

Utilizing an Osteopathic Manipulative Technique to Improve Tibio-Fibular Restriction at the Knee

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Received date: February 03, 2025, **Accepted date:** May 14, 2025

Citation: Burr Z, Barros M, Bennett A, Kochno T, Fotopoulos TJ. Utilizing an Osteopathic Manipulative Technique to Improve Tibio-Fibular Restriction at the Knee. J Phys Med Rehabil. 2025;7(1):79-85.

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Abstract

Background: A restricted tibio-fibular joint can result in decreased internal and external rotation of the ankle and feet. This decreased range of motion disrupts musculoskeletal function. The musculoskeletal function of the tibio-fibular joint promotes ankle stability and shock absorption during weight bearing activities. The leg tug technique (LTT) technique will be used to promote restoring the normal range of motion of this tibio-fibular joint.

Methods: This study focuses on restoring the loss of range of motion in the proximal tibio-fibular joint, with an application of an HVLA adjacent technique. Referred to as the leg tug technique (LTT), this manipulation involves a practitioner grasping the calcaneal region (heel) and applying a quick caudal thrust. To evaluate LTT efficiency on foot/ankle rotation a sample of 20 participants (ten male and ten female) from a southeastern osteopathic medical school participated in a quasi-experimental study. Range of motion at the ankle and foot was measured prior to and directly after the manipulation. To maintain measurement consistency, each measured leg was stabilized at the proximal tibio-fibular joint at the knee and assessed for external and internal rotational motion at the ankle with a goniometer. LTT was performed with the participant's leg stabilized in neutral positioning.

Results: Measurements taken before and after the LTT performance indicated statistically significant improvement in the passive range of motion. Internal rotation before and after comparison in females had a p-value of 0.01 and males had a p-value of 0.001 and for external rotation, females had a p-value of 0.02 and males had a p-value of 0.001. External range of motion showed a mean improvement of 10.2 degrees in females and 6.3 degrees in males and internal range of motion showed a mean improvement 9.2 degrees in females and 12.9 degrees in males.

Conclusion: The LTT improved the tibio-fibular range of motion at the knee among the current sample of participants. The limitations of the current study preclude declaring the LTT as a universal method for improving tibio-fibular range of motion at the knee. However, this limited study offers an effective manual manipulative technique to restore loss of range of motion due to a tibio-fibular restriction.

Keywords: Manual medicine, Muscle and joint injuries, Osteopathic manipulative medicine

Background

Osteopathic manipulative techniques (OMT) are non-invasive manipulations that are effective in treating and relieving musculoskeletal misalignments. In the presented study, a modification of the leg tug technique (LTT) will be used to address limitations in participant range of motion which may improve patient ability to internally and externally rotate the ankle [1,2]. A study by Decker *et al.* (2024) [3] assessed the proximal tibiofibular joint and manipulation of said joint to improve motion using muscle energy and high-

velocity, low amplitude techniques. Muscle energy techniques utilize active participation from the patient to mobilize joints. High-velocity, low-amplitude techniques utilize a short thrust to restore motion through engagement of a restrictive barrier. These can be conducted on the anterior or posterior fibular head. Grindstaff *et al.* (Oct. 2011) conducted a study using high-velocity, low-amplitude and its effect on the posterior tibia through making contact at the anterior aspect of the ankle, while rotating and flexing the knee to a barrier, where a thrust was then applied through the tibia towards the individual's heel [4]. The hypothesis of the current study is that the range

of motion restriction seen in the tibio-fibular joint could be addressed utilizing a controlled manual traction technique. More specifically, restriction and therefore dysfunction can be determined by measuring participant pre-corrective range of motion by goniometer. When pre-corrective range of motion is compared to post-corrective range of motion, dysfunction is retroactively identified. Additionally, comparing range of motion in one joint to the same joint on the contralateral side allows for insight into participant restriction in range of motion. The fibula has two joints: the superior and the inferior. The inferior joint, located at the lateral malleolus, is supported by many ligaments and is quite stable. The proximal (superior) joint of the fibula is the tibiofibular joint, which is movable [5]. The distal tibio-fibular joint impacts the motion of the ankle joint overall, with a significant effect on the range of ankle dorsiflexion [6]. When the ankle is plantar flexed, the distal fibula moves medially, anteriorly and simultaneously internally rotates. When the ankle is dorsiflexed, the distal fibula moves laterally, posteriorly, and simultaneously externally rotates [7]. An anterior proximal fibula results in a posterior distal fibula, likewise a posterior proximal fibula results in an anterior distal fibula [8]. The proximal head of the fibula can be found at the level of the tibial tuberosity on the posterior-lateral aspect of the knee. Palpation of the fibular head during dorsiflexion and plantarflexion can be utilized to appreciate the anterior or posterior positioning of the fibular head. Patients can present with asymptomatic and symptomatic somatic dysfunction in their tibio-fibular region. Tibio-fibular joint dysfunction can result in decreased internal and external rotation of the ankles and feet. Tibial rotation is approximately 15° in normal individuals [5]. This rotation becomes restricted when the tibio-fibular joint is out of alignment.

Healthy individuals are expected to have overall range of motion in the sagittal plane of between 65 and 75°, moving from 10 to 20° of dorsiflexion through to 40–55° of plantarflexion [5]. The total range of motion in the frontal plane is approximately 35° (23° inversion – 12° eversion) [5]. However, based on individual differences, some individuals may have a restriction despite having the expected rotation, which can be improved using manual medicine. Fibular head can be evaluated through palpation of the fibular head [3]. The fibula head can be located slightly distal and lateral to the knee. On some occasions, the assessment of the fibula head can be difficult, and motion tests with ankle pronation and supination can be used for evaluation. In instances where supination is favored, the posterior fibular head is often present and where pronation is favored, the fibular head tends to be anterior. There are few techniques to target the restriction of the tibio-fibular joint, creating a need for additional techniques that can alleviate tibio-fibular joint restriction and provide relief to patients. Due to the gap in the nascent literature regarding techniques addressing tibio-fibular dysfunction, the present study analyzes a novel manual medicine technique that targets the tibio-fibular joint and hopes to address many

of the current gaps in the current body of knowledge on improving mobility. Specifically, the LTT technique will add to the literature by providing a simple technique that can be utilized by practitioners. As the LTT has not been studied previously, the current study is an initial investigation aimed at assessing the effectiveness of the LTT technique on alleviating restriction in the tibio-fibular joint as well as its efficacy as a technique to improve overall leg mobility. This study is to identify a shift of the tibio fibular joint by noting restrictions in range of motion from expected normal range. This study then applies an osteopathic technique which corrects this abnormal shift and restores the expected full range of motion for that joint.

To test the study hypothesis, researchers employed the LTT in efforts to quantifiably improve the range of motion of study participants. The application of the LTT in treating tibio-fibular joint restriction is a new application of an established leg tugging technique. The established technique is currently used as a treatment modality for an upslipped innominate. The leg tug process for an upslipped innominate is to have a patient lay either supine or prone with the physician at the foot of the table. The physician grasps the patient's tibia and fibula above the ankle while internally rotating the leg to close pack the hip joint, locking the femoral head in the acetabulum. The leg is abducted 5 to 10 degrees to take tension of the sacroiliac ligament and then the physician gently leans back, maintaining axial traction on the patient's leg. The patient is instructed to inhale and exhale as the physician increases traction for 5 to 7 cycles. With the last exhalation, the physician tugs on the leg [1]. However, no studies have been identified discussing the use of the leg tug to treat tibio-fibular joint restriction. Conversely, several studies have been published detailing ankle pain resulting from tibio-fibular dysfunction [9,10]. More specifically, Babu *et al.* (2006) reports a case of tibio-fibular synostosis causing ankle pain in a 61 year old male with a history of tibia fracture [10]. Babu *et al.* goes on to shed light on the lack of literature regarding treatment modalities directed at ankle pain caused by tibio-fibular dysfunction. Similarly, Frick *et al.* (2001) describes iatrogenic tibio-fibular synostosis in pediatric patients resulting in ankle pain, joint deformity, and prominence of the proximal fibula [9]. Rahm *et al.* (1924) claimed the first published recording of proximal tibio-fibular joint synostosis in a 43 year old patient in 1924 [11]. Wong *et al.* (1978) furthered Rahm's research by reporting 2 cases of proximal tibio-fibular joint dysfunction resulting in ankle pain and altered gait [11]. Studies mentioned previously bolster the idea that tibio-fibular joint restriction can result in altered gait, decreased range of motion within the ankle joint, and ankle pain. The fact that tibio-fibular restriction causes pain, paired with the absence of literature describing effective treatment modalities provided the impetus to develop and test the LTT as a safe and novel treatment modality focused on the alleviation of ankle pain resulting from tibio-fibular joint restriction.

Methods

All procedures and protocols for the current study were reviewed by the Alabama College of Osteopathic Medicine (ACOM)'s Office of Research and Grant development and was approved by ACOM's IRB, study number 24-02-05- 003.

Participants

To address the hypothesis that the LTT is effective in alleviating restriction at the tibio-fibular joint, a quasi-experimental pre-and-post experimental design was developed. Twenty individuals (10 males and 10 females) from a college of osteopathic medicine in the southeastern United States were recruited to participate in the current study. The mean age for male participants was 36.1 with a range of ages from 26 to 62. The mean age for female participants was 27, with a range of ages from 22 to 49 years old.

Participants were recruited through a mixture of institutional email, social media or in person at the college. Any individual classified as a student or faculty member was eligible to participate. Inclusion criteria included any individual who presented with a restriction in range of motion, determined by goniometer. Participants were included if their range of motion differed from the expected range of motion in the general population. The expected range of motion considered was between 65-75 degrees in the sagittal plane and 35 degrees in the frontal plane. However, the individual participants' range of motion was compared bilaterally, with discrepancies in comparative range of motion determining restriction. Exclusion criteria of anyone over the age of 65 years old. Other exclusion criteria included any trauma, surgical procedures affecting the knee, tibia, fibula, or ankle of the tested limb.

All recruited persons were verbally screened to determine whether inclusion/exclusion criteria were met prior to participation in the study. All participants meeting inclusion criteria and willing to participate in the study were supplied with a consent form, to which they were given the risks, benefits, and alternatives to the study. Participants were given adequate time to review the informed consent and ask questions, and each participant signed an informed consent and received a copy on email. All 20 study participants were adults who displayed a restriction of the tibio fibular joint but were otherwise (self-reported) healthy and had standard activity levels.

Measurement

All measurements involving physical interaction with the participants were taken by a board-certified osteopathic physician who is faculty at the school of Osteopathic medicine.

The participants were measured for their tibio-fibular rotation range of motion. Each leg was measured independently for foot-ankle inversion and eversion. The knee leg ankle

measurements that identified a restricted range of motion were chosen for the study of this corrective technique.

As this was a pilot study, the decision was made to test one leg to determine if this technique was effective for alleviating restriction. Additionally, with these joints being separated, manipulating one leg was not expected to impact the other leg. Of the twenty participants, 6 participants had their left tibio-fibular joint manipulated and 14 had their right joint manipulated. All six of the participants who had their left tibio-fibular joint manipulated were female. In total, all male participants had their right leg manipulated and females had six participants with their left leg manipulated and four with their right leg manipulated.

The foot was measured after the LTT was completed with the foot inverted, internally rotated and plantar flexed until the restrictive barrier was met with the palmar side of the physician's hand placed flat against the dorsal surface of the participant's foot. The measurement maneuver was repeated with the foot everted, externally rotated, and dorsiflexed. These positions were used to determine the internal and external rotation of the tibio-fibular joint in the sagittal and frontal plane to determine the given restriction.

Passive range of motion was measured using a goniometer due to its common usage in physical therapy and orthopedics to measure joint range of motion to diagnose musculoskeletal conditions. Restriction was determined as any individual who had restriction at the end range of motion that was determined using palpatory skills and the aforementioned values above by a board-certified physician. Both legs were compared during internal and external rotation measurements and the leg that had the most restriction was chosen for the technique [5]. In total, all 10 males had their right leg manipulated, whereas six participants in the female group had their left leg manipulated and four had their right leg manipulated.

Pre-corrective range of motion of the tibio-fibular joint (TFJ) was determined with the patient supine with their lower extremities in neutral position. The set up for measurement is as follows. The physician stabilized the tibia and fibula just caudal to the patellar tendon insertion while the physician passively manipulated the foot and ankle so that the plantar surface was perpendicular to the table.

The goniometer was then used to measure the foot in the perpendicular position with the initial measurement set to 0. The participant's foot was initially positioned so that the metatarsals pointed to the ceiling with their heel resting on the table. The stationary and moving arm were aligned upwards so that they were parallel with the participant's first metatarsal. Next, the physician moved the foot into either internal or external rotation, with the moving arm following the participant's first metatarsal until the restrictive barrier was met. The bottom of the goniometer was positioned so it rested on the table to ensure that it was not moving during

the measurements. The physician then returned the foot/ankle into neutral position in order to perform the technique. A visual depiction of how the measurements were taken is provided in **Figure 1**.

Technique

All techniques and manipulations involving physical interaction with the participants were conducted by a board-certified Osteopathic physician who is faculty at the school of Osteopathic medicine. By placing the goniometer so that the stationary arm is parallel to the second metatarsal in neutral position and again in inversion and eversion, the degree of change was able to be accurately collected. This method was applied before and after the performance of the technique and resulted in the data depicted below. The initial measurement was taken of both legs and the leg that had the lowest measurements for internal and external rotation was chosen to be manipulated. Participants included in the study were instructed to lay supine on an exam table with their shoes off and their toes pointed up towards the ceiling.

Both of their legs are fully extended and relaxed. Once the foot was stabilized in a neutral position, the physician held the talo-calcaneal junction in both hands so that the physician's thumbs were near the participant's medial and lateral malleolar surfaces. The physician then elevated the ankle 10-15 degrees off of the table and applied caudal traction until the restrictive barrier was felt. When the restrictive barrier was met, a second researcher stabilized the tibio-fibular joint at the knee, by compressing the tibia and fibular heads below the patellar tendon and applying an inferior force that followed the motion of the physician's short caudal thrust, see mock technique photo below. The caudal thrust allowed the tibia and fibula to temporarily distract which resulted in their return to proper alignment. The physician then returned the ankle/foot to the table for post-corrective measurement. Post-corrective measurement was performed in the exact same manner as the pre-corrective measurements. Measurements were performed in the same manner before and after the LTT was performed to ensure measurement accuracy. An image of the LTT being performed is provided in **Figure 2**.



Goniometer measurements (from left to right): Demonstrating internal rotation at the ankle with stabilization at the knee, external rotation at the ankle with stabilization at the knee, Foot pointing up to ceiling for initial measurement, external rotation measuring in line with the first metatarsal, and internal rotation measuring in line with the first metatarsal.

Figure 1. Internal and External Rotation Measurements.



Technique: Leg tug in neutral position with stabilization at the knee

Figure 2. Administration of the Leg Tug Technique (LTT).

Analysis

Patient data was collected in real-time by the research team and entered into a Microsoft Excel [12] spreadsheet upon conclusion of each session.

Summary statistics included mean and standard deviations of leg mobility before and after the LTT was implemented. These data were collected for the total sample as well as by gender. To evaluate differences in mobility pre- and post-manipulation, paired sample t-tests were calculated for the total sample as well as for gender. An alpha level of 0.05 was set as the threshold to determine if the change in range of motion could be considered statistically significant. Once calculated, the within group differences were compared using an independent t-test with the same level of significance (i.e., $\alpha=0.05$).

Results

Six of the total participants had greater restriction in their left leg and fourteen had greater restriction in their right leg.

Female participants had a mean internal range of motion of 47.30 degrees, with a standard deviation of 15.62 degrees and a mean external range of motion of 48.40 degrees, with a standard deviation of 16.21 degrees prior to the administration of the LTT. The mean internal range of motion for female participants after administration of the LTT was 56.50 degrees, with a standard deviation of 13.05 degrees and a mean external range of motion of 58.60 degrees, with a standard deviation of 13.07 degrees. Statistical comparisons of the range of motion differences before and after the LTT was administered indicated a statistically significant improvement in internal rotation ($p=0.01$) and external rotation ($p=0.02$) for all female participants combined.

In female participants who had their left leg evaluated ($n=6$), goniometer measurements indicated a mean internal range of motion of 53.50 degrees, with a standard deviation of 17.21 degrees, and a mean external range of motion mean of 46.83 degrees, with a standard deviation of 19.98 degrees prior to the administration of the LTT. Goniometer measurements after administration of the LTT indicated a mean internal range of motion of 62.33 degrees, with a standard deviation of 12.03 degrees and a mean external range of motion of 55.83 degrees, with a standard deviation of 14.22 degrees. None of the comparisons were shown to be statistically significant for the left leg.

In female participants who had their right leg evaluated ($n=4$), goniometer measurements indicated a mean internal range of motion mean of 38, with a standard deviation of 6.78 and a mean external range of motion of 50.75, with a standard deviation of 10.5 prior to the administration of the LTT. The mean internal range of motion for female participants

after administration of the LTT was 47.75, with a standard deviation of 9.98, and the mean external range of motion mean was 62.75, with a standard deviation of 11.73. Statistical comparisons of the range of motion differences on the right leg before and after the LTT was administered indicated a statistically significant improvement in external rotation ($p=0.02$), comparisons of the internal rotation values of the right leg were not observed to be statistically significant.

All male participants had their right leg manipulated ($n=10$). Male participants had a mean internal range of motion of 37.70, with a standard deviation of 11.86 and an external range of motion mean of 55.30, with a standard deviation of 8.45 prior to the administration of the LTT. The internal range of motion for male participants after administration of the LTT was 50.60, with a standard deviation of 8.76 and an external range of motion mean of 55.30, with a standard deviation of 7.62. Statistical comparisons of the range of motion differences before and after the LTT was administered indicated a statistically significant improvement in internal rotation ($p>.001$) and external rotation ($p>.001$) for all participants combined.

Male participants had an internal range of motion mean of 37.70, with a standard deviation of 11.86 and an external range of motion mean of 55.30, with a standard deviation of 8.45 prior to the administration of the LTT. The internal range of motion for male participants after administration of the LTT was 50.60, with a standard deviation of 8.76 and an external range of motion mean of 55.30, with a standard deviation of 7.62.

The p-value for males comparing the internal before and after technique was 0.0001 and for external rotation before and after comparison was 0.001; both statistically significant using a significance value of $p<0.05$. Based on the calculated values, the data was significant and proved the hypothesis that this LTT technique was effective in increasing range of motion for the tibio-fibular joint.

Overall, comparing males to females, the female mean internal range of motion was 47.30 degrees, with a standard deviation of 15.62 degrees, compared to the male mean internal range of motion of 37.70, with a standard deviation of 11.86. In external rotation prior to LTT the mean in females was 48.40 degrees, with a standard deviation of 16.21 degrees compared to males of 55.30, with a standard deviation of 8.45. The mean internal range of motion for female participants after administration of the LTT was 56.50 degrees, with a standard deviation of 13.05 degrees, compared to the male 50.60, with a standard deviation of 8.76 and the male external range of motion mean of 55.30, with a standard deviation of 7.62 compared to a mean external range of motion of 58.60 degrees, with a standard deviation of 13.07 degrees for females. Both males and females had significant values found in both internal and external range of motion.

Discussion

This study was conducted in effort to determine if the LTT could be utilized to increase range of motion in participants that presented with a restriction in the expected range of motion of the tibio-fibular joint. Previous iterations of a leg tug have been used to treat an upslipped innominate, however, there remained a literature gap regarding techniques to alleviate tibio-fibular joint restriction.

The determined data indicates a significant increase in the degree of range of motion after technique performance, potentially contributing to the alleviation of pain stemming from restriction and misalignment. With each individual, the same physician and medical student measured each participant's passive range of motion, which was determined by the point of resistance that was initially experienced by the physician as they moved the participant's joint. Both male and females saw a significant increase in range of motion when assessing overall increase of range of motion in both internal and external rotation. However, in female participants, when analyzed based on which leg was manipulated, females with left leg manipulation had no significant increase from before technique usage to after and females who had their right leg manipulated had significant increase in external range of motion only after technique administration.

With the use of the LTT technique, participants experienced an increase in their range of motion. The current study was a proof-of-concept study that demonstrated that a misaligned tibio-fibular joint can result in a decreased range of motion, which can be improved by utilizing the LTT technique. More specifically, the average range of motion of internal rotation prior to technique application in females was 47.30 degrees, average external rotation before the technique of 48.40 degrees, average internal rotation after the technique of 56.50 degrees, and an average external rotation after the technique of 58.60. Overall, female participants saw a mean increase of 9.2 degrees in internal rotation and a mean increase of 10.2 degrees in external rotation. Males showed an average range of motion of internal rotation prior to technique application in males was 37.70 degrees, average external rotation prior to technique application was 49.00 degrees, average internal rotation after the technique of 50.60 degrees, and average external rotation of 55.30 degrees after the technique was performed. Overall, male participants saw a mean increase of 12.9 degrees in internal rotation and a mean increase of 6.3 degrees in external rotation.

The LTT technique had significant positive results and supported our hypothesis that the LTT technique would help with improvement of tibio-fibular restriction and therefore could be used in clinical practice or in medical schools to benefit future patients. The calculated values proved the hypothesis of this study that the LTT technique was effective for range of motion increase in the tibio-fibular joint.

Some limiting factors of the present study included the sample size. There was a small sample size used and was justified due to the study serving as a proof of concept. The small sample size may have influenced the results as there were limited data points that were analyzed between both male and female participants and combined. This small sample size may have influenced the findings because it was a small group that may or may not have been representative of the general population. Additionally, all participants used in the LTT study were healthy participants who were part of a southeastern osteopathic medical school. Since these individuals were all relatively healthy and active, this served as a limitation as individuals that have limited mobility or activity, or previous surgeries in the lower extremity may be affected by this technique differently. The results may have been impacted as the general population would include individuals who have lower extremity ailments, which were excluded during this study. Each individual participant was assessed for range of motion restriction prior to being selected for the study to ensure that a restriction was present despite the individuals presenting as healthy. Additionally, demographic information, aside from age, including height and weight, was not collected during this pilot study as this study served to demonstrate if this technique was effective, leading this to be a limitation of the study. Additional demographics may have impacted the results as it remains unknown whether height or weight can impact the effectiveness of this technique.

Future research can investigate this technique taking height and weight of participants into consideration along with other demographic information. Investigating dominant vs nondominant legs should be addressed in the future. Future research can also focus on a larger population size with more varied individuals, as well as stabilizing the joint at the ankle to more accurately measure range of motion. Future work will analyze the LTT technique on a larger scale to continue benefiting patients with the LTT technique. Although the participant size in this study was small, the significant positive results found from this study indicate that this technique could be useful in medical practice to help patients. Additionally, this technique should be studied in hospitalized patients and athletes seeking to improve their performance. These initial findings indicate that this technique and this study can be further researched and built upon to help close the literature gap surrounding techniques to alleviate tibio-fibular joint restrictions and further studies regarding mobility of the lower leg and particularly the tibio-fibular joint.

Conclusion

There remains limited literature surrounding the tibio-fibular joint and techniques that can be utilized to fix tibio-fibular restrictions. This study was designed to assess the range of motion at this joint and how the LTT would correct a tibio-fibular restriction, measuring the pre-and-post corrective range of motions. This study had statistically significant

results demonstrating that the LTT was effective in improving the range of motion at the tibio-fibular joint and reducing restriction present. Further studies can investigate the clinical significance of having a misaligned tibio-fibular joint and the benefits associated with correcting the restriction.

Acknowledgements

We would like to acknowledge Dr. Shane Warren who greatly assisted with the editing and revising process of our manuscript.

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