Chronic Ankle Instability

HISTORICAL PERSPECTIVE

CLINICAL EVALUATION

TREATMENT GUIDELINES

"When Can I Return to Sport"

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ANKLE SPRAINS

Most common injury in Sports (40%)

Colville

23,000 sprains / day in U.S.

Makhani, McCullock

Account for 10% of all ER visits in U.S.

Holmer

Long term sequelae occur in up to 50% of patients

Anderson, Brostrom, Freeman, Smith

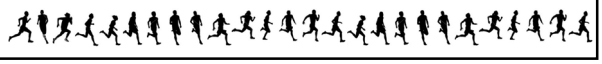
Long Term Sequelae

The development of residual instability with pain and swelling will occur in 20% to 40% of people after a Grade II lateral ankle sprain.

Bosien, 1955
Brand, 1977
Itay, 1982
Yeung, 1994
Dettori, 1994
Verhagen, 1995
Gerber, 1998

Biology of Ankle Sprain Tx

1. **Immediately after injury: RICE**
   - ~minimizes hemorrhage, swelling, inflammation, cellular metabolism, pain.
2. **Protection of ligaments: week 1-3**
   - ~proliferation phase: collagen production
   - ~ligament stress ⇨ Type III (weaker) collagen



Biology of Ankle Sprain Tx

3. **Controlled mobilization: week 4-8**
   - ~maturation phase: final scar formation
   - ~controlled exercise ⇨ increased mech strength of ligament collagen fiber orientation.
4. **Final Maturation and Remodeling: 6-12 mos**
   - ~ Full return to activity
   - ~ Full neuromuscular control

RETURN TO PRE INJURY ACTIVITY

With Functional Treatment Protocol:

GRADE III
6 weeks

Ardevol, 2002

GRADE II
12 days

Wilson, 2002

J Athl Train. 2008 Sep-Oct;43(5):523-9. Ankle ligament healing after an acute ankle sprain: evidence-based approach. Hubbard TJ, Hicks-Little CA.

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OBJECTIVE: To perform a systematic review to determine the healing time of the lateral ankle ligaments after an acute ankle sprain.
DATA SOURCES: We identified English-language research studies from 1964 to 2007 by searching MEDLINE, Physiotherapy Evidence Database (PEDro), SportDiscus, and CINAHL using the terms ankle sprain, ankle rehabilitation, ankle injury, ligament healing, and immobilization.
STUDY SELECTION: We selected studies that described randomized, controlled clinical trials measuring ligament laxity either objectively or subjectively immediately after injury and at least 1 more time after injury.
CONCLUSIONS/RECOMMENDATIONS: In the studies that we examined, it took at least 6 weeks to 3 months before ligament healing occurred. However, at 6 weeks to 1 year after injury, a large percentage of participants still had objective mechanical laxity and subjective ankle instability. Direct comparison among articles is difficult because of differences in methods. More research focusing on more reliable methods of measuring ankle laxity is needed so that clinicians can know how long ligament healing takes after injury. This knowledge will help clinicians to make better decisions during rehabilitation and for return to play.

ANKLE INSTABILITY

- **Mechanical**
- **Functional**

MECHANICAL INSTABILITY

Objective Measures:

- **Anterior drawer**
- **Talar tilt**
- **Ligamentous laxity**
- **FF & RF deformities**
- **Tibial varum**
- **Ankle axis deviation**

Stress Radiographs

Karlsson J, Bergsten T, Lasinger O, et al: Surgical treatment of chronic lateral instability of the ankle joint. Am J Sports Med 17:208-274,1989

Anterior drawer – Absolute Displacement: 10mm
Side to side: >3mm

Talar Tilt – Side to side: >10º

STRESS RADIOGRAPHY

Stress radiography has long been utilized to diagnose mechanical instability of the lateral ligaments of the ankle. However, the reliability of these measures has been questioned. Radiographic measure of anterior drawer and talar tilt show a low sensitivity (50 and 36%) but a high specificity (100%). A critical review of seven studies of stress radiography to diagnose ligament rupture after acute ankle sprain concluded that talar tilt and anterior drawer stress x-rays are not reliable enough to make the diagnosis of ligament rupture regardless of whether mechanical devices or local anesthesia are used. Presently, the only possible valid use of stress radiography is in the evaluation of patients with chronic mechanical instability of the ankle.

Breitenseher MJ, Trattnig S, Kukla C, Gaebler C, Daider, A, Baldt M et al. MRI versus lateral stress radiography in acute lateral ankle ligament injuries. Journal of Computer Assisted Tomography 1997 March/April; 21(2): 280-285.

Ray, RG; Christensen, JC; Gusman, DN: Critical evaluation of anterior drawer measurement methods in the ankle. Clin Orthop Relat Res, 215 – 224, 1997.

Harper, MC: Stress radiographs in the diagnosis of lateral instability of the ankle and hindfoot. Foot Ankle, 13:435 – 438, 1992.

Lohrer, H; Nauck, T; Arentz, S; Sch¨oll, J: Observer reliability in ankle and calcaneocuboid stress radiography. Am J Sports Med

SENSITIVITY vs SPECIFICITY

High sensitivity indicates that a test can be used for excluding, or ruling out, a condition when it is negative, but does not address the value of a positive test.

Specificity indicates the ability to use a test to recognize when the condition is absent. A highly specific test has relatively few false positive results, and therefore speaks to the value of a positive test.

Sackett DL. A primer on the precision and accuracy of the clinical examination. *JAMA.* 1992;267:2638–2644.

Schulzer M. Diagnostic tests: a statistical review. *Muscle Nerve.* 1994;17:815– 819

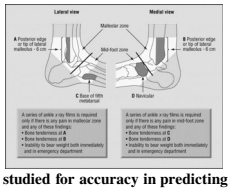
IMAGING THE ACUTE ANKLE SPRAIN

Imaging Osseous Injuries

Radiographs are ordered for 80 to 95% of patients who present to the hospital emergency room after foot and ankle trauma, yet studies reveal that only 15% of these patients actually have a bone fracture. (1-3) The Ottawa Ankle Rules were developed to reduce unnecessary radiography of ankle sprain patient.. These rules are a clinical decision guideline which state that radiographs of the ankle are necessary only when there is pain in the malleolar zone and the patient exhibits any of the following findings: (1) bone tenderness along the distal 6 cm of posterior edge of the of the medial or lateral malleolus, or (2) bone tenderness directly on the tip of the medial or lateral malleolus, or (3) inability to bear weight and walk 4 steps immediately after the injury or at the emergency department. Radiographs of the feet are indicated when there is pain in the midfoot zone and any of the following findings: (1) bone tenderness of the navicular or base of the 5th metatarsal, or (2) inability to bear weight and walk 4 steps immediately after the injury or at the emergency room.

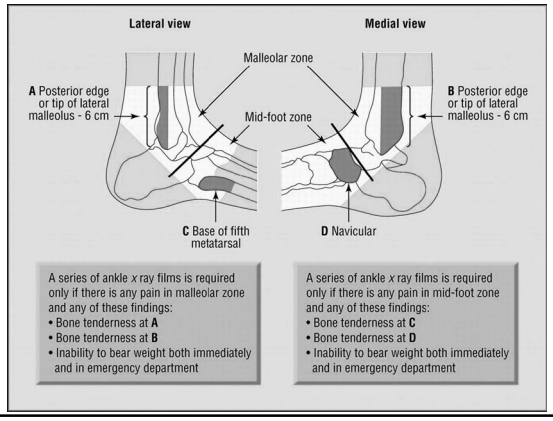
Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. Ann Emerg Med. 1992;21:384-399.

OTTAWA ANKLE RULES



The Ottawa Ankle Rules have been extensively studied for accuracy in predicting the presence of a fracture in the ankle and mid-foot of patients suffering an ankle sprain. Bachman conducted a systematic review of 27 studies of 15,581 patients who had suffered an ankle sprain. The Ottawa Ankle Rules demonstrated nearly 100% sensitivity in detecting a fracture of the ankle or midfoot while specificity was quite variable, ranging from 10% to 79%. The missed fracture rate was 1.4% which indicates that less than 2% of patients who were negative for fracture according to the Ottawa Ankle Rules, actually had a fracture.

Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa Ankle Rules to exclude fractures of the ankle and mid-foot: systematic review. BMJ. 2003 Feb 22;326(7386):417



For example, using the Ottawa Ankle Rules, palpable bone tenderness at the fibular malleolus may suggest a fracture and would mandate an x-ray.

When there is no palpable bone tenderness, it is highly likely that there is not a fracture present- i.e. high value of sensitivity.
However, since many of these patients with palpable bone tenderness do not, in fact show a fracture on subsequent x-ray, this test has low value of specificity. This test has a high number of false positive results for bone tenderness, thus low value of specificity.

When a test has few false positives, the value of a positive test is significant. For example, a positive anterior drawer on manual stress exam of the ankle is correlated with mechanical instability of the ankle. Thus, the anterior drawer has few false positive results and has high value of specificity.

Sensitivity and specificity values provide useful information for interpreting the results of diagnostic tests.

Sensitivity represents the ability of the test to recognize the condition when present.

A highly sensitive test has relatively few false negative results. High test sensitivity, therefore, attests to the value of a negative test result.

High specificity attests to the value of a positive test result: there are relatively few false positives.

Thus, palpable bone tenderness is highly correlated with fracture, and absence of bone tenderness is almost never seen when a fracture is present. Therefore, a negative test result (i.e. no bone tenderness) is almost never seen when there is a fracture present (i.e. high sensitivity).

EVALUATING LIGAMENTOUS INJURY

The purpose of advanced imaging is to determine the exact location of ligament injury and to grade severity of injury. However, imaging studies which evaluate ligament integrity have questionable value in the assessment of the acute ankle injury since treatment decisions and outcomes are not usually influenced by these studies.

Frost CL, Amendola A. Is stress radiography necessary in the diagnosis of acute or chronic ankle instability? Clin J Sport Med 1999;9:40-45.

Griffith JF, Brockwell J. Diagnosis and imaging of ankle instability. Foot Ankle Clin Am 2006;11: 475-496.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI) has replaced arthrography as the preferred imaging technique to detect ligament rupture after an ankle sprain. However, the accuracy, sensitivity and specificity of this imaging technique to diagnose ligament injury in acute ankle injuries is inconsistent, particularly when comparing studies of acute injury vs chronic ankle instability. Breitenseher et al found that MRI could detect lateral collateral ligament disruption after acute ankle injury.

TEAR OFLATERAL COLLATERAL	74% Sensitivity	100% Specificity

Breitenseher MJ, Trattnig S, Kukla C, Gaebler C, Daider, A, Baldt M et al. MRI versus lateral stress radiography in acute lateral ankle ligament injuries. Journal of Computer Assisted Tomography 1997 March/April; 21(2): 280-285.

MAGNETIC RESONANCE IMAGING: ACUTE SPRAIN

Conversely, Verhaven et al showed:

TEAR OF ATFL	100% Sensitive	50% Specificity
TEAR OF CFL	92%	100%

Verhaven EF, Shahabpour M, Handelberg FW, Vaes PH, Opdecam PJ. The accuracy of three-dimensional magnetic resonance imaging in the diagnosis of ruptures of the lateral ligaments of the ankle. Am J Sports Med 1991;19:583-587.

MRI: CHRONIC ANKLE INSTABILITY

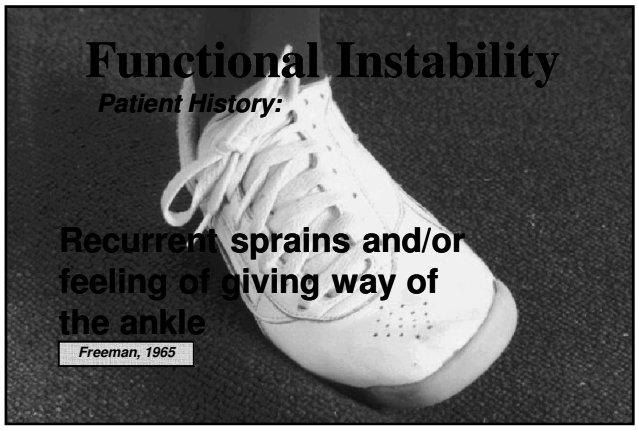
In patients with chronic ankle instability, MRI showed 100% specificity for the diagnosis of ATFL and CFL tears and accuracy of 91.7% in ATFL and 87.5% in CFL tears.

Joshy S, Abdulkadir U, Chaganti S, Sullivan B, Hariharan K. Accuracy of MRI scan in the diagnosis of ligamentous and chondral pathology in the ankle. Foot Ankle Surg 2010; 16(2): 78-80.

MRI: ACUTE VS CHRONIC INJURY

In a mixed population of chronic and acute ankle instability patients, MRI showed a 97% sensitivity, 100% specificity and 97% accuracy. However, when evaluating acute patients only, the results were 100% for all three categories.

Oae K, Takao M, Uchio Y. Evaluation of anterior talofibular ligament injury with stress radiography, ultrasonography and MR imaging. Skeletal Radiol 2010; 39:41-47.



Mechanical vs. Functional

No consistent cause-effect relationship has been found between mechanical instability and functional instability of the ankle.

Moppes, 1982 Staples, 1975
Staples, 1972 Tropp, 1988

FIGURE 1

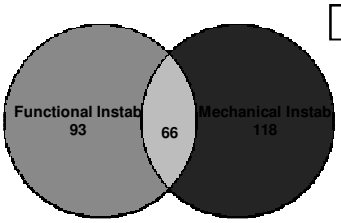
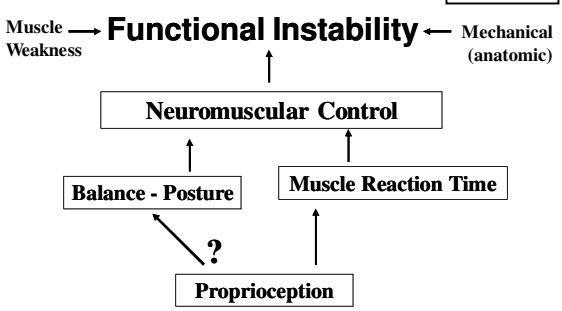


Fig. 1 The association between functional and mechanical instability of the ankle joints in 444 soccer players

Tropp, H. Odenrick, P. Gillquist, J. Stabilometry recordings in functional and mechanical instability of the ankle joint. Int J Sports Medicine 6:180, 1985 1985

FIGURE 2



Richie DH: Functional Instability of the Ankle and the Role of Neuromuscular Control; A Comprehensive Review, J Foot and Ankle Surgery, 40:240-251, 2001.

Persistent Ligamentous Laxity

CHRONIC ANKLE INSTABILITY

Deficit in Neuromuscular control

Hertel, J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability J Athl Train 37 (4): 364, 2002

http://www.youtube.com/watch?v=im9voO0-HNI

http://www.youtube.com/watch?v=zAwHVXLo_xA

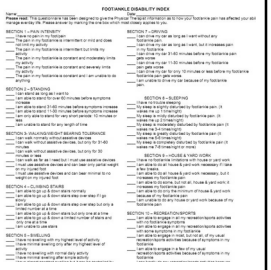
Functional Instability

MANIFESTS WITH DEFICIENT POSTURE CONTROL (single leg stance).

Karlsson, 1989
Jerosch, 1995
Lentell, 1990
Konradsen, 1993

MEASURING CHRONIC ANKLE INSTABILITY

Eechaute et al. systematically reviewed the clinimetric qualities of patient-assessed instruments for patients with chronic ankle instability. They concluded that two instruments—the Foot and Ankle Disability Index (FADI) and the Functional Ankle Ability Measure (FAAM)—were the most appropriate tools to quantify functional disability for chronic ankle instability.


FOOT/ANKLE DISABILITY INDEX

Eechaute C, Vaes P, Van Aerschot L et al. The clinimetric qualities of patient-assessed instruments for measuring chronic ankle instability: a systematic review. BMC Musculoskelet Disord 2007;8:6.

BALANCE = POSTURAL CONTROL?

BALANCE: Ability of a human to remain upright in stance

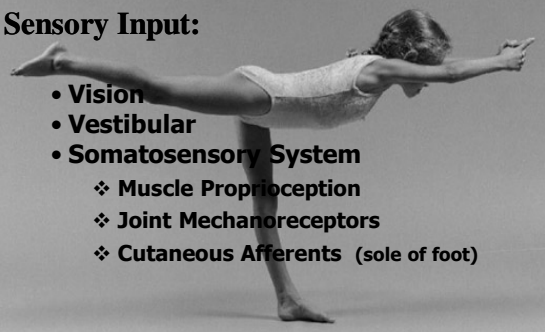
POSTURAL CONTROL: Ability to keep the body's center of gravity (COG) within the borders of the base of support (Nashner 1985)

BALANCE is an activity which occurs both during static stance and dynamic gait

POSTURAL CONTROL is measured during quiet static stance. It has been studied during both double-limb and single limb support.

POSTURAL CONTROL

Sensory Input:



- Vision
- Vestibular
- Somatosensory System
  - Muscle Proprioception
  - Joint Mechanoreceptors
  - Cutaneous Afferents (sole of foot)

Postural Control and CAI

Deficits in postural control appear to be the most consistent finding in patients with chronic ankle instability.

Garn SN, Newton RA: Kinesthetic awareness in subjects with multiple ankle sprains Phys Ther 68: 1667, 1988.

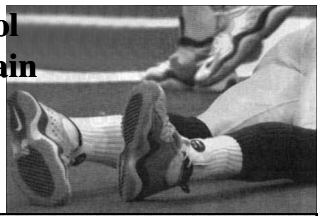
Tropp H, Odenrick P: Postural control in single-limb stance. Jour Orthop Res 6: 833, 1988.

Gauffin H, Tropp H, Odenrick P: Effect of ankle disk training on postural control in patients with functional instability of the ankle joint. Int J Sports Med 9:141, 1988.

Forkin DM, Koczur C, Battle R, Newton RA: Evaluation of kinesthetic deficits indicative of balance control in gymnasts with unilateral chronic ankle sprains. J Orthop Sports Phys Ther 23: 245, 1996.

Perrin PP, Bene MC, Perrin CA, Durupt D: Ankle trauma significantly impairs postural control-a study in basketball players and controls. Int J sports Med 18: 387, 1997.

Postural Control After Ankle Sprain

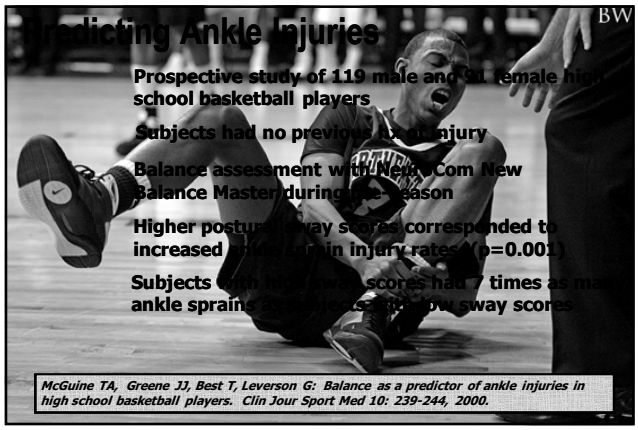


Loss of postural control has also been demonstrated in patients after acute ankle sprain.(Cornwall, MW, Murrell P. Postural sway following inversion sprain of the ankle. J Am Podiatr Med Assoc. 81:243-247, 1991.

Friden T, Zatterstrom R, Lindstrand A, Moritz U: A stabilometric technique for evaluation of lower limb instabilities. Am J Sports Med 17: 118, 1989.

Hertel J, Buckley WE, Denegar CR: Serial testing of postural control after acute lateral ankle sprain. J Athl Train 35: 363, 2001.

Predicting Ankle Injuries



- Prospective study of 119 male and 91 female high school basketball players
- Subjects had no previous lower injury
- Balance assessment with Neurocom New Balance Master during pre-season
- Higher postural sway scores corresponded to increased risk for ankle injury rates ($p=0.001$)
- Subjects with high sway scores had 7 times as many ankle sprains as subjects with low sway scores

McGuine TA, Greene JJ, Best T, Leverson G: Balance as a predictor of ankle injuries in high school basketball players. Clin Jour Sport Med 10: 239-244, 2000.

Loss of Postural Control

Risk of future ankle injury:

127 soccer players, mean age 24.6 years

postural sway measured in pre-season

23 new ankle sprains in subsequent season:
12 had pathologic sway
risk of sprain was 42% in those with abnormal pre-season sway
risk of sprain was 11% in those with normal pre-season sway

Tropp H, Edstrand J, Gillquist J: Stabilometry in functional instability of the ankle and its value in predicting injury. Med Sci Sports Exerc 16: 64-66, 1984.

Chronic Ankle Instability: Centrally Mediated Mechanisms

Sedory et al revealed bilateral hamstring inhibition in CAI patients

Sedory EJ, McVey ED, Cross KM, Ingersoll CD, Hertel J. Arthrogenic muscle response of the quadriceps and hamstrings with chronic ankle instability. J Athl Train 2007;42:355–60.

Abstract

CONTEXT: Kinematic patterns during gait have not been extensively studied in relation to chronic ankle instability (CAI). *OBJECTIVE:* To determine whether individuals with CAI demonstrate altered ankle kinematics and shank-rear-foot coupling compared with controls during walking and jogging *RESULTS:* The CAI group demonstrated more rear-foot inversion and shank external rotation during walking and jogging. There were differences between groups in shank-rear-foot coupling during terminal swing at both speeds. *CONCLUSIONS:* Altered ankle kinematics and joint coupling during the terminal-swing phase of gait may predispose a population with CAI to ankle-inversion injuries. Less coordinated movement during gait may be an indication of altered neuromuscular recruitment of the musculature surrounding the ankle as the foot is being positioned for initial contact

J Sports Rehabil 2009 Aug;18(3):375-88. Altered ankle kinematics and shank-rear-foot coupling in those with chronic ankle instability. Drewes LK, McKeon PO, Paolini G, Riley P, Kerrigan DC, Ingersoll CD, Hertel J. Dept of Human Services, University of Virginia, Charlottesville, VA, USA.

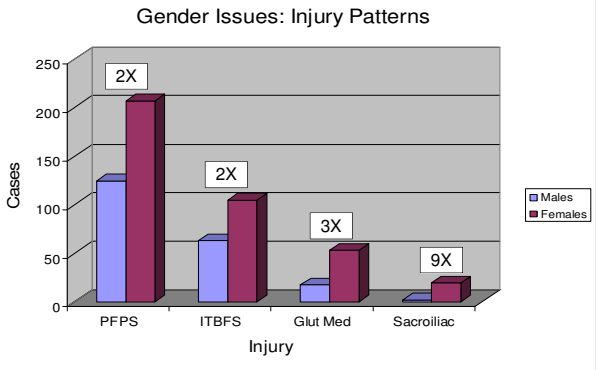
Postural Control

- **Improves after balance and coordination training exercises**

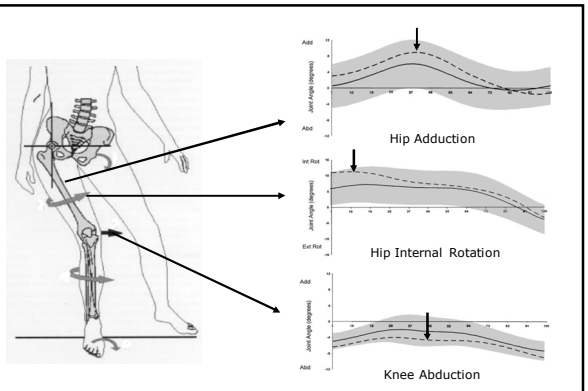
Leanderson 1996, Goldie 1994, Pintsaar 1996, Tropp 1984

Balance exercises cause Bilateral Improvements

Gauffin, 1988
Hertel, 2001



Taunton et al., 2002



Ferber et al., 2005

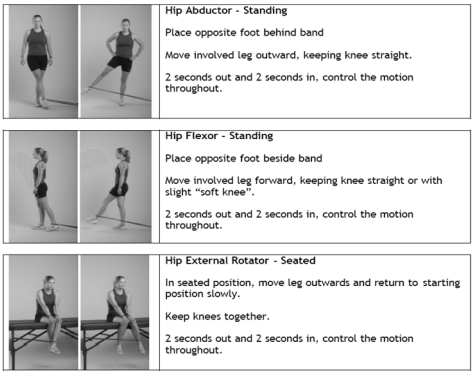
Interventions: Exercise

*Of **165 patients** who visited Ferber's clinic complaining of overuse running injuries (33% PFPS; 25% ITBFS), **92 per cent had weak hip muscles**.*

As part of each patient's consultation, he gave them a program to improve hip strength, along with other recommendations to speed their recovery.

***89 per cent** of the patients reported a significant **improvement in pain** within four to six weeks.*

Ferber, 2008



Ferber, 2008

POSTURAL CONTROL

Sensory Input:

- **Vision**
- **Vestibular**
- **Somatosensory System**
  - ❖ **Muscle Proprioception**
  - ❖ **Joint Mechanoreceptors**
  - ❖ **Cutaneous Afferents** (sole of foot)

Peroneal Reaction: Stretch Reflex

Receptors: Muscle Spindle

Reflex: Afferent neurons connect to alpha motor neurons in spinal cord

Efferent: motor neurons stimulate peroneal muscle contraction

Sensitivity: Gamma motor neurons (GMN's) contract muscle spindles: lowers threshold of response

How does pain affect postural control?

Pain and Loss of Proprioception

Afferent articular nerves found in joints of the LE:

Type I receptors: slow adapting mechanical and dynamic receptors

Type II: rapidly adapting, mechanical and dynamic receptors

Type III: high threshold, slow adapting, mechanical and dynamic

Type IV: high threshold pain receptors

Wyke B: The neurology of joints. Ann R Coll Surg Engl 41: 24-50, 1967.

Painful Subtalar Joint and Chronic Ankle Instability

- **EMG activity of the Peroneus Brevis and Longus is diminished in sinus tarsi syndrome.**
- **Injection of local anesthetic into the sinus tarsi restores normal EMG function.**

Taillard W, Meyer JM, Garcia J, Blanc Y: The sinus tarsi syndrome. Int Orthop 5: 117-130, 1981.

Sinus Tarsi Pain and Prolonged Peroneal Reaction Time

- **18 pts with functional ankle instability**
- **8 healthy controls**
- **measurement of peroneal reaction times with trapdoor mechanism and EMG readings of p. brevis and p. longus**
- **recordings before and after injection of 2 mL of 1% Lidocaine into sinus tarsi**

Khin-Myo-Hla, Ishii T, Sakane M, Hayashi K: Effect of anesthesia of the sinus tarsi on peroneal reaction time in patients with functional instability of the ankle. Foot and Ankle Int 20,9: 554-558, 1999.

Sinus Tarsi Pain and Prolonged Peroneal Reaction Time

Before Injection:

Subjects with Functional Instability of Ankle	**82.0 ms**
Controls	**82.0 ms**

After Injection:

Subjects with Functional Instability of Ankle	**69.3 ms**
Controls	**70.5 ms**

P < 0.0001

Khin-Myo-Hla, Ishii T, Sakane M, Hayashi K: Effect of anesthesia of the sinus tarsi on peroneal reaction time in patients with functional instability of the ankle. Foot and Ankle Int 20,9: 554-558, 1999.

Theory of Prolonged Peroneal Reaction Time

- **inflammation from sprain causes irritability of mechanoreceptors and nociceptors in the affected ankle and subtalar joints**
- **excitation of leg flexors and inhibition of leg extensors (shown in previous animal studies with joint inflammation)**
- **inhibitory stimulation affects GMN's of both extensors and peroneal muscles**
- **local anesthetic reverses inhibitory stimulus of gamma motor neurons**

Khin-Myo-Hla, Ishii T, Sakane M, Hayashi K: Effect of anesthesia of the sinus tarsi on peroneal reaction time in patients with functional instability of the ankle. Foot and Ankle Int 20,9: 554-558, 1999.

Prolonged Peroneal Reaction Time (PRT)

"We suggest that irritability of mechanoreceptors or nociceptors or both, induced by inflammation at the sinus tarsi, may suppress the activities of gamma motor neurons of peroneal muscles, which in turn might cause the symptoms of functional instability and prolonged PRT."

Khin-Myo-Hla, Ishii T, Sakane M, Hayashi K: Effect of anesthesia of the sinus tarsi on peroneal reaction time in patients with functional instability of the ankle. Foot and Ankle Int 20,9: 554-558, 1999.

Postural Control

Sensory Input:
Plantar cutaneous afferents

The Foot:
A Major Proprioceptive Organ

- ✓ **Merkel Cell Complexes**
  Pressured Deformation
- ✓ **Meissner Corpuscles**
  Vibration 5-40 Hz
- ✓ **Pacinian Corpuscles**
  Vibration 60-300 Hz

SPORTS MEDICINE OF THE LOWER EXTREMITY
ORIGINAL ARTICLES

Effects of Foot Orthoses on Patients with Chronic Ankle Instability

Douglas H. Richie, Jr., DPM*

Chronic instability of the ankle can be the result of mechanical and functional deficits. An acute ankle sprain can cause mechanical and functional instability, which may or may not respond to standard rehabilitation programs. Chronic instability results when there is persistent joint laxity of the ankle or when one or more components of neuromuscular control of the ankle are compromised. A loss of balance or postural control seems to be the most consistent finding among athletes with chronic instability of the ankle. Recent research in patients with acute and chronic ankle instability has revealed positive effects of foot orthoses on postural control. This article reviews the current research relevant to the use of foot orthoses in patients with chronic ankle instability and clarifies the suggested benefits and the shortcomings of these investigations. (J Am Podiatr Med Assoc 97(1): 19-30, 2007)

STUDIES OF FO'S AND POSTURAL CONTROL

Lundin TM, Feurbach JW, Grabiner MD: Effect of plantar flexor and dorsiflexor fatigue on unilateral postural control. J Appl Biomech. 9:191, 1993.

Hertel J, Denegar CR, Buckley WE, Sharkey NA, Stokes WL: Effect of rearfoot orthotics on postural sway after lateral ankle sprain. Arch Phys Med Rehabil 82: 1000, 2001.

Hertel J, Denegar CR, Buckley WE, Sharkey NA, Stokes WL: Effect of rear-foot orthotics on postural control in healthy subjects. J Sport Rehabil 10: 36, 2001.

STUDIES OF FO'S AND POSTURAL CONTROL

Percy ML, Menz HB: Effects of prefabricated foot orthotics and soft insoles on postural stability in professional soccer players. J Am Podiatr Med Assoc 91:194, 2001.

Rome K, Brown CL: Randomized clinical trial into the impact of rigid foot orthoses on balance parameters in excessively pronated feet. Clinical Rehab18: 624, 2004.

Effect of foot orthotics on single- and double-limb dynamic balance tasks in patients with chronic ankle instability.

Foot Ankle Spec. 2008 Dec;1(6):330-7. Sesma AR, Mattacola CG, Uhl TL, Nitz AJ, McKeon PO. Division of Athletic Training, Departement of Rehabilitation Sciences, University of Kentucky, Lexington, Kentucky 40536-0200, USA.

Deficits have been observed in patients with chronic ankle instability while performing dynamic balance tasks. Foot orthotic intervention has demonstrated improvements in static balance following lateral ankle sprain, but the effect is unknown in patients with chronic ankle instability during dynamic balance tasks. Twenty patients with self-reported unilateral chronic ankle instability volunteered for participation. They completed a familiarization session and 2 test sessions separated by 4 weeks. The familiarization session consisted of practice trials of the Star Excursion Balance Test (SEBT) and Limits of Stability (LOS) test, orthotic fitting, and the Cumberland Ankle Instability Tool (CAIT) questionnaire. Patients were instructed to wear the custom-fitted orthotics for at least 4 hours a day to a preferred 8 hours a day for the 4 weeks between sessions. There was an increase in distance reached in the posterolateral direction over the 4-week period in the orthotic condition. There was an increase in distance reached in the medial direction, demonstrating an improvement on the injured side in the orthotic condition after 4 weeks of orthotic intervention. No consistent, meaningful results were observed in the LOS. The involved leg had a significantly lower CAIT score than the uninvolved leg during both sessions, but the involved leg CAIT scores significantly improved over 4 weeks compared with the baseline measure. Orthotic intervention may prove beneficial for improving dynamic balance as measured by the SEBT in individuals with chronic ankle instability and may be a useful adjunct to clinical and sport interventions.

Effect of orthoses on postural stability in asymptomatic subjects with rearfoot malalignment during a 6-week acclimation period.

Arch Phys Med Rehabil. 2007 May;88(5):653-60. Mattacola CG, Dwyer MK, Miller AK, Uhl TL, McCrory JL, Malone TR.Division of Athletic Training, College of Health Sciences, University of Kentucky, Lexington, KY 40536-0200, USA. carlmat@uky.edu

OBJECTIVE: To determine the effect of custom-fitted orthoses on postural sway over a 6-week acclimation period. DESIGN: Repeated-measures analysis of variance on postural sway measures with factors being group (control, malaligned), time (initial, 2 wk, 4 wk, 6 wk postintervention), and condition (with orthoses, without orthoses). For single-limb stance, side (right, left) was analyzed to determine bilateral differences. SETTING: Biodynamics laboratory. PARTICIPANTS: Twenty-one subjects, 11 asymptomatic with rearfoot malalignment and 10 asymptomatic with normal rearfoot alignment. INTERVENTIONS: Orthoses were prescribed and worn for 6 weeks. Balance testing was performed on 4 different dates with each subject tested in both orthotic conditions. Postural control was measured with three 10-second eyes-closed trials for single-limb stance, one 20-second eyes-closed bilateral stance with the platform moving, and one 20-second eyes-open bilateral stance with the platform and surroundings moving. MAIN OUTCOME MEASURES: Sway velocity (in deg/s) for single-limb stance and equilibrium score for bilateral stance. RESULTS: Postural sway measures were significantly decreased during single-limb testing with orthoses versus without orthoses, regardless of group. The orthotic intervention significantly improved bilateral stance equilibrium score in the malaligned group at weeks 2, 4, and 6 when compared with measures at the initial week. Equilibrium score of the malaligned group with orthoses at initial week was significantly lower (worse) than the control group with orthoses at initial week; however, these results were not repeated during measurements taken at weeks 2, 4, or 6. CONCLUSIONS: The application of orthoses decreased sway velocity for single-limb stance, improving postural stability regardless of group when visual feedback was removed. During bilateral stance, postural stability was initially worse for the malaligned group with and without orthoses when compared with the control group; however, improvements were seen by week 2 and continued throughout the remainder of testing. Clinically, the application of orthoses appears to improve postural control in people with rearfoot malalignment, particularly when vision is removed.

The effect of 6 weeks of custom-molded foot orthosis intervention on postural stability in participants with >or=7 degrees of forefoot varus.

Clin J Sport Med. 2006 Jul;16(4):316-22. Cobb SC, Tis LL, Johnson JT. Center for Rehabilitation Research and Master of Athletic Training Program, Texas Tech University Health Sciences Center, Lubbock, TX 79430-6226, USA. steve.cobb@ttuhsc.edu

OBJECTIVE: Postural stability (PS) was assessed in a group of participants with >or=7 degrees of forefoot varus (FV) after 6 weeks of custom-molded functional foot orthosis (FO) intervention to investigate the effect of FO intervention in a population that may have decreased PS due to their foot structure. DESIGN: A force platform was used to assess right and left single-limb stance position and eyes open and eyes closed condition PS. SETTING: PS was assessed in a biomechanics research laboratory. PARTICIPANTS: Twelve participants with >or=7 degrees of FV (MFV) and 5 participants with <7 degrees of FV (LFV) participated in the study. INTERVENTIONS: PS of the MFV group was assessed initially when FOs were received and after 6 weeks of FO intervention. The LFV group PS was assessed during initial and 6-week testing sessions. MAIN OUTCOME MEASURES: The root mean square of the center of pressure velocity was used to quantify single-limb stance PS during no FO and FO conditions. RESULTS: LFV group PS did not change significantly (P=0.829) over the 6-week time period. Significant improvement was, however, reported in the MFV group anteroposterior (P=0.003) and mediolateral (P=0.032) PS at the 6-week assessment versus the initial assessment during both the noFO and FO conditions. CONCLUSIONS: Six weeks of FO intervention may significantly improve PS in participants with >or=7 degrees of FV both when wearing FOs and when not wearing FOs.

SUMMARY OF STUDIES OF FO'S AND POSTURAL SWAY

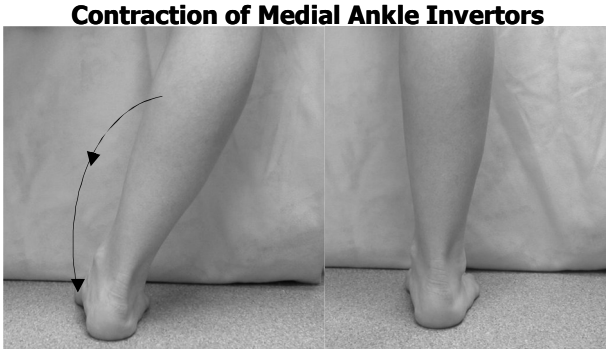
- three studies utilized injured (ankle sprain) subjects : 2 studies used custom FO's and showed improvements in the injured subjects only. One study used pre-fabricated FO's and showed no improvements with or without FO's.
- all studies, except two, showed improvements of postural control with foot orthoses. The two studies (no improvement) both utilized pre-fabricated foot orthoses
- one study evaluated subjects with pronated feet and showed improvement only after 4 wks.
- four studies utilized prefabricated orthoses
- two studies utilized custom orthoses fabricated from foam box impressions
- one study utilized direct mold custom orthoses
- no study used Root protocol of negative impression casting

"Therefore, we recommend the use of orthotics during the acute and subacute phases for subjects after an ankle sprain.

The use of orthotics provides somatosensory benefits because cutaneous afferents contribute to human balance control and may provide neutral alignment for proper muscle activation and reduce unnecessary strain on the already stressed soft tissue."

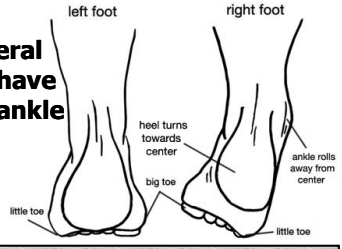
Mattacola CG, Dwyer MK: Rehabilitation of the ankle after acute sprain or chronic instability. J Athl Train. Dec (4): 413-429, 2002.

Correction of Lateral Body Sway=Concentric Contraction of Medial Ankle Invertors



Reduce Pronation= Reduce Supination Ankle Injuries???

Patients with lateral ankle instability have weaker invertor ankle strength



Munn J, Beard D, Refshauge K, Lee R: Eccentric muscle strength in functional ankle instability. Med Sci Sport Exerc 35(2): 245, 2003.

DETERMINING SEVERITY OF INJURY

- Prognosis
- Timeline for return to sport
- Timeline for complete recovery

CLINICAL TESTS FOR SEVERITY OF SPRAIN

Ankle ROM

Ankle Strength: DF/PF/Inv/Ev

Swelling

Wt. Bearing ability

None have been validated as accurate prognostic indicators of recovery

Alonso et al, de Bie et al, Wilson and Gansneder

"Among the clinical variables implemented in this study, the self reported functional variables (global function question, SF-36 PF) and the subjects ambulation status appear to be the best potential prognostic factors in predicting the number of days to return to sports in Division II athletes with acute lateral ankle sprains."

Cross KM, Worrell TW, Leslie JE, Khalid RV: The relationship between self reported and clinical measures and the number of days of return to sport following acute lateral ankle sprains. J Ortho Sports Phys Ther 32: 16-23, 2002.

PREDICTING DISABILITY

72 Hours post Grade II LAS:

- Swelling & ROM: poor predictor
- Functional limitation: good predictor

40 m walk/run, Figure 8
Single hop, Stair hop, Cross-over hop

Wilson RW, Gansneder BM: Measures of functional limitation as predictors of disablement in athletes with acute ankle sprains. JOSPT 30(9) : 528, 2000

TOOLS TO MONITOR RECOVERY

Modification of outcome measurement techniques

- Clinical Assessment
- Self Reported Assessment

ANKLE SPRAIN

Initial Treatment:

P ROTECTION
R EST
I CE
C OMPRESSION
E LEVATION

A Prospective, Randomized Clinical Investigation of the Treatment of First-Time Ankle Sprains

Bruce D. Beynnon,*† PhD, Per A. Renström,‡ MD, PhD, Larry Haugh,† PhD, Benjamin S. Uh,† MD, and Howard Barker,† MD *From the †Department of Orthopaedics & Rehabilitation, McClure Musculoskeletal Research Center, University of Vermont, Burlington, Vermont, and the ‡Department of Orthopaedics, Sports Medicine & Arthroscopy, Karolinska Institute, Stockholm, Sweden*

Background: Acute ankle ligament sprains are treated with the use of controlled mobilization with protection provided by external support (eg, functional treatment); however, there is little information regarding the best type of external support to use. **Hypothesis:** There is no difference between elastic wrapping, bracing, bracing combined with elastic wrapping, and casting for treatment of acute, first-time ankle ligament sprains in terms of the time a patient requires to return to normal function. **Study Design:** Randomized controlled clinical trial; Level of evidence, 1. **Methods:** Patients suffering their first ligament injury were stratified by the severity of the sprain (grades I, II, or III) and then randomized to undergo functional treatment with different types of external supports. The patients completed daily logs until they returned to normal function and were followed up at 6 months. **Results:** Treatment of grade I sprains with the Air-Stirrup brace combined with an elastic wrap returned subjects to normal walking and stair climbing in half the time required for those treated with the Air-Stirrup brace alone and in half the time required for those treated with an elastic wrap alone. Treatment of grade II sprains with the Air-Stirrup brace combined with the elastic wrap allowed patients to return to normal walking and stair climbing in the shortest time interval. Treatment of grade III sprains with the Air-Stirrup brace or a walking cast for 10 days followed by bracing returned subjects to normal walking and stair climbing in the same time intervals. The 6-month follow-up of each sprain severity group revealed no difference between the treatments for frequency of reinjury, ankle motion, and function.

Conclusion: Treatment of first-time grade I and II ankle ligament sprains with the Air-Stirrup brace combined with an elastic wrap provides earlier return to preinjury function compared to use of the Air-Stirrup brace alone, an elastic wrap alone, or a walking cast for 10 days.

ANKLE SPRAIN

Immediate treatment:

Immobilization vs. "Protected Mobilization"

Recommended: Dettori, 1994 **Recommended: Eiff, 1994**
Klein, 1993

ANKLE SPRAIN:
IMMOBILIZATION vs FUNCTIONAL TREATMENT

A systematic review by Kerkhoffs et al. assessed the effectiveness of methods of immobilization for acute lateral ankle ligament injuries and compared immobilization with functional treatment methods. Functional interventions (which included elastic banding, soft cast, taping or orthoses with associated coordination training) were found to be statistically better than immobilization for multiple outcome measures.

Kerkhoffs GM, Rowe BH, Assendelft WJ et al. Immobilization and functional treatment for acute lateral ankle ligament injuries in adults. Cochrane Database Syst Rev 2002;3:CD003762.

Rehabilitation

Immobilization decreases ligament repair via rate and strength of collagen synthesis.

Andriacchi, 1988
Buckwalter, 1995
Vialas, 1981

Rehabilitation

Excessive motion, post injury, can lead to joint instability.

Burroughs, 1990
Buckwalter, 1996
Cawley, 1991

Lancet. 2009 Feb 14;373(9663):575-81. Mechanical supports for acute, severe ankle sprain: a pragmatic, multicentre, randomized controlled trial.

BACKGROUND: Severe ankle sprains are a common presentation in emergency departments in the UK. We aimed to assess the effectiveness of three different mechanical supports (Aircast brace, Bledsoe boot, or 10-day below-knee cast) compared with that of a double-layer tubular compression bandage in promoting recovery after severe ankle sprains. METHODS: We did a pragmatic, multicentre randomised trial with blinded assessment of outcome. 584 participants with severe ankle sprain were recruited between April, 2003, and July, 2005, from eight emergency departments across the UK. Participants were provided with a mechanical support within the first 3 days of attendance by a trained health-care professional, and given advice on reducing swelling and pain. Functional outcomes were measured over 9 months. The primary outcome was quality of ankle function at 3 months, measured using the Foot and Ankle Score; analysis was by intention to treat. This study is registered as an International Standard Randomised Controlled Trial, number ISRCTN37807450. RESULTS: Patients who received the below-knee cast had a more rapid recovery than those given the tubular compression bandage. We noted clinically important benefits at 3 months in quality of ankle function with the cast compared with tubular compression bandage (mean difference 9%; 95% CI 2.4-15.0), as well as in pain, symptoms, and activity. The mean difference in quality of ankle function between Aircast brace and tubular compression bandage was 8%; 95% CI 1.8-14.2, but there were little differences for pain, symptoms, and activity. Bledsoe boots offered no benefit over tubular compression bandage, which was the least effective treatment throughout the recovery period. There were no significant differences between tubular compression bandage and the other treatments at 9 months. Side-effects were rare with no discernible differences between treatments. Reported events (all treatments combined) were cellulitis (two cases), pulmonary embolus (two cases), and deep-vein thrombosis (three cases). INTERPRETATION: A short period of immobilisation in a below-knee cast or Aircast results in faster recovery than if the patient is only given tubular compression bandage. We recommend below-knee casts because they show the widest range of benefit. FUNDING: National Co-ordinating Centre for Health Technology Assessment.

Rehabilitation

Exercise and joint motion stimulate healing and influence the strength of ligaments after injury.

Buckwalter, 1995
Gomez, 1991
Iarvinen, 1993

Rehabilitation

It can be concluded that for functional rehabilitation, loading of the ankle joint is desirable in order to increase joint stability.

Scheufflen, 1993
Sammarco, 1977
McCullough, 1980

Dorsiflexed Ankle Position

- Talar position: close packed
- Achilles tendon tension: joint compression
- Lateral ligaments: minimal distraction torn ends re-opposed

Smith, Rico, Reischl, S. The influence of dorsiflexion in the treatment of severe ankle sprains: An anatomic study. Foot and Ankle 9:28, 1988

Acute Inversion Sprain

Position of ankle during sleep:

- Foot plantarflexed
- Unloaded ankle
- Foot inverted
- Prolonged abnormal positioning

Solution: Dorsiflexion – night splinting

***Non-Pneumatic Walking Splint*, With or Without Joints. Prefabricated, includes fitting and adjustment.**

CODE:
L4386

REIMBURSEMENT:
$114 to $152

METHOD OF IMMOBILIZATION

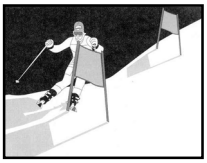
Lamb et al. conducted a single-blinded randomized control trial, assessing the effectiveness of three different mechanical supports (the Aircast brace, the Bledsoe boot or 10-day below-knee cast) against that of a double-layered tubular compression bandage in promoting recovery after severe ankle sprains. They found that a short period of immobilization in a below-knee cast or Aircast brace resulted in faster recovery than if the patient is only given tubular compression bandage. They noted clinically important benefits in terms of ankle function, pain, symptoms and activity at 3 months.

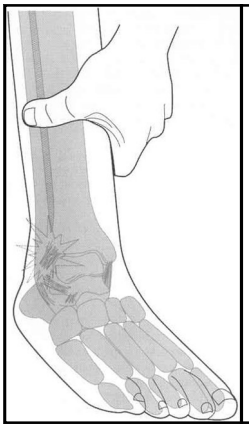
Lamb SE, Marsh JL, Hutton JL et al. Collaborative Ankle Support Trial (CAST Group). Mechanical supports for acute, severe ankle sprain: a pragmatic, multicentre, randomized controlled trial. Lancet 2009;373:575–81.

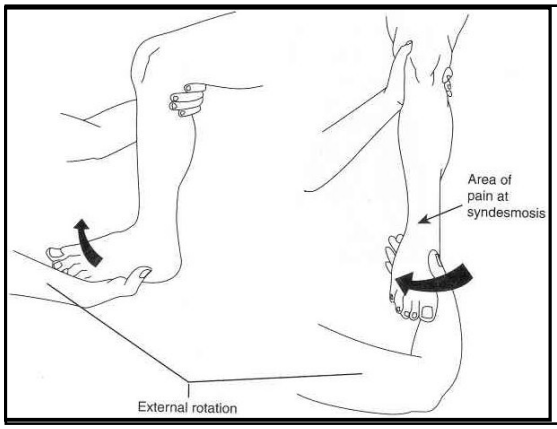
SYNDESMOSIS INJURIES

Incidence:

- ✓ **15/1344 ankle sprains**
  West Point, 1990
- ✓ **10% incidence – Cedell, 1975**
  Brostrom, 1965
- ✓ **5% incidence – Fallat, 1998**
- ✓ **18% incidence – Minnesota Viking**
  Boytim et al 1991



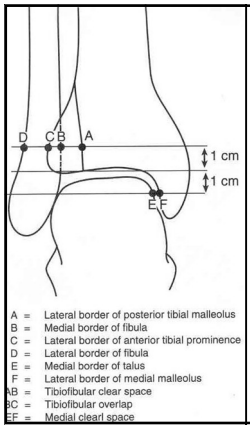




DIASTASIS

Radiographic Criteria:

1. Medial clear space
- widened
2. Tibiofibular overlap
- reduced
3. Tibiofibular clear space
- increased



HIGH ANKLE SPRAIN: *Initial Treatment*

Short leg cast, ankle plantarflexed
10 degrees and Int. Rotated

Non-weight bearing with crutches or scooter

Rehabilitation

- Dorsiflexed position of ankle most stable

Smith 1988, Stormont 1985

- Early weight bearing increases stability of the ankle joint after injury

McCullough 1980, Scheuffelen 1993

Immobilize vs. Mobilize

After acute sprain:

- *Immobilize* to allow pain free weight bearing
- Must allow *Active Range of Motion*

Functional Rehabilitation Program

Four Stages:

Range of Motion

Strengthening

Proprioception

Activity-specific training

Postural Control

- Improves after balance and coordination training exercises

Leanderson 1996, Goldie 1994, Pintsaar 1996, Tropp 1984

Balance Training after LAS

- 4 fold reduction of recurrent sprain

Holme, 1999

- 2 fold reduction

Wester, 1996

McKeon PO, Hertel J. Systematic Reviw of postural control and lateral ankle instability, Part II: Is balance training clinically effective? Journal of Athletic Training 2008;43(3):305–315

"Prophylactic balance training substantially reduced the risk of sustaining ankle sprains, with a greater effect seen in those with a history of a previous sprain. Completing at least 6 weeks of balance training after an acute ankle sprain substantially reduced the risk of recurrent ankle sprains; however, consistent improvements in instrumented measures of postural control were not associated with training. Evidence is lacking to assess the reduction in the risk of recurrent sprains and inconclusive to demonstrate improved instrumented postural control measures in those with chronic ankle instability who complete balance training."

Star Excursion Balance Test (SEBT)

LAYOUT OF SEBT

LATERAL REACH ON SEBT

Photos From: Relationship between Ground Reaction Force and Stability Level of the Lower Extremity in Runners. Kimitake Sato, Monique Butcher-Mokha Barry University Miami Shores, FL

ACUTE ANKLE SPRAIN: TREATMENT PROTOCOL

Initial Evaluation

History- Mechanism, Wt. Bearing Status, Immediate Tx

Presentation-Wt Bearing? Self-assessment of severity

Radiographs-Almost every time!

Exam-Edema, ecchymosis, erythema

Palpation-Ligaments, osseous structures

Stress Exam- Anterior Drawer, Inversion-Eversion, Medial Calcaneal Glide

ACUTE ANKLE SPRAIN: TREATMENT PROTOCOL

Initial Treatment

Walking Boot (in 90% of cases)

Weight Bearing to tolerance, except in High Ankle Sprain

Sleep with Boot for 3-5 days

Ankle Plantarflexion-Dorsiflexion T.I.D.

Ice 20 min T.I.D.

ACUTE ANKLE SPRAIN: *Treatment Protocol*

Phase 2: Day 7 thru 21

Evaluate in clinic at Day 7: Ability to walk w/o boot, Rhomberg, Drawer , Pt self-assessment

Walk w/o limp: Dispense articulated footplate ankle brace

Walk with limp: Continue walking boot for 14 more days

For All: Begin Functional Rehabilitation Protocol for 8-12 weeks

Continuum of Care Sales Strategy

walking boot
cast

→

Rebound™ Ankle Brace with Stability Strap
(instead of stirrup, lace-up ankle brace, and/or sleeve)

→

Soft Ankle Brace

D

Velocity Ankle Brace by Donjoy

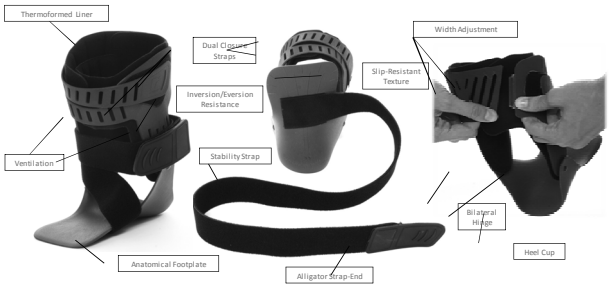
VELOCITY MS

VELOCITY LS
(light support)

VELOCITY ES
L1971

$96.95 ES Version Available in Black or White Color
$86.95 MS Version Available in Black Color Only
$76.95 LS Version Available in Black Color Only

Product Diagram



L1906 Soft Ankle Braces

3/26/2011

Exoform Ankle Brace

Product Type: Figure 8 Lace Up

Performance Features

- Exoform's advanced design with Figure-8 heel lock strapping provides the compression and comfort of a soft ankle with 35% more protection then traditional stirrups
- Figure-8 heel lock strapping performs consistently unlike taping that stretches over time
- Without Figure-8 heel lock strapping, the Exoform offers the compression and comfort of a soft ankle with 20% more protection than a stirrup
- The lowest profile and lightest ankle brace of Ossur's entire family
- Allows for normal plantar and dorsi flexion
- Constructed of highly breathable, quick drying fabric

Sizing

- X Small – X Large

Options

- Exoform Ankle Brace
- Exoform Ankle Brace with Figure-8 Straps

Part#	Size	Ankle Circ.*	U/M
20611	XSmall	11" - 12"	1 ea
20612	Small	12"-13"	1 ea
20613	Medium	13"-14"	1 ea
20614	Large	14"-15"	1 ea
20615	XLarge	15"-16"	1 ea

*Measure ankle circumference diagonally over the base of the heel and across the ankle bone as shown.

U.S. Patent# 5,715,821; 6,164,294

3/26/2011

Swedo Ankle Loc

Product Type: Figure 8 Lace Up

Performance Features

- Exclusive ANKLE LOK® offset panel traps the laces between the inner and outer flap to hold the laces tighter longer than any other brace.
- Exclusive close spaced eyelets concentrate the holding power where it's needed most creating the most effective heel lock.
- Full elastic back ensures complete unrestricted blood flow to the Achilles' tendon and virtually eliminates the chance for blistering
- Internal U-shaped spiral stays provide extra support and further minimize the chance for ankle injury.
- Arch fits the contour of the foot and is seamless so it virtually eliminates irritation to the bottom of the foot.
- Triple layer vinyl laminate provides durability and comfort.
- Optional side stabilizer inserts provide additional medial and lateral support for injured ankles.
- Available in either black and white.

Sizing

- X Small – X Large

Options

- Black or White
- Stabilizer strut

3/26/2011

Reimbursement

- L1906 – Most states have a reimbursement of around $90

3/26/2011

ACUTE ANKLE SPRAIN: *Treatment Protocol*

Phase 3: Return to play

Evaluation may occur between day 7 and day 21.

Follow SARS Protocol

Patient will move out of articulated footplate ankle brace to lace-up brace

Evaluate for custom functional foot orthotic therapy

Balance training to continue for 12 weeks total

Grade II / III LAS
"When can I return to sport?"

TOOLS TO MONITOR RECOVERY

Modification of outcome measurement techniques

- **Clinical Assessment**
- **Self Reported Assessment**

Performance Test Protocol

3 Subjective Questions:

1. **Has the ankle recovered fully after the injury?**
   Yes or No. If no, how does it compare to before the injury, better, same or worse.
2. **Can you walk normally?**
3. **Can you run normally?**

Kaikkonen A, Kannus P, Jarvinen M: A performance test protocol and scoring scale for the evaluation of ankle injuries. Am Journal Sports Medicine 22: 462, 1994.

Performance Test Protocol

2 Clinical Measures:

ROM – Ankle dorsiflexion, plantarflexion
Anterior drawer sign

1 Functional Stability Test:

Walking down staircase *

2 Muscle Strength Tests:

Rising on heels
Rising on toes

1 Balance Test:

One legged stance on 10 cm square beam

Kaikkonen A, Kannus P, Jarvinen M: A performance test protocol and scoring scale for the evaluation of ankle injuries. Am Journal Sports Medicine 22: 462, 1994.

SPORTS ANKLE RATING SYSTEM

1. **Quality of Life Measure**
2. **Clinical Rating Score**
3. **Single Assessment Numeric Evaluation (SANE)**

Williams GN, Molloy JM, DeBernardino TM et al: Evaluation of the Sports Ankle Rating System in Young Athletic Individuals with Acute Lateral Ankle Sprains. Foot and Ankle Int 24:274, 2003

SPORTS ANKLE RATING SYSTEM – CLINICAL RATING SCORE
Part I: SUBJECTIVE VISUAL ANALOG SCALES (Compiled by the Patient)

Instructions: Each line below represents a range of function in the item listed to its left (Pain, Swelling, Stiffness, Giving Way, and Function). The left end of each line indicates severe difficulty in the listed item and the right end of each line indicates perfect function in that item. Please draw a vertical line across the point on each line that represents the level of difficulty you have experienced with your ankle in each item during the past week. You may mark anywhere along each line.

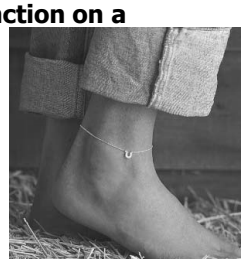
EXAMPLE constant symptoms ——|—— no symptoms

PAIN	severe pain	no pain
SWELLING	severe swelling	no swelling
STIFFNESS	very stiff	no stiffness
GIVING WAY	gives way often	no giving way
FUNCTION	walking on level surface is difficult	totally normal ankle function

SPORTS ANKLE RATING SYSTEM

3. Single Assessment Numeric Evaluation

"Rate your ankle's function on a scale of 0 → 100"



ANKLE PERFORMANCE MILESTONES

- **Single leg stance (Romberg)**
- **Lateral hop**
- **Run down stairs**
- **Toe/Heel Raise**

SPORTS ANKLE RATING SYSTEM

Postural Stability Assessment

Single Leg Stance Test:

Barefoot, stance on one leg
Eyes closed
Arms at sides

Time compared to contralateral side

SPORTS ANKLE RATING SYSTEM

Ankle Function Assessment

- **stand on one leg**
- **hop laterally, as far as possible**
- **three continuous hops**
- **compare distance to un-involved leg**

CRITERIA FOR RETURN TO SPORT

In-Office Assessment
On-Field Assessment

ON-FIELD ASSESSMENT

- **40 METER RUN**
- **FIGURE OF 8 RUN**
- **CUTTING DRILLS**
- **NON-CONTACT KICKING, RUNNING**
- **SPORT SIMULATION**
- **DEVELOP RESTRICTIONS AND LIMITATIONS**

BRACING THE ANKLE

- Enhance recovery ?
- Protect from re-injury ?

METHOD OF IMMOBILIZATION

In a separate article, Kerkhoffs et al. systematically assessed the effectiveness of various treatments of acute ruptures of the lateral ankle ligaments in adults. They found that lace-up supports were a more effective functional treatment than elastic bandaging. Lace-up supports resulted in less persistent swelling in the short term when compared with semi-rigid ankle supports, elastic bandaging and tape. Tape resulted in more dermatological complications than elastic bandage. Struijs and Kerkhoffs could not be certain whether homeopathic ointment or physiotherapy significantly improved function due to a paucity of studies after an extensive review of the evidence.

Kerkhoffs GM, Struijs PA, Marti RK et al. Functional treatments for acute ruptures of the lateral ankle ligament: a systematic review. Acta Orthop Scand 2003;74:69–77.

TAPING AND BRACING IMPROVE PROPRIOCEPTION.

Garn, 1998
Guskiewicz, 1996
Jerosch, 1995
Feuerbach, 1994
Friden, 1989
Heit, 1989
Tropp, 1985

TAPING AND BRACING THE ANKLE WILL LIMIT INVERSION / EVERSION.

Hughes, 1983
Myburgh, 1984
Gross, 1987
Greene, 1990
Lofuenberg, 1993
Shapiro, 1994
Thonnard, 1996
Vaes, 1998

ANKLE TAPING

Loses up to 40% restrictive function after 10 minutes of exercise.

Glick, 1976 Fumich, 1981 Greene, 1990

Brace vs Non-brace

SIGNIFICANT REDUCTION OF INJURIES.

Rovere, 1988
Sitler, 1994
Surve, 1994

Prophylactic Ankle Bracing in Sport

Sitler, MR; Horodyski, M: Effectiveness of prophylactic ankle stabilizers of prevention of ankle injuries. Sports Med. 20:53 – 7, 1995.

Surve, I; Schwellnus, MP; Noakes, T; Lombard, C: A fivefold reduction in the incidence of recurrent ankle sprains in soccer players using the sport-stirrup orthosis. The American Journal of Sports Medicine. 22: 604-605, 1994

Thacker, SB; Stroup, DF; Branche, CM; et al.: The prevention of ankle sprains in sports. The American Journal of Sports Medicine. 27: 753 – 760, 1995.

Tropp, H; Askling, C; Gillquist, J: Prevention of ankle sprains. The American Journal of Sports Medicine. 13: 259 – 262, 1985.

Pedowitz, DI; Sudheer, R; Parekh, SG; Huffman, G; Sennett, BJ: Prophylactic bracing decreases ankle injuries in collegiate female volleyball players, American Journal of Sports Medicine. 36:324– 327,2008.

Frey, C, Feder KS, Sleight J: Prophylactic ankle brace use in high school volleyball players. Foot Ankle Int. 31: 296-300, 2010

J Sci Med Sport. 2009 Jul 7. [Epub ahead of print] A systematic review on the effectiveness of external ankle supports in the prevention of inversion ankle sprains among elite and recreational players. Dizon JM, Reyes JJ.

Epidemiological studies have shown that 10-28% of all sports injuries are ankle sprains, leading to the longest absence from athletic activity compared to other types of injuries. This study was conducted to evaluate the effectiveness of external ankle supports in the prevention of inversion ankle sprains and identify which type of ankle support was superior to the other. A search strategy was developed, using the keywords, ankle supports, ankle brace, ankle tapes, ankle sprains and athletes, to identify available literature in the databases (MEDLINE, PubMed, CINAHL, EMBASE, etc.), libraries and unpublished papers. Trials which consider adolescents and adults, elite and recreational players as participants were the study of choice. External ankle supports comprise ankle tape, brace or orthosis applied to the ankle to prevent ankle sprains. The main outcome measures were frequency of ankle sprains. Two reviewers assessed the quality of the studies included using the Joanna Briggs Institute (JBI Appraisal tool). Whenever possible, results were statistically pooled and interpreted. **A total of seven trials were finally included in this study. The studies included were of moderate quality, with blinding as the hardest criteria to fulfill. The main significant finding was the reduction of ankle sprain by 69% (OR 0.31, 95% CI 0.18-0.51) with the use of ankle brace and reduction of ankle sprain by 71% (OR 0.29, 95% CI 0.14-0.57) with the use of ankle tape among previously injured athletes. No type of ankle support was found to be superior than the other.**

PREVENTION OF SPRAIN

Handoll et al. also carried out a systematic review to assess the effects of interventions used for the prevention of ankle ligament injuries in physically active individuals. They concluded there is good evidence for the beneficial effect of ankle support in the form of semi-rigid orthoses or Aircast braces to prevent subsequent ankle sprains during high-risk sporting activity. There was limited evidence for reducing ankle sprains in patients with previous ankle sprains who did ankle disk training exercises. There was no conclusive evidence on the protective effect of 'high-top' shoes. Hupperets et al. evaluated the effectiveness of an unsupervised proprioceptive training programme on ankle sprain recurrence in athletes by means of a randomized control trial. They found that the use of such a programme is effective for the prevention of self-reported recurrence. It was specifically beneficial in athletes whose original sprain had not been medically treated. Although studies considered were of higher levels of evidence, small finite numbers once again preclude us from making any meaningful conclusions as to the strength of evidence.

Handoll HH, Rowe BH, Quinn KM et al. Interventions for preventing ankle ligament injuries. Cochrane Database Syst Rev 2001;3:CD000018. Hupperets MD, Verhagen EA, van Mechelen W. Effect of unsupervised home based proprioceptive training on recurrences of ankle sprain: randomised controlled trial. BMJ 2009;339:b2684

- **1601 U.S. Military cadets**
- **1424 non-injured, 177 prev. injured**
- **Randomized, prospective study**
- **No evidence of FI**
- **Intra-mural basketball**
- **13,430 athlete exposures**
- **Randomized brace assignment – B/L (Aircast Sport Stirrup)**
- **All ankle injuries evaluated by 2 M.D.'s**

Sitler M, Ryan J, Wheeler B et al: The efficacy of a semi rigid ankle stabilizer to reduce ankle injuries in basketball. Am Jour Sports Med 22: 454-461, 1994.

RESULTS

- **2.9% of subjects (46) had ankle sprain**
- **Injury rate was 1.4 x greater injured vs non**
- **Of the 46 injuries:**
  - **11 in brace group**
  - **35 in control group**
- **No difference in severity**
  - **Brace vs control**
- **No difference in non-contact sprains**

Sitler M, Ryan J, Wheeler B et al: The efficacy of a semi rigid ankle stabilizer to reduce ankle injuries in basketball. Am Jour Sports Med 22: 454-461, 1994.

RESULTS by POSITION
OF 46 INJURED SUBJECTS

43% - Guard

39% - Forward

18% - Center

Sitler M, Ryan J, Wheeler B et al: The efficacy of a semi rigid ankle stabilizer to reduce ankle injuries in basketball. Am Jour Sports Med 22: 454-461, 1994.

RESULTS

- Ankle bracing was protective for both prev. inj. And non inj. groups
- ATF ruptured in 66% of injuries
- CF ruptured in 17% of injuries
- Greater reduction of CF injuries with brace
- No difference in knee injuries: brace vs control

Sitler M, Ryan J, Wheeler B et al: The efficacy of a semi rigid ankle stabilizer to reduce ankle injuries in basketball. Am Jour Sports Med 22: 454-461, 1994.

SOCCER

- Randomized, prospective study
- Senior club soccer player – S. Africa
- 258 prev. injured
- 246 no prev. history
- Excluded "gross pathologic ankles"
- Random assignment of braces (Aircast sport stirrup)
- Unilateral use of brace – dominant or injured side

Surve I, Schwellnus MP, Nokes T, Lombard C: Ankle sprains in soccer players using the Sport Support Orthosis. Am Jour Sports Med. 22: 601-606, 1994.

RESULTS

	N	Sprains
Prev. Hist. - Braced	127	16 *
Prev. Hist. – Control	131	42
No Hist. - Braced	117	32
No Hist. - Control	129	33

P < 0.001

SEVERITY OF SPRAIN

Brace vs non brace
- Significant difference only with previously injured

Dominant vs Non Dominant
- No difference in frequency of sprains

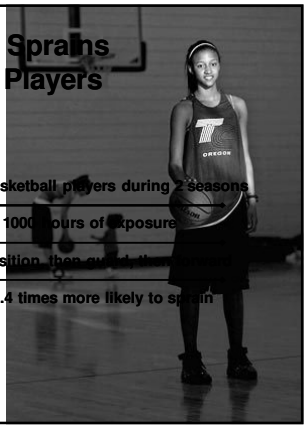
KNEE
- No difference in injury rates

Surve I, Schwellnus MP, Nokes T, Lombard C: Ankle sprains in soccer players using the Sport Support Orthosis. Am Jour Sports Med. 22: 601-606, 1994.

"We postulate that the main effect of the orthosis is to improve proprioceptive function of the previously injured ankle rather than to provide mechanical support alone."

Surve I, Schwellnus MP, Nokes T, Lombard C: Ankle sprains in soccer players using the Sport Support Orthosis. Am Jour Sports Med. 22: 601-606, 1994.

Ankle Braces Prevent Sprains in Female Basketball Players



Prospective study of 204 professional basketball players during 2 seasons

32 ankle sprains; Rate of 1.12 per 1000 hours of exposure

Ankle sprain more frequent in Center position than guard

Players without an ankle brace were 2.4 times more likely to sprain

Kofotolis N, Kellis E. Ankle sprain injuries: a 2-year prospective cohort study in female Greek professional basketball players. J Athle Train. 2007 Jul-Sep; 42(3): 388-94.

Prophylactic Bracing in Female Volleyball Players

Prospective study at U Penn from 1998-2005

All athletes required to wear ankle braces (Active Ankle®)

One injury in 13,500 exposures: 0.07 per 1000 exposures

Compared to NCAA female average: 0.98 per 1000 exposures

Significant reduction of injury rate with brace (P= .001)

Pedowitz DI, Reddy S, Parekh SG, Huffman GR, Sennett BJ. Prophylactic bracing decreases ankle injuries in collegiae female volleyball players. Am J Sports Med, 208 Feb; 36(2): 324-327.

52 female volleyball players with ankle sprain the previous year

Comparison of three prevention programs during the subsequent season:

Technical training
Proprioceptive training
Ankle brace

All three methods equally effective in preventing another sprain

Ankle braces not as effective in athletes with more than 3 prev. sprains

Stasinopoulos D. Comparison of three preventive methods in order to reduce the incidence of ankle inversion sprains among female volleyball players. Br J Sports Med, 2004 Apr: 38(2): 182-185.

Frey, C, Feder KS, Sleight J: Prophylactic ankle brace use in high school volleyball players. Foot Ankle Int. 31: 296-300, 2010

RESULTS

"Regardless of gender there was no significant difference in the ability of each brace to prevent injury (p = 0.691). In addition, the braced group did not have any significant advantage in preventing injury when compared to the control group (p = 0.824)."

Frey, C, Feder KS, Sleight J: Prophylactic ankle brace use in high school volleyball players. Foot Ankle Int. 31: 296-300, 2010

RESULTS

"In the group that wore the non-rigid brace, there was a statistically significant increase in female ankle sprains as compared to male ankle sprains (p = 0.045). There was an even more significant increase in ankle sprains seen in the group of women wearing a non-rigid brace as compared to
the group of women wearing a semi-rigid or rigid brace (p = 0.0032)."

Frey, C, Feder KS, Sleight J: Prophylactic ankle brace use in high school volleyball players. Foot Ankle Int. 31: 296-300, 2010

DISCUSSION

"The authors conclude that ankle braces should be recommended for female players with or without a history of ankle sprains. When a brace is used, a rigid or semi-rigid device should be used."

TAPE

- No reduction of talar tilt or anterior talar translation
- Unstable ankles = longer peroneal reaction time
- Tape = shorter reaction time; unstable ankles only

Karlsson, American Journal of Sports Medicine 20: 257-260, 1992

Vaes P.H. et al: Static and Dynamic Roentgenographic Analysis of Ankle Stability in Braced and Non-braced Stable and Functionally Unstable Ankles. Am Journal Sports Medicine 26:692, 1998

TALAR TILT - UNSTABLE ANKLES

	NON-BRACED	*BRACED*	
Supine	13.1°	4.8°	*
Standing	16.6°	12.0°	†
Dynamic	9.8°	6.4°	†
Speed (40-80 msec)	110.6pixels	92.4pixels	†

* $p < 0.001$

† $p < 0.01$

Cost to prevent one sprain during a season

	Hx		No Hx	
	TAPE	BRACE	TAPE	BRACE
Garrick, Requa	2,778	910	15,281	5,005
Sitler et al	1,923	630	4,168	1,305
Surve et al	4,534	175	6,091	1,195

Olmstead LC, Vela LI, Denegar CR, Hertel J: Prophylactic ankle taping and bracing: A numbness needed-to-treat and cost-benefit analysis. J Athl Train. 39(1): 95-100, 2004

"Our cost-benefit analysis determined that ankle taping would be 3.05 times as expensive as ankle bracing over the course of a competitive season."

Olmstead LC, Vela LI, Denegar CR, Jertel J: Prophylactic ankle taping and bracing: A numbness needed-to-treat and cost benefit analysis. J Athl Train. 39(1): 95-100, 2004.

Monitor Return to Sport After Ankle Sprain: *Take Home Message*

1. Listen to your patient: their own assessment of injury is most important
2. Anterior Drawer is just as valuable as stress radiographs
3. Best functional tests:
   i. Single Foot Balance (Romberg)
   ii. Lateral Hop Test
   iii. Forward Hop Test
4. *You cannot over-brace the injured ankle!*

Lateral Ankle Instability

ASSOCIATED INJURIES:

Peroneal Tenosynovitis	47/61	77%
Anterolateral impingement	41/61	67%
Atten. Peroneal retin.	33/61	54%
Ankle synovitis	30/61	49%
Loose body	16/61	26%
P. brevis tear	15/61	25%
Talar lesion	14/61	23%
Med. Tend. Tenosyn.	3/61	5%

DiGiovanni BF, Fraja CJ, Cohen, BE, Shereff MJ: Associated injuries found in chronic lateral ankle instability. Foot & Ankle 21: 805-815