DELTIOID LIGAMENT INJURY

Raymond Tsukuda, D.P.M., F.A.C.F.A.S.
Department of Podiatry
Kaiser Baldwin Park Medical Center
Objectives

1) Historical and recent perspective on deltidoid injuries
2) Update review on anatomy of deltidoid complex
3) Review evaluation and presentation of injury
4) Discuss controversy on treatment of injury
5) Review recent literature
6) Determine need to change treatment protocol
7) Case presentations
8) Discuss potential need for further research
History

- treatment protocol for deltoid ligament injuries have varied for years
- many feel deltoid ligament tears do not have to be repaired due to functional anatomy of ankle joint
- recent interest in medial ankle instability has made us re-evaluate if these injuries should be primarily repaired (Hintermann B and Porter DA)
- does recognizing injury in acute versus chronic state make a difference?
Incidence

- 20-40% of ankle injuries will lead to chronic instability and disability (Renstrom P. J Am Acad Orthop Surg 1994;2(5):270-80)
- Deltoid ligament injuries are seen with syndesmotic injuries and can occur up to 18% of the time with ankle sprains (Lin et al. J Orthop Sports Phys Ther 2006; 36:372-384)
- Deltoid insufficiency can be seen after chronic posterior tibial tendon dysfunction, trauma, triple arthrodesis, and total ankle arthroplasty
Occurrence

- seen either acute or chronic
- Isolated injuries are rare
- seen with syndesmotic sprains and inversion sprains
- associated mostly with fractures
  - Danis-Weber B and C
  - SER, PER, and PAB
  - Bimalleolar equivalent fractures (Porter)
**Terminology**

- Medial Ankle Instability (Hintermann)
- Deltoid Insufficiency
- Bimalleolar Equivalent Fracture Injury (Porter)
- “Invisible Injury” (Staples)
Anatomy

- Deltoid Ligament
Anatomy

- various descriptions in literature and research
- all agree multi-banded
- most agree there is a superficial and deep component
- cadaver studies show difficulty to distinguish separate ligaments
- studies also show inconsistency on what components are present in all specimens
Anatomy

  - cadaver study to detail medial anatomy of ankle
  - 16 specimens
  - 2 deep portions of deltoid:
    - deep anterior talotibial
    - deep posterior talotibial ligaments
  - 3 superficial portions:
    - naviculotibial
    - calcaneotibial
    - superficial talotibial
Anatomy

  - studies 40 cadavers
  - found 6 components
  - superficial (4)
    - tibiospring, tibionavicular, tibiocalcaneal, superficial posterior tibiotalar
  - Deep (2)
    - deep posterior tibiotalar and deep anterior tibiotalar
The Medial Collateral Ligaments of the Human Ankle Joint: Anatomical Variations.
Milner, Clare; Soames, Roger

Fig. 1. The bands of the medial collateral ligament of the human ankle joint: medial ligament intact. A, Tibial spring ligament. B, Tibionavicular ligament. C, Tibiocalcaneal ligament.
Fig. 2. Tibiospring ligament reflected, tibionavicular (B), and tibiocalcaneal (C) ligaments visible beneath.
The Medial Collateral Ligaments of the Human Ankle Joint: Anatomical Variations.
Milner, Clare; Soames, Roger


Fig. 3. Tibiospring and tibionaviclar ligaments reflected, tibiocalcaneal ligament (C) visible beneath.
Fig. 4. Tibiospring, tibionavicular, and tibiocalcaneal ligaments reflected, deep posterior tibiotalar ligament (D) visible beneath.
Fig. 6. Tibiospring and tibionavicular ligaments reflected, superficial posterior tibiotalar ligament (E) visible beneath.
Fig. 7. Location of the deep anterior tibiotalar ligament (F): tibiospring and tibionavicular ligaments reflected, deep posterior tibiotalar ligament (D) also visible.
Anatomy

- Boss AP, Hintermann B; 2002, Foot Ankle Int 23(6)547-53
  - 12 cadaver studied
  - found 5 ligaments in superficial and deep layers
  - strongest are tibiocalcaneal and deep posterior tibiotalar, next is tibiospring
  - tibiocalcaneal is longest and thickest
  - tibionavicular is more capsular
Function of Deltoid Ligament

- limits talar abduction when isolated (Close; Grath)
- stabilizes ankle against plantar flexion, external rotation and pronation (Rasmussen; Harper; Nigg)
  - superficial component crosses both ankle and subtalar joints
  - deep component crosses only ankle joint
Mechanism of Injury

- pronation (eversion) trauma leading to forced external rotation and abduction of ankle
  - running downstairs
  - landing on uneven surfaces
  - simultaneous rotation (soccer, dancing, football)
- SER, PAB, or PER ankle fractures
Pankovich Study

- 1979; Acta Orthop Scand, 50:225-236
- described various medial ankle injuries and clinical implications
- studied 102 ankle fractures and found 6 patterns:
  - rupture of deep and superficial deltoid ligaments
  - fracture of anterior colliculus
  - fracture of anterior colliculus and rupture of deep deltoid
  - fracture of posterior colliculus
  - supracollicicular fracture (most common)
  - avulsion chip fracture
Tornetta Study

- in vivo study of 27 ankles
- evaluated competence of deltoid ligament after medial malleolar fixation
- 26% deltoid incompetence with external stress after fixation
- caused by size and height of medial malleolus fragment
- thus can have both fracture and ligamentous injury
- did not talk discuss repair deltoid
Subjective Findings

- history of mechanism of injury (acute or chronic)
- unable to weight bear after injury (acute)
- ankle feels like it “gives way” (chronic)
- pain located to anteromedial and/or lateral ankle (acute and chronic)
Physical Findings

- Tenderness over ligament - how reliable?
- Hematoma common (acute)
- Pain over medial gutter or anterior margin of fibula
- Rearfoot valgus and over pronation on stance reducible with active posterior tibial tendon firing (chronic)
- Positive stress tests of the ankle
Medial ankle pain reliability?

- DeAngelis NA, Eskander MS, French BG J Orthop Trauma 2007; 21(4):244-47.
  
  - 55 patients with Weber B fracture and normal medial clear space evaluated
  - 25% had medial tenderness and a positive stress test
  - 25% had no medial tenderness but had a positive stress test
  - 42% accuracy
  - *should we stress all fractures?*
Clinical Exam of Chronic Medial Ankle Instability
Clinical Stress Tests

- Anterior drawer test
- Inversion stress
- External rotation
- Squeeze (not accurate)
Clinical Stress Test

- external rotation to evaluate integrity of deltoid
Imaging Evaluation

- Plain x rays
- Stress views
- Arthrography
- CT scan
- MRI
- Ultrasound
Radiographs

- standard AP, mortise and lateral (weight bearing if possible)
- medial clear space (MCS)
  - most reliable radiographic measurement
  - > than 2-5 mm MCS is documented as pathologic
X ray images
Stress Radiographs


- Physician does not have to be present at time of gravity stress test.

- Does not account for muscle firing.

- How often do we perform this test?
The Gravity Stress View

  - to aid in diagnosing deltoide injury to determine if surgery is needed
  - studied 8 cadavers under serial stress under sequential conditions
  - showed combined transection of superficial and deep deltoide showed
talus shift and valgus tilt
Stress Radiographs

  - cadaver study
  - looked at ankle position to measure clear space with stress
  - found ankle in dorsiflexion and external stress with >5mm medial clear space was most predictive
  - feels Michelson gravity view does not account for syndesmotic injury
  - gravity stress does not account for muscle firing
Gravity Stress Technique
MRI Images

- Normal
MRI

- Normal T2
MRI

- Deltoid Sprain T1
MRI

- Deltoid Sprain
MRI

- Deltoid Partial Tear T1
MRI

- Deltoid Partial Tear T2
MRI

- Deltoid Complete Tear
  T1
MRI

- Deltoid Complete Tear
  T2
MRI

- **Advantages:**
  - identify more detail about extent of injury
  - non-invasive
  - less risk of increase injury
  - no need for anesthesia

- **Disadvantages:**
  - higher cost
  - not always available
  - does it change prognosis???

- used MRI to identify ligaments injured in isolated fibular fractures
- retrospective look at 19 patients with widened medial clear space
- anterior-inferior tibiofibular ligament (aitfl) torn in all
- 83% had a partially torn deltoid
- challenges prior studies that the deep deltoid ligament must be completely torn to have a wide medial clear space

- used MRI to evaluate accuracy of x ray measurements
- a prospective study of 70 patients
- evaluated tibiofibular clear space, tibiofibular overlap, and medial clear space
- found only medial clear space >4 mm correlated with MRI pathology and deltoid injury
- MRI useful adjunctive tool

- retrospective review using MRI to evaluate need for surgery after positive stress test
- 21 patients with positive stress of Weber B fractures
- if MRI showed complete rupture, then surgery was performed
- 90% showed partial rupture and were treated non-operatively
- all had good to excellent functional outcome after one year
Arthroscopy

  - evaluated if medial clear space (MCS) was an accurate predictor of deltoid injury
  - MCS measured on 40 patients over 4 years with isolated displaced fibular fractures
  - false positive rates:
    - MCS > 3mm (88.5%)
    - MCS > 4 mm (53.6%)
    - MCS > 5mm (26.9%)
    - MCS > 6mm (7.7%)
  - therefore, MCS is not an accurate predictor of deltoid ligament injury
Arthroscopy


- Arthroscopic exam of 148 patients with ankle instability
  - 40% had a rupture or elongation of deltoid ligament
  - 98% of ankles with deltoid injury also had cartilage injury
  - Created grading system
Arthroscopy

  - Stage 1
    - stable; cannot open tibiotalar joint more than 2 mm
  - Stage 2
    - moderately unstable; able to introduce 5 mm scope into space
  - Stage 3
    - severely unstable, able to see posterior ankle joint with traction
Ultrasound

- Chen PY, et al. 2008; Foot Ankle Int, 29(9):883-86

- examined 15 patients with isolated fibular fractures
- 6 patients found to have complete rupture
- if ruptured, ORIF of fibula and deltoid ligament repair was performed
- no analgesia or anesthesia required to study patient
Medial Ankle Instability

  - prospective study of 52 cases
  - identified by arthroscopic and surgical exploration
  - 100% had pain in the medial gutter
  - 77% associated with lateral instability
  - 3 types identified arthroscopically
Classification of Anterior Deltoid Injury

- Hintermann B. 2003; Foot Ankle Clin N Am 8:723-38
  - Type I: proximal tear of or avulsion of deltoid
  - Type II: intermediate tear of deltoid
  - Type III: distal tear or avulsion of deltoid and spring
# Hintermann Surgical Options

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Incidence</th>
<th>Procedure</th>
<th>Post op</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Proximal</td>
<td>72%</td>
<td>repair, reattachment</td>
<td>CAM walker</td>
</tr>
<tr>
<td>II</td>
<td>Intermediate</td>
<td>9%</td>
<td>repair, reattachment two flap</td>
<td>plaster</td>
</tr>
<tr>
<td>III</td>
<td>Distal</td>
<td>19%</td>
<td>repair, reattachment</td>
<td>plaster</td>
</tr>
</tbody>
</table>
**Hintermann Techniques**

Deltoid and Syndesmosis Injury

- Porter DA; 2009, AAOS Instr Course Lect 58:575-81
  - seen in athletic population
  - challenging to detect and treat
  - 1%-18% of ankle sprains involve syndesmosis
  - must evaluate thoroughly
  - poor outcome if missed
Classification of Syndesmosis Injury


- Grade I (stable): injury to anterior deltoid ligament and distal syndesmosis, no diastasis

- Grade II (unstable): injury to anterior and deep deltoid and syndesmosis, diastasis with stress

- Grade III (unstable): injury to deltoid and syndesmosis with proximal fibular fracture, obvious
Treatment

- Grade I injury treated conservatively with boot
- Grade II and III syndesmotic injury and bimalleolar equivalent fractures are primarily repaired
  - uses #2 and #0 vicryl in horizontal suture pattern to repair deltoid ligament
  - don’t be afraid to re-examine periodically
Advantage of Repair

  - can evaluate joint for osteochondral injury
  - allows earlier range of motion
  - deters laxity
  - do not have to address potential deltoid insufficiency in the future
Treatment of Chronic Instability

- Nelson DR, Younger A; 2003 Foot Ankle Clin N Am, 8:521-37
  - repair of superficial deltoid in conjunction with NCJ arthrodesis and lateral column procedure for post traumatic planovalgus deformity
  - used peroneus longus tendon graft
Deltoid Ligament Repair Not Necessary

- many studies that support good functional outcome of bimalleolar equivalent ankle fractures treated with no deltoid ligament repair
  - Tourne, et al. (J Foot Ankle Surg, 1999)
- key is good anatomic reduction of fibular fracture and syndesmosis

- evaluated functional outcomes of bimalleolar and bimalleolar
equivalent fractures surgically repaired
- 266 patients
- evaluated at 3, 6, and 12 months
- no deltoid ligaments were repaired
- those with bimalleolar fractures had worse functional outcome scores
Long Term Outcome

  - long term outcome after SER IV ankle fractures
  - 13 year mean follow up, 36 patients
  - evaluated SER with deltoid ligament injury versus with medial malleolus fracture
  - All evaluated arthroscopically and found increase loose bodies with medial malleolus fracture group
  - found SER IV with deltoid ligament injury had better functional outcome than medial malleolar fracture group base on AOFAS hindfoot score
Complications

- chronic instability
- osteoarthritis
- posterior tibial tendon dysfunction
- loss of functional activity
- osteochondral defects
Treatment Algorithm

Adopted from Koval et al. 2007; J Orthop Trauma
Isolated Lateral malleolus fracture

Clinical and x ray exam

Ankle dislocated

MCS $> 4 \text{ mm}$

Medial Symptoms

Stress Test

MCS $> 5 \text{ mm}$

Get MRI

Deep Deltoid Intact

Deep Deltoid Rupture

Operative Treatment
Conclusions

- Critical to do thorough examination of deltoid ligament injury with acute events.
- If anatomic reduction of fibula and syndesmosis is stable, non-operative care is acceptable.
- Careful re-examination for questionable deltoid integrity is important.
- MRI and/or arthroscopy can be beneficial adjunctive tools.
- Avoid potential for chronic instability.
Case #1

- 41 yo female seen at ER after twisting fall off table
- Initial exam and diagnosed with stable SER ankle fracture
- Placed in CAM walker with crutches
Case #1

- follow up exam one week later in fracture clinic
- still significant medial tenderness and pain
- stress exam and view taken (5 mm MCS)
Case #1

- had ORIF
- no laxity or widened MCS after fibular fixation
- deltoid not repaired
Case #2

- 17 yo male soccer athlete
- division one recruit
- intermittent medial ankle pain
- recent aggravation due to rotational injury
Case study #2
Case #2

- immobilized for 10-14 days in CAM walker
- medial edema and pain resolved
- sent for aggressive proprioceptive physical therapy
- currently deciding which college to attend and playing at full functional capacity
Research

- Correlate and compare arthroscopic and MRI findings as predictive value tools.
- Is deltoid ligament alone strong enough repair?
- Proprioceptive benefit of muscle groups.
- Establish treatment protocol and long term outcome based study.
- Lateral ankle instability has shown to be effectively treated with stabilization procedures when necessary with good long term outcomes.
- Medial ankle instability still has poor objective data to support repair or no repair in acute setting.
Thanks!
Article Reviews

Residents from Providence Tarzana Podiatric Residency Program


Bibliography


Bibliography

- Hintermann B. Medial ankle instability. Foot Ankle Clin 8:723-738, 2003


• Nigg BM, Skarvan G, Frank CB, Yeadon MR. Elongation and forces of ankle ligaments in a physiological range of motion. Foot Ankle 11:30-40, 1990.


Bibliography


• Tornetta P III. Competence of the deltoid ligament in bimalleolar ankle fractures after medial malleolar fixation. J Bone Joint Surg Am