**Prompt:** Lateral ankle sprains, risk factors, and effective course of treatment.

Lateral Ankle Sprains (LAS) are frequent injuries, from athletes, to individuals going about their day to day. The mechanism of injury can vary, from poor landings to stepping on an uneven object and rolling off it. The motion is typically in a form of plantarflexion when combined with excessive inversion of the foot, which then strains the 3 ligaments lateral to the ankle; the anterior talofibular ligament (ATFL), the calcenofibular (CFL), and the posterior talofibular ligament (PTFL).1 Of these, the anterior talofibular ligament is the most often injured; as the foot moves into plantarflexion, it becomes the ligament most directly under strain with an inversion force of the foot, and therefore the most likely to be injured.1 Many individuals are able to recover independently, but anywhere from 33-40% of these individuals will go on to develop Chronic Ankle Instability (CAI).2 With increased severity and frequency of these ankle sprains, the ligaments growing increasingly ‘stretched out,’ and are unable to activate the stretch-based spinal reflexes of protectives muscles that typically help avoid end range of motion (ROM).3 Given the frequency of individuals that go on to develop CAI, it’s quite possible that current treatments of lateral ankle sprains are lacking in fully preparing an individual to return to full activity safely. The purpose of this paper is summarize current evidence on risk factors for lateral ankle sprains, effective course of treatment, and prevention of recurrent lateral ankle sprains.

 There are two categories of risk factors; modifiable and non-modifiable. Non-modifiable risk factors include age, sex, tissue mobility, where females, children and adolescents, and hypermobile individuals report higher rates of ankle sprains compared to males, and adults.4 Modifiable risk factors include muscle strength of the lower leg, proprioception of the lower leg, balance, and activity participation.4,5 Professionals can intervene only on the modifiable risk factors, and should consider a strengthening protocol that targets the everters of the foot, intrinsic muscles of the foot, balance, as well as recommendations for changes in activity to reduce risk.

 Before one can get to the concept of preventing a recurrent sprain, professionals must first treat the injured individual in front of them. The Ottawa Ankle rules are an accurate tool to screen individuals for possible fractures, and should be utilized in individuals presenting to direct access for treatment to insure the patient presents only soft tissue injuries.6 While the RICE method remains a popular at home method for treating acute injuries, there is no evidence that RICE has any specific benefit on a lateral ankle sprain.2 Furthermore, icing the joint may put the individual at risk for another at-home injury, by further reducing proprioception, and decreasing their balance, increasing the likelihood of another injury. However, following an acute sprain, it is considered safe for relatively young and healthy individuals to take NSAIDs, to help reduce pain and swelling.2 This reduction in swelling is beneficial, as it helps preserve any proprioception in the joint that might be remaining. However, NSAIDs may delay the natural healing process by this reduction of inflammation and should not be used to excess.2,7 Secondly, full immobilization of the joint immediately following a LAS is not recommended; immobilization of the lower leg with a cast has numerous ill side effects, including atrophy of muscles associated with ankle control, decreasing load on the bones, weakening them, and decreased load on other tendons and ligaments, further weakening them as well.2,3 In other words, immobilization takes a weak tissues, and makes it weaker. Functional support for the first 4-6 weeks is acceptable as long as its allows protective motion of the joint (limiting ROM of inversion and eversion while allowing plantarflexion and dorsiflexion). ACE bandages while useful and beneficial, are not as effective as more rigid external supports, and that lace up braces result in better outcomes. The purpose of these braces is to allow loading of the tissue in a safe and tolerable manner; the fibroblasts responsible for tendon healing are responsive to load, and the new collagen fibers being laid down align themselves to lines of tension. These early stages of loading promote fibroblasts activity and align collagen fibers for increased strength.3 If the tissue heals without adequate load, unstructured scar tissue will form, which will be weaker, and leave the individual more prone to further injuries.7 Some individuals may find benefit from more supportive shoes later on in treatment, including those with more rigid side walls and higher ankle cuts, but the evidence supporting such choices is unclear, and shoe choice remains to be decided on a case-by-case basis.2

 Decreased proprioception and positional sense of the lower leg is strongly correlated with increased risk of lateral ankle sprains, and increased risk of developing chronic ankle instability.2,6,8,9 This fits with two key points; knowing where your joint is in space accurately informs you of how and when to land, allowing to correctly position for safe contact. With decreased proprioception, there’s decreased accuracy, and increased likelihood of a poor landing that could potentially roll force through the lateral ankle. Secondly, ligaments play a key role in activating protective spinal reflexes. If a ligament is stretched, a sensory receptor responds, and activates a spinal reflex within milliseconds.3 If a ligament is fully ruptured, these reflexes are lost, resulting in what is called ‘functional instability,’ where the individual simply lacks key components of maintaining position under dynamic stress. However, even while a ligament’s role for proprioception and reflex are damaged, other coping mechanisms and tissues can supplement this loss. The surrounding soft tissue, skin, fascia, and muscle can also provide positional sense, and given adequate training, provide input to the brain for relevant information. This theory is the basis for coordination training following a lateral ankle sprain.3,8,9

 Coordination and exercise training increases balance, loads the tissue, and also trains the brain to rely on auxiliary tissues for proprioception, addressing the deficiencies following LAS on multiple levels. It is one of the most commonly referred to intervention, though its actual manifestation varies.2,6,8,9 The most commonly utilized method to achieve this kind of training is the use of the wobble board.8,9,10 An instrumented wobble board can be used as an assessment tool to evaluate an individual’s ankle control, but it can also be used as treatment.11 Freeman et al asked their patients to perform single leg balance on a wobble board, with none of the edges touching the floor.12 After just 5 sessions of wobble board training, only 7% of treatment patients reported a recurrent of giving way, while 46% of controls receiving immobilization or conventional therapy (such as thera-bands and exercise) reported recurrence, which is a relative risk reduction of 85%. The follow up of this particular study was quite poor, making its number somewhat questionable. However, wobble board consistently appears in the literature with positive effects. The Freeman study also demonstrates that wobble board training is not only beneficial, but potentially superior to pure strengthening. In another study, proprioceptive therapy and exercise combined had a relative risk reduction of recurrence from 54% to 76%, indicating that balance training following a LAS has a strong ability to reduce another. The number needed to treat to avoid an adverse event was 4-5 patients from these studies was, which is fairly small.9 The evidence is broad and supportive of balance training, wobble board training, particularly in single leg stance.

 An important question when dealing with LAS is *when*; when to initiate exercise and balance training after the initial injury. Temporally, the typically recommended time for rest and recovery is approximately 1 week post injury that therapy can be safely initiated.2 During this first week, the individual should be protecting the joint from excessive ROM and further injury, while also continuing to move it within pain free ROM to reduce excessive deconditioning. The recommended limiting factor for initiating training, and later on for return to sport is pain.8,12 On the 10 point analog scale, patients should be able to perform activities with pain levels not rising about 1-3. Some level of discomfort is acceptable, given that the tissue is injured, and slow to heal, but ‘loud’ experiences of pain may be indicative of further injury being done. As the tissue heals, increasing its collagen density, it will steadily be able to tolerate more and more load, and improvement in pain will similarly follow. Pain should also be monitored post-intervention; if a client performs an exercise successfully, but has significant pain the hours later, this is a strong indicator that the previous session delivered too much load, and further sessions should be reduced to tolerance.

 Balance training is most powerful in the first 8-12 weeks for its ability to reduce risk;8 this is when the individual is most vulnerable to another injury, as their proprioception, strength, balance, and coordination is at its worst, making it a time ripe for intervention. However, even after treating a patient for the regular course of 8-12 weeks, regular weekly exercises for the months and years following have been found to have protective benefits against recurrent sprains.13 The Bahr et al study found that amongst Norwegian volleyball players, a combined training program consisting of an injury awareness session, take-off and landing techniques, and a weekly balance board training was able to reduce recurrence rate of injury for the following two years, with even greater benefit demonstrated in the second year. That is, continuing to participate in the program, including the wobble board training, was *protective*.13 McKeon also found that while intervention in the early stages had a stronger protective and preventative effect, intervention in the form of exercises a few times a week was still protective for a year, and two years following intervention.8 Therefore, even when a program has been initiated, individuals with a novel or a recurrent sprain should be educated about the importance of continuing to condition the ankle for the years following a sprain. Therapists should plan on crafting an ankle training program for their patients to continue to utilize upon discharge. Discussion what this more advanced exercise program can look like will be discussed later in this paper.

 Pure strength training may have a role in reducing recurrent ankle sprains, but it lacks functional aspects that allows it to be integrated in daily life. Exercise therapy compared to inactive controls found a relative risk of 0.37 with statistical significance, indicating that current methods that focus on reconditioning are effective are reducing the likelihood of future sprains.18 Kobayashi et al found that specifically, slow eccentric inversion strength and fast concentric plantar flexion strength were both risk factors for increased frequency of LAS. Given the understanding of the mechanism of injury, this conclusion is reasonable; individuals with poor control of their inversion are at a higher risk, as well as individuals that rapidly move into plantarflexion, the secondary positional component that particularly strains the ATFL.5 Thus, in programs seeking to prevent lateral ankle sprains, strengthening the muscles of eversion may reduce the risk of further sprains. However, more recent research indicates that strength of the ankle does not necessarily correlate with postural control in individuals with CAI.14 What’s more, in individuals with recurrent LAS and CAI, the patients themselves are reporting a feeling of ‘giving way,’ indicating a psychological component associated with their lower leg. It’s also key to point out that while risk is *reduced* with exercise, it is not gone, indicating room to improve. And, even as strength returns, these associations with weakness do not necessarily abate, further indicating this psychological component.8 McKeon emphasizes the importance of a biopsychosocial model of disability when considering individuals with CAI for this reason. This has two distinct implication; for individuals who have had a LAS, addressing this psychological perception of the ankle may help reduce the likelihood of a recurrence, and for someone with CAI, their psychological perception of their ankle may be feeding their sense of instability. Nagi et al found that functional limitations were highly influenced by a patient’s perception of their injury.15 Therefore, an intervention should be addressing the whole person, and the potential emotional content that could arise with an ankle sprain. Some individuals may respond with grief or sadness at another sprain, frustration, disassociation with the body part. The physical therapist then, should hold space for this emotional content, and clearly provide support and discuss the potential for recovery. However, merely offering a differing perspective of an individual’s ankle may not be enough; McKeon had discussed interventions involving an individual *looking* at their ankle as they perform exercises. In this way, they visually see *and* feel their ankle holding steady under load. This provide visual and sensory input contrary to their psychological perceptions, and the physical therapist can provide a guided perspective through this process, drawing the patient’s attention to the functional status of the ankle, and pain levels.

 Following LAS, many patients report noticeable losses in Dorsiflexion ROM, and there is Level I evidence to indicate that manual joint mobilization can improve ankle DF ROM.2,16,18,19 In a study of 12 athletes following LAS, there was reduced posterior talar glide; this decrease in motion in the talus reduces the tibia’s ability to glide forward, relative to the talus, and inhibits dorsiflexion.16 Interestingly enough, this reduced dorsiflexion shifts the talus more anteriorly when in weight bearing, which then forces more load through the anterior talofibular ligament, leaving it even more vulnerable to further sprains.17 This may be a mechanism for why many individuals experience a second LAS shortly following their initial sprains; a shift in their biomechanics leaves them predisposed. Functional instability, as discussed earlier, may be contributing due to decreased responsiveness of the ligaments, but this biomechanical instability may be another contributor. There is some research that joint mobilization can restore the natural mobility of the talus, however, how long lasting and the size of its effects are contested. 3 systematic reviews concluded that manual mobilization of the ankle improved pain and ROM when compared to exercise and standard care alone.16,18,19 The Vuurberg guidelines also conclude that joint mobilization, when combined with exercise, improves outcomes, and should be incorporated. It’s important to note that the evidence only confirms that mobilization improves ROM in the short term, and in some cases, only immediately after treatment.18  What’s more, the Weerasekara systematic review concludes that this increase in ROM is only in weight bearing, not necessarily in open chain conditions.19 Only one study so far has been done to analyze the long term effects of joint mobilization on the ankle, indicating that there’s a clear lack of evidence on the subject.16 Regardless, the short term effects on ROM clearly indicate its benefits, and the data confirms that it has longer lasting effects on single leg stance, balance, and reduced pain that make it a worthwhile component of intervention. Mobilizations should be done to tolerance, and should not increase patient pain. Given their ability to increase range in the short term, it makes sense to incorporate mobilization in the earlier half of the sessions, creating a ’window’ of increased range that the patient can load their tissue in.

 So far, the patient has passed through the acute phase; they’ve benefited from the protective effects of bracing, and transitioned to pain limited exercise, progressing to uniplanar, and then multi-planar wobble board exercises. Joint mobilizations have helped improve their balance, their pain, and made short term gains in their dorsiflexion. Throughout intervention, they’ve been coached to avoid catastrophizing concerning the weakness and instability in their ankle. For all intents and purposes, the patient is mostly functional, and able to resume their normal activities. As mentioned earlier, exercise and activity in the year, even years, following injury are protective and preventative following the initial LAS, and even amongst individuals with CAI. Admittedly, for individuals with CAI, balance training had smaller effect sizes than those with 1st time sprains, but a positive effect and improvement remained.9 But what does this extended, or more advanced exercise program look like? It looks similar to the interventions earlier; progressing the wobble board from bi-planar, to multi-planar, for longer and longer durations, along with the reduction of visual input. Following a LAS, individuals are predisposed to relying more heavily on visual input to maintain balance.20 This adaptation is helpful in the acute phase, as the ankle’s sensory input is impaired, but to continue to rely on it leaves the individual vulnerable when the patient is distracted, or is not looking directly at the ground and their ankle. Furthermore, this poor balance leaves them more prone to other injuries, and potentially developing CAI.20 It is particularly important to force the patient to use sensory and proprioceptive input, rather than their visual input, to balance. Therefore, practicing single leg balance with closed eyes can improve balance, and reduce risk for future injury.21 Single leg stance training not only improves postural sway, but also strength, addressing two key factors that leave individuals more prone to injury.

 There has been an abundance of research in the past 10 years of the importance of neuroplasticity training following ACL injury. Unfortunately, these has been less research on the role of neuroplasticity and motor learning principles in training on the ankle, but utilizing ACL research, it is possible to draw out some key concepts for application, as both these tissues are addressing acute injuries to ligaments. The research listed earlier, discussing visual reliance, poor positional sense, and poor motor control post-LAS mimics similar symptoms in individuals post ACL tear and repair.22,23 20% of individuals with an ACL tears experience a rupture within the year following, similar to the LAS rate of recurrence.23 What follows is an intuitive jump not yet supported by the evidence; the neurological training necessary to help ACL patients recover their subconscious motor control and protective responses could be similarly beneficial to patients following LAS. In fact, the framework presented by Grooms et al in Figure 1 on the left side in fact matches the conclusions made by Kim et al and by Moussa.20,12,22 Grooms, however, takes the discussion of ‘blind’ challenges, and takes them one step further; static balance and simple movements are simply not enough for full neurological recovery.

 There are four key principles of motor learning; 1) external focus of attention, 2) implicit learning, 3) differential learning, 4) self controlled learning and contextual interference.23 However, most physical therapists provide ‘internal focus of attention,’ cues that draw the patient’s attention to the orientation of their body in space. However, recent research suggests that drawing a patient’s attention to the effect of a patient’s movement on the environment is *more* effective. The example in the Gokeler paper is facilitating knee extension during gait; many PTs will instruct patients to ‘straighten their knee’ when walking. An external focus of attention would be to instruct the patient to ‘pretend they’re kicking a ball at the end of stance’ phase.23 Cues like this are more effective, and often result in more efficient movements, facilitating an ‘automatic’ nature to the movement. By transitioning focus on the effect, the conscious mind transitions its focus and allows more automatic control processes of the limb. To drive home that these concepts are applicable across the body, a randomized control trial of individuals post LAS had a greater improvement postural balance when provided with external focus of attention.24 This improvement also happened in only 2 days, indicating that these improvements are neurological in nature. The second concept of motor learning is implicit learning; it minimizes the need for ‘declarative’ knowledge about the movement, and generally results more in a ‘feel’ or understanding of the movement. Post injury, athletes are predisposed to consciously trying to control movement, dedicating part of their cognitive capacity to managing movement. The goal of implicit learning is to allow more automatic control, which LAS and post-ACL tear patients lack. Implicit learning suggests athletes and patients should steadily be exposed to more and more of the challenges they will face under stress; patients should progress to being able to walk with their eyes closed, walk with the foot everted with eyes closed, jumping, balancing on the wobble board with eyes closed, walking on an uneven slope. Tasks must engage the individual with the environment in a complex way, particularly with limited visual information.23 These all mimic the challenges they must be able to tolerate when their attention is elsewhere. The goal of the third motor learning principle, differential learning, is to practice a diverse set of movement patterns, allowing individuals to explore a range of patterns and identify what works best for them in the given environment. Walking with an everted or inverted foot not only supports implicit learning, but also differential learning, helping the individual expand the range of known movement patterns.23 Differential learning can also manifest in diverse environments for practice, such as performing these activities across grass, gravel, a slope, or a foam pad; individuals must be able to adapt different strategies in different environments, and the way to train that plasticity is to provide a variety of input. The fourth and final tenant of motor learning regards the structure of the practice is contextual interference; is the practice scheduled in a block, serial, or variable manner? Current evidence suggests that variable practice has the best results on regaining neuroplasticity in adults. Variable practice often has poorer performance in the movement, but increases the rate of skill acquisition. These principles of motor learning need not only apply to ACL recovery, and the world of LAS is ripe for improved application of the principles of motor learning in improving patient outcome.

 Motor learning principles can be applied throughout the intervention, but they provide a window into what the more advanced and long term training can look like when the individual is discharged and maintaining their own exercise program. A diverse set of activities across diverse textures and surfaces, with limited visual reliance will be most beneficial in improving neural control and conditioning the tissue. Longer durations on the multi-planar wobble boards, while performing dynamic tasks such as ball throwing increasing strength, balance, and promote neurological adaptation. Independently, patients can use pillows, rolled up towels, or diverse outdoor settings to challenge their ankles. As the McKeon article demonstrates, protective interventions over the long term need only happen a few times a week, for 20 minutes a week.8

In conclusion, LAS require a multi-modal and long-term approach to allow for full recover and protect against recurrent injury. Acute intervention should aim to reduce swelling and pain, with the use of bracing to protect the joint against further injury. Joint mobilizations of the talocural, substalar, and inferior talofibular joint can be initiated within 10 days to increase function and accelerate recovery, while also increasing balance and proprioception, helping prevent the individual from more injury. Training and intervention should occur with minimal pain, and progress with patient’s tolerance. Wobble board training, progressing from uni-planar to multi-planar can improve balance and motor control. Intervention should also seek to integrate treatment of a patient’s psychological perception of their ankle, helping patient’s view their body without catastrophizing. Throughout intervention, therapists should also utilize the principles of motor learning to provide external cues and provide a diversity of inputs in a random order to support neuroplasticity and adaptation.

Figure 1:



Citations

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