Talocrural Joint Mobilization’s Lack of Effect on Postural Control in Healthy Subjects

Kevin G. Laudner, Mike Moline, Todd A. McLoda, and Steve McCaw

The ankle is one of the most often injured joints in athletes. Ankle sprains account for up to 15% of all time lost from sport participation. An inversion and plantarflexion mechanism can sprain the lateral ligaments of the ankle, specifically the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament. Therefore, soft-tissue restrictions for dorsiflexion, which position the talocrural joint in increased plantar flexion, could possibly predispose the ankle to a lateral sprain. Furthermore, after an initial sprain, an estimated 80% of athletes will suffer a recurrent sprain to the lateral ligaments.

Previous studies have shown the association between sensorimotor deficits, such as increased ankle repositioning errors and decreased postural control, and ankle sprains. In a recent review of the literature Hertel reported there is evidence that supports the association between ankle instability and altered sensory perception, reflex responses, and motor control. Other studies have shown that assessment of postural control can predict ankle-sprain susceptibility and that decreased sensorimotor control increases the risk of sprain. Furthermore, reports have shown that patients diagnosed with chronic ankle instability have deficits in postural control.

Proper care and rehabilitation of the injury is thought to be critical to reduce the incidence of recurrent ankle sprains. Joint-mobilization techniques are routinely used to treat hypomobility because they are believed to stretch connective tissue. This is an important treatment because range of motion (ROM) is often compromised after injury, and a lack of ROM can predispose athletes to reinjury. Other effects attributed to this treatment include decreased pain, increased muscle tone, and improved postural and kinesthetic awareness (proprioception). More specifically, ankle-joint mobilizations have been reported to decrease pain, increase ROM, and improve function among patients diagnosed with both acute and chronic ankle sprains. Joint mobilizations are thought to lengthen the joint capsule and associated ligaments by stretching them through accessory motion, causing the mechanoreceptors in these structures to increase their sensory output as gamma motor neurons are activated with tissue traction as the joint reaches...
the end points of its available ROM.\textsuperscript{21} However, it has been noted that the mechanoreceptors may be active throughout the joint’s entire ROM.\textsuperscript{26} Furthermore, the Ruffini ending mechanoreceptors are considered slow adapting because they may remain active briefly after tissue attenuation,\textsuperscript{26} such as that experienced after a joint mobilizations has ceased.

By increasing the activity of these slow-adapting mechanoreceptors, the central nervous system might be more effective at improving postural control because it will receive more afferent information from the activated mechanoreceptors. As such, the purpose of this study was to quantify the effect of ankle-joint mobilizations on postural control in asymptomatic individuals. We hypothesized that the application of a joint-mobilization technique to a healthy ankle would decrease the displacement and velocity of the center of pressure (CoP) during single-leg stance.

\textbf{Methods}

\textbf{Participants}

Thirty-one physically active college students (16 men age 21.3 \(\pm\) 2.0 y, height 179.8 \(\pm\) 7.9 cm, mass 82.7 \(\pm\) 12.7 kg; 15 women age 20.9 \(\pm\) 2.3 y, height 164.3 \(\pm\) 6.7 cm, mass 60.7 \(\pm\) 9.7 kg) were recruited from a university setting over a 1-month period. Inclusion criteria included being physically active, age 18–29, and being able to perform a single-leg balance task. This balance test was performed before any data collection and was included in an effort to exclude individuals who would not be able to complete the balance test and subsequently would provide incomplete data for analysis. Physically active was defined as participation in moderate physical activity at least 30 min/day, 3 d/wk. A screening session before testing was used to assess the ability to balance on 1 leg for 15 seconds 3 times and to apply the exclusion criteria of any lower extremity injury in the past 6 months or any history of vestibular or neurological impairments or lower extremity surgery. Before participation, each participant signed an informed consent. This experimental protocol was approved by the institutional review board.

\textbf{Instrumentation}

An AMTI Biomechanics force platform (Advanced Mechanical Technology, Inc, Newton, MA) was used to quantify postural control during single-leg stance. The anteroposterior (AP) and mediolateral (ML) measures of the CoP were collected at a frequency of 100 Hz.\textsuperscript{27} These data were smoothed using a fourth-order Butterworth filter before data analysis.

\textbf{Procedures}

All data were collected in a university biomechanics laboratory. Participants identified the leg used to strike the ball during a soccer kick. By random assignment, half the participants used the striking leg as the mobilization leg (received mobilization) and the stance leg as the control leg (did not receive mobilization); the assignment was reversed for the other half of participants.
A pretest–posttest design was used. After an opportunity to practice the balance procedure on each leg immediately before the testing session, participants performed 3 trials of single-leg balance on their mobilization leg. Each trial lasted 15 seconds and was performed barefoot. Eyes were open and focused on a fixed point directly in front of the subject. The contralateral knee was bent to approximately 90°, and the participants rested their hands on their hips with the tested side knee in extension. Instructions were to remain as motionless as possible during each trial.

Three trials were collected from each leg in the pretest and posttest sessions consisting of testing the mobilization leg first followed by the control leg. A 1-minute rest period was provided before the treatment was performed. After the treatment, participants immediately performed the posttest trials. Approximately 1 minute of rest was provided between trials to eliminate fatigue, but participants were allowed to take as much time as needed. A trial was redone if the participant touched down with the contralateral foot, touched the ipsilateral leg with the contralateral leg, or the hands came off the hips. However, because all subjects successfully completed the prescreening balance task before any data collection, there were no failed trials among the subjects.

**Intervention**

All treatments were administered by a certified athletic trainer with approximately 4 years experience using joint mobilizations in the prevention, evaluation, and treatment of various orthopedic injuries. The mobilization of the talocrural joint on the mobilization leg was performed using the Kaltenborn approach. Participants lay supine on a standard treatment table with the mobilization ankle slightly off the table and shoe removed. A rolled towel was placed under the distal shank. The plantar surface of the foot was positioned against the investigator’s thigh to ensure a neutral position (open-packed) of the talocrural joint. The investigator stabilized the distal shank with one hand and performed joint mobilizations with the other (Figure 1). The hand performing the mobilizations was placed over the talus and applied 30 grade III posterior glides of the talus in approximately 30 seconds. Grade III glides are large-amplitude mobilizations from midrange to end range of the capsular ROM. The Kaltenborn method was chosen based on the training and familiarity of the investigators with this technique. Furthermore, 30 grade III mobilizations were used based on investigators’ clinical experience with improving hypomobility. Immediately after joint mobilization, participants completed 3 balance trials on the mobilization leg, followed by 3 trials on the control leg using the same protocol as the premobilization session.

![Figure 1 — Application of posterior talar glide at the talocrural joint.](image-url)
Outcome Measures

Custom software (Microsoft QuickBasic, Microsoft Corp, Redmond, WA) was used to calculate the kinetics of the CoP data in both the AP and ML directions from the final 10 seconds of data collection. CoP data were measured and quantified with the following variables: y range and x range quantified the AP and ML motion, respectively. The $x \times y$ area was calculated as the product of the AP and ML ranges to quantify the overall area enclosed by the CoP. The radial area, defined by Hasan et al as the area of the circle whose radius was the average of all the radial distances of the CoP at each sampling interval from the mean position of the CoP, was also calculated. The resultant velocity of CoP was calculated by determining the change in position of the CoP between sampling points, then by dividing the change in position by the sampling interval, and was used to quantify rate of change of position of the CoP. These variables were chosen based on previous studies looking at joint mobilizations and postural control in patients with ankle dysfunction in an effort for comparison with the current study.

Statistical Methods

A 1-way between-groups multivariate analysis of variance (SPSS version 18.0, SPSS Inc, Chicago, IL) was performed to compare the pretest and posttest differences in sway between limbs. Five dependent variables were used: radial area, ML range, AP range, area, and CoP speed. The independent variable was limb (mobilization, control). Statistical significance was set at $P < .05$.

Results

Preliminary assumption testing showed no violations for homogeneity of variance–covariance matrices and equality for all variables. There was no significant difference between limbs on the combined dependent variables ($P = .72$). There were also no significant differences between the mobilization and control limbs when the dependent variables were considered separately: radial area ($P = .94$), ML range ($P = .80$), AP range ($P = .69$), area ($P = .48$), or CoP speed ($P = .48$). All means, standard deviations, differences between groups, and $P$ values can be found in Table 1.

Discussion

This study investigated the effects of posterior talar glides at the talocrural joint on postural control in asymptomatic subjects. We found no significant differences between the mobilized and control leg for any of the CoP measures. These results suggest that a single application of a posterior talar glide does not have any acute effects on postural control and perhaps sensorimotor control in asymptomatic individuals. However, McKeon and Hertel suggested that differences in postural control among chronic ankle-instability patients may be partially a result of measurement sensitivity. Therefore, other methods of assessing postural control may elicit different findings.
Table 1  Differences Between Mobilized Limb and Control Limb, Mean (SD)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mobilized Leg</th>
<th></th>
<th>Control Leg</th>
<th></th>
<th>Difference</th>
<th></th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Difference</td>
<td>Pre</td>
<td>Post</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>Radial area (cm²)</td>
<td>1.8 (1.0)</td>
<td>1.8 (1.5)</td>
<td>–0.01 (1.5)</td>
<td>1.9 (0.9)</td>
<td>1.9 (0.8)</td>
<td>0.02 (0.8)</td>
<td>.94</td>
</tr>
<tr>
<td>ML range (cm)</td>
<td>2.6 (0.5)</td>
<td>2.6 (0.6)</td>
<td>–0.1 (1.1)</td>
<td>2.6 (0.5)</td>
<td>2.5 (0.5)</td>
<td>0.01 (0.8)</td>
<td>.80</td>
</tr>
<tr>
<td>AP range (cm)</td>
<td>3.2 (0.9)</td>
<td>3.2 (1.2)</td>
<td>–0.03 (0.6)</td>
<td>3.2 (1.1)</td>
<td>3.2 (0.9)</td>
<td>0.02 (0.5)</td>
<td>.69</td>
</tr>
<tr>
<td>Area (cm²)</td>
<td>8.7 (3.3)</td>
<td>9.2 (6.1)</td>
<td>–0.5 (5.3)</td>
<td>8.6 (4.6)</td>
<td>8.3 (3.4)</td>
<td>0.3 (3.1)</td>
<td>.48</td>
</tr>
<tr>
<td>CoPS (cm/s)</td>
<td>4.7 (1.4)</td>
<td>4.7 (1.6)</td>
<td>0.1 (1.2)</td>
<td>4.6 (1.5)</td>
<td>4.3 (1.3)</td>
<td>0.2 (0.6)</td>
<td>.48</td>
</tr>
</tbody>
</table>

Diff, difference; ML, mediolateral; AP, anteroposterior; CoPS, center-of-pressure speed.
Unfortunately, very little research has investigated the effects of joint mobilizations for improving balance. More specifically, no research has reported the specific effects of joint mobilizations for improving balance in asymptomatic individuals. However, Hoch and McKeon performed a study similar to the current study but used individuals diagnosed with chronic ankle instability. Those authors reported acute improvements in balance after posterior joint mobilizations to the talus. These improvements may have occurred as a result of the soft-tissue restrictions that generally present among chronic ankle-instability patients, leading to increased benefits of joint mobilizations. Vaillant et al also reported improvements in balance after the application of joint mobilization of the ankle and feet. However, those mobilizations were performed on elderly individuals who also received massage, making it difficult to determine which manual therapy provided the most benefit.

A critical component of sensorimotor control is the activation of mechanoreceptors that are stimulated during tissue mobilization. Several mechanoreceptors stimulated during joint motion, such as those in the ligaments and joint capsule (Ruffini endings and Golgi tendon-like organs) and the skin (Meissner’s corpuscles), are slow adapting and may continue firing after the cessation of joint mobilization. However, it is unclear how long the receptors continue to be active after the stimulus is removed. There are several possibilities to help explain why our joint mobilizations did not improve postural control. First, the slow-adapting mechanoreceptors may have not provided enhanced sensory information by the time the posttest sway measures were collected. Approximately 10 seconds elapsed between the end of joint mobilization and the first postmobilization data collection, and about 2.5 minutes elapsed before the end of the third postmobilization trial. Second, it is possible that the joint mobilizations did enhance the sensory information from the mechanoreceptors, but not to the level necessary to improve postural control measures. Third, there may have been a ceiling effect on the postural control measures resulting from the use of healthy control subjects. Individuals with various lower extremity orthopedic injuries may have presented with different findings. Finally, there is always a chance that the joint mobilizations did not stimulate the articular mechanoreceptors. However, previous research using joint mobilizations has found these techniques effective for improving postural control. Those previous findings suggest that joint mobilizations do activate the mechanoreceptors, thereby eliciting improvements in postural control.

As with any study, we had some limitations. Our methods of assessing postural control may not have been challenging enough to reflect any difference induced by the mobilization. Similar to many clinically used balance exercises, our participants were tested with eyes open, allowing for potentially increased balance control from visual stimuli with less reliance on mechanoreceptors. Although each component of sensory information (vestibular, visual, and somatosensory) has unique functions, some of the information is redundant, so they may compensate for one another if one is compromised. We believed that using an eyes-open condition would lead to fewer failed trials. However, future investigations should take this into account and perhaps use an eyes-closed condition, as well as other attempts to limit the contribution of senses other than the mechanoreceptors of the joint being tested.

Joint-mobilization techniques are typically applied after an ankle injury in an effort to increase ROM, prevent subsequent decreases in ROM, and increase sensorimotor control. Our participants had neither a recent ankle injury nor a
history of ankle instability and therefore may not have had a proprioceptive deficit. Although using manual therapy and therapeutic exercise to prophylactically increase sensorimotor control is common, our results suggest there is no beneficial effect of a single bout of joint mobilizations (30 posterior glides) on sway measures when applied to a healthy joint.

There was a possible learning effect during the pretest and posttest sessions. Participants ultimately completed 12 balance trials. Because they balanced on the treatment leg first in every posttest, it is possible that this experience affected the results of the study. However, in order to limit the amount of time between mobilization and the balance trial, we chose to test the mobilized leg first. We tried to control for this limitation by using a screening process before participation. This allowed participants to practice the balance procedures before actual participation. In addition, fatigue may have influenced the results, but we allowed participants as much time as they wanted between trials.

The joint mobilization in this study consisted of posterior glides of the talus, which are commonly used to increase dorsiflexion ROM in individuals with a lack of ROM in that direction and are therefore predisposed to lateral ankle sprains. Although the ankle complex moves in a triplanar motion, the mobilizations were performed in a single plane. Therefore, it is reasonable to believe that sway in the AP direction would be more affected than that in the ML direction. However, our results showed no change in sway in the AP range, ML range, or area (Table 1). Although it has been proposed that ML sway is controlled by the hip muscles, it is also believed that lateral ankle sprains affect postural control because of deficits to the ankle ligaments, thus altering the neuromuscular function at both the hip and the ankle during a balance test. Therefore, it might be beneficial to investigate the effects of ML ankle-joint mobilizations on postural control and once again compare the AP range and ML range.

Future research should investigate the effects of joint mobilizations for improving sensorimotor control in various populations, including different age ranges and populations with orthopedic pathologies, because the pathologies tend to lead to proprioceptive deficits. In addition, this study only looked at the acute effects of 1 joint-mobilization treatment. Future research should investigate the acute effects of multiple sets of mobilizations, as well as the long-term effects of several joint-mobilization treatments. A proposed outcome of joint-mobilization treatments is an increase in muscle tension. Furthermore, increased muscle tension has been shown to increase proprioception. It may also be beneficial to test the effects of joint mobilizations on other measures of sensorimotor control, such as kinesthesia, joint-position sense, or during a functional activity. This study used grade III posterior mobilizations of the talocrural joint. Other mobilization grades, directions, and joints should be investigated in the future.

Summary

The results of this study suggest that a commonly used posterior ankle-joint mobilization (30 glides) does not acutely affect postural control, as measured during a single-leg stance with eyes open, in participants with a healthy ankle. However, using these mobilization techniques on individuals with chronic ankle instability or acute ankle injuries may produce different results.
References

31. McKeon PO, Hertel J. Spatiotemporal postural control deficits are present in those with chronic ankle instability. *BMC Musculoskelet Disord.* 2008;9:76.