Lateral ankle instability – surgical considerations

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- No Conflicts
Overview

- Epidemiology
- Anatomy
- Classifications
- Acute Injury
- Clinical Findings
- Radiology
- Conservative Treatment
- Surgical Treatment
Ankle Sprain Facts

- One of most common F&A injuries
  - Lateral ankle sprains 85%
- 2 million acute ankle sprains per year in US
  - ~ 60% seek medical care
  - ~ $2 billion
- Peak Incidence: 15-19yo
  - 50/50 M/F
- 50% occur during athletic activity, 27% stairs
  - 30% of sports injuries = sprain

Waterman et al. JBJS. 2010.
Anterior Talofibular Ligament

- Intracapsular
- Weakest
  - Primary stabilizer in PF

- Origin: 1cm proximal to distal tip of fibula
- Insertion: lateral talar neck

- 6-10 mm wide

- Restrains plantar flexion & internal rotation of the ankle
- Prevents anterior translation of talus
Calcaneofibular Ligament

- Extra capsular
- Crosses AJ & STJ
- Critical for STJ stability

- Origin- distal tip fibula
- Insertion- calcaneus 13mm distal to STJ

- Forms floor of peroneal sheath

- Prevent excessive supination, inversion, internal rotation
**Posterior Talofibular Ligament**

- Intracapsular
- Strongest

- Origin: 10mm prox to distal tip of fibula
- Broad insertion into posterior talus → FHL groove

- Resist external rotation of talus

- Rarely injured?
- Rarely problematic in chronic ankle instability
Medial Ligaments

- Deltoid Ligaments
- Superficial vs Deep
- ~5% sprains tear deltoid ligaments
- More associated with PTTD?
• 14 cadavers
• Individuals ligament bands isolated
• All specimens with tibionavicular, tibiospring, and deep posterior tibiotalar
• Tibiocalcaneal, superficial posterior tibiotalar, deep anterior tibiotalar all variable
• Deep posterior tibiotalar largest band
Syndesmotic Ligaments

- Syndesmotic injury associated with ankle sprain 1-11%
  - Hopkinson, FAI, 1990

- Anterior Inferior Tibiofibular
  - Bassett’s

- Posterior Inferior Tibiofibular
  - Deep and SF

- Interosseous
  - Strongest
Injury Mechanism

- Lateral ligaments:
  - Injury mechanism
    - Combination of plantarflexion or dorsiflexion and inversion
Injury Mechanism

- Medial Ligaments
  - Usually forced pronation, eversion
  - External rotation of foot/talus
  - Tend to be more problematic/longer to heal than lateral injuries
  - Chronic weakness/insufficiency associated with PTTD
• Syndesmosis
  – “High ankle sprain”
  – Most often from high energy contact sport
  – Forces disrupt the mortise can result in injury
    • External talar rotation
  – Isolated syndesmotic injuries rare
    • Chronic pain from untreated/not appropriately treated in associated injuries may result in chronic symptoms
Lateral Ankle Sprains

• Rupture Rates

  – ATFL
    • 75% ruptures
    • Stressed on PF and inversion

  – CFL:
    • 60% ruptures
    • Stressed on DF and inversion

  – PTFL
    • Rarely ruptures, 5%
    • Stressed on DF
# Classification of Acute Sprains

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ligament Injury</th>
<th>Clinical Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>ATF stretched, partially torn</td>
<td>Mild swelling, point tenderness, mild restriction of ROM, difficulty WB, No laxity</td>
</tr>
<tr>
<td>II</td>
<td>ATF completely ruptured + partial tear of CFL</td>
<td>Moderate swelling, ecchymosis, localized tenderness, restricted ROM, difficulty WB, abnormal laxity</td>
</tr>
<tr>
<td>III</td>
<td>ATFL and CFL completely ruptured + capsular tear + PTFL tear</td>
<td>Diffuse swelling, ecchymosis, inability to WB</td>
</tr>
</tbody>
</table>

Predisposing Factors

• Cavus foot type
• Rigid PF 1st Ray
• Tibial/Calcaneal Varus
• Forefoot Valgus
• Peroneal muscle weakness
• Limb Length Discrepancy
• Ligamentous laxity
  – Marfans
  – Ehler’s Danlos
  – Osteogenesis Imperfecta
Intrinsic Risk Factors for Inversion Ankle Sprains in Male Subjects

• Methods
  – 241 male PE students
  – Initially evaluated at start of study

• Results
  – 44/241 (18%) sprained
  – Slower running speed, lower cardioresp endurance, decreased balance, less DF strength, less DF ROM, less coordination, faster reaction of TA and gastroc all at higher risk of sprain

• Conclusion
  – Above reflect persons at higher risk of inversion ankle injury
Intrinsic Risk Factors for Inversion Ankle Sprains in Male Subjects

Tine Marieke Willeme,† PT, PhD, Erik Wiltouwe,† PT, PhD, Kim Delbaere,† PT, PhD, Nela Mahieu,† PT, Ilse De Bourdeaudhuys‡, PSY, PhD, and Dirk De Clercq,‡ PE, PhD
From the †Department of Rehabilitation Sciences and Physiotherapy, and the ‡Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium

\[\text{TABLE 4} \]
Means and Standard Deviations for Lower Leg Alignment Characteristics for Uninjured and Injured Subjects

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Uninjured Subjects</th>
<th>Injured Subjects</th>
<th>P (Cox Regression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talocrural PF</td>
<td>52.39 ± 8.29</td>
<td>52.03 ± 8.64</td>
<td>NS</td>
</tr>
<tr>
<td>Talocrural DF (knee extended)</td>
<td>29.25 ± 7.38</td>
<td>25.88 ± 6.52</td>
<td>.013*</td>
</tr>
<tr>
<td>Talocrural DF (knee flexed)</td>
<td>34.85 ± 7.59</td>
<td>32.88 ± 6.06</td>
<td>.092</td>
</tr>
<tr>
<td>Subtalar INV</td>
<td>18.90 ± 6.49</td>
<td>19.41 ± 8.00</td>
<td>NS</td>
</tr>
<tr>
<td>Subtalar EV</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>MTPJ flexion</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>MTPJ extension</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Hip external rotation</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Hip internal rotation</td>
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<tr>
<td>Position calc unloaded (ST)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Position calc WB (STJN)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Position calc WB</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Expressed in degrees. P

\[\text{TABLE 6} \]
Means and Standard Deviations for Muscle Reaction Time of the Peroneus Longus, Peroneus Brevis, Tibialis Anterior, and Gastrocnemius Muscles for Uninjured and Injured Subjects

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Uninjured Subjects</th>
<th>Injured Subjects</th>
<th>P (Cox Regression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroneus longus</td>
<td>83.12 ± 14.12</td>
<td>75.99 ± 10.06</td>
<td>NS*</td>
</tr>
<tr>
<td>Peroneus brevis</td>
<td>80.40 ± 13.25</td>
<td>73.55 ± 10.90</td>
<td>NS*</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>89.80 ± 11.50</td>
<td>78.67 ± 10.45</td>
<td>.045*</td>
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<tr>
<td>Gastrocnemius</td>
<td>90.31 ± 16.09</td>
<td>79.76 ± 10.66</td>
<td>.033*</td>
</tr>
</tbody>
</table>

*NS, not significant.

\[\text{TABLE 5} \]
Means for Lower Leg Alignment Characteristics for Uninjured and Injured Subjects

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Uninjured Subjects</th>
<th>Injured Subjects</th>
<th>P (Cox Regression)</th>
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<tbody>
<tr>
<td>Weightbearing, % BW</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Bilat firm EO, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Bilat EC, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Bilat foam EO, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Bilat foam EC, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Unilat EO, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Unilat EC, %</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>LOS reaction time, s</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>LOS movement velocity, %s</td>
<td>5.56 ± 1.57</td>
<td>5.61 ± 1.77</td>
<td>.097</td>
</tr>
<tr>
<td>LOS directional control, %</td>
<td>79.70 ± 5.57</td>
<td>77.85 ± 6.95</td>
<td>NS</td>
</tr>
<tr>
<td>LOS endpoint excursion, %</td>
<td>80.47 ± 7.62</td>
<td>81.62 ± 9.17</td>
<td>NS</td>
</tr>
<tr>
<td>LOS max endpoint excursion, %</td>
<td>90.07 ± 5.04</td>
<td>91.50 ± 6.41</td>
<td>NS</td>
</tr>
<tr>
<td>FL distance, % BH</td>
<td>57.69 ± 6.05</td>
<td>57.73 ± 5.28</td>
<td>NS</td>
</tr>
<tr>
<td>FL contact time, s</td>
<td>.84 ± .22</td>
<td>.86 ± .21</td>
<td>NS</td>
</tr>
<tr>
<td>FL impact index, % BW</td>
<td>30.50 ± 9.67</td>
<td>31.99 ± 11.39</td>
<td>NS</td>
</tr>
<tr>
<td>FL force impulse, % BW</td>
<td>89.59 ± 22.22</td>
<td>91.69 ± 20.90</td>
<td>NS</td>
</tr>
</tbody>
</table>

*BW, body weight; NS, not significant; Bilat, bilateral stance; firm, firm surface; EO, eyes open; EC, eyes closed; foam, foam surface; unilat, unilateral stance; LOS, limits of stability; max, maximal; FL, forward lunge; BH, body height.

*Significant difference between the 2 groups (P < .05).
Clinical Presentation
Acute Lateral Ankle Sprain

• Patient Presentation
  – Rolling
  – “pop/snap”
  – +/- WB
  – Ecchymosis
  – Swelling
  – Tenderness
  – h/o sprains or laxity

• ↑ time to examination = ↓ specificity of tenderness
Presentation

• History
  – Previous ankle sprains/injury
  – Relate instability, “giving out”, difficulty with activities, pain and tenderness to lateral ankle
    • May be asymptomatic between events

• Physical Exam
  – Anterior drawer
  – Talar tilt
  – POP
  – Pain with ROM
Physical Exam

Lateral ligaments
- ATFL
- CFL
- PTFL
Clinical Exam-Lateral Ankle

- Fibula
- 5th metatarsal base
- Navicular
- LisFranc complex
- Calcaneus
- Peroneals

5th metatarsal

Fibula
Clinical Exam: Anterior Drawer

Suction/Dimple Sign
Clinical Exam – Talar Tilt
Clinical Exam - Syndesmosis

Squeeze, external rotation, palpation of AITFL
Ottawa Ankle Rules

A series of ankle x-ray films is required only if there is any pain in malleolar zone and any of these findings:
- Bone tenderness at A
- Bone tenderness at B
- Inability to bear weight both immediately and in emergency department

A series of ankle x-ray films is required only if there is any pain in mid-foot zone and any of these findings:
- Bone tenderness at C
- Bone tenderness at D
- Inability to bear weight both immediately and in emergency department
Methods
- 32 studies, 15,581 patients
- 27 studies included in meta-analysis
- Evaluated sensitivities, negative likelihood ratios

Results
- Negative likelihood ratio 0.08 for midfoot and ankle fracture
- Much more sensitive than specific

Conclusion
- Effective if used, often not in ED setting, per authors likely secondary to readily available x-ray
Imaging

- **Plain XR**
  - Ankle and foot
  - Tib/fib?
  - Concomitant pathology

- **Stress XR**
  - Drawer, tilt, external rotation

- **Ultrasound**
  - Dynamic evaluation

- **MRI**
  - Typically not in acute setting
  - Inflammation from injury
Imaging

- Talocrural angle
- Varus tilt
- Anterior drawer
- Medial clear space
- Tib fib overlap
• Mortise View
  – Tibia Fibula Overlap:
    • (AP= 5mm, 1/3 fibular width)
  – Tibia Fibula clear space
    • (AP <6mm)*
      – Most accurate
  – Symmetric Mortise
Imaging – Stress Radiographs

- Telos
- 150N

3-5mm > other side,
>10mm total
Imaging – Stress Radiographs

- Telos

>10 degrees
• External rotation XR
Treatment
Acute Surgical Repair

- Typically direct repair
- Becoming less common
  - Benefit in athletes?
- Seems to show equivocal outcomes when compared to functional treatment
Methods
- 42 consecutive professional athletes, 2 yr follow up
- Modified Brostrom for Grade III injury, clinically and radiographically
  - 30/42 had isolated ATFL and CFL rupture
  - 12/42 had concomitant OCD, deltoid injury

Results
- Faster return in isolated injury
- Lower FOAS pain/symptom scores in combined injuries
- No recurrent instability

Conclusion
- Effective for severe injuries, with return to sport around 10 wks
• Methods
  – 51 males Grade III injury, 25 randomized to surgery (direct suture repair, WB cast x 6 weeks), 26 functional treatment (Aircast brace x 3 weeks)
  – 15 surgery and 18 functional follow up of 14 years

• Results
  – All at pre-injury functional level
  – Re-injury:
    • 1/15 surgical, 7/18 functional
    • No difference in ankle score outcomes
    • No difference in anterior drawer or talar tilt
    • Increased osteoarthritis in surgical group on f/u MRI
      – Unclear why?

• Conclusion
  – Similar functional outcomes, surgery may reduce rate of re-injury but increase OA
• **Methods**
  – 12 prospective, randomized studies
    • Acute repair, cast immobilization, early mobilization
    • f/u 6m-3.8yrs
    • Return to work and return to activity

• **Results**
  – Return to work 2-4x sooner after functional treatment vs surgery/cast
  – Return to activity sooner in 4 studies with functional, 3 with surgery, and same in 5
  – No difference in pain/swelling/stiffness
  – No difference in anterior drawer/tilt (5 studies)
  – Chronic instability not different (short follow ups)

• **Conclusions**
  – Functional preferred treatment
  – Less complications than surgery
  – Can perform secondary reconstruction at later date if needed with good results
  – Exceptions: medial and lateral damage, large avulsions

**Treatment for acute tears of the lateral ligaments of the ankle. Operation, cast, or early controlled mobilization**

P Kannus and P Renstrom
Chronic Instability
Symptoms of Chronic Instability

- 20% of Acute sprains → chronic instability
- 10-20% require surgical correction
- Recurrent inversion sprains
- “Giving out”
- Pain > 3 mo post injury
- Difficulty with uneven ground
  - Associated STJ pathology?
- “Lateral Ankle Triad”
  - Synovitis, instability, peroneal tear
    (Franson & Baravarian)
Development of Instability

Chronic Ankle Instability

Mechanical Insufficiencies
- Arthrokinematic Restrictions
- Pathologic Laxity
- Degenerative Changes
- Synovial Changes

Functional Insufficiencies
- Impaired Proprioception
- Impaired Neuromuscular Control
- Strength Deficits
- Impaired Postural Control

Mechanical Instability + Functional Instability = Recurrent Ankle Sprain
Causes

- Decreased proprioception
  - Loss of mechanoreceptors
    - Joint capsule, ligaments, tendons
  - Nerve injury

- Decreased muscle strength
  - Peroneals
  - Eccentric weakness

- Ligamentous laxity
Lateral Ankle Instability

• Mechanical vs Functional Instability (Hertel, 2002)

  – Mechanical:
    • Pathologic laxity
    • Arthrokinematic restrictions
    • Synovial irritation
    • Degeneration of the joints
    • Surgical treatment

  – Functional:
    • Decreased proprioception
    • Decreased neuromuscular control
    • Decreased postural control
    • Decreased strength
    • Non surgical management
Functional Instability

• Dynamic and static restraints that work together
  – Dynamic = muscles
  – Static = ligaments

• Neuromuscular Control
  – Interaction between the nervous system and musculoskeletal system to produce a desired effect or response to a stimulus

• Open & Closed Loop Control
• **Closed Loop Control**
  - Reflex arc, mechanoreceptors
  - As ligaments are stretched an afferent signal → spinal cord → peroneals contract
  - Sprains cause damage to the proprioceptive feedback
  - Delayed reaction time to peroneal tendons
  - PT exercises
    • Balance boards
    • Proprioception training
• Open Loop Control
  – Anticipatory – before the stimulus
  – Sprains can cause reduced/delayed peroneal activation = ankle more inverted with landing

  – Training muscle activation, pre-activation
  – Visual and vestibular feedback
    • PT exercises
      – Altering jumping conditions
      – Evert ankle prior to landing
Proprioception and Muscle Strength in Subjects With a History of Ankle Sprains and Chronic Instability

Tine Willems*; Erik Witvrouw*; Jan Verstuyft†; Peter Vaes‡; Dirk De Clercq*

• Methods
  – 87 participants, 4 groups
  – Symptom free, chronic instability, sprain within 2 years w/o instability, sprain 3-5 years w/o instability
  – Proprioception and muscle strength

• Results
  – Decreased active position sense and eversion muscle strength in chronic instability group

<table>
<thead>
<tr>
<th>Table 3. Exact Error on the Proprioception Test*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Active joint-position sense</td>
</tr>
<tr>
<td>Maximal active inversion minus 5°</td>
</tr>
<tr>
<td>15° of Inversion</td>
</tr>
<tr>
<td>Passive joint-position sense</td>
</tr>
<tr>
<td>Maximal active inversion minus 5°</td>
</tr>
<tr>
<td>15° of Inversion</td>
</tr>
<tr>
<td>Eversion (Nm/kg)</td>
</tr>
<tr>
<td>30°·s⁻¹ Concentric/body weight</td>
</tr>
<tr>
<td>30°·s⁻¹ Eccentric/body weight</td>
</tr>
<tr>
<td>120°·s⁻¹ Concentric/body weight</td>
</tr>
<tr>
<td>120°·s⁻¹ Eccentric/body weight</td>
</tr>
</tbody>
</table>
Treatment-Chronic

- Non-surgical
  - RICE
  - Bracing
  - PT
  - Injections
    - Diagnostic vs therapeutic

- Surgical
  - Up to 50 different procedures described
    - Anatomic vs non-anatomic
  - More common are Brostrom and its variants
    - Modified Brostrom-Gould:
      - Direct anatomic repair of ATFL and CFL, reinforced with inferior extensor retinaculum
      - Most commonly open repairs, but arthroscopic and percutaneous described
  - Often concomitant procedures secondary to associated pathology
Methods:
• 12 pts with CAI; 9 healthy volunteers
  – CAI completed 6-wk balance training
  – Healthy controls with no training were compared at 0 and 6 wks

Results:
• CAI group who performed balance training demonstrated better performance than control participants on:
  – Baseline adjusted posttraining measures of dynamic balance in the anterior medial (P = .021), medial (P = .048), and posterior medial directions (P = .030)
  – Motoneuron pool excitability hmax/mmax ratio (P = .044)
  – Single-limb presynaptic inhibition (P = .012); and joint position sense inversion variable error (P = .017)

Conclusion:
• Results suggest that balance training may lead to a reduction in the incidence of repeated injury
Imaging

• Plain XR
  – Ankle and foot
  – Concomitant pathology
  – Predisposing pathologies

• Stress XR
  – Drawer, tilt, external rotation

• Ultrasound
  – Dynamic evaluation

• MRI
  – Associated pathology
  – Peroneal, OCD, deltoid, syndesmosis, STJ
  – Surgical planning
Advanced Imaging-MRI

- If conservative treatment fails, the next step is MRI for surgical planning.
- >80% accurate for diagnosis of OCD and peroneal tendon tears, syndesmotic injury.
- 20-40% accurate for identifying ankle impingement and synovitis.
  - Under-appreciated by musculoskeletal radiologist when compared to intraoperative findings.
Methods
- 48 pts (25 men, 23 women)
  - MRI read/agreed upon by 2 MSK trained radiologists
  - No clinical information given

Results
- ATFL
  - Full tear: 75% sensitive and 86% specific
  - Partial tear: 75% sensitive and 78% specific
  - Sprain: 44% sensitive and 88% specific
- CFL
  - Full tear: 50% sensitive and 98% specific
  - Partial tear: 83% sensitive and 93% specific
  - Sprain: 100% sensitive and 90% specific

Conclusions
- Assessment of ATFL more sensitive than CFL
- CFL findings more specific than ATFL findings
Normal MRI Anatomy
Abnormal MRI Anatomy
Associated injuries with Chronic Ankle Sprains/Instability

**Soft Tissue**
- Peroneal tenosynovitis
- Anterolateral ankle impingement
- Syndesmosis
- Talus OCD
- Medial ankle tenosynovitis
- Attenuated retinaculum/peroneal subluxation
- STJ ligaments
- Peroneal Nerve

**Osseous**
- Lateral process talus
- 5th metatarsal base
- Fibula (proximal & distal)
- Anterior process of calcaneus
- Tibia (Volkmann’s, Tillaux)
- Posterior Talus
- STJ synovitis

UPMC
Methods
– Retrospective, 61 pts

Results
– None with isolated lateral ankle injury
– Peroneal, anterolateral impingement most common

Conclusion
– High frequency of associated injuries
– Should have high index of suspicion to evaluate for concomitant injury in patient with chronic ankle instability

<table>
<thead>
<tr>
<th>Pathologic Structure</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>peroneal tenosynovitis</td>
<td>47/61</td>
<td>77 %</td>
</tr>
<tr>
<td>anterolateral impingement lesion</td>
<td>41/61</td>
<td>67 %</td>
</tr>
<tr>
<td>attenuated peroneal retinaculum</td>
<td>33/61</td>
<td>54 %</td>
</tr>
<tr>
<td>peroneal retinaculum avulsion</td>
<td>4</td>
<td></td>
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<tr>
<td>ankle synovitis</td>
<td>30/61</td>
<td>49 %</td>
</tr>
<tr>
<td>intra-articular loose body</td>
<td>16/61</td>
<td>26 %</td>
</tr>
<tr>
<td>peroneus brevis longitudinal tear</td>
<td>15/61</td>
<td>25 %</td>
</tr>
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<td>peroneus brevis + longus tear</td>
<td>2</td>
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</tr>
<tr>
<td>talus osteochondral lesion</td>
<td>14/61</td>
<td>23 %</td>
</tr>
<tr>
<td>chondral flaps</td>
<td>12</td>
<td></td>
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<tr>
<td>full thickness defect</td>
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<tr>
<td>anterior talofibular ligament avulsion</td>
<td>7/61</td>
<td>11 %</td>
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<td>accessory peroneus quatus muscle</td>
<td>5/61</td>
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<td>medial ankle tendon tenosynovitis</td>
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<td>05 %</td>
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<td>FHL tenosynovitis</td>
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<tr>
<td>PT tenosynovitis</td>
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<td></td>
</tr>
<tr>
<td>ankle capsular avulsion fracture</td>
<td>2/61</td>
<td>03 %</td>
</tr>
</tbody>
</table>
Associated Intra-articular Ankle Pathologies in Patients With Chronic Lateral Ankle Instability: Arthroscopic Findings at the Time of Lateral Ankle Reconstruction

- **Methods**
  - 28 ankles, 28 pts
  - Modified Brostrom-Gould with arthroscopy

- **Results**
  - Every patient with intra-articular pathology

- **Conclusion**
  - High incidence of intra-articular pathology associated with chronic lateral ankle instability
OLT

- Incidence of OLT in patients undergoing surgery for lateral ankle instability 17-63%
- Diagnosis
  - CT, MRI, Scope
- Treatment
  - Microfracture/subchondral drilling, allograft, autograft, ACI
• Methods
  – 85 patients, 87 ankles
    • 79 patients at follow up
  – 58 male, 27 female
  – Arthroscopy and lateral ligament repair
  – AOFAS pre/post op

• Results
  – Chondral lesions significantly decreased post-op score
  – Other pathologies without significant difference

• Conclusion
  – Chondral lesions significantly decrease outcomes in patients with chronic lateral ankle instability
Peroneal Tendon Injury

- Peroneal tendon synovitis - 75%
- Peroneal retinaculum attenuation – 50%
- Peroneal tendon Tears
  - Split tear in Peroneus Brevis 10%
Ankle Impingement

- Bassett’s ligament
  - Nikolopoulos 1st described 1982
  - Bassett 1st in English literature 1990

- Treatment with arthroscopy

- Kim et al JBJS 2000
  - 50% of patients with chronic ankle instability had anterior impingement
• Bassett’s fascicle
  - Present ~ 91% cadaver studies
  - Inferior/parallel to AITFL
  - Aggravated post-trauma
    • Tear ATFL
    • ↑ laxity of ATFL
    • Talar dome extrudes anterior on DF → Soft tissue impingement
Chronic injury can mimic lateral ankle symptoms

- Due to external rotation of the talus on the fibula
- Longer recovery
- Ossification of syndesmosis
- Overlap
- Visualized with stress test
- If ruptured allows widening of tib-fib joint and lateral shift of the talus
Peroneal Nerve Injury

• Traction Injury
• Potential cause of chronic morbidity
• Symptoms
  – Peroneal weakness, instability, paresthesias

• O’neill et al
  – Significant increase in excursion and strain on superficial peroneal nerve with ATFL transection in cadaver
Nerve injury and Grades II and III ankle sprains

ARThUR J. NITZ,* PhD, JOSEPH J. DOBNER,†‡ MD, AND DOUGLAS KERSEy,$ LTC, USA

• Methods
  – 66 consecutive Grade II/III (lateral/deltoid and lateral/deltoid/syndesmosis)
  – EMG at 2 weeks

• Results
  – Grade II
    • 17% injury to peroneal nerve
    • 10% injury to tibial nerve
  – Grade III
    • 86% injury to peroneal nerve
    • 83% injury to tibial nerve

• Conclusion
  – Severe injury (those with syndesmotic injury) more likely to have peroneal and tibial nerve injury
  – Likely contribute to functional instability
Methods
- 47 ankles, 46 pts
  - Reviewed MRI of those undergoing OR for chronic lateral ankle pathology
  - None complained of medial pain

Results
- 100% with ATFL, 91% with CFL, 49% with PTFL on MRI
- Deltoid injury in 72% of studies
  - 23% superficial, 6% deep, 43% both

Conclusion
- Deltoid complex injuries relatively common in patients undergoing lateral ankle reconstruction without medial complaints
- Clinical significance unclear
Methods of Repair/Augmentation
Methods of Repair

• Direct repair
• Augmented direct repair
  – Bone anchors
  – Internal brace
• Non anatomic/tendon reconstruction
• Arthroscopic reconstruction
Methods of Repair

• Direct repair
• Augmented direct repair
  – Bone anchors
  – Internal brace
• Non anatomic/tendon reconstruction
• Arthroscopic reconstruction
Direct Ligament Repair

• Brostrom 1966

• Gould modification 1980
  – Retinaculum

• Avoids sacrificing tendons

• 87-95% good to excellent results, large review of 460 pts (Peters, FAI)
  – Less postoperative pain, instability, and loss of inversion/eversion strength
  – Only 15-35% of patients continued to have pain and symptoms post op
  – Only 20% of intra-articular pathology seen with open lateral repair

• Addressing other pathology/intra articular?
Contraindications for Direct Repair

• Cavovarus foot types
• Obese patients
• Peroneal weakening
• Severe mechanical instability
• Poor soft tissues
• Isolated STJ instability

• As stand alone procedure
Technique – Brostrom Primary ligament repair

- Curvilinear incision anterior to fibula
- Pants over vest
- Small suture anchors
- Post op course: splint with ankle DF neutral in Eversion. NWB 2-3 wks, ankle brace for 3-6mo
Biomechanical Analysis of Brostrom Versus Brostrom-Gould Lateral Ankle Instability Repairs

• Methods
  • 10 cadaveric specimens, Telos ankle stress of 170N to simulate anterior drawer (AD) and talar tilt (TT)
  • Measured (1) intact, (2) sectioned (division of ATFL and CFL), (3) Brostrom repair, and (4) Gould modification states

• Results
  • Sectioned state demonstrated increased inversion and translation at all ankle positions during TT and AD testing
  • No significant difference between intact state and either of the repaired states
  • No difference in biomechanical stability between Brostrom repair and modified Brostrom-Gould procedure

• Conclusion
  • Additional reinforcement of lateral ankle ligament complex with inferior extensor retinaculum may be marginal at time of surgery
Methods
- 42 athletes, 4 without follow up
- Arthroscopy and ATFL direct repair
- Average of 8.7 yr follow up

Results
- 22 (58%) at preinjury sport level, 6 (16%) at lower level, 10 (26%) no longer in sport, but still physically active
- Outcomes:
  - AOFAS (51 → 90 at f/u)
  - Kaikkonen (45 → 90 at f/u)
- Arthritis:
  - None pre-op: 30% with arthritis at f/u
  - 18% with existing had worsening

Conclusion
- Most (74%) return to some level of sport at long-term follow up
- Many with development/progression of ankle arthritis
Twenty-six-Year Results After Broström Procedure for Chronic Lateral Ankle

Methods
- 31 male pts, all enrolled at Naval Academy; 22 responded
- Broström at time of treatment for chronic instability
- Mailed questionnaire with AOFAS, scale score (Good et al), single assessment numeric evaluation score
- Avg f/u 26.3 yrs (24.6-27.9)

Results

Conclusion
- Excellent long term results

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Follow-up, y</th>
<th>SANE</th>
<th>Good et al Scale</th>
<th>Mean AOFAS Score</th>
<th>Comments</th>
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<tbody>
<tr>
<td>1</td>
<td>27.9</td>
<td>80</td>
<td>3</td>
<td>93.2</td>
<td>Lost to follow-up</td>
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<td>2</td>
<td>27.7</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>27.7</td>
<td>95</td>
<td>4</td>
<td>98.9</td>
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<tr>
<td>5</td>
<td>27.6</td>
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<td>3</td>
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<td>26.4</td>
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<td>100</td>
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<td>11</td>
<td>26.3</td>
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<td>1</td>
<td>47.4</td>
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<tr>
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<td>25.4</td>
<td>80</td>
<td>3</td>
<td>64.1</td>
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<td>26</td>
<td>24.6</td>
<td>80</td>
<td>3</td>
<td>82.1</td>
<td></td>
</tr>
</tbody>
</table>

Fifteen patients scored their ankles as grade 1 as described by Good; 5, as grade 2; and 11, as grade 4. The mean functional outcome scores were divided into sections, as defined

80
Methods of Repair

- Direct repair
- Augmented direct repair
  - Bone anchors
  - Internal brace
- Non anatomic/tendon reconstruction
- Arthroscopic reconstruction
Fixation Options

- Bone tunnel
- Interference screw
- Suture anchor
  - Internal brace
  - SutureTak
  - FiberTak
• Methods
  – 40 pts
    • 20: Suture anchor (29.2m f/u); 20: Trans-osseous suture (28.4m f/u)
• Results
  – Karlsson score:
    • Anchor: 46.4 -> 90.8
    • Transosseous: 44.5 -> 89.2
  – No difference in talar tilt or anterior drawer
• Conclusion
  – No difference in outcomes between the groups, both reasonable for modified Brostrom fixation

Table 3: Comparison Between Transosseous Suture Group and Suture Anchor Group With Ankle Stress Radiographs (Mann-Whitney Test)

<table>
<thead>
<tr>
<th></th>
<th>Talar tilt angle (°)</th>
<th>Anterior talar translation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transosseous</td>
<td>Suture anchor</td>
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<tr>
<td>Preoperative</td>
<td>15.8 ± 5.1</td>
<td>17.2 ± 4.9</td>
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<tr>
<td>Postoperative (3 months)</td>
<td>4.7 ± 1.9</td>
<td>5.1 ± 2.1</td>
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<tr>
<td>Postoperative (1 year)</td>
<td>5.5 ± 2.2</td>
<td>5.8 ± 2.3</td>
</tr>
<tr>
<td>Final followup</td>
<td>5.4 ± 1.9</td>
<td>5.9 ± 2.5</td>
</tr>
</tbody>
</table>
• Methods
  – 81 pts
    • 40: bone tunnel (34.2m f/u)
    • 41: suture anchor (32.8m f/u)

• Results
  – No significant difference between the two groups for AOFAS, Karlsson, anterior drawer, or talar tilt post-op

• Conclusion
  – Both techniques effective and reliable with comparable outcomes
Internal Brace

- Uses ankle and FiberTape to reconstruct ATFL
- Can be adjusted to repair ATFL and CFL
- Created hard stop point
  - Increased stiffness?
Comparison of Broström technique, suture anchor repair, and tape augmentation for reconstruction of the anterior talofibular ligament

R. Schuh¹ · E. Benca¹ · M. Willegger¹ · L. Hirtler² · S. Zandieh³ · J. Holinka¹ · R. Windhager¹

• Methods
  – 18 fresh-frozen human anatomic lower leg specimens were randomly assigned to three different groups:
    • Traditional Broström (TB) group
    • Sutures Anchor (SA) (SutureTak) group
    • Suture Anchor with Internal Brace (IB) augmentation group
  – Torque (Nm) to resist and rotary displacement were recorded

• Results
  – In TB group, ATFL reconstruction failed at an angle of 24.1°
  – SA group failure occurred at 35.5°
  – IB group it failed at 46.9° (p = 0.02)
  – Torque at failure reached 5.7 Nm for the TB repair, 8.0 Nm for the SA repair, and 11.2 Nm for the IB group (p = 0.04)
  – There was no correlation between angle at ATFL failure, torque at failure, and BMD for the SA or IB groups.

• Conclusion
  – Internal brace with significantly higher angle of failure and failure torque relative to SA and TB
JuggerKnot-Biomet

- They're Small
  - The volume of bone that is removed with a 3.0mm drill is equivalent to four 1.4mm anchor drill holes
  - Reduces the amount of native bone removal
  - Allows for multiple points of fixation when repairing soft tissue to bone
  - Smaller diameter drill size reduces the likelihood of intersecting anchor tunnels when placing multiple anchors

- They're Strong
  - Strength is equal to or greater than some anchors two or three times larger
  - High pullout strength ranging from 20-120 lbs., depending on size of anchor

- They're All-Suture
  - Soft anchor deployment system with no rigid component
  - Eliminates the possibility of rigid material loose bodies in the joint
  - Allows blood to repair site
Methods:

- Incised ATFL on 10 matched pairs of cadaveric ankles
  - Two 1.4-mm JuggerKnot all-soft suture anchors
  - Modified Brostrom-Gould technique using 2-0 FiberWire.
- Mounted to the testing machine in 20° of plantar flexion and 15° of internal rotation and loaded to failure after the repair.
- Stiffness, failure torque, and failure angle were recorded

Results:

- No significant difference in failure torque, failure angle, or stiffness.
- No anchors pulled out of bone. The primary mode of failure was pulling through the ATFL tissue, rather than knot failure or anchor pull-out

<table>
<thead>
<tr>
<th>Repair Type</th>
<th>Failure Torque, N-m</th>
<th>Failure Angle, deg</th>
<th>Repaired Stiffness, N-mm/deg</th>
<th>Normalized Stiffness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suture</td>
<td>5.7 ± 6.5</td>
<td>19.0 ± 5.8</td>
<td>315 ± 278</td>
<td>0.6 ± 0.2</td>
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<tr>
<td>Anchor</td>
<td>6.9 ± 5.9</td>
<td>21.7 ± 7.3</td>
<td>417 ± 301</td>
<td>0.8 ± 0.3</td>
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</tbody>
</table>
FiberTak
Outcomes of the Modified Brostrom Procedure Using Suture Anchors for Chronic Lateral Ankle Instability—A Prospective, Randomized Comparison between Single and Double Suture Anchors
Byung-Ki Cho, MD, Yong-Min Kim, MD, Dong-Soo Kim, MD, Eui-Sung Choi, MD, Hyun-Chul Shon, MD, Kyoung-Jin Park, MD

- **Methods**
  - 50 pts, follow up of at least 2 years
    - 25: one anchor (30.2m f/u)
    - 25: two anchor (29.8m f/u)

- **Results**
  - Similar clinical and functional outcomes, however better post op talar tilt in double anchor group

- **Conclusion**
  - Double suture anchors provide possibility of improved mechanical stability
Complications – Primary Repair

- Poorer results if patients >250lbs
- CFL should be restored to prevent STJ laxity
- Must address underlying foot deformities
- Arthroscopy
  - 9% complications overall
  - 49% neurologic injury, distraction may increase risk
    - Most resolve by 6mo postop
  - Infection: 1.4% ankle scopes
Methods of Repair

• Direct repair
• Augmented direct repair
  – Bone anchors
  – Internal brace
• Non anatomic/tendon reconstruction
• Arthroscopic reconstruction
Graft/Reinforcement Materials

• Used in both anatomic and non-anatomic repairs

• Include:
  – Peroneal tendons
    • Elmslie 1934; Watson-Jones 1952
    • Evans 1953; Chrisman & Snook 1969
  – Achilles split tendon
  – Semitendinosis tendon
    • (Miller, 2013, FAI)
  – Palmaris longus tendon
    • (Okuda, 1999, FAI)
  – Gracillaris tendon
    • (Ibrahim, 2011, JFAS)
Figure 4. Elmslie double-ligament reconstruction.

Figure 5. Christman and Shook lateral ankle stabilization.

Figure 6. Hambly's lateral ligament reconstruction procedure.

Figure 7. Whinfield double-ligament lateral ankle stabilization.

Figure 9. Lee lateral ankle stabilization.

Figure 10. Nilsonne lateral ankle ligament repair.

Figure 11. Evans lateral ankle stabilization.
Biomechanical Properties of Commonly Used Autogenous Transplants in the Surgical Treatment of Chronic Lateral Ankle Instability

Dr. med. Michael Bohnsack, Bert Sürie, Dipl.-Ing. Ludger Kirsch, Prof. Dr. med. Nikolaus Wülker
Hannover, Germany

• **Methods**
  - 13 fresh anatomic specimens, mean age 43
  - Assessed the smallest cross-sectional area of each sample and biomechanical stability

• **Results**
  - Peroneus brevis, peroneus longus, and Achilles significantly higher biomechanically than other transplants

<table>
<thead>
<tr>
<th></th>
<th>peroneus longus</th>
<th>achilles split tendon</th>
<th>peroneus brevis</th>
<th>peroneus brevis split</th>
<th>fascia</th>
<th>corium</th>
<th>plantaris-tendon</th>
<th>periosteal flap</th>
<th>ant. talofib. ligament</th>
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<tbody>
<tr>
<td>crossectional area (cm²)</td>
<td>22.4 (±5.3)</td>
<td>38.1 (±34.6)</td>
<td>19.5 (±5.3)</td>
<td>7.7 (±1.8)</td>
<td>22.4 (±8.3)</td>
<td>45.5 (±14.2)</td>
<td>2.1 (±0.8)</td>
<td>35.3 (±15.7)</td>
<td>6 (±6)</td>
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<tr>
<td>stiffness</td>
<td>156.9</td>
<td>122</td>
<td>116.2</td>
<td>77</td>
<td>94.8 (±31.9)</td>
<td>40.9 (±14.6)</td>
<td>42.6 (±12.9)</td>
<td>30.2</td>
<td>29.5</td>
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<tr>
<td>(N/mm)</td>
<td>(±21.4)</td>
<td>(±27.9)</td>
<td>(±15.2)</td>
<td>(±20)</td>
<td>(±19.5)</td>
<td>(±11.2)</td>
<td>(±19.5)</td>
<td>(±11.2)</td>
<td>(±12.6)</td>
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<td>absorbed energy</td>
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<td>58</td>
<td>37.4</td>
<td>15.6</td>
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<td>225</td>
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<td>(%)</td>
<td>(±14.7)</td>
<td>(±28.3)</td>
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<td>(±29.4)</td>
<td>(±21.1)</td>
<td>(±6.8)</td>
<td>(±11.5)</td>
<td>(±27.5)</td>
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<td>modulus of elasticity (N/mm²)</td>
<td>191.8 (±55.8)</td>
<td>105.6 (±55.8)</td>
<td>149.7 (±56.3)</td>
<td>171.5 (±33.3)</td>
<td>59.1</td>
<td>22.5</td>
<td>442.5</td>
<td>10.3</td>
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Methods of Repair

- Direct repair
- Augmented direct repair
  - Bone anchors
  - Internal brace
- Non anatomic/tendon reconstruction
- Arthroscopic reconstruction
• **Methods**
  - 45 consecutive patients
  - “Arthroscopic repair” with double suture anchors

• **Results**
  - Followed for avg 14 months
  - Wbing with crutches at 3.3 day avg, FWB 14.4 day avg, PT at avg 21.6 day avg, shoes with stirrup ankle brace at 28.7
  - AOFAS 48.7 → 95.4
  - VAS 8 → 0.6

• **Conclusion**
  - Good clinical and functional outcomes with this technique
Methods of Repair

- Direct repair
- Augmented direct repair
  - Bone anchors
  - Internal brace
- Non anatomic/tendon reconstruction
- Arthroscopic reconstruction

- Does any of it restore mechanics?
Lateral Ligament Repair and Reconstruction Restore Neither Contact Mechanics of the Ankle Joint nor Motion Patterns of the Hindfoot

Victor R. Prisk, MD, Carl W. Imhauser, PhD, Padhraig F. O’Loughlin, MD, and John G. Kennedy, MD, FRCS

• Methods
  – 8 cadavers for compression and inversion at 0 and 20 deg PF
  – Contact at ankle joint measured
  – Compared initial with:
    • Sectioned ATFL, sectioned CFL, Brostrom, Brostrom-Gould, graft reconstruction

• Results
  – Cut ligaments caused medial and anterior shift of center of pressure
  – No difference in inversion or axial rotation with inversion in intact vs Brostrom, but Brostrom with changed location of center of pressure
    • Brostrom Gould with higher control than intact ligaments
  – Graft more accurately restored motion, but altered center of pressure

• Conclusion
  – No ligament reconstruction completely restored contact mechanics of ankle joint and hindfoot motion patterns
Post-op Management
Methods
- Cadaver study
- Prevented inversion, allowed for 30 deg plantarflexion and 10 deg dorsiflexion
- 1000 cycles (20/day x 50 days)

Results
- No difference in elongated except for repaired, unprotected group

Conclusion
- Supports protected range of motion after ligament repair

Table 1: Percent elongation for protected intact, protected sectioned, protected repaired, and unprotected repaired ATFL at the initial and final stages (mean ± SEM) (n = 6)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Initial</th>
<th>Final</th>
<th>p</th>
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<tbody>
<tr>
<td>ATFL protected intact</td>
<td>3 ± 1</td>
<td>3 ± 1</td>
<td>0.61</td>
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<tr>
<td>ATFL protected sectioned</td>
<td>4 ± 1</td>
<td>3 ± 1</td>
<td>0.20</td>
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<tr>
<td>ATFL protected repaired</td>
<td>2 ± 1</td>
<td>3 ± 2</td>
<td>0.62</td>
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<tr>
<td>ATFL repaired unprotected</td>
<td>10 ± 1*</td>
<td>12 ± 1*</td>
<td>0.02†</td>
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</table>

* Statistically significant difference between initial and final (p ≤ 0.05).
† Statistically significant difference from all protected groups (p ≤ 0.05).
• Methods
  – 49 patients; 23 male, 26 female
  – Repair of ATFL and CFL with metallic suture anchors
  – FWB POD 1 in walking boot
  – 2 year follow up

• Results
  – Significant improvement in FOAS
  – No difference in motion relative to contralateral limb
  – Failure rate 6% (residual instability)

• Conclusion
  – Immediate weightbearing tolerated in lateral ankle reconstruction

Figure 6. Diagram showing the trend in Foot and Ankle Outcome Score before and after surgery: the improvement in each subscale was significant ($P < .05$). QOL, quality of life.
• Methods
  – 33 patients with ATFL recon. Using gracilis autograft
    • 15: 4 weeks WB cast, 4 weeks WB soft ankle orthosis (Group I)
    • 18: Accelerated rehab without immobilization—WBAT in soft ankle orthosis (Group A)
      – Motion at 2-3 days; Treadmill, sport specific drills, balance board at 6-7 wks

• Results
  – No difference in scores or radiology at 2 years
  – Accelerated rehab group returned to athletic activity 5 weeks earlier

• Conclusion
  – Accelerated rehab improves return to sport without sacrificing outcome

<table>
<thead>
<tr>
<th></th>
<th>Before Surgery</th>
<th>2 Years After Surgery</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karlsson and Peterson score</td>
<td>62.3 ± 4.7 (54-72)</td>
<td>94.4 ± 7.1 (76-100)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Talar tilt angle compared with contralateral side, deg</td>
<td>8.7 ± 2.6 (7-16)</td>
<td>3.8 ± 1.5 (1-6)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Anterior displacement of the talus, mm</td>
<td>7.7 ± 1.8 (6-12)</td>
<td>4.0 ± 1.6 (2-8)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Group A</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Karlsson and Peterson score</td>
<td>64.1 ± 4.8 (57-70)</td>
<td>91.7 ± 7.7 (74-100)</td>
<td>&lt;.0001</td>
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<tr>
<td>Talar tilt angle compared with contralateral side, deg</td>
<td>10.5 ± 3.4 (6-15)</td>
<td>4.3 ± 1.8 (2-6)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Anterior displacement of the talus, mm</td>
<td>8.7 ± 2.1 (6-13)</td>
<td>4.3 ± 1.2 (3-7)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
• Lateral ankle sprains are a very common pathology which can be treated non-surgically in the acute setting

• 20% of acute sprains lead to chronic lateral ankle instability, of which 10-20% require surgical intervention

• Consider pathology associated with chronic sprains/instability

• Advanced imaging (MRI) can assist with diagnoses with chronic instability and associated pathology

• Brostrom-type procedures are primary line in surgical intervention

• Autograft, allograft, labral tape/internal brace should be considered if failed Brostrom, generalized laxity, obesity, etc

• Increasing role for arthroscopy both treatment and diagnosis associated pathology
Final thoughts