Diagnosis and Treatment of Ankle Instability and Ligamentous Injuries
An Evidence Based Approach to the Evaluation and Treatment of Ankle Instability

Jaime L. Caillet, PT, DPT, OCS, Cert. DN

Course Outline

- Relevant Anatomy and Biomechanics
- Syndesmotic and Lateral Ankle Sprain
  - Epidemiology and Etiology
  - Evaluation and Evidence Based Treatment
- Chronic Ankle Instability
  - Functional vs. Mechanical
  - Evaluation and Evidence Based Treatment
- Ankle Sprain Prevention Programs

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<table>
<thead>
<tr>
<th>Bones</th>
<th>Joints</th>
<th>Classification</th>
<th>Key ligaments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia, Fibula, Trochlea of Talus</td>
<td>Ankle/Talocrural</td>
<td>Hinge uniaxial</td>
<td>Deltoid, ATFL, CFL, talofibular</td>
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<tr>
<td>Talus (inf facets) and calcaneus (sup facets)</td>
<td>Subtalar/Talocalcaneal</td>
<td>Hinge uniaxial</td>
<td>CFL, deltoid, interosseus, talocalcaneal</td>
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<tr>
<td>Calcaneus (posterior) and cuboid (anterior)</td>
<td>Calcaneocuboid</td>
<td>Planar, nonaxial</td>
<td>Long and short plantar</td>
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<tr>
<td>Talus (talar head) and navicular (anterior and distal)</td>
<td>Talonavicular</td>
<td>Ball and socket triaxial</td>
<td>Plantar calcaneonavicular (Spring)</td>
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<td>Medial cuneiform and second metatarsal</td>
<td>Tarsometatarsal</td>
<td>Planar, nonaxial</td>
<td>Dorsal, plantar, lisfranc (interosseus)</td>
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<td>Proximal phalangeal and first metatarsal</td>
<td>First MTP</td>
<td>Bicondylar</td>
<td>Sesamoid collateral, interosseal</td>
</tr>
</tbody>
</table>

![Ligaments and Tendons of Right Ankle Lateral View](https://www.sports-medicine-institute.com)
High Ankle Sprains
Epidemiology/Etiology

• Involves disruption of the ligamentous structures between the distal syndesmotic articulation between the tibia and fibula
• 3 major ligaments:
  – anterior inferior tibiofibular ligament (AITFL)
  – posterior inferior tibiofibular ligament (PITFL),
  – interosseus ligament

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Epidemiology/Etiology

• Stabilize articulation so that fibula only rotates externally up to 2° relative to tibia and ankle mortise only widens 1mm as intact ankle joint moves from PF to DF
• Deltoid ligament injury may also occur and would result in significant ankle mortise instability
Epidemiology/Etiology

- Waterman et al looked at syndesmotic ankle sprains which may account for 10-15% of ankle sprains in athletic population
- 20,336 physically active cadets
  - 1206 ankle sprains; 6.7% were syndesmotic
  - No difference in rate of sprains based on sex
  - Analyzed by exposure found males (3.53) had greater risk than females (1.26)

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High Ankle Sprains Diagnosis
Diagnosis

• Pain localized to the AITFL, tenderness with palpation of AITFL, pain with A/P ER of foot, pain with A/P forced DF
• Heel-rise gt or antalgic gt avoiding excessive DF
• Severe swelling typically not present
• Pain may extend proximally if IOM involvement

Diagnosis

• Pain may be medial if deltoid involvement with swelling, tenderness and ecchymosis over medial ankle
• Imaging: AP and mortise view: tibiofibular clear space should be <6mm
• Stress Radiographs in DF and ER or WB
  – May have false negatives
• MRI shows high Sn and Sp
Special Tests

- **Cotton test**: Pt. supine or sitting; examiner lightly stabilizes distal tibia and grasps rear foot. Examiner attempts to move talus/calcaneus medial and laterally
  
  - Positive if incr translation of talus in mortise
    - Indicates syndesmotic instability and potential injury
    - May hear a click in ankle mortise
    - Compare to contralateral side ¹⁰⁹
Special Tests

- **Fibula Translation Test**: Supine and examiner stabilizes distal tibia with one hand and moves lateral malleolus anterior and posterior
- Positive: pain reproduced along syndesmosis

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Special Tests

- **External Rotation Test**: Maintain knee in 90 flexion and ankle in neutral, passively ER involved foot and ankle
- **Squeeze Test**: Pt. in NWB position, manually squeeze fibula and tibia together just above midpoint of calf
- Both tests **positive** with pain in area of syndesmosis ligaments

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<table>
<thead>
<tr>
<th>Article</th>
<th>Sample Size</th>
<th>Sensitivity (95% CI)</th>
<th>Specificity (95% CI)</th>
<th>LR + (95% CI)</th>
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<td>28 ankles</td>
<td>.25</td>
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<td>NA</td>
<td>NA</td>
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<td>Beumer et al</td>
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<tr>
<td>ER Test</td>
<td>294 ankles</td>
<td>NA</td>
<td>.99 (.97-.99)</td>
<td>NA</td>
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<td>Beumer et al</td>
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<tr>
<td>ER test</td>
<td>56 subjects</td>
<td>.20 (.04-.56)</td>
<td>.85 (.71-.93)</td>
<td>1.31* (.32-5.41)</td>
<td>.94* (.69-1.30)</td>
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<td>de Cesar et al</td>
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<tr>
<td>Fibula Translation Test</td>
<td>322 ankles</td>
<td>.75 (.55-.89)</td>
<td>.88 (.84-.91)</td>
<td>6.3 (4.32-9.19)</td>
<td>.28 (.15-.54)</td>
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<td>Beumer et al</td>
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<tr>
<td>Syndesmosis Squeeze Test</td>
<td>56 subjects</td>
<td>.30 (.08-.65)</td>
<td>.93 (.81-.98)</td>
<td>4.60 (1.08-9.55)</td>
<td>.75* (.50-1.13)</td>
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</table>

*Denotes confidence intervals which cross 1.0, Schwieterman et al, IJSPT 2013)

Flow chart for diagnosis and management of syndesmosis injuries
High Ankle Sprains
Treatment

• Conservative treatment if no obvious or severe tear to ligaments or bone fx
• Syndesmotic screw fixation typically needed if Grade III injury
• Outcome: varies considerably
  – Return to play weeks to 2 months
  – Reinjury rate is low

Conservative Treatment: Syndesmotic Injury

Phase One:
  – Pain and Swelling Control (RICE, ESTIM), toe curl, ankle pumps, cryotherapy
  – Temporary Stabilization (short leg cast, splint, heel lift)
  – NWB with crutches
Conservative Treatment

**Phase Two Criteria:** pain and swelling subsided, amb PWB with a.d.
- Pt. can amb PWB without pain
- Low level balance trng: B standing activity or standing on balance pad
- Lower level Tband strengthening

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Conservative Treatment

**Phase Three Criteria:** Amb FWB without pain possibly still needing heel lift or brace
- Unilateral Balance Trng
- DHR to SHR
- TM or ground walking
- Progress to fast walking

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Conservative Treatment

Phase Four Criteria: Able to perform HR in unilateral stance
- Fast pain free walk without heel lift
- Jog to run progression
- Shuttle run and cutting maneuver
- Sport specific Training

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Lateral Ankle Sprains
Epidemiology/Etiology

- Most common acute sports trauma
  - Ankle sprains account for 14% of all sports related trauma
  - 77% were lateral sprains
- ATFL is weakest ligament supporting talocrural joint at 138.9N
  - Posterior Talofibular Ligament 261.2N
  - Calcaneofibular ligament 345.7N

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Epidemiology/Etiology

• Most common mechanism: landing on PF/INV foot; foot twists medially in relation to ER tibia
• More stability in neutral position with compressive load of body. Ligaments play a greater role when in PF position especially ATFL because parallel to axis of leg when PF

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Epidemiology/Etiology

• Intrinsic risk factors include:
  – **Men**: Decreased cardiorespiratory fitness, slower running speed, decreased DF strength at 30°/sec, higher first MTP ext ROM, decreased DF ROM with knee extended

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Epidemiology/Etiology

- **Females**: Higher 1\textsuperscript{st} MTP ext ROM, decr endpoint excursion and max endpoint excursion regarding limits of stability test, less accurate passive joint inversion position sense, and less coordination of postural control\textsuperscript{140}
- Previous sprain
- Positive SLB Test (OR 2.54)\textsuperscript{126}

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Epidemiology/Etiology

- High school and collegiate basketball players: **sex** shows min difference: 25\% for Grade I in females; Grade II, III not statistically significant
- **Anatomic foot type** does not appear to show difference but solid classification system lacking in research
- Generalized **joint laxity** not predictive for ankle sprains but research is conflicting; possible trends toward ankle injury with increased laxity with anterior drawer\textsuperscript{10}

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Epidemiology/Etiology

- Extrinsic Risk factors:
  - **Bracing or taping** shows a consistent reduction in athletes having recurring ankle sprains
  - Limited research supporting effect of **shoe type** on an increase or decrease in ankle sprain

Diagnosis

- Assess postural stability
- Can use traditional ligament grading system
  - Grade I: microscopic injury
  - Grade II: intact ligaments but macroscopic stretching;
  - Grade III: complete ligament rupture
Diagnosis

• Clinical severity system:
  – **Grade I**: little swelling and tenderness, min or no functional loss, no mechanical joint instability
  – **Grade II**: some loss of function, mod pain, swelling, tenderness over involved structure, decreased ankle ROM, mild to mod joint instability
  – **Grade III**: complete ligament rupture with marked swelling, hemorrhage and tenderness; function lost and marked abn motion and stability

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Ottawa Ankle Rule
Bachmann et al, BMJ 2003

• Highly Sensitive Rule
  – 99.3% in children
  – 97.3% in adults
• Negative LR (assuming 15% prevalence of fracture)
  0.1%
• Less than 2% who were (-) for fracture actually had a fracture

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Special Tests

• Difficult in hours right after injury
• Special tests best performed 4-7 days post injury. Significant muscle guarding may occur making assessment less reliable before this time

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Special Tests

• Anterior drawer: Evaluates ATFL integrity.
• Ant. translation of talus reported physiological norms vary from 2-9 mm so compare to uninvolved to determine if pathologic
• Pain reproduced in area ant./inf. to lat malleolus

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Special Tests

• Sensitivity of test may be incr by putting ankle in 10° of PF
  – Positioning the knee at 90 ° flex and ankle at 10° PF produces most amount of torque on ATFL
  – Because passively performed in sagittal plane can be effected by noncontractile components of the Gastrocnemius-Achilles tendon complex

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Martin et al

- Pain with palpation of ATFL, lat hematoma, (+) ADT 5 da after injury
  - Sn 100%, Sp 75%
  - (+)LR = 4.13, (-)LR = 0.01

- Diagnostic Accuracy of ADT:
  - Sn 0.80 (95% CI: 0.71, 0.86). Sp: 0.74 (95% CI: 0.57, 0.85);
  - (+) LR = 3.01 (95% CI: 1.71, 5.31), (-) LR = 0.28 (95% CI: 0.18, 0.42)

Special Tests

- Talar Tilt: Evaluates CFL integrity
  - Pain inferior to the lateral malleolus
  - Can be performed in 10° DF to bias CFL
  - Greater than 10° is abnormal but can range from 5°-23°

- Diagnostic accuracy
  - Sn, 0.50 (95% CI: 0.25, 0.75) Sp, 0.88 (95% CI: 0.53, 0.98)
  - (+) LR = 4.00 (95% CI: 0.59, 27.25)
  - (-) LR = 0.57 (95% CI: 0.31, 1.07)
Treatment

- Consider phase of healing: joint protection in first 1-5 days post injury
- Decrease pain, swelling, inflammation
- Avoid being too aggressive and causing additional inflammation

Ankle Ligament Sprain: CPG

- **Strong Evidence** for external support and progressive WB
- **Moderate Evidence** for lymphatic drainage, STM, A/P talar mobilization (pain-free), in acute/protected motion phase
- **Weak Evidence** for WB functional exercises, single-limb balance activities with unstable surfaces during post acute period
- **Strong Evidence** for MT in progressive loading stage: graded joint mobs, manipulations, NWB/WB MWM to improve ROM, proprioception and WB when recovering from ankle sprain
Whitman et al

- 18-60 y/o (N=85) with hx of Gr I/II ankle sprain within last yr, pain > 3 on NPRS over last week

- Day One:
  - Thrust: rearfoot distraction, prox tibfib PA manipulation
  - Non thrust: talocrural AP, lat glide rearfoot technique, distal tibfib technique
    - Gr III-IV mob, 5x, 30sec bout
  - Achilles tendon stretching, general ROM, self mobilization within pain tol both after treatment, for HEP

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Whitman et al

- Treatment Day Two
  - Establish a priori if GROC > +5 then considered a success and finished with study
  - Same as Day One

- Treatment Day Three
  - Administered GROC to determine success; study completed and treatment at discretion of therapist

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Whitman et al

• Success:
  – 64 (75%) successful outcomes
  – 25 (55%) at 2\textsuperscript{nd} visit

• 4 predictor variables:
  – Sx worse when standing
  – Sx worse in evening
  – Navicular drop >5.0mm
  – Distal tibiofibular joint hypomobility

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Whitman et al

• 3 out of 4 variables: +LR 5.5 (95% CI, 1.08, 41.6)
  – 95% post test probability of success (using 75% pretest probability)

• If 2 out of 4 variables + LR 1.2 (95% CI, 0.67, 2.0)

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Whitman et al

- Possible explanations for benefits include positional faults after ankle sprain at distal tib-fib joint
- Ant. Positioned fibular hd has been found after acute sprain with video fluoroscopy
- Could be subgroup of patients with these variables that may benefit from addition of MT

Whitman et al: Study Limits

- Subjects with short duration ankle pain (Mean 22 days)
- Possibly did not capture all potential predictor variables in exam
- Prospective cohort design
- Study may be capturing natural progression of ankle sprain vs. response to PT
  - Ankle sprain resolves within 2 wks significantly; study looked at pts. with longer duration sx (3 wks)

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Truyols-Dominguez et al

- Randomized 50 18-60 y/o with hx of grade I,II ankle sprain in <5 days
- Compared exercise protocol with thrust/non thrust manip to exercise protocol with thrust/non thrust manip and myofascial MT
  - 4 sessions/1x per week
- Same package of care as previous study plus:
  - Pressure-release techniques to gastroc, fibularis
  - Static strokes and cross handed techniques over gastroc, TA

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Truyols-Dominguez et al

- Outcomes: measured at baseline, after last treatment session, at 1 month f/u
- Combined approach adding myofascial technique had better outcomes after 4 wks and 1 mo after end of therapy
  - Between group change statistically significant but did not surpass previously reported MCID for pain (2.1 points)

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Truyols-Dominguez et al

- Theorized that manual techniques acts over central pain control by stimulating desc inhibitory pain mechanisms
- Also had a reduction in PPT over ATFL, CFL, lat malleolus, med malleolus
  - Decr mechanical sensitivity and antinociceptive effects with myofascial interventions

Study Limits

- Lack of a control group
- One therapist provided rx
- Attention bias: more time with PT due to myofascial technique
- Short term f/u: one month
- Between group differences were statistically significant but not clinically meaningful
Chronic Ankle Instability (CAI)
Epidemiology/Etiology

• CAI: classify both functional and mechanical instability of ankle joint
• Up to 32-74% with previous hx of ankle sprain have residual and chronic symptoms

Epidemiology/Etiology

• Characteristics: recurrent sprain, mechanical instability, ‘giving way’ of ankle, functional instability, pain and swelling
• Sensorimotor deficits play role in chronic sx
• Characteristics of pts with recurrent injury not homogenous

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Epidemiology/Etiology

- **Functional Ankle Instability**: Minimally accepted criteria as described by Freeman:
  - Suffered one ankle sprain
  - Subjective feeling of ankle giving way

- **Mechanical instability**: presence of incr rearfoot INV laxity or excessive talocrural anterior excursion

Chronic Ankle Instability (CAI): Diagnosis

- Discrepancy exists on how to classify patients into these 2 categories (Mechanical vs. Functional)
- Cumberland Ankle Instability Tool (CAIT)
  - 9 item questionnaire designed to evaluate severity of functional ankle instability
  - Scored 0-30 (worst to best)
  - ICC 0.96
Diagnosis

– Score of ≥ 28, Sn 85.5, Sp 82.6 in differentiating those who have experienced a sprain or not
– Score of ≥ 28 = Sn 82.9, Sp 74.7 in differentiating between individuals with and without FAI

International Ankle Consortium
Gribble et al, JOSPT 2013

Standard inclusion/exclusion criteria for ankle instability research:
1. Hx of at least 1 significant ankle sprain
2. Report of “giving way” or “feeling of instability”
3. Ankle instability questionnaire cutoff scores
   • Ankle instability instrument: “Yes” to 5 ?’s
   • CAIT: score of ≤24
   • Identification of Functional Ankle Instability: score of ≥ 11
Treatment

• Sefton et al (N=12) looked at 6 wks of balance training (8 females, 4 males) with CAI
  – Examined Modified SEBT, SLS, motorneuron pool excitability at soleus (dbl limb soleus H-reflex), paired reflex depression, recurrent inhibition, joint kinesthesia
  – Balance trng: 3x/wk x 6 wks using marble maze, 4 levels of difficulty; 3 min x4 trials

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Sefton et al

• SEBT/dynamic balance improved vs. controls in AM, Med, PM directions
• Higher paired reflex depression (presynaptic) in SLS after trng
• Ability to modulate response important in maintaining balance in challenging conditions

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Sefton et al

• Motorneuron pool excitability can vary between CAI and healthy controls.
  – est. # of motorneurons excited under specific conditions; reflex response can effect postural control and response to perturbations
• Incr Hmax/Mmax ratio in CAI group posttrng so higher # of motorneurons recruited suggesting reflex response can be modified with rehab protocols

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Sefton et al

• JPS can be limited in CAI
• Study produced significantly lower INV variable error in CAI vs. controls which may improve ankle sensorimotor control
• Limits: trng healthy group may get similar results, self reported CAI, small sample size, one type of program

Hip Kinematics During a Stop-Jump Task in Patients With Chronic Ankle Instability
Brown et al

• 3 groups: copers, MAI, FAI
• **MAI group** displayed different hip motion patterns than copers
  – Greater hip flex at initial contact, greater max hip flex and ER than coper group
  – Greater total hip flex displacement than coper and FAI

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Brown et al

• Explanations for the changes:
  • Ankle laxity
  • Changed hip extensor activity causing incr hip flexion kinematics
  • Sensorimotor system changes
  • Hip strategy vs. ankle strategy\textsuperscript{13}

Lateral Ankle Sprains Prevention

• Direct costs treating ankle sprains for 15-18 y/o soccer and basketball players was $70 million, indirect costs $1.1 billion (est. 2003)
• Can also lead to long term disability\textsuperscript{77}
Prevention

McGuine and Keene (N=765) M/F high school basketball and soccer players
5 phase program using these exercises:
• SLS on flat surface with EO/EC
• Functional sport activities such as throwing, catching, dribbling on 1 leg
• Maintaining DLS while rotating balance board
• SLS on balance board with EO/EC
• Functional sport activities in SLS on board

Prevention

• In season trng program ↓ ankle sprain rate by 38%
• Also reduced rate of re-injury in subjects with history of ankle sprain
  – Risk of sustaining an ankle injury if had previous injury in last 12 months was 2.14 (95% CI, 1.25-3.65)
  – Participation reduced risk to 0.56 (95% CI, 0.33-0.95)
Study Limits

- Recall bias: self report questionnaire; Responses could be inaccurate
- Lack of subject blinding and ATCs knew what teams were in what groups; inherent in this type of study
- Ratio of female: male = 2:1
  - Female parents more compliant and interested in participating

Clinical Guideline
Kerkhoffs et al

- Conflicting evidence for use of prevention programs
  - 2 RCTs and 2 SRs suggest training can prevent
  - One SR shows no significant benefit at 6-9 mos.
- Recommended after ankle sprain to train balance and coordination especially among athletes within 12 mos after the injury
  - Can be included in regular training or home based
### Timed unipedal stance test

<table>
<thead>
<tr>
<th>Age and Gender</th>
<th>EO, Mean 3 trials (sec); ICC=0.994 Mean (SE)</th>
<th>EC, Mean 3 trials (sec); ICC=0.998 Mean (SE)</th>
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<tr>
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<td>Female</td>
<td>7.4 (10.7)</td>
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### Caffrey et al

<table>
<thead>
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<th>Test</th>
<th>Psychometric</th>
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<tr>
<td><strong>Figure of 8</strong></td>
<td>ICC=0.95, SEM=1.66 sec, MDC=4.59 sec</td>
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<tr>
<td><strong>Side-hop</strong></td>
<td>ICC=0.84, SEM=2.10 sec, MDC=5.82</td>
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<td><strong>6-meter crossover hop</strong></td>
<td>ICC=0.96, SEM=0.37 sec, MDC=1.03 sec</td>
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<tr>
<td><strong>Square hop</strong></td>
<td>ICC=0.95, SEM=0.37 sec, MDC=3.88 sec</td>
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Star Excursion Balance Test

- Inexpensive, quick reliable method
- Tests dynamic balance
- Stand on stable base and reach in 8 directions: medial, lateral, anterior, anterolateral, anteromedial, posterior, posteriolateral, posteromedial
- Combined sagittal, transverse, and frontal plane movements
SEBT

- Used in research including lower leg injuries, CAI
- Research supports use to:
  - Identify dynamic balance deficits
  - Predict risk of lower limb injury
  - Determine response to rehab, training programs

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SEBT

- Reach in one direction has been found to correlate to other 7 directions
  - 3 directions recommended: Anterior, PM, PL
- 4 practice trials appropriate for clinical research
- Test-retest reliability ICC=0.84-0.92

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Normative data for the SEBT

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<td></td>
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<td>Gender</td>
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<td>Anterior</td>
<td>79.2 ± 7.0</td>
<td>76.9 ± 6.2</td>
</tr>
<tr>
<td>Posterior</td>
<td>97.7 ± 9.5</td>
<td>90.7 ± 10.7</td>
</tr>
<tr>
<td>Lateral</td>
<td>80.0 ± 17.5</td>
<td>79.8 ± 13.7</td>
</tr>
<tr>
<td>Anterolateral</td>
<td>103 ± 3</td>
<td>102 ± 6</td>
</tr>
<tr>
<td>Anteromedial</td>
<td>90.4 ± 13.5</td>
<td>85.5 ± 13.2</td>
</tr>
<tr>
<td>Posteroakstalateral</td>
<td>112 ± 4</td>
<td>111 ± 5</td>
</tr>
</tbody>
</table>

Data from Lanning et al., 2006 and Gribble and Hertel 2003, expressed as a percentage of leg length.