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

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

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
ANKLE INSTABILITY

- Mechanical
- Functional

MECHANICAL INSTABILITY

Objective Measures:

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

Stress Radiographs


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

Talar Tilt – Side to side: >10°

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.


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.


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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 patients. 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 tip 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 malleolar zone and any of the following findings: (1) bone tenderness of the navicular or base of the 3rd metatarsal, or (2) inability to bear weight and walk 4 steps immediately after the injury or at the emergency department.


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.


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.


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 OF LATERAL COLLATERAL


MAGNETIC RESONANCE IMAGING: ACUTE SPRAIN

Conversely, Verhaven et al showed:

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


MAGNETIC RESONANCE IMAGING: 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.


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.


Functional Instability

Patient History:

Recurrent sprains and/or feeling of giving way of the ankle

Freeman, 1965
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

Persistent Ligamentous Laxity

CHRONIC ANKLE INSTABILITY

Deficit in Neuromuscular control


Functional Instability

MANIFESTS WITH DEFICIENT POSTURE CONTROL (single leg stance).

MEASURING CHRONIC ANKLE INSTABILITY

Echaute 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.

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)

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

Postural Control and CAI


Predicting Ankle Injuries

Prospective study of 119 male and 91 female high school basketball players
Subjects had no previous ankle injury
Balance assessment with NeuroCom New Balance Master during pre season
Higher postural sway scores corresponded to increased likelihood in injury rates (p=0.001)
Subjects who scored highest postural sway times at season
Higher injury rates

**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


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**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.

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**Postural Control**

- Improves after balance and coordination training exercises

**Gender Issues: Injury Patterns**

Taunton et al., 2002

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**Balance exercises cause Bilateral Improvements**

Gauffin, 1988
Hertel, 2001

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**Chronic Ankle Instability: Centrally Mediated Mechanisms**

Sedory et al revealed bilateral hamstring inhibition in CAI patients

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.

**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?**
Prolonged Peroneal Reaction Time (PRT)

Theories of Prolonged Peroneal Reaction Time

- Prolonged peroneal reaction times in patients with functional ankle instability and prolonged PRT.

- 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.

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


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.


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


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."

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

STUDIES OF FO’S AND POSTURAL CONTROL


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

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 orthoses 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. 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.

STUDIES OF FO’S


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, McCory JL, Malone TJ.Division of Athletic Training, College of Health Sciences, University of Kentucky, Lexington, KY 40536-0200, USA. carmit@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, intervention), phase (initial, 2 wk, 4 wk, 6 wk postintervention), and condition (with orthoses, without orthoses). PARTICIPANTS: Twenty-one subjects, 13 asymptomatic with rearfoot malalignment and 10 asymptomatic with normal rearfoot alignment. INTERVENTIONS: Orthoses were prescribed and worn for 6 weeks. Postural sway was assessed in a biomechanics laboratory. MEASUREMENTS: Twenty-one subjects, 13 asymptomatic with rearfoot malalignment and 10 asymptomatic with normal rearfoot alignment. SETTINGS: Biomechanics laboratory. MAIN OUTCOME MEASURES: Postural sway was assessed in a biomechanics laboratory. RESULTS: Postural sway measures were significantly decreased during single-limb stance 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 orthotics at initial week was significantly lower (worse) than the control group with orthotics at initial week; however, these results were not repeated during measurement intervals from weeks 2, 4, or 6. CONCLUSIONS: The application of orthotics decreased sway velocity by improving the ability to maintain balance during single-limb stance in subjects with rearfoot malalignment. However, these improvements were not observed during week 2 or 4, with results being observed only in the final week of measurements.

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-Aug;16(4):218-22. Cobb SC, Tix LL, Johnson JT. Center for Rehabilitation Research and Master of Athletic Training Program, Texas Tech University Health Sciences Center, Lubbock, TX 79430-6126, USA. steve.cobb@ttuhsc.edu

OBJECTIVE: Postural stability (PS) was assessed in a group of participants with > or = 7 degrees of forefoot varus (FFV) 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. SETTINGS: PS was assessed in a biomechanics research laboratory. PARTICIPANTS: Twelve participants with > or = 7 degrees of FFV (MFV) and 5 participants with <7 degrees of FFV (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=0.825) over the 6-week time period. Significant improvement was, however, reported in the MFV group anteposterior (P=0.001) 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 FFV 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 prefabricated 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."


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"

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."


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 BE: 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:

PRICE
- PROTECTION
- REST
- ICE
- COMPRESSION
- LEVATION
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, grade II 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 from acute grade II ankle ligament sprains were randomized to receive treatment with one of four methods: air-stirrup brace alone, elastic wrap alone, air-stirrup brace with elastic wrap, or cast immobilization. Functional outcomes were assessed using the AOFAS score at 3 months and 1 year. Results: Treatment of grade II 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.

**ANKE 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 bandaging, soft cast, taping, or orthoses with associated coordination training) were found to be statistically better than immobilization for multiple outcome measures.


**ANKE SPRAIN IMMEDIATE TREATMENT:**
**Immobilation vs. “Protected Mobilization”**
Recommended: Dettori, 1994
Recommended: Elf, 1994
Klein, 1993

**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 sprains: 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, Blueline boot, or 10-day below-knee cast) compared with that of a double-layer tubular compression bandage in promoting recovery after severe ankle sprain, and to assess whether the optimal mechanical support and duration of treatment can be determined using pragmatic methods. METHODS: We did a pragmatic, multicentre, randomised controlled trial with blinded assessment of outcomes. 584 participants with severe ankle sprains were recruited between April, 2003, and July, 2005, from eight emergency departments across the UK. Participants were randomly assigned to one of four support and treatment groups: 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


Acute Inversion Sprain
Position of ankle during sleep:
- Foot plantarflexed
- Unloaded ankle
- Foot inverted
  Prolonged abnormal positioning
Solution: Dorsiflexion – night splinting

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 18-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.


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

CODE: L4386

REIMBURSEMENT: $114 to $152

METHOD OF IMMOBILIZATION
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SYNDESMSOSIS 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, Schauffelen 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

Balance Training after LAS

- 4 fold reduction of recurrent sprain
  Holmes, 1999
- 2 fold reduction
  Wester, 1996

"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."
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

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.L.D.
- Ice 20 min T.L.D.

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
- Rebound™ Ankle Brace (instead of stirrup, lace-up ankle brace, and/or sleeve)
- Soft Ankle Brace
- Velocity Ankle Brace by Donjoy
  - VELOCITY MS
  - VELOCITY LS (light support)
  - VELOCITY ES

- $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

Star Excursion Balance Test (SEBT)

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

**L1906 Soft Ankle Braces**

**Exoform Ankle Brace**
Product Type: Figure 8 Lace Up

- Performance Features:
  - Exclusive Exoform ankle brace figure eight lacing provides compression and support.
  - Advanced design with figure 8 heel lock strapping provides the compression and support of a soft brace with 25% more protection than traditional supports.
  - Figure 8 heel lock strapping performs consistently unlike taping that bunches and splits.
  - Designed for maximum dorsal and plantar control.
  - Patented ankle brace is guaranteed to work.
  - Constructed of highly breathable, quick drying fabric.

- Sizing:
  - X Small – X Large

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

**Swedo Ankle Loc**
Product Type: Figure 8 Lace Up

- Performance Features:
  - Exclusive ANKLE LOK® offset panels trap the laces between the inner and outer flap to hold the laces tighter longer than any other ankle brace.
  - Excluded backstrap which prevents the healing process which could lead to ankle instability.
  - Full elastic back ensures complete consistent boot fit to the ankles which can be very restricting.
  - Constructed of high quality breathable, quick drying fabric.

- Sizing:
  - X Small – X Large

- Options:
  - Black or White
  - Stabilizer strut

**Reimbursement**

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

**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?


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


SPORTS ANKLE RATING SYSTEM

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

3. Single Assessment Numeric Evaluation

“Rate your ankle’s function on a scale of 0 → 100”

Postural Stability Assessment

Single Leg Stance Test:
- Barefoot, stance on one leg
- Eyes closed
- Arms at sides

Time compared to contralateral side

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

ANKLE PERFORMANCE MILESTONES

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

SPORTS ANKLE RATING SYSTEM

Ankles Function Assessment

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

SPORST ANKLE RATING SYSTEM

SPORTS ANKLE RATING SYSTEM

Ankle Function Assessment

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


**TAPING AND BRACING**

**IMPROVE PROPRIOCEPTION.**

<table>
<thead>
<tr>
<th>Garn, 1998</th>
<th>Friden, 1989</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guskiewicz, 1996</td>
<td>Heit, 1989</td>
</tr>
<tr>
<td>Jerosch, 1995</td>
<td>Trapp, 1985</td>
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<tr>
<td>Feuerbach, 1994</td>
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<tr>
<th>Hughes, 1983</th>
<th>Lofuenberg, 1993</th>
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<td>Myburgh, 1984</td>
<td>Shapiro, 1994</td>
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<td>Gross, 1987</td>
<td>Thonnard, 1996</td>
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<tr>
<td>Greene, 1990</td>
<td>Vaes, 1998</td>
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</tbody>
</table>

**TAPING AND BRACING THE ANKLE**

**WILL LIMIT INVERSION / EVERSION.**

<table>
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<th>Hughes, 1983</th>
<th>Lofuenberg, 1993</th>
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<tbody>
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<td>Gross, 1987</td>
<td>Thonnard, 1996</td>
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<tr>
<td>Greene, 1990</td>
<td>Vaes, 1998</td>
</tr>
</tbody>
</table>

**ANKLE TAPING**

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


**Brace vs Non-brace**

**SIGNIFICANT REDUCTION OF INJURIES.**


**BRACING THE ANKLE**

- Enhance recovery?
- Protect from re-injury?
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 reduce ankle injuries in basketball. Sitler et al. found that the use of such a programme is effective for the prevention of ankle sprain recurrence in athletes by means of a randomized controlled trial. BMJ 2009;339:b2684

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. Huppersets et al. evaluated the effectiveness of an unsupervised proprioceptive training programme on ankle sprain recurrence in athletes by means of a randomized controlled 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 level of evidence, small finite numbers once again preclude us from making any meaningful conclusions as to the strength of evidence.

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

RESULTS by POSITION OF 46 INJURED SUBJECTS

<table>
<thead>
<tr>
<th>Position</th>
<th>Number of Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guard</td>
<td>43%</td>
</tr>
<tr>
<td>Forward</td>
<td>39%</td>
</tr>
<tr>
<td>Center</td>
<td>18%</td>
</tr>
</tbody>
</table>

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


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


RESULTS

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Sprains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev. Hist. - Braced</td>
<td>127</td>
<td>16 *</td>
</tr>
<tr>
<td>Prev. Hist. – Control</td>
<td>131</td>
<td>42</td>
</tr>
<tr>
<td>No Hist. - Braced</td>
<td>117</td>
<td>32</td>
</tr>
<tr>
<td>No Hist. - Control</td>
<td>129</td>
<td>33</td>
</tr>
</tbody>
</table>

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


"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."

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

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)


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

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."

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

TAPE

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

Cost to prevent one sprain during a season

<table>
<thead>
<tr>
<th>Hx</th>
<th>No Hx</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPE</td>
<td>BRACE</td>
</tr>
<tr>
<td>Garrick, Requa</td>
<td>2,778</td>
</tr>
<tr>
<td>Siller et al</td>
<td>1,923</td>
</tr>
<tr>
<td>Surve et al</td>
<td>4,534</td>
</tr>
</tbody>
</table>

“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.”

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:

<table>
<thead>
<tr>
<th>Injury</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peroneal Tenosynovitis</td>
<td>47/61</td>
<td>77%</td>
</tr>
<tr>
<td>Anterolateral impingement</td>
<td>41/61</td>
<td>67%</td>
</tr>
<tr>
<td>Attent. Peroneal retin.</td>
<td>33/61</td>
<td>54%</td>
</tr>
<tr>
<td>Ankle synovitis</td>
<td>30/61</td>
<td>49%</td>
</tr>
<tr>
<td>Loose body</td>
<td>16/61</td>
<td>26%</td>
</tr>
<tr>
<td>P. brevis tear</td>
<td>15/61</td>
<td>25%</td>
</tr>
<tr>
<td>Talar lesion</td>
<td>14/61</td>
<td>23%</td>
</tr>
<tr>
<td>Med. Tend. Tenosyn.</td>
<td>3/61</td>
<td>5%</td>
</tr>
</tbody>
</table>