Athletic Ankle Sprains and Best Approach to Rehabilitation to Prevent Re-injury: A Literature Review

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ABSTRACT

Introduction: This Review provides an overview of literature of rehabilitation approaches to athletic ankle sprains and preventing re-injury of the components of the ankle and surrounding tissues. Emphasis is given to rehab methods which decrease pain, increase range of motion, restore strength and prevent re-injury. Experimental evidence of rehabilitation techniques are provided and treatment options for chronic and acute ankle sprains are given. This paper also will introduce what little is known regarding the incidence of first-time ankle sprains and how it is influenced by factors including sex, level of competition, and sport.

Data Collection: A computer search using Pub Med, Rehabilitation Reference Center and Sports Discus was used to generate articles relevant to chronic and acute ankle sprains, post injurious physical therapy, balance training to prevent injury and re-injury, therapeutic exercises, effects of analgesics, proprioceptive training, surgical interventions, immobilization, passive accessory mobilization technique, sensorimotor training, Mulligan's mobilization with movement technique, high-voltage pulsed current and joint stability prior to rehabilitation. The Referenced sources were identified from the individual searches. Thirty three articles from Pub Med, Rehabilitation Reference Center and Sports Discus searches were reviewed and thirteen were excluded due to irrelevance and out dated information, leaving twenty eligible randomized controlled trials. This review includes randomized controlled trials. Full text articles until May 2011, published in English, were considered for this study. To determine whether a study should be included, the abstracts of all identified articles were assessed by the reviewer.

Conclusion: An accurate diagnosis and prompt treatment can minimize an athlete's time lost from sport and prevent future re-injury. Most ankle sprains can be successfully managed using a nonsurgical approach.

Key Indexing Terms: ankle sprain, ligamentous ankle injury, rehabilitation, neuromuscular training, non-steroidal anti-inflammatory drugs (NSAIDS), physical therapy, manual therapy, inversion injury, sensorimotor training, chronic ankle instability, electrical stimulation, balance training, high-voltage pulsed current, therapeutic exercise, surgical intervention, risk factor
INTRODUCTION

Ligamentous ankle injuries, particularly those of the lateral ligament complex are the most common sports trauma accounting for 10% to 30% of all sports injuries.1 The rehabilitation of ankle sprains is complex, with as many as 70% of athletes in some sports suffering recurrent sprains and between 55% and 72% of patients complaining of residual symptoms 6 to 18 months after injury.2,3 At extremes of plantarflexion and inversion, influenced by the shorter medial aspect of the ankle mortise, the relatively weak anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) are prone to varying grades of rupture, often via minimal force (Hockenbury and Sammarco, 2001).

Immediate inflammatory processes produce acute anterolateral pain and edema, with avoidance of movement and weight bearing (Wolfe et al., 2001). Subsequent losses of joint range, particularly dorsiflexion, and muscle strength results in significant gait dysfunction. When an injury to the foot or ankle occurs athletes are limited in their abilities to run, jump, kick and change directions. Thus, the treatment and rehabilitation of these injuries are crucial in returning athletes to full participation at full function.

DISCUSSION

Neuromuscular Training A 4-week neuromuscular training program was implemented by the National Athletic Trainers' Association to measure the effects of a training program on gait patterns and the ankle joint, during walking and running in an active athletic population. The training program included exercises such as, bilateral stance and single leg exercises, with no change in the base of support, including squats, heel raises and toe raises, as well as an introduction to dynamic exercises on the unstable surface of the BOSU ball. The program
included 20 physically active subjects age 18-40 years old, fully participating in training or activity with no current injury complaints. The mechanism by which neuromuscular training improves function in normal and functional instability subjects does not appear to result in measurable changes in gait kinematics. The findings raise issues regarding methods of ankle sprain rehabilitation and the measurement of their effectiveness in improving functional activities. Further research is necessary into the effects of neuromuscular training on subjects with functional instability 4.

**Non-steroidal anti-inflammatory drugs (NSAIDS)** NSAIDs are the most widely used drugs for reduction of inflammation and pain in clinical situations 5. However, side effects upon oral administration of NSAIDs include gastrointestinal disturbance and hepatic dysfunction. Reducing these side effects while maintaining the drug’s therapeutic effects is important, as is exposing the target region to the drugs for a suitable length of time. To reduce side effects and enhance therapeutic effects, changing the route or method of administration is effective even without changing the chemical structure. Drugs can be given orally, intravenously, intra rectally or percutaneously. Blood concentration of NSAIDs rise after oral administration, and systemic side effects may result. In contrast, percutaneous absorption only acts locally and is expected to increase drug concentrations and produce higher effects at the site of inflammation, thus reducing side effects throughout the whole body. Percutaneously delivered NSAIDs were thus developed to reduce inflammation and pain. Percutaneous absorption allows drugs to permeate the skin and affect the local area. 6 However, this method is not used as main clinical treatment due to the placebo effect. Depending on the substances facilitating permeability of NSAIDs through the skin, patients feel coldness or warmth on the skin and can also notice various smells. These factors can act to created placebo effects, influencing assessment of the effect of plasters.
that contain NSAIDs. The present experimental study was performed to exclude such possible placebo effects. There is evidence that percutaneously absorbed NSAIDs have an analgesic effect, inhibit expression of c-fos in the dorsal horn, and reduce PGE2 in inflamed tissue, indicating the efficacy of this method of administration for acute inflammation and localized pain.7

**Manual Therapy** In a high quality study, Green et al (2001) assessed the effect of adding six sessions of ankle mobilizations, to a standard regimen. Results showed that significantly more participants in the mobilization group had full range of movement into ankle dorsiflexion, by day 8-10 post injury, compared to those receiving standard intervention. Similarly, a lower quality study by Eisenhart et al (2003) found that the addition of a single manipulation (plus soft tissue techniques), to standard rest, ice, compression, and elevation, resulted in significantly greater range of movement, in comparison to rest, ice, compression, and elevation alone at week one.

There is moderate evidence that manual therapy can increase ankle range of movement at week 1 post injury. Clinical guidelines suggest that normal range of movement should be achieved within two weeks of ankle sprain (van Dijk 1999). Green et al (2001) found that participants using rest, ice, compression, and elevation, in combination with manual therapy were more likely to reach this milestone compared to those receiving rest, ice, compression and elevation alone. Restrictions in range of movement after ankle injury are common and often long lasting with restrictions in posterior talar gliding, can predispose to ankle sprain and fracture (Tabrizi et al 2000). There is evidence that such persistent restrictions in talar gliding, can predispose to ankle sprain and fracture. (Tabrizi et al 2000), and may contribute to long term ankle problems such as chronic ankle instability (Hertel 2002).8
**Sensorimotor Training**  Sensorimotor training is effective in preventing ankle sprain recurrences, but the pathway through which this effect is unknown. Biomechanical and neurophysiological analyses of sensorimotor training leading to functional changes of the ankle are needed to establish this pathway. There was a critical review published on sensorimotor training of the ankle which addresses this topic. The review found that the pathway through which sensorimotor training reduces re-injury risk remains unclear. The 'black box' on the 'true' effect of sensorimotor training remains unopened. Using enhanced measurement techniques, which equate to specific physiological processes that are inside the 'black box,' would be beneficial for future research. 9

**Post Injurious Physical Therapy**  In a study done to assess correcting of the muscle atrophy, proprioceptive loss, and slowing of the reflex arc around the ankle after ankle sprain with rehabilitation, 20 cases with chronic instability who had at least two episodes of ankle sprains (mean 20.6 years, range 16-32 years); control group consisted of 20 patients with same demographic characteristics but without instability. Isokinetic muscle strength measurements and proprioceptive evaluations were made using the Cybex device before and 1.5-month after rehabilitation period. Additionally, the inversion simulation device, which was developed together with the mechanical engineering department of our university, was correlated with the EMG device, and response periods of muscles to stimulation were measured.

The study found that the proprioceptive loss present in all cases with ankle instability before treatment significantly improved after effective rehabilitation. It was detected that lengthened peroneal latent periods shortened with effective rehabilitation. Cross-interaction of rehabilitation was shown with the preservation of the difference between the pathologic and
normal sides regarding proprioception and peroneal latent periods before and after treatment, without any difference between the control group and the pathologic sides.

After ankle sprains, especially in patients with chronic instability, strengthening of the muscles around the ankle with well-planned proprioceptive exercises helps the patients return to normal living and sports activities, and prevents unnecessary surgery, especially in cases with functional instability.10

**Balance Training to Prevent Injury** In a study done to assess the effect of 6 weeks of balance training on sensorimotor measures previously found to be deficient in participants with chronic ankle instability (CAI). CAI is the tendency toward repeated ankle sprains and recurring symptoms, occurring in 40% to 70% of individuals who have previously sustained a lateral ankle sprain. Recent studies have found deficits in sensorimotor measures in individuals with CAI. As balance training is a common component of ankle rehabilitation, understanding its effect on the sensorimotorsystem in individuals with CAI may enable us to optimize protocols to better utilize this rehabilitation method.

Twelve participants with CAI and 9 healthy volunteers participated. Independent variables were group (CAI, control) and time (pre-training, post-training). Participants with CAI who completed a 6-week balance training program and healthy controls who did not get any training were pretested and post-tested at the beginning and at the end of 6 weeks.

The individuals in the CAI group who performed balance training demonstrated better performance than control participants on baseline adjusted posttraining measures of dynamic balance in the anterior medial, medial, and posterior medial directions; motoneuron pool excitability and single-limb presynaptic inhibition; and joint position sense inversion variable
error. It may be of note that no systematic differences were detected for static balance or plantar flexion joint position sense tasks.

After 6 weeks of balance training, individuals with CAI demonstrated enhanced dynamic balance, inversion joint position sense, and changes in motoneuron pool excitability compared to healthy controls who did not train.11

**Bracing versus Neuromuscular Exercises** As of today I could not find any studies conducted to directly compare the secondary preventive effect of the combined use of braces and neuromuscular training, against the use of either braces or neuromuscular training as separate secondary preventive measures. However, I found a study testing this that will have the results in 2012. It evaluated the effect of the combined use of braces and neuromuscular training (e.g. proprioceptive training/sensorimotor training/balance training) against the individual use of either braces or neuromuscular training alone on ankle sprain recurrences, when applied to individual athletes after usual care.

Their study was designed as three way randomized controlled trial with one year follow-up. Healthy individuals between 12 and 70 years of age, who were actively participating in sports and who had sustained a lateral ankle sprain in the two months prior to inclusion, were eligible for inclusion. After subjects had finished ankle sprain treatment by means of usual care, they were randomized to any of the three study groups. Subjects in group 1 received an eight week neuromuscular training program, subjects in group 2 received a sports brace to be worn during all sports activities for the duration of one year, and group 3 received a combination of the neuromuscular training program and a sports brace to be worn during all sports activities for the duration of eight weeks. Outcomes were assessed at baseline and every month for 12 months thereafter. The primary outcome measure was incidence of ankle sprain recurrences. Secondary
outcome measures included the direct and indirect costs of recurrent injury, the severity of recurrent injury, and the residual complaints during and after the intervention.

This study expects to identify the most effective and cost-efficient secondary preventive measure for ankle sprains. The study results could lead to changes in the clinical guidelines on the prevention of ankle sprains.12

**Surgical Interventions** In 2010 there was an article published in *The Journal of Bone and Joint Surgery* on the surgical interventions to the Lateral Ligament of the ankle. The study used eight cadaveric specimens to test the use of robotic technology to apply combined compressive and inversion loads to the hind foot with 0-20 degrees of plantar flexion. Contact mechanics at the ankle joint were simultaneously measured. Three types of surgical repairs were performed including Brostrum (sectioned anterior talofibular and calcaneofibular ligaments), the Brostrom-Gould (suturing the inferior extensor retinaculum to the fibular periosteum by means of two horizontal sutures over the Brostrom repair for the anterior talofibular and calcaneofibular ligaments repairs) and a graft reconstruction (5-mm-thick strip of the peroneus brevis to replace the anterior talofibular and calcaneofibular ligaments).

Ligament sectioning decreased contact area and caused a medial and anterior shift in the center of pressure with inversion loads relative to those with the intact condition. There were no significant differences in inversion or coupled axial rotation with inversion between the Brostrom repair and the intact condition; however, medial translation of the center of pressure remained elevated after the Brostrom repair relative to the intact condition. The Gould modification of the Brostrom procedure provided additional support to the hind foot relative to the Brostrom repair, reducing inversion and axial rotation with inversion beyond that of intact ligaments. There were no significant differences in center-of-pressure excursion patterns
between the Brostrom-Gould repair and the intact ligament condition, but this repair increased contact area beyond that with the ligaments intact. Graft reconstruction more closely restored inversion motion than did the Bronstrom-Gould repair at 20 degrees of plantar flexion but limited coupled axial rotation. Graft reconstruction also increased contact areas beyond the lateral ligament-deficient conditions but altered center-of-pressure excursion patterns relative to the intact condition.

No lateral ankle ligament reconstruction completely restored native contact mechanics of the ankle joint and hind foot motion pattern.13

**High-Voltage Pulsed Current:** The effectiveness of high-voltage pulsed current treatments in humans as a means of controlling edema and post-traumatic pain has not yet been established. There was a randomized, controlled, double-blind clinical trial with three intervention groups, controlled group with conventional treatment, conventional treatment plus negative polarity and conventional treatment plus positive polarity. Twenty-eight participants with lateral ankle sprain were evaluated. Conventional treatment consisted of cryotherapy (20 min) plus therapeutic exercises. Additionally, the HVPC(-) and HVPC+ groups received 30 min of electrical stimulation (submotor level; 120 pps). Pain, edema, range of motion (ROM) and gait were assessed before the first treatment session and after the last treatment session.

At the final evaluation, there were no significant differences between groups. Nevertheless, the HVPC(-) group had greater values in all assessed parameters. The data analysis showed that the HVPC(-) group had greater reductions in volume and girth, and greater recovery of ROM and gait velocity. This group also reached the end of the treatment (1.7 weeks; range 1.2-2.2) faster than the HVPC+ group and the CG (2.2 weeks; range 1.8-2.6).
There were no differences between the study groups, but the results suggest that HVPC(-) can accelerate the initial phase of recovery from ankle sprain.  

**Risk factors** Inversion ankle trauma is disabling, yet little is known regarding the incidence rate of first-time ankle sprains and how it is influenced by factors including sex, level of competition, and sport.

Between 1999 and 2003, high school and college athletes were evaluated before participation in their sports. Subjects were included in the study if they had not experienced a prior ankle or lower extremity injury and were then followed during participation in soccer, basketball, lacrosse, or field hockey to document their days of exposure to sport and injuries sustained. The relative risk associated with sex, level of competition, and sport was estimated by Cox regression.

A total of 901 athletes had 50,680 person-days of exposure to sports, and 43 had an inversion injury that produced an ankle ligament sprain. Overall, the injury incidence rate was 0.85 sprains per 1000 person-days of exposure to sport. There were 0.68 and 0.97 ankle sprains per 1000 person-days of exposure to sport for the men and women, respectively. Although the risk of suffering an ankle sprain was higher for women than for men, the difference was not statistically significant and was owing to the increased risk in female basketball athletes compared to male basketball athletes. Risk of injury was similar for the high school athletes in comparison to the college athletes. For the men, there was no difference in the risk of suffering an ankle sprain between the sports of basketball, soccer, and lacrosse, whereas for the women, the risk of suffering an ankle sprain was significantly greater during participation in basketball compared to lacrosse.
In this study of first-time ankle sprains, for most sports, the incidence rate of inversion injury is less than 1 per 1000 days of exposure to sport, a value lower than previously reported. Among female athletes, ankle injury is associated with type of sport. Risk is highest for female basketball athletes, who are at significantly greater risk than male basketball athletes and female lacrosse athletes. The risk of first-time ankle injury is similar for high school and college-level athletes.15

**Functional treatment compared to immobilization** In a study performed on twenty-one trials involving 2184 participants. Statistically significant differences in favor of functional treatment when compared with immobilization were found for seven outcome measures: more patients returned to sport in the long term; the time taken to return to sport was shorter; more patients had returned to work at short term follow-up; the time taken to return to work was shorter; fewer patients suffered from persistent swelling at short term follow-up; fewer patients suffered from objective instability as tested by stress X-rays; and patients treated functionally were more satisfied with their treatment. A separate analysis of trials that scored 50% or more in quality assessment found a similar result for time to return to work only. No significant differences between varying types of immobilization, immobilization and physiotherapy or no treatment were found, apart from one trial where patients returned to work sooner after treatment with a soft cast. In all analyses performed, no results were significantly in favor of immobilization.

Functional treatment appears to be the favorable strategy for treating acute ankle sprains when compared with immobilization. However, these results should be interpreted with caution, as most of the differences are not significant after exclusion of the low quality trials. Many trials were poorly reported and there was variety amongst the functional treatments evaluated.16
CONCLUSION

Although such injuries are often regarded as being fairly innocuous, recurrent sprains and sensations of instability are a frequent sequelae of lateral ankle sprain. Part of the problem may be that treatment recommendations are insufficient. A more intensive treatment initially and professional advice on the potential complications, may help to reduce the incidence and costs of long-term symptoms after an initial sprain. Intermittent, twenty minute periods of ice application and therapeutic exercise in the early stages of injury may represent a simple and cost effective intervention for both athletic and non-athletic populations. However, high quality randomized controlled trials are first required in order to examine the effectiveness of such interventions.

Lateral ankle sprains receive the spotlight in athletic training practice and research, they still remain the most common injury in many sports. Although the functional limitations and time loss from lateral ankle sprains are apparent, consistently reducing their incidence is less certain. One important step in preventing lateral ankle sprains is identifying their risk factors. Such risk factors include, gender, age and type of sport.
References


