Effectiveness of Joint Mobilization in Patients With Chronic Ankle Instability

A Review of the Literature

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ABSTRACT

Individuals with chronic ankle instability (CAI) exhibit talocrural and tibiofibular arthrokinematic restrictions and sensorimotor alterations, which may contribute to functional loss and recurrent ankle sprains. To address these impairments, joint mobilization interventions have become an increasingly prevalent treatment in the rehabilitation management of CAI. Although the use of joint mobilizations in CAI management may be considered novel, several investigations have examined the effects of joint mobilization from patient, clinical, and laboratory perspectives. The purposes of this review are to discuss the rationale for using joint mobilization for patients with CAI and to examine the patient-, clinician-, and laboratory-oriented evidence associated with joint mobilization outcomes and CAI. The findings of this review indicate (1) talocrural joint mobilization interventions enhance dorsiflexion range of motion, (2) joint mobilization interventions have an acute effect on sensorimotor function, and (3) additional evidence is needed to determine whether joint mobilization influences patient-centered aspects of function.

ANKLE sprains are the most frequently occurring injury sustained by physically active individuals.1,2 The general population demonstrates ankle sprain incidence rates of 2.15 per 1,000 person-years, meaning these injuries affect approximately 2 million people per year.3 Although often considered benign in nature, ankles sprains demonstrate the highest recurrence rate of all musculoskeletal injuries (including low back pain), with up to 70% of individuals experiencing repetitive sprains, residual symptoms, and recurrent ankle instability following a single acute sprain.4 The culmination of these negative sequelae, known as chronic ankle instability (CAI), are not only associated with repetitive incidents of acute joint trauma but also with long-term reductions in health-related quality of life and an increased potential for developing ankle osteoarthritis.5,6 On the basis of the prevalence of CAI, understanding the factors contributing to dysfunction and identifying novel and effective intervention strategies continues to be a focus of clinicians and researchers.

The contributing factors for CAI have been traditionally separated into mechanical or functional impairments.7 Mechanical contributing factors include arthrokinematic alterations, ligamentous laxity, and degenerative changes in structure.7 Functional impairments are associated with sensorimotor alterations that affect dynamic stability, such as deficits in postural control, muscle activation, and neuromuscular control.7 Although mechanical and functional impairments may independently contribute to CAI, the interaction between impairments is thought to be a critical component for this clinical phenomenon.7,8 The multifactorial nature of CAI suggests that interventions addressing both mechanical and functional impairments are ideal to reduce ankle sprain reoccurrence, prevent episodes of giving way, and diminish functional loss.7,8

Although CAI is often attributed to ligamentous laxity and joint hypermobility as a result of ligamentous trauma, arthrokinematic restrictions can develop independently or in conjunction with other mechani-
cal impairments and result in hypomobility of the talocrural, distal tibiofibular, and proximal tibiofibular joints. To address issues of hypomobility that are arthrogenic, clinicians often use manual therapy techniques known as joint mobilization. Manual therapy has traditionally been used to increase the extensibility of the noncontractile structures of a joint (ligament, capsule) in an effort to restore arthokinematic motion. In addition to addressing mechanical impairments, it has been speculated that these techniques may also augment sensorimotor function by stimulating sensory receptors within and surrounding the joint. Therefore, joint mobilization interventions may serve a multimodal purpose in targeting mechanical and functional contributing factors for CAI.

Although joint mobilization is certainly not a novel intervention to most rehabilitation specialists, the use of these interventions for individuals with CAI may be a novel treatment approach, particularly when examining aspects of function beyond range of motion (ROM). Recent findings regarding the arthokinematic impairments in individuals with CAI have provided new insights and fortified clinical intuition regarding the arthokinematic alterations associated with CAI. These findings have stimulated inquiries into the relationship between the mechanical and functional contributing factors associated with CAI. As a result, recent investigations have examined the use of talocrural and tibiofibular joint mobilization for enhancing sensorimotor system function and patient-reported outcomes, which has expanded the applications for using joint mobilization for patients with CAI. Due to the surge of recent research, the purposes of this review are to (1) define the common arthokinematic alterations and their potential link to functional impairments associated with CAI, (2) describe joint mobilization techniques commonly used for individuals with CAI, and (3) examine the patient-, clinician-, and laboratory-oriented evidence associated with joint mobilization outcomes and CAI.

LITERATURE REVIEW

Arthokinematic Alterations
Normal ankle arthokinematics during dorsiflexion require the talus to glide posteriorly within the ankle mortise, the distal fibula to glide superiorly and posteriorly on the tibia, and the proximal fibula to glide inferiorly and anteriorly on the tibia. After a lateral ankle sprain, individuals may demonstrate altered arthokinematics of the talocrural or tibiofibular joints. The movement restrictions may be due to a combination of 2 factors: tightness of the posterior portions of the respective joint capsules or an anterior displacement of the fibula relative to the talus. Restrictions in ankle arthokinematics may be identified by examining joint mobility and measuring ankle dorsiflexion ROM. It is important to note that although ankle dorsiflexion ROM may be considered normal following a lateral ankle sprain, a deficit in talocrural joint arthokinematics may still exist. For additional information regarding clinical techniques to assess dorsiflexion ROM and posterior talar glide, refer to the studies by Grindstaff et al and Cosby and Chinn.

A clinical consequence of restricted ankle joint mobility is the potential for deficits in ankle dorsiflexion ROM. Limitations in dorsiflexion ROM, in individuals with CAI, have been identified with static ROM measures, as well as during gait. In addition to dorsiflexion ROM impairments, individuals with CAI have also demonstrated deficits in postural control, as well as changes in spinal and cortical motor excitability. Changes in sensorimotor function may be a result of altered afferent signals from the injured joint structures or may be related to decreased ankle dorsiflexion ROM. Ultimately, the deficits in dorsiflexion ROM and sensorimotor function may contribute to CAI. Therefore, using joint mobilization to target arthokinematic alterations may concurrently address impairments in dorsiflexion ROM and sensorimotor function.

Joint Mobilization Techniques
Multiple joint mobilization techniques and treatment volumes that target talocrural or tibiofibular arthokinematics have been implemented for individuals with CAI. These techniques are typically classified as Maitland joint mobilizations (Grades I-IV), Mulligan’s mobilization with movement (MWM), or high-velocity low-amplitude (HVLA) thrusts (Maitland Grade V). Maitland joint mobilizations use different velocities of passive joint oscillations through a specific arthokinematic range (amplitude) to achieve therapeutic effects, which include pain relief to gradual increases in ROM. Mulligan’s MWM is a combination of actively or passively moving a joint through an
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osteokinematic ROM (commonly in a weight-bearing position) while providing a force that increases the agonist arthrokinematic ROM. High-velocity low-amplitude thrusts are joint manipulation techniques that incorporate strategic patient positioning with short, quick thrusts (high velocity) applied over short distances (low amplitude) across areas of tissue restriction. The volume of manual therapy interventions varies across studies ranging from a single HVLA thrust to multiple bouts (2-4 bouts) consisting of multiple oscillations (eg, 30-60). For additional information on joint mobilization techniques for restricted dorsiflexion ROM, see the studies by Beazell et al and Grindstaff et al.

Patient-oriented Evidence
Patient-oriented evidence is derived from the investigation of self-reported function, activity limitation, or participation restriction from the perspective of the patient. Despite the emergent clinician- and laboratory-oriented evidence surrounding joint mobilization and CAI, the evidence regarding patient-oriented outcomes is limited. A 2-week (6 treatments) talocrural Maitland Grade III intervention increased self-reported function on the Foot and Ankle Ability Measure Activities of Daily Living Index (FAAM-ADL), as well as on the FAAM Sports Index (FAAM-Sports), in a cohort of individuals with CAI. The FAAM-ADL and FAAM-Sports improved approximately 8% and 15%, respectively, which surpasses the minimal clinically important difference (8 points on the FAAM-ADL, 9 points on the FAAM-Sports) for these measures. However, the isolated use of distal or proximal tibiofibular joint mobilization over a number of treatment sessions did not demonstrate improvements in FAAM-Sports scores in individuals with CAI. On the basis of the limited evidence and conflicting findings, it is unclear whether joint mobilization is able to have a meaningful effect from a patient perspective.

Figure. Theoretical model for the role of arthrokinematic impairments associated with chronic ankle instability (CAI). This model highlights the negative feedback loop that may be created by arthrokinematic alterations and how it may contribute to the progression and perpetuation of CAI. Using joint mobilization interventions in combination with other therapeutic treatments may interrupt this loop and ultimately contribute to the resolution of this condition.
Clinician-oriented Evidence

Clinician-oriented evidence is generated through assessment techniques used in clinical practice to identify impairment during the management and rehabilitation of injuries. The clinical outcomes measured following joint mobilization in individuals with CAI can be divided into 2 areas: (1) ROM and (2) clinical assessment of balance.

Range of Motion

Joint mobilization may be used to address arthrokine-matics restrictions that limit dorsiflexion ROM. Talocrural joint mobilization (anterior-to-posterior–directed Maitland Grade III or posterior-to-anterior–directed Mulligan’s MWM) has been shown to improve ankle dorsiflexion ROM in individuals with CAI, but the evidence is primarily limited to the effects of a single treatment session. However, a recent investigation determined that talocrural joint mobilization, performed over several treatment sessions, created dorsiflexion ROM gains substantially greater than those reported following a single treatment of a similar joint mobilization technique (1.4-cm increase compared with a 0.4-cm increase on the Weight-Bearing Lunge Test). Improvements in talocrural joint arthrokine-matics following joint mobilization have demonstrated mixed findings, with clinical and instrumented measures of joint displacement not consistently demonstrating changes in posterior translation of the talus within the ankle mortise. Joint mobilization of the distal tibiofibular joint has been shown to improve ankle dorsiflexion ROM in a fresh frozen cadaveric model, but the use of a distal tibiofibular HVLA thrust performed in isolation had no effect on ankle dorsiflexion ROM within a single session or across multiple treatment sessions in participants with CAI. Changes in proximal or distal tibiofibular joint arthrokine-matics following joint mobilization interventions have not been investigated. Overall, it appears talocrural joint mobilization can effectively increase dorsiflexion ROM in individuals with CAI; however, changes in joint arthrokine-matics following talocrural and distal tibiofibular joint mobilization require additional investigation.

Clinical Balance Assessments

Decreased ankle dorsiflexion ROM has been shown to contribute to decreased anterior reach distance during the Star Excursion Balance Test (SEBT), as well as increased step-down test scores, which are indicative of poor movement quality. Both tests place the ankle at or near the end-range dorsiflexion ROM, and limitations in motion may contribute to dynamic balance deficits during these tasks. Talocrural joint mobilizations have been found to improve static single-limb stance balance measures but not dynamic balance measured using the SEBT following a single joint mobilization (Maitland Grade III, two 60-second bouts, ~100 oscillations) treatment session. However, significant increases in anterior, posteromedial, and posterolateral reach distance on the SEBT have been demonstrated by those with CAI following a series of treatment sessions over 2 weeks.

The use of a distal tibiofibular joint HVLA thrust, both in a single session as well as cumulative sessions during a 3-week period, has not demonstrated changes in static balance using the Balance Error Scoring System or dynamic balance using the SEBT. Although there is a relationship between ankle dorsiflexion ROM and measures of dynamic balance using the SEBT and the Step Down Test, other factors, such as neuromuscular control and mobility of other joints (trunk, hip, and knee), contribute to test performance and may explain the mixed findings across these investigations. It is possible that joint mobilization used to address motion restrictions, in addition to a comprehensive intervention program (ie, balance, strengthening, static stretching), may demonstrate the greatest improvements in clinical balance assessments.

Laboratory-oriented Evidence

Laboratory-oriented evidence comprises observation or experimentation at the cellular, tissue, organ, or system level following injury or therapeutic intervention in well-controlled environments. This type of evidence has been used to examine the effects of joint mobilization on sensorimotor system function. Although this is a relatively novel concept, several recent investigations have examined sensorimotor alterations following joint mobilization in individuals with CAI. Köhne et al examined the effect of multiple HVLA long-axial thrust treatments on ankle joint position sense. This investigation identified enhanced articular proprioception on the basis of significant decreases in the absolute error during joint reposition sense testing for ankle sagittal and frontal plane move-
ment following the joint mobilization intervention. Although the investigation by Köhne et al focused on sensory alterations following joint mobilization, Grindstaff et al examined changes in soleus and fibularis longus activation following a single HVLA joint mobilization of either the proximal tibiofibular joint or the distal tibiofibular joint compared with a control group. The distal tibiofibular joint manipulation group demonstrated increased soleus activation (4% to 8%); measured by the Hoffman reflex, for up to 30 minutes. The proximal tibiofibular manipulation group did not demonstrate alterations in soleus activation. Therefore, they determined that distal tibiofibular joint manipulation can increase soleus muscle activation, which may influence efferent motor output in individuals with CAI. These studies documented the potential of joint mobilization to stimulate afferent receptors, which can enhance joint awareness as well as synapse with interneurons at the spinal level to influence motoneuron pool availability. The clinical consequences of changes in motoneuron pool excitability, including recurrence of injury, has not yet been determined.

To understand the ability of joint mobilization interventions to enhance sensorimotor function during balance, Hoch and McKeon examined the effects of a single Maitland Grade III anterior-to-posterior talocrural joint mobilization treatment on single-limb stance postural control in individuals with CAI. They determined that a single joint mobilization treatment significantly increased single-limb stance, with eyes open, time-to-boundary measures in the anteroposterior direction. These changes in postural control indicate that joint mobilization can immediately increase the amount of time available to make postural corrections (0.98-s increase in mean minima of time-to-boundary in the anteroposterior direction) and decreased the level of constraint experienced by the sensorimotor system during single-limb stance (0.81-s increase in the standard deviation of the mean minima of time-to-boundary in the anteroposterior direction). Despite these findings, a later study examined the effects of multiple Maitland Grade III anterior-to-posterior talocrural joint-mobilization treatment sessions over 2 weeks and determined that time-to-boundary measures were not altered. These studies suggest that joint mobilization may result in transient enhancements in the afferent and/or efferent mechanisms responsible for postural control regulation, but the longer term effects require additional investigation. In addition, as previously stated, it is likely that joint mobilization is most effective when combined with a comprehensive intervention program.

**DISCUSSION**

The primary objective of this review was to examine the evidence associated with using joint mobilization interventions for individuals with CAI. This review categorized the available evidence as patient-, clinician-, or laboratory-oriented outcomes and provided particular emphasis on aspects of function that extend beyond the traditional rationale for using joint mobilization techniques.

The main findings were that joint mobilization can enhance dorsiflexion ROM and alter sensorimotor function; however, the effects on patient-reported function remain unclear. Overall, joint mobilization has beneficial effects for individuals with CAI, but additional evidence regarding the effects on arthrokine-

A previous study attempted to determine a subset of individuals with ankle pathology who would benefit from joint mobilization and manipulation interventions. However, no studies have attempted to determine whether there is a subset of individuals with CAI who would benefit from specific joint mobilization interventions. Clinical reasoning suggests that
individuals with arthrokinematics restrictions at a specific joint would demonstrate the greatest benefit from corresponding mobilization interventions. Therefore, future research should examine the relationship between arthrokinematics and dorsiflexion ROM, the techniques used for evaluating arthrokinematics, and specific cohorts of individuals with CAI who may demonstrate the greatest mechanical benefits from joint mobilization.

In addition to the mechanical effects of joint mobilization, using these techniques to enhance sensorimotor function in individuals with CAI has also been investigated. The studies presented in this review demonstrated that joint mobilization can enhance proprioception, motoneuron pool excitability, and static and dynamic postural control. Improvements in soleus motoneuron pool excitability and instrumented measures of postural control have been identified immediately following joint mobilization. However, when instrumented measures of static postural control were measured 24 to 48 hours following a 2-week intervention, no differences were identified. Conversely, no changes in SEBT reach distance were identified immediately following a single talocrural joint mobilization treatment; however, significant increases in reach distance were identified after a series of treatments. Despite these findings, no differences were identified in Balance Error Scoring System or step-down test performance following a series of distal or proximal tibiofibular manipulations.

On the basis of the available evidence, it appears that changes in sensorimotor function are short lived following joint mobilization application, and changes in SEBT performance may be linked to dorsiflexion ROM improvements and not sensorimotor function. Combining joint mobilization with comprehensive rehabilitation interventions may generate more consistent improvements in sensorimotor function and maximize rehabilitation outcomes. Future studies should systematically examine the timeline associated with changes in muscle activation and postural control following joint mobilization, the underlying mechanisms responsible for sensorimotor alterations associated with manual therapy, and the effects of joint mobilization in conjunction with other rehabilitation interventions.

Despite the clinician- and laboratory-oriented evidence supporting the use of joint mobilization for individuals with CAI, this review determined that there is a dearth of patient-oriented evidence. Although 2 studies have examined self-reported function following a multiweek joint mobilization intervention, the findings were inconsistent, which further convolutes this area of evidence. The inconsistency between these studies may be associated with different joints being mobilized, different joint mobilization techniques, and different study designs. In addition, both of these studies included participants who were volunteers not currently seeking rehabilitation services. Although the participants in these studies reported reductions in self-reported function prior to inclusion, future studies should elicit patient-centered measures of function from clinical populations seeking formal rehabilitation services. Also, the interventions in both studies comprised only joint mobilization. A study that used joint mobilization as part of a comprehensive rehabilitation intervention following acute ankle sprain demonstrated robust changes in patient-reported outcomes, which supports the combined approach for people with CAI. Overall, more patient-oriented evidence is needed, as this information is paramount for successful evidence-based practice.

Several limitations are present in this body of research. In addition to the discussed limitation in the amount of patient-oriented evidence, there is a lack of multitreatment intervention studies that mimic a clinical course of joint mobilization. Although the information gained following a single treatment is valuable, the summative effects of multiple treatment sessions may better align with clinical practice and provide better insight into the relevance of incorporating joint mobilization into the rehabilitation strategy for CAI. Furthermore, few studies have provided a prolonged follow-up period after intervention or examined the effects of joint mobilization in combination with other rehabilitation techniques. It is also unclear whether specific cohorts of individuals with CAI will demonstrate greater benefits from these interventions. However, the emergent list of mechanical and sensorimotor benefits of joint mobilization suggests that this intervention may be beneficial for a plethora of different clinical presentations of CAI. Future studies should systematically address these limitations through high-quality studies representative of higher levels of evidence.
CONCLUSIONS
The currently available evidence indicates that joint mobilization is likely a beneficial intervention for individuals with CAI, particularly for enhancing dorsiflexion ROM and influencing certain aspects of sensorimotor function. Multiple treatment sessions seem to provide greater improvements than do single sessions, but the optimal mobilization technique (Maitland or Mulligan’s MWM) and volume has not yet been determined. In addition, the underlying mechanisms associated with increases in dorsiflexion ROM and changes in sensorimotor function require further inquiry. The effect of joint mobilization on patient-centered outcomes requires further investigation because the evidence was limited and conflicted in this area. The major limitations in this body of research include a lack of multitreatment studies, prospective follow-up following intervention, comparison of different joint mobilization strategies, and integration with other rehabilitation techniques. Future studies addressing these limitations and exploring other outcomes will continue to refine the application of joint mobilization in the rehabilitation strategy for individuals with CAI.

REFERENCES


