common Flexor Tendon
SUS - Muscle/Tendon
Distal Biceps Tendon Tear
Triceps Tendon Partial Tear

SUS - Neurovascular
Ulnar Nerve Subluxation
Extension
Flexion

Stress Ultrasound
Evaluation of Medial Elbow Instability in a Cadaveric Model
Michael C. Cicotti B.A., MSc
Sommer Hamoudi M.D.
Christopher C. Dodson M.D.
Steven Cohen M.D.
Levon Nazarian M.D.
Michael G. Cicotti M.D.
Materials & Methods

- 12 fresh-frozen cadaveric elbows
- Baseline stress ultrasound (SUS) of the medial elbow at 30 degrees of flexion both at rest and with applied Telos valgus force (15lbs)

Sequential sectioning of medial elbow structures was then carried out
SUS with Telos valgus stress (15lbs) performed at each step of sectioning

Results

<table>
<thead>
<tr>
<th>Delta's (Combined Sectioning Sequences)</th>
<th>Mean Increase in Laxity</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of Stress</td>
<td>1.1 mm</td>
<td>0.5-1.8 mm</td>
</tr>
<tr>
<td>Transverse Band Cut (1st seq)</td>
<td>0.7 mm</td>
<td>0.2-1.3 mm</td>
</tr>
<tr>
<td>Posterior Band Cut</td>
<td>0.9 mm</td>
<td>0.3-1.3 mm</td>
</tr>
<tr>
<td>Ant. Portion of Ant. Band Cut (1st Seq)</td>
<td>2.0 mm</td>
<td>1.1-2.8 mm</td>
</tr>
<tr>
<td>Post. Portion of Ant. Band Cut (2nd Seq)</td>
<td>1.4 mm</td>
<td>0.6-2.2 mm</td>
</tr>
<tr>
<td>Entire Anterior Band</td>
<td>3.4 mm</td>
<td>2.4-4.3 mm</td>
</tr>
<tr>
<td>Flexor-Pronator Mass Cut (2nd seq)</td>
<td>0.5 mm</td>
<td>0.0-0.9 mm</td>
</tr>
</tbody>
</table>
The current study indicates that:

- SUS can identify progressive laxity with sequential sectioning of medial elbow structures identifying their relative contribution to stability
- Sectioning of the Anterior Band is the greatest contributor to medial elbow instability
- This data may allow correlation of SUS laxity findings in the injured athlete with anatomic damage to specific medial structures

Conclusions

Purpose

- To longitudinally evaluate MLB players over a 10 year period with Stress US to determine if it can be predictive of possible UCL injury
Methods & Materials

- Stress US on 348 professional pitchers at each Spring Training over a 10 year period
- Mean age = 22.8 yrs
- Mean time as pro = 2.5 yrs
- Dominant and non-dominant arms

UCL evaluated for:
- Thickness
- Hypoechoic focii
- Calcifications
- Joint space width at rest and stressed (30°)

Baseline SUS data on all players
Longitudinal comparison in players with multiple SUS during study
Players who subsequently incurred UCL injury had pre-injury SUS findings compared to asymptomatic players
Conclusions

- Those players with:
  - Dom – Non-Dom Joint Space Gapping > 1.5-2.0mm
  - Dom UCL hypoechoic foci

...may be at higher risk for UCL injury and close monitoring of ROM, strength, endurance, technique and exposure should be carried out.

AJR, 2003
AJSM, 2014

Potential Utility of a Combined Ultrasound and MR Arthrography in Imaging of Medial Elbow Pain in Baseball Players

JB Roedl, MD, FM Gonzalez, MD, Adam Zoga, MD, William Morrison, MD, MT Nevalainen, MD, Michael G. Ciccotti MD, Levon Nazarian, MD

Radiology, 2016

Methods & Materials

- 144 throwers with medial elbow pain underwent both US and MRA
- 191 Medial Elbow diagnoses included:
  - UCL tear (53)
  - Flexor-Pronator Injury (59)
  - Osteochondral Injury (48)
  - Ulnar Neuritis (31)
- Sensitivity, specificity and accuracy for each diagnosis assessed for US and MRA individually and combined

Radiology, 2016
Conclusions

- For UCL Injury:
  - US alone = 96%(Sen), 81%(Spec), 87%(Accu)
  - MRA alone = 81%, 91%, 88%
  - Combined US + MRA = 96%, 99%, 98%

- For Ulnar Neuritis:
  - MRA alone = 74%, 92%, 88%
  - Combined US + MRA = 90%, 100%, 98%

- For Flex-Pron and Osteochondral Injuries:
  - MRA alone = 94%, 93%, 97%
  - Combined US + MRA = 94%, 98%, 97%

Statistically significant added diagnostic value was noted with combined ultrasound and MR arthrography for medial elbow pain in the throwing athlete

Most especially for UCL injury

History

- 21 y.o. RHD minor league baseball pitcher
- Acute R medial elbow pain while throwing
- Unable to throw
Exam
- Moderate swelling
- ROM – 12-125 deg
- NVI; - Tinel’s
- Mild Flex/Pron tenderness, but no defect
- Pain with valgus stress and milking test

Imaging
Dominant elbow > 1.5mm gapping (2.5mm)
**Diagnosis: UCL Tear**
- Underwent R UCL Modified Jobe Reconstruction
- Rehab progressed smoothly
- At 8 months postop developed vague, recurrent R medial elbow pain while throwing

**Exam**
- No swelling
- ROM – 5-145 deg
- No Flex/Pron tenderness
- NVI; - Tinel’s
- - Milking Test
- Vague posteromed pain

**Imaging**
Dominant elbow < 1.5mm gapping (1.6mm)

Diagnosis: Kinetic Chain Deficits

- Exam revealed weak hip and core musculature with right shoulder internal rotation deficit
- Underwent Kinetic Chain Rehab
- Improved throwing mechanics
- Symptoms completely resolved; returned to competition
- Advanced to MLB

Recommendations

- Begin with a thorough history and physical exam
- Plain X-Rays should be obtained
- If symptoms and exam suggest a structural injury, then progress to advanced imaging
- MR (Arthrogram most often utilized)
- Stress Ultrasound - especially for:
  - Partial UCL injury
  - Recurrent UCL injury after reconstruction
Recommendations

- Combined Ultrasound and MR Arthrography provide added diagnostic value, especially with UCL Injury
- Asymptomatic changes exist with all imaging, particularly in throwers
- Interpret the imaging findings with respect to the history and exam
- ALWAYS treat the athlete, not the imaging!

THANK YOU.