INTRODUCTION 

Ankle injuries, resulting in damage to the lateral ligamentous complex, are often associated with limited dorsiflexion (DF) range of motion (ROM). Deficits in dorsiflexion ROM may be the result of arthrokinematic restrictions, specifically in posterior talar glide [1]. To restore normal ankle arthrokinematics and ROM, clinicians often use manual therapy techniques referred to as joint mobilization (JM). Anterior-to-posterior joint mobilization techniques are frequently employed to increase dorsiflexion ROM of the talocrural joint [2]. Several studies have identified immediate improvements in dorsiflexion ROM following JM treatment; however, these studies failed to confirm the arthrokinematic alterations that were involved[3, 4]. Therefore, the mechanisms underlying the effect of talocrural JM have not been satisfactorily explored.

Examining the effects of JM using in vitro testing methods may provide a model to capture subtle changes at the arthrokinematic level. Distal tibiofibular JM was simulated in vitro and was able to detect increased ankle dorsiflexion after treatment [5]. However, arthrokinematic changes at the talocrural and subtalar joints remain unclear [3, 4] and an in vitro model examining kinematics following talocrural joint mobilization has not been investigated. Therefore, the purpose of this preliminary in vitro study was to examine changes in talocrural arthrokinematics and dorsiflexion ROM after performing Maitland Grade III anterior-to-posterior JM to the talocrural joint.

METHODS 

Three fresh frozen cadaver lower extremities (3 left limbs, age 68.3 ±8.08, one male) with no documented history of ankle injury were secured to a custom 6 degree of freedom ankle loading device. A certified athletic trainer with 3 years of experience performed two sets of Maitland Grade III anterior-to-posterior JM to the talocrural joint with 200 oscillations per set. The Grade III JM was defined as a 1-second large amplitude rhythmic oscillation applied from the mid-range of accessory motion to the area of tissue restriction. Data were collected at baseline and after each set of JM.

A six camera Motion Analysis Eagle System (Motion Analysis Corporation, Santa Rosa, CA) was used in combination with the MotionMonitor (Innovative Sports Training, Chicago, IL) to track and collect 3D motion of retroreflective sensors installed directly to the talus, calcaneus and tibia bones during dorsiflexion and posterior translation of the ankle joint. Kinematic motion of the foot during data collection included neutral to anterior to posterior translation and neutral to maximum dorsiflexion. Two separate data sets were collected at each interval with each data set containing two cycles of rotational and translational motion.

Dorsiflexion data were exported from the MotionMonitor using an Euler sequence of Z-X’Y”.

RESULTS AND DISCUSSION 

This preliminary study suggests that talocrural JM did not increase dorsiflexion ROM or posterior talar translation. On the contrary, a slight decrease in dorsiflexion ROM and posterior talar
translation was observed across all three specimens. These results are in opposition to many in vivo studies that determined talocrural JM can effectively increase dorsiflexion ROM [3, 4] and in vitro research which identified dorsiflexion improvements following tibiofibular JM [5].

**Figure 1:** Effects of talocrural JM on ankle dorsiflexion ROM (a) and posterior translation (b). *The talus bone cracked during Post 2 testing in Specimen 2 and was not included in this aspect of the analysis.*

**Table 1:** Mean ±SD of dorsiflexion and posterior translation of the talocrural joint. Positive values represent gains in range of motion.

<table>
<thead>
<tr>
<th>Interval Relation</th>
<th>Dorsiflexion (°)</th>
<th>Posterior Translation (mm)</th>
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<tbody>
<tr>
<td>Base to Post 1</td>
<td>1.66±7.07°</td>
<td>0.45±0.83</td>
</tr>
<tr>
<td>Post 1 to Post 2</td>
<td>1.48±8.76°</td>
<td>0.66±0.93</td>
</tr>
<tr>
<td>Base to Post 2</td>
<td>2.81±10.24°</td>
<td>1.11±0.64</td>
</tr>
</tbody>
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The decreased posterior translation dorsiflexion ROM may be associated with the open kinetic chain model used for assessing motion in this study. The decrease in posterior translation may actually represent a posterior shift in the location of the talus with each subsequent JM session, creating a new starting point for the beginning motions of dorsiflexion and posterior translation. While we tracked motion of the talus during anterior and posterior glides, we were unable to account for the starting position of the talus between JM treatments. A posterior migration of the talus in an open kinetic chain may alter the contact between the talar dome and ankle mortise which could change the axis of rotation. A weight bearing model observed that JM expanded the range of ankle dorsiflexion [5]. Therefore, if a closed kinetic chain test were implemented, the talus may not shift posteriorly and an increase in dorsiflexion may be observed. Furthermore, the use of an open chain versus a closed chain model may explain the opposing effects of the JM between the two studies. Additional exploration which may include advanced imaging and closed kinetic chain models may clarify relationships between boney positioning and ROM and elucidate the underlying mechanisms of talocrural JM.

**CONCLUSION**

Further investigation should be performed to clarify the effects of JM including closed kinetic chain in vitro models or radiographic imaging to examine changes in boney positioning.

**REFERENCES**