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A SYSTEMATIC REVIEW STUDY TO DETERMINE THE CAUSATIVE FACTORS AND THE REHABILITATIVE APPROACH FOR LATERAL ANKLE SPRAIN

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***Abstract*: Ankle sprain is one of the most common musculoskeletal sports injury encountered. In sports injuries throughout the countries studied, the ankle was the second most common injured body site after the knee. The purpose of the review study is to study the pathophysiology, predisposing factors, and the current evidence regarding therapeutic modalities and exercises used in the treatment of ankle sprain. There is a high incidence rate of approximately 75% of lateral ankle sprain; it also possesses a high incidence rate of re-injury. Recent researches have proved that immobilization post ankle sprain facilitates ligament healing and enhances the rehabilitative protocol. In addition to that the other treatment protocols are to be implemented as an adjunct for instance graded joint mobilization, proprioceptive training and balance training. Altering current rehabilitative protocol to enhance the joint range of motion and to maintain the soft tissue integrity with stringent immobilization, and including graded joint mobilizations and balance training may be the first step to decreasing the incidence of short and long term ankle joint dysfunction.**

***Keywords*: Ankle joint, Sprain, Ligament, Immobilization, Proprioceptive, Pathophysiology, Sports, Athletic, Degeneration.**

I. INTRODUCTION

The lateral ankle sprain is amongst the most common injuries sustained during athletic/recreational activities. Specifically, more than 45,000 ankle sprains are estimated to occur per day in Europe. Despite the frequency of lateral ankle sprain, the trauma is often erroneously believed to be an inconsequential injury. As a consequence of the societal insignificance assigned to lateral ankle sprain, about 55% of people who suffer from an ankle sprain do not seek treatment from a health care professional thus, the true incidence of trauma may be much larger. Around 70% of the patients that suffer from repetitive lateral ankle sprain experience chronic symptoms after the initial injury in case the condition is left unattended. The development of these residual symptoms has been termed chronic ankle instability[1]. Not only does the chronic ankle instability limit physical activity, but also leads to articular degeneration of the talus, and thus increasing the risk of degenerative osteoarthritis. With the high incidence of chronic ankle instability and potential for the development of ankle osteoarthritis, it is essential that the lateral ankle sprain is managed effectively from the onslaught[2-5]. The aim of this systemic review is to study three important aspects that are important to properly manage lateral ankle sprain and to prevent the development of chronic ankle instability:

- The pathophysiology of lateral ankle sprain.
- Predisposing factors relating to lateral ankle sprain.
- The current evidence regarding therapeutic modalities and exercises used for treating the lateral ankle sprain.

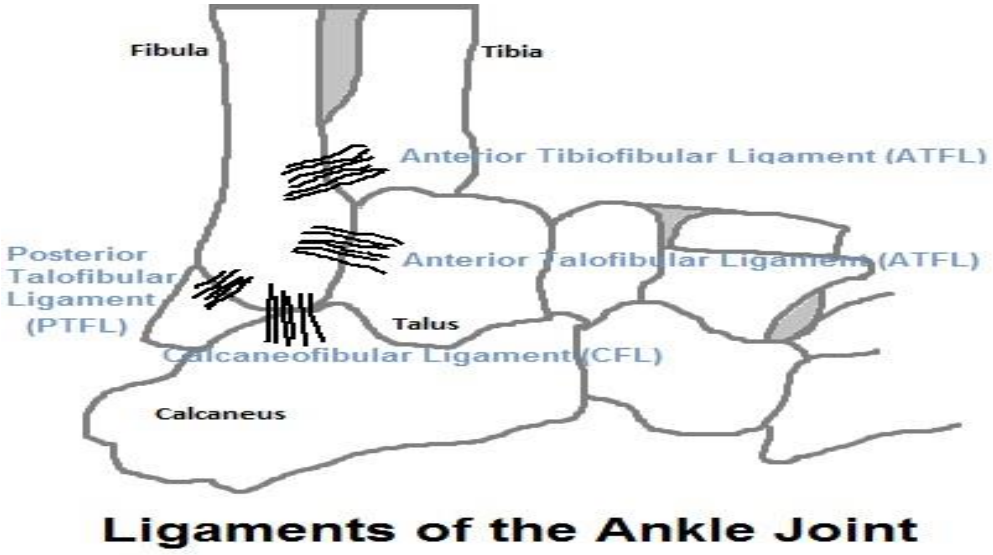

Diagram 1

II. PATHOPHYSIOLOGY

The lateral ankle sprain results in impairment to the passive ligamentous structures of the ankle joint. Indeed, forceful ankle plantar flexion and inversion, the most common mechanism of injury, often leads to tearing of the lateral ligaments of the ankle. Specifically, the anterior talofibular ligament (Diagram 1.0) reported to be the weakest is first ligament injured [4-9]. Trauma to the anterior talofibular ligament is followed by additional damage to the calcaneofibular ligament and finally to the posterior talofibular ligament. Isolated injury to the anterior talofibular ligament occurs in 66% of lateral ankle sprain while anterior talofibular ligament and calcaneofibular ligament ruptures occur concurrently in another 20%[7]. Trauma to the posterior talofibular ligament is highly uncommon because of the great amount of force required to do impairment, as considerably as the amount of dorsiflexion needed to strain the ligament. The level of dorsiflexion required to filter out the posterior talofibular ligament places the ankle joint in a compact state and so adjusting it in a more stable position which cuts the likeliness of harm to the ligament[8-10]. In summation to the lateral ligament structures of the talocrural joint, the subtalar ligaments are also prone be injured. Rubin and Witten were the first to examine the subtalar instability as an independent clinical entity; however, they assumed that injury to the subtalar joint often occurs in combination with injury to the lateral ankle ligaments[11-13].

Further, the incidence of subtalar instability is estimated to be in between 70% to 85% in individuals with chronic ankle instability[12-14]. With damage to the ligaments supports of the ankle post a lateral ankle sprain, an associated increase in the motion available between the bones of the ankle/foot complex occurs[15]. The resulting hypermobility can be measured qualitatively and by trial and error by implementing various clinical techniques such as manual stress tests, instrumented arthrometry and stress radiographs. In order to regain stability of the ankle joint, immediate care and rehabilitation should focus upon enhancing ligament reconstruction. In the acute duration the rehabilitation is procured by protecting the joint by immobilizing it by using protective braces and using crutches for locomotion further slowly adding exercises that aid the newly laid down collagen align along the forces of the ankle. The review study postulates that it contains about six weeks for ligament healing to take place. However, studies have also documented joint laxity six months post injury[16]. The chronic laxity developed might be as a consequence of inappropriate rehabilitation, this demands the need for further study into the type of attention and treatment that will best facilitate tissue healing, and normal joint use[17-22].

III. PREDISPOSING RISK FACTORS

Determining the predisposing risk factors is essential in preventing lateral ankle sprain. Indeed, this kind of review study attempts to identify specific characteristics (both intrinsic and extrinsic) that increase an individual's chance of suffering a lateral ankle sprain[20-23]. Nevertheless, the greatest benefit of risk factor research is that the findings allow clinicians to

apply focused therapeutic interventions to compensate and/or limit the effects of identifying risk genes. A few prospective studies that have examined the predisposing factors related to lateral ankle sprain, but the researches that had been conducted have reported several intrinsic and extrinsic risk factors. Numerous intrinsic factors have been examined, but the most correlated factor is a chronicle of a previous ankle sprain[24]. Unfortunately, the literature studies remain contradictory upon the thing, with several studies reporting that a history of a previous lateral ankle sprain both increases and has no effect on an individual's risk of having a recurrent lateral ankle sprain. Additional factors that have been reported to enhance an individual's risk of recurrent lateral ankle sprain, including: height and weight, limb dominance, ankle joint laxity, anatomical alignment, muscle strength, muscle reaction time and postural sway[25]. Further prospective research is necessary to better understand if these factors actually predispose patients to lateral ankle sprain. Standardized to the intrinsic risk factors, the literature has consistently reported that patients with a previous account of lateral ankle sprain who wear ankle braces or use supportive taping have lower incidence of lateral ankle sprain than those that do not[24-29]. Research hypothesizes that the reduction in lateral ankle sprain may be preferable to either the mechanical support, i.e. bracing or taping and with the enhanced proprioception offered by the proprioceptive training. Established on the available evidence, it seems that those patients who earlier had suffered from lateral ankle sprain should wear ankle braces and/or athletic tape when taking part in physical activity as it is an efficient way of preventing recurrent lateral ankle sprain. An analysis conducted by Olmsted et al indicated that braces are better in terms of price savings compared to taping. Other extrinsic factors that have been examined include shoe type, duration and strength of competition and player status[11,30-35]. The research has not shown either factor to significantly increase or decrease the risk of developing or injuring the ankle. Further prospective research is required to evaluate both intrinsic and extrinsic factors relating to the lateral ankle sprain. The evidence however proves ankle bracing as the most efficient method to manage lateral ankle sprain[31-36].

IV. MANAGEMENT STRATEGIES

Acute lateral ankle sprain management typically involves pressure, rest, ice, compression, elevation (PRICE) further electrotherapeutic modalities, for example (TENS) transcutaneous electrical stimulation, (IFT) Interferential therapy, (LASER) therapy light amplification and stimulated emission of radiation can also be implemented to stipulate soft issue injury. In addition, that implementation of restrictive taping, bandaging and bracing is also beneficial. Severe lateral ankle sprain cases are to be treated with strict immobilization for a few days until optimal recovery has taken place and inflammation subsided[37]. Numerous investigations have evaluated the efficacy of rehabilitation techniques in improving clinical outcomes post lateral ankle sprain. The inquiries have been principally concentrated on short term outcomes, including: pain, range of motion. Even so, the high share of injury occurrence (up to 70%) and development of chronic ankle instability (up to 75%) after a lateral ankle sprain, suggests that further research of both short and long-term outcomes following rehabilitation is required[8,38-46]. Currently, cross-sectional and case control investigations have identified numerous mechanical and neuromuscular impairments in subjects suffering with chronic ankle instability and post-traumatic ankle osteoarthritis, the long-term sequel of acute lateral ankle sprain. Researchers have argued that many of these handicaps can be processed with a mixture of healing modalities and practices. The three impairments that have been implicated as causal agents of chronic ankle instability, and are the focus of this review study they include increased joint laxity, arthrokinematic impairments, and balance deficits[45-52].

V. ACUTE CARE/IMMOBILIZATION PHASE

Immediately post a lateral ankle sprain the primary goals are to effectively manage pain, control inflammation and protect the joint so that the healing process can be started. In the intense form of healing, the most important structures to protect are the lateral ligaments of the ankle, as the traumatic mechanism have caused increased laxity in the joint structure. In the past, the majority of the studies has focused upon functional rehabilitation post a lateral ankle sprain[25,38,42,52-54]. But with the high recurrence rates of lateral ankle sprain and further development of chronic ankle instability later, which results in the development of degenerative arthritis at the ankle joint. Nevertheless, functional rehabilitation may not permit enough time for the ligaments of the ankle to heal and the stability to be repaired. Indeed, increased laxity has been described using both subjective, i.e. ankle giving way, or notions of instability and objective i.e. manual stress tests, radiographs outcome measures[55]. Unfortunately, ankle laxity often persists despite treatment. Specifically, positive anterior drawer tests were present in approximately 3%–31% of subjects six months after injury and feelings of instability were present in 7%–42% of subjects up to one year post injury. There remains a large need for data obtained from reliable and

quantifiable methods of measuring ankle laxity. For instance, Hubbard and Cordova assessed the natural recovery of ankle ligament laxity post-acute lateral ankle sprain with an instrumented ankle arthrometer. More specifically, the authors quantified the anterior-posterior load displacement and inversion eversion rotational laxity characteristics of the ankle subtalar joint complex within three days after injury and again eight weeks after trauma[43,56-63]. The results indicate that ankle laxity did not significantly decrease over eight weeks, which suggests that the lateral ligaments of the ankle need to be protected for a longer period than eight weeks if mechanical stability is to be restored post an acute lateral ankle sprain. These studies however provide strong evidence that better and longer protection of the ankle joint post an acute lateral ankle sprain is essential for restoring the mechanical stability of the ankle joint[64]. If mechanical stability is not fixed, increased laxity would further contribute to mechanical adaptations for instance greater laxity in joint structures, altered joint alignment and deficits in sensorimotor control, i.e. impaired balance, altered movement patterns and recurrent injury as a maladaptive compensation of the alterations in joint laxity and/or sensorimotor control[8,65]. To help examine the effects of immobilization, a multicenter prospective randomized controlled test was conducted examining three different mechanical supports, for example Aircast brace, Bledsoe boot compared with that of a dual-layer tubular compression bandage in promoting recovery post severe lateral ankle sprain. A total of 584 patients with lateral ankle sprain were followed over nine months. The principal issue was that the quality of ankle function measured using the foot and ankle score. The research proclaimed that the patients that received a below knee cast had a more speedy recovery than those compared to the tubular compression bandage with clinically significant benefits in quality of ankle function three months post trauma, Bledsoe boots though were reported to be the least effective treatment throughout the recovery period[66-73]. Established on the data, a short period of immobilization in a below knee cast or Aircast ankle brace may result in faster recovery than the current measure of rehabilitation. In summation to that the researchers recommended the below knee cast because it presented the wide range of benefit. Nevertheless, future research is needed to find out if similar benefits will be establish in more objective standards such as ligament laxity and postural control[36,58,63,72-75]. A research concluded by Beynnon et al also examined the type of immobilization that had the best results. The authors stratified acute lateral ankle sprain based on the degree (I, II, or III). Patients were then randomized to undergo functional treatment with different cases of ankle immobilization. They compared a lateral ankle spraintic wrap, Air Stirrup ankle brace, Air stirrup ankle brace with a lateral ankle spraintic wrap and fiber lateral ankle sprains walking cast. They reported that the treatment of grade I and grade II ankle sprains with the help of Air Stirrup brace combined with a lateral ankle spraintic wrap allowed patients to return to preinjury function quicker than the other immobilizers. For grade III sprains, there were no differences between the Air stirrup brace and the fiber Lateral ankle sprains walking cast[71-79]. The topics in the research conducted by the Lamb et al study were studied to have severe ankle sprains, which may be why they reported the below-knee cast as most favorable. In less severe sprains less stringent immobilization like an Air Stirrup brace combined with a lateral ankle spraintic wrap may best restore function, but in more serious cases the below knee cast may best enable return to normal function[28,37,39,56]. Established along the research available to treat an acute lateral ankle sprain, some kind of immobilization needs to be applied to help protect the joint and allow ligament healing to take place. Thus, lateral ankle sprints or tubular wraps are not recommended because research suggests that they do not offer enough shelter to permit return of social occasion. An Air Stirrup brace with lateral ankle sprints wraps for grade I and grade II, and below knee casts for grade III sprain might be the most efficient treatment strategy to preclude long term pathology. After a period of controlled immobilization functional exercises are necessary to rehabilitate the joint[80-86].

VI. JOINT MOBILIZATIONS

To date a range of manipulative therapy techniques including Maitland's mobilizations, Mulligan's mobilizations with movement, and High velocity, low amplitude thrusts, have all been postulated to be effective treatment methods for acute lateral ankle sprain. Indeed, manipulative therapy techniques are theorized to reduce pain, improve function and increase range of motion via the restoration of arthro-kinematic motions i.e. rolling, gliding, spinning motion of the joint surfaces upon each other thus recommendations to employ these techniques make intuitive sense. Further, at that place is a heavy deal of anecdotal evidence in the form of published case studies backing the role of manipulative therapies to improve various outcome measures in acute lateral ankle sprain, a recent follow-up study indicated that multiple high velocity, low amplitude thrusts delivered over several treatment sessions resulted in a statistical trend towards improving pain, pressure scores and self-report levels of pain upon a Visual analog scale[33,43,56-59,73,87-90]. Further, a single treatment session, which involved multiple osteopathic and manipulative techniques, immediately reduced self-reported pain relative to a control group in patients with an acute lateral ankle sprain. Similarly, studies that used multiple manipulative techniques delivered over several treatment sessions reported significant improvements in pain outcome measures[91]. Therefore, the current data

strongly indicate that multiple manipulative therapy treatments are exceedingly good to improve outcome measures associated with pain in patients with an acute lateral ankle sprain[92]. However, the exact number of treatments and the dosage within each treatment session remains unknown and should be the focus of future research prospects. The available literature also suggests that both active and passive range of motion has improved following the rescue of multiple treatment sessions consisting of Maitland's mobilization and high velocity low amplitude thrusts[90-93]. Additionally, significant improvement in non-weight bearing range of apparent movement was described after the legal transfer of a variety of manipulative therapy techniques over a two week intervention. Nevertheless, single treatment sessions regardless of the manipulative therapy technique used have failed to improve range of motion in patients with an acute lateral ankle sprain, in patients who had earlier suffered from lateral ankle sprain more than six months prior to testing, and in uninjured controls[54,66-75,88-91]. Therefore, the cumulative data suggest that multiple treatment sessions are required to assess the range of motion improvements in patients suffering from an acute lateral ankle sprain. Nevertheless, substantial improvements in dorsiflexion range of motion have been reported after just a single treatment session of Maitland's mobilizations in patients who underwent a lengthy period of ankle immobilization for a sort of pathological conditions. Therefore, it seems that even if acute lateral ankle sprain patients are immobilized following a lateral ankle sprain, ankle joint mobilizations could be utilized to help restore range of movement. Additionally, investigations that used several techniques during multiple treatment sessions also found improvements in self-reported use. Likewise, a single treatment session consisting of two manipulative therapy techniques leads to an immediate redistribution of foot loading patterns during static stance relative to a placebo laying of hands procedure in patients with acute grade II lateral ankle sprain[77,81-91]. Based on this evidence, it appears that multiple treatment sessions are needed to consistently see improvements in a variety of outcome measures, regardless of the specific manipulative therapy technique used, in patients with an acute lateral ankle sprain. All the same, no investigation has directly compared the strength of different manipulative therapy techniques on any outcome measures in patients with an acute lateral ankle sprain. Hence, direct comparisons of manipulative therapy techniques should be the focal point of the future research endeavors.

VII. BALANCE EXERCISES

One of the most commonly examined sensorimotor outcome measured post the lateral ankle sprain is single leg postural control. A prospective investigation has demonstrated that single leg postural control is impaired for at least four weeks post trauma. Further, recent systematic reviews have shown that postural control is impaired on both the involved as well as the uninvolved limb relative to an uninjured control group within six weeks of a lateral ankle sprain. The presence of bilateral balance impairments as well as bilateral alterations at joints proximal to the ankle suggests changes in the motor control patterns that are centrally mediated[44,67-73,91]. Further, impaired postural control is linked with an increased danger of ankle injury and because of this strong association; balance training is a common part of therapeutic intervention programs used by allied health care practitioners to handle an acute lateral ankle sprain. Fortunately, balance training is efficient in improving postural control scores in subjects with an acute lateral ankle sprain and at reducing the risk of recurrent lateral ankle sprains. The effectiveness of balance training is hypothesized to be preferable to the modality's ability to repair and/ or correct feed-forward and feedback neuromuscular control alterations that have taken place as a consequence of a lateral ankle sprain. Indeed, neural adaptations occur at multiple sites within the central nervous system as a result of balance training intervention programs. In other words, balance training capitalizes on the incredible lateral ankle sprain possibilities of the central nervous system and enhances a patient's ability to react to both internal and external perturbations. While balance training improves postural control the exact treatment dosage needed to cause balance improvements and cut down the risk of recurrent injury remains unknown[93,95]. For example, postural control improvements have been reported after only three days and after weeks of balance training. While rapid improvements are extremely exciting to patients and clinicians alike, Bahr reports that the longer a correspondence training program is implemented the greater preventative effects accrue from the plan. Balance training, investigations primarily use prospective cohort designs where the baseline measures represent postural control prior to the intervention but not pre-injury postural control values. So while the literature suggests that balance training improves postural control, it is not clear if balance training restores postural control to pre-injury balance values. While balance training is efficient in restoring postural control, recent investigations have identified several adjunctive treatments that may further heighten the strength of balance training including stochastic resonance and the patient's attentional focus. Stochastic resonance is the entry of low degrees of sub sensory or mechanical disturbance into the nervous system during balance training. This technique is thought to enhance the sensorimotor system's ability to detect afferent information from a number of origins which is believed to subsequently result in a more efficient motor response from the cardinal nervous system, a vital

element for maintaining equilibrium along the neurological and musculoskeletal structures[91-97]. Stochastic resonance has improved postural stability in healthy young and elderly people when compared to postural stability tests without stimulation present. Additionally, stochastic resonance stimulation applied during balance training improved both static and dynamic postural stability before and with greater efficacy than balance, coordination training alone in both healthy and subjects with chronic ankle instability[88, 92-96]. However, the effectiveness of stochastic resonance in patients with acute lateral ankle sprain has not been investigated. Attentional focus, principally in the area of motor control has also been investigated in an attempt to enhance learning motor skills including postural control. There are two types of attentional focus: internal attentional focus and external attentional focus. An instance of internal attentional focus is when a clinician instructs the patient to 'stand as yet as possible' when completing a balance training task and/or course of study. These instructions address the patient's attention towards themselves and emphasize an internal attentional focus. Nevertheless, research shows that an external attentional focus, i.e. focusing on the result of their movement enhances motor skill learning more effectively. For example, an external attentional focus resulted in greater acquisition, retention and transfer of postural control when compared to an internal attentional focus in patients suffering from an acute lateral ankle sprain. Researchers hypothesize that an external attentional focus facilitates more effective movement patterns by allowing the sensorimotor system to self-organize, so leaving the completion of movement patterns to be more automated. While balance training is effective, the exact dosage, type of use and level of intensity needed to improve various indices of postural control and reduce recurrent injury may never be recognized because these issues are most likely multi-actorial in nature. Still, balance training is effective and therefore, patients with a history of lateral ankle sprain should complete a correspondence training program because:

- The balance training is hypothesized to enhance neuromuscular control deficits.
- The balance training enhances postural control, a measure associated with an increased danger of sustaining lateral ankle sprain.
- The balance training reduces the recurrence of lateral ankle sprain.

VIII. CONCLUSION

Short and long term disability after an acute lateral ankle sprain remains a public health concern. Research reports instability and joint laxity to still be present over six months after injury. Acutely, evidence suggests rigid immobilization as an effective means to help restore joint stability. In summation to the need for proper acute care, two adjunctive therapies should be a part of the rehabilitation process: joint mobilizations and balance training. The literature has reported the benefit of using both to help improve function and balance training has been shown to cut the incidence of wound. Further future research is indispensable to find out the test dose of treatments and rehabilitation modalities to best maximize function and prevent chronic joint dysfunction.

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