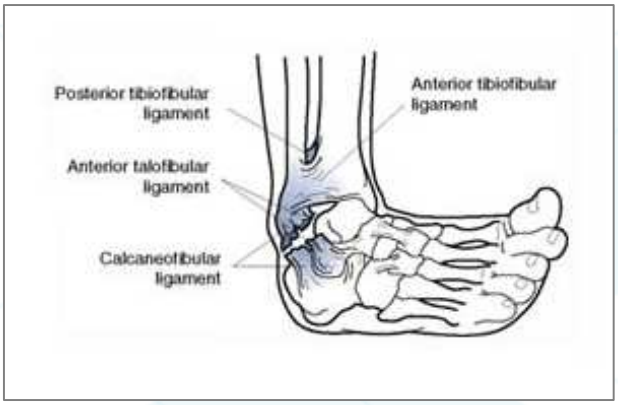
ANKLE SPRAINS / ANKLE INSTABILITY

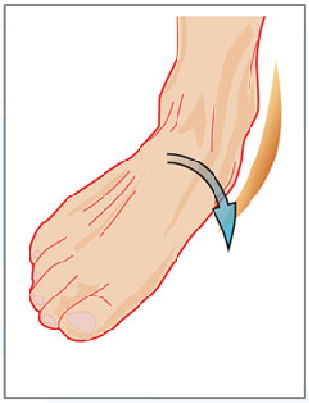
An ankle sprain is an injury in which one or more of the ligaments that stabilize the ankle joint are torn or partially torn. There are three different types of ankle sprains:

1. lateral, or inversion sprain, in which the underside of the foot rotates to the inside (see image #1),
2. medial, or eversion sprain, in which the underside of the foot rotates to the outside (see image #2), and
3. a high ankle sprain, in which there is damage to the ligaments that join the two lower leg bones (tibia and fibula) together above the ankle joint (see image #3). A high ankle sprain is typically caused when the leg rotates inward forcefully while the foot is planted.

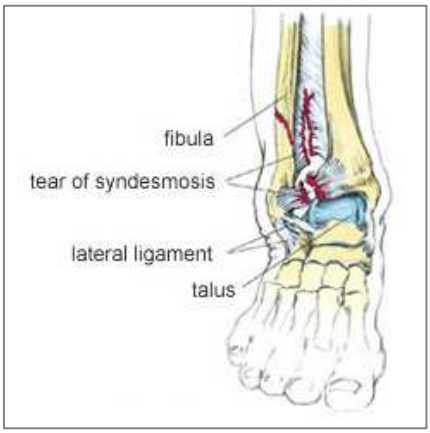
The vast majority of ankle sprains (approximately 85%) occur on the lateral, or outside of the ankle joint (Maffulli and Ferran, 2008), primarily when the foot is inverted and plantar flexed, which is the weakest biomechanical position of the ankle. Lateral ankle sprains are one of the most common sports-related injuries, with 23,000 to 27,000 ankle sprains being reported daily in the United States alone, and more than 40% of all ankle sprains progressing to chronic conditions (Safran et al, 1999).



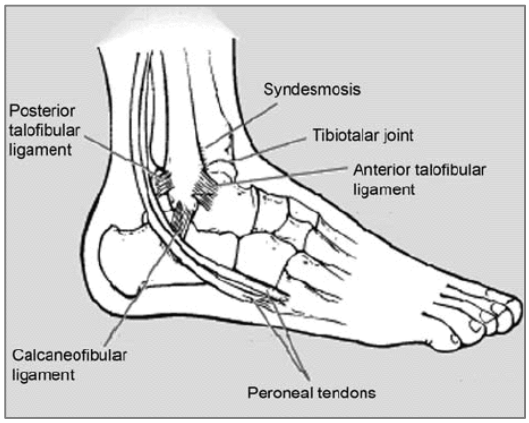
#1. Source: Kennedy Brothers Physical Therapy (2012)



#2. Source: The Bayside Well Being Center (2012)



#3. Source: Peterson & Renstrom (2005)



#4. Source: McTimoney & Purcell (2007)

Risk Factors for Lateral Ankle Sprains

The predominant stabilizing structures on the lateral side of the ankle are ligaments, and peroneal tendons (see image #4) that arise from the peroneal muscles in the lower leg. If the peroneal muscles are relatively weak, there is less structural support and, as a result, the ligaments can become stretched or torn more easily when an incident occurs. Once a ligament is stretched beyond its elastic limit, tearing of the collagen fibers will occur, resulting in permanent elongation of the tissue. As a result, there will be a loss of stability across the ankle joint, resulting in an increased risk of recurrent sprains, and a greater reliance on the peroneal muscles and tendons to stabilize the joint. If the muscles are not properly strengthened following an ankle sprain, recurrent ankle sprains are more likely to occur, along with further stretching and weakening of the ligaments, which can lead to a condition known as Chronic Ankle Instability (CAI). CAI can lead to debilitating ailments such as degeneration of the articular cartilage in the ankle joint and an increased risk of osteoarthritis (Brotzman and Manske, 2011).

One of the main factors involved in ankle instability is weakness of the sub-talar evertor muscles (Hartsell and Spaulding,1999). A meta-analysis of 12 research studies conducted by Arnold et al (2009) concluded that the sample size of the majority of studies that examined the relationship between Functional Ankle Instability (FAI) and concentric eversion strength was too small to detect a significant difference, but when the studies were combined, it was found that concentric eversion peak torque was significantly less for individuals with FAI as compared to those with stable ankles. Yildiz et al (2003) found that end range (15°-20°) eccentric evertor / concentric inverter strength ratios and eccentric evertor muscle torque for the chronically unstable ankle are significantly lower than those of the healthy ankle. Given that the normal range of joint motion for subtalar eversion is approximately 25 degrees (Eustice and Eustice 2009), the finding by Yildiz et al (2003) indicates that eccentric eversion strength near the end of the joint range of motion may be relatively weak in individuals with a chronically unstable ankle. The results of these studies indicate that both concentric and eccentric eversion strength over the full range of joint motion, as well as balanced strengthening between the inverters and evertors, are important for the prevention and treatment of lateral ankle sprains.

In addition to the loss of joint stability following an ankle sprain, damage to the ligamentous tissue can also cause damage to sensory cells called proprioceptors, which are designed to provide feedback to the central nervous system (CNS) on joint position. Damage to the proprioceptors results in a disruption in communication between these sensory cells and the CNS, which can result in a delay in muscular response to an off-balance position, resulting in an increased risk of injury. Balance board training has been shown to have a positive effect on restoring proprioception and reducing risk of recurrent injuries in athletes with a history of ankle sprains (Wedderkopp et al, 2003; Verhagen et al, 2004). However, studies that have examined the effectiveness of balance/coordination training on subjects without a history of ankle sprains have not demonstrated a conclusive reduction in risk for ankle sprains (McKeon and Mattacola, 2008).

Although ankle taping and bracing can help to increase support around the ankle joint and prevent the ankle from going into end ranges of motion, thereby reducing risk of incidence of ankle sprains while the taping and bracing is worn (McGuine et al, 2011), reliance on them for long periods of time without proper rehabilitation of the injury can make the situation worse because the muscles and tendons that support the ankle may become weaker in the end ranges of motion, which can lead to even greater ankle instability, and an increased risk of ankle sprains once the taping and bracing is removed.

Additional risk factors for ankle sprains:

- weak toe flexor muscles, which can lead to poor foot mechanics such as over-pronation;
- ankle flexibility, especially poor dorsiflexion range of motion (de Noronha et al, 2006), which can be affected by calf muscle/Achilles tightness;
- misalignment of the talus (ankle-mortice joint), which typically fixates anterolaterally in inversion sprains (Pellow and Brantingham, 2001);
- lack of warm-up and/or stretching before activity;
- inadequate joint proprioception (i.e. sense of joint position);
- slow neuromuscular response to an off-balance position;
- running on uneven surfaces;
- shoes with inadequate heel support; and
- wearing high-heeled shoes – research has shown that a heel height of 3 inches or greater significantly increases the potential for ankle sprains (Foster et al, 2012).

ANKLE SPRAIN PREVENTION

To prevent sprains or re-injury from occurring, balanced foot and ankle strengthening, which includes strengthening of all foot and ankle movements through a full range of motion should be performed, and should also incorporate eccentric loading, especially for the peroneal (evertor) muscles that help to stabilize the lateral side of the ankle (see images #5 to #7). Functional movements incorporating combined movements such as dorsiflexion / eversion and plantarflexion / inversion through a full range of motion should be performed to ensure that strengthening occurs in ranges of motion that are relatively weak biomechanically (see images #8 to #9). Strengthening the toe flexor muscles can help to provide greater support and stability to the arch of the foot during weight bearing activities, which can help to improve foot posture. Full range of motion stretching is also important to ensure that the ankle has full mobility in all directions, to reduce risk of injury and improve performance (see images #10 to #11).

Eccentric loading of foot/ankle evertors

#5. Eversion – start position

#6. Eversion – end position start of eccentric loading

#7. Eccentric eversion – mid position

Combined movements

#8. Dorsiflexion / Eversion

#9. Plantarflexion / Inversion

Stretching

#10. Dorsiflexor stretch

#11. Evertor stretch

Mobility and Proprioception

To improve ankle mobility, foot circles can be performed by extending the leg in front of the body and then rotating the foot in a circle (see image #12). Another common exercise to improve mobility as well as proprioception is to use the toes to draw the letters of the alphabet in the air (see image #13). This can be done first with the eyes open, and then progress to doing it with the eyes closed.

Mobility exercises

#12. Foot circles

#13. Alphabet

Balance and Stability

While balance and stability training is important to improve neuromuscular control, muscle coordination and proprioception following an ankle sprain, ankle strengthening using balance devices is limited to a relatively small range of ankle motion. It is therefore recommended that full range of motion ankle joint strengthening be performed in conjunction with balance and stability training. Balance and stability training includes exercises that can be performed on the Wobble board (see image #14) and the Bosu™ stability platform (see image #15) – these exercises should be done initially with the eyes open, and then progress to doing them with the eyes closed. These exercises can also be done progressing from double-leg to single-leg stance and, where applicable, employing functional sport activities such as throwing, catching, and ball dribbling.

Balance exercises

#14. Wobble board

#15. Bosu stability platform

Other strategies that can be used to prevent ankle injury include:

- ensure proper warm-up prior to stretching and activity;
- when running, choose level surfaces and avoid rocks or holes;
- ensure that shoes have adequate heel support;
- specific adjustments to the talus, primarily posterior line of correction help to align the talus, thus removing significant irritation to the involved ligaments and preventing long term fixation of the ankle mortice joint (Pellow and Brantingham, 2001);
- if high-heeled shoes are worn, ensure that heels are no more than 2 inches in height, and avoid heels with a narrow base.

REHABILITATION

The main goal of any rehabilitation program is to restore normal biomechanics to the ankle and improve joint stability to allow the individual to return to his/her activity and decrease the risk for a recurrent sprain. Rehabilitation protocols progress in a step-wise fashion, beginning with range of motion exercises and progressing to restoration of neuromuscular control, strengthening, proprioceptive training, and functional training before return to regular activity (Barr and Harrast, 2005). It is recommended that the concepts discussed in the section above titled “Ankle Sprain Prevention” be incorporated into a rehabilitation program during the appropriate phases, to ensure that optimal biomechanics and joint stability are achieved, to minimize risk of injury and optimize performance.

SUMMARY

- Strengthen the peroneal muscles (evertors) through a full range of motion, incorporating eccentric loading, to reduce risk of lateral (inversion) ankle sprains;
- Strengthen the tibialis posterior muscle (inverter), tibialis anterior (inverter and dorsiflexor), and toe extensors through a full range of joint motion, incorporating eccentric loading, to provide balanced strengthening around the ankle joint;
- Strengthen the toe flexor muscles to improve foot posture, and minimize stress on the ankle joint;
- Employ functional strengthening movements such as dorsiflexion/eversion, dorsiflexion/inversion, plantarflexion/eversion, and plantarflexion/inversion to ensure that strengthening occurs in all ranges of motion;
- Include flexibility training and mobility exercises for all the muscles of the foot and ankle, with emphasis on calf muscle/Achilles stretching;
- Incorporate balance and stability training utilizing devices such as the Wobble board and the Bosu™ stability platform to improve proprioception, muscle coordination, and neuromuscular response;
- Do not rely on ankle taping or bracing for the long-term prevention of ankle sprains.

HOW AFX HELPS

- All exercises can be performed from one comfortable seated position, so you are not required to continually reposition the athlete or re-tie elastic bands;
- The entire foot and ankle complex can be engaged (including toe flexors/extensors) due to the flexible foot support and resistance that aligns with the toes & distal metatarsals;
- The resistance system and techniques are designed to provide balanced strengthening between agonists and antagonists, to minimize risk of injury and optimize performance;
- Eccentric loading for all movements can easily be accomplished by pulling back on the handle(s) of the AFX, without concern for slippage of the resistance;

- AFX uses military-grade bungee that does not over-stretch and is safer than rubber bands, due to a built-in safety feature that prevents rupture of the elastic resistance;
- AFX's foot support doesn't slip-off, which can frustrate both the athlete & practitioner;
- Engaged athlete = improved compliance = better outcomes

~ Rick Hall, M.Sc.

Rick is the Principal Scientist for Progressive Health Innovations, and co-inventor of the AFX. Rick has a M.Sc. in Biomechanics, and has conducted research in athletic performance enhancement, exercise physiology, and injury prevention for over 20 years. He is a member of the International Foot and Ankle Biomechanics Community, and is also a reviewer for the Journal of Biomechanics.

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