THE EFFECT OF 'BALANCING LIGAMENTOUS TENSION' (AN INDIRECT TECHNIQUE) ON RANGE OF MOTION AT THE ANKLE.

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ABSTRACT

Objective: To determine the effectiveness of an indirect technique (balancing ligamentous tension) on altered talocrural joint range of motion (ROM).

Design: A randomised, controlled, blinded study.

Subjects: Asymptomatic male and female volunteers (n=40), aged between nineteen and twenty nine years (Mean = 21.8).

Methods: Subjects with a 6° or more difference between ankle joint sagittal plane range of motion values were randomly allocated to either a treatment (n=20) or control group (n=20). The "restricted" ankle of the treatment group was treated with 'balancing ligamentous tension' at the ankle complex and tibiofibula articulations. Pre-test, initial post-test and post-test at thirty minutes measurements were collected for passive dorsiflexion range of motion.

Results: Whilst there was a significant increase in ROM with time (p=0.000), no significant changes were identified in dorsiflexion range of motion between those subjects that received treatment intervention and those that did not.

Conclusion: Balancing the ligamentous tension at the ankle complex and interosseous membrane of the lower limb in asymptomatic subjects does not show a significant increase in range of motion compared to subjects who do not receive any treatment.

Keywords: Ankle Joint, Balancing Ligamentous Tension, Dorsiflexion, Range of Motion, Osteopathy.

INTRODUCTION

The talocrural joint plays an important part in the normal gait cycle. It is a large weight-bearing joint that has significant loads placed through it while walking, running or standing. As a result of this weight-bearing load, stresses such as tensile, shearing, compressive and rotatory forces are placed through the joint.[1] With these stresses acting upon the ankle, frequent injury occurs in sporting and normal daily activities.[2]

Stress placed on the ankle complex can lead to an abnormal distribution of forces which may cause microtraumas and incompetence of the ligaments surrounding the joint.[3] A strain, which is placed upon a joint of the body primarily affects the ligaments of that joint. Therefore function of the joint is impaired due to the "ligamentous articular strain".[4] Ankle joint ligaments are the most recurrently injured structure in the body and if poorly treated can progress to instability, decreased mobility and abnormal function.[3,5,6] Therefore it is beneficial to have an extensive array of treatment techniques available in treatment of the joint.

Rozzi et al.[7] suggests that one factor leading to ankle joint instability is a deficit in ankle proprioception. When the ligaments of the ankle are stressed the proprioceptive sensors in the ligaments are damaged.[8] The proprioceptors of the ankle joint are required for adequate postural stability and joint function, and with satisfactory joint function comes normal joint motion.[9] Ligaments that sustain microtrauma or damage interrupt the proprioceptive feedback which would otherwise be normal.

Two major approaches of osteopathic treatment for the whole body have been employed to date, direct and indirect. Direct treatment involves the practitioner applying a direct pressure or force to a restricted area/region in order to engage a restrictive barrier of the musculoskeletal system. Indirect treatment involves applying a force to the area/region of restriction in order to move that area/region into a position of ease away from the restrictive barrier.

In this study an “Indirect Technique” refers to balancing the ligamentous tension within the ligamentous structure of the joint.[23] This is achieved by: (a) contacting the bones in relation to the joint; (b) moving them passively to test the motion of that joint; (c) locating the direction of restriction and ease. The operator places the joint into the range of ease until a balanced force is found (this is established when the surrounding tissues are at ease or a state of relaxation), and holds this position until a release is felt.

The tibia and fibula are in direct contact with each other via the proximal and distal tibiofibula joints. These two bones are also connected via the interosseous membrane that runs along the shaft of the bones and helps to support both proximal and distal articulations. With movement of the ankle complex comes rotation of the fibula in the horizontal plane, around its vertical axis. Superior and inferior gliding also occurs.[1,10] Therefore with movement of the fibula there will be movement of the interosseous membrane. If the fibula is displaced slightly from its tibial articulation then the interosseous membrane may be unbalanced or on strain.

There has been no specific research to date on the effects of balancing ligamentous tension at the ankle. This type of treatment technique requires minimal movement and force being applied to the subject, it less invasive than direct techniques and is a generally safe and comfortable technique approach.[25] Using this approach allows for the practitioner to treat acute and chronic injuries that present in practice, whereas a more direct treatment technique approach may not be possible with the acute patient. The use of balancing ligamentous tension techniques in practice would therefore be of advantage to a broader range of the population.

Over the past twelve years previous studies on increasing ankle range of motion (ROM) have focussed on manipulation (high-velocity, low-amplitude (HVLA) thrust technique) of the talocrural joint.[11-15] These studies have produced varied results.

Anderson et al.[11] measured passive dorsiflexion range of motion (DFR) in asymptomatic subjects using a consistent torque applied to both the pre and post treatment measurements. The fifty-two subjects participating in the study had a history of unilateral ankle sprain, which became the ankle of focus for the trial. A single HVLA technique was performed to those subjects in the treatment group. Passive DFR was measured pre and post treatment with a Nicholas hand-held dynomometer, which provided a constant level of force that was recorded and used for both pre and post treatment measurements. There was no significant alteration found between the pre and post measurement in DFR of either control or treatment groups.

Whilst the majority of studies conducted measuring ankle DFR after HVLA intervention have reported no significant changes[11-13], Dananberg et al.[14] reported an immediate increase in DFR. Their study had a small sample size (n=22) and was limited by the measurement procedure employed. "Passive" DFR was determined by making each subject pull on a cord placed around their forefoot. This provided, according to the authors, "sufficient" force to produce end range in the desired direction. Dananberg's technique of creating DFR end range, combined with the application of the treatment technique, produced an increase in DFR in all subjects. The left ankle had an average increase of 4.9˚, while the right ankle had an average increase of 5.54˚. Differing from other studies, Danaberg's study also performed two separate HVLA techniques. Firstly, the proximal head of the fibula was manipulated, followed by the talocrural joint. Traction was also applied to the ankle between the two HVLA thrusts. Whilst other studies applied a single HVLA thrust to the ankle joint.[11-13,15]

Bones, ligaments and fascia are considered an integrated system that provides support and stability within the body. The neuromuscular system provides a power source for locomotion of the body. Both functionally and anatomically these two systems are mutually related and therefore dysfunction of one will fundamentally affect normal function of the other. If there is strain to the bony-ligamentous-fascial system then the mechanical conditions may be altered.[16]

It is this structure and function relationship that concerns Osteopaths. The talocrural joint has a biomechanical influence on the body as a whole, as strain placed on the ankle complex may alter an individual's gait pattern and place further strain on adjacent joints of the limb. Ligaments act to stabilise the bony joint and are under constant tension. If part of this ligamentous structure is under continuous strain then the stability and function of that joint is compromised. Greenman[17] suggests that a basic principle of indirect techniques is the close relationship of the body's structure and function, enabling one's body to self-regulate.

The aim of this study is to determine the effect of an indirect technique upon the talocrural joint range of motion by the balancing of ligamentous tension at the ankle complex and the interosseous membrane.

METHODS

Participants

After approval by the Human Research Ethics Committee of Victoria University, forty volunteers participated in the study. Thirty-one females (n=31) and nine males (n=9) aged between nineteen (19) and twenty-nine (29) years (mean age of 21.8 years) gave written consent prior to participation. No subjects exhibited or reported any lower limb pain or discomfort during the study. Subjects were recruited from the student body at Victoria University and were free to withdraw from the study at any time.

Study Design

The design was a randomised controlled and blinded experimental study (Figure 1). ROM testing of both ankles was completed to determine if there was a minimum of six degrees difference between the subjects' ankle complexes. Normal sagittal plane ankle ROM data suggests a total range of 60 degrees, with a standard deviation of 6 degrees.[18] Assuming a difference of one standard deviation between a restricted and non-restricted ankle exists (that is 54 degrees or less on the restricted side), the aim of the treatment is to return that ankle to normal range. This would effect a change of 6 degrees or more providing an effect size of 1 assuming standard deviation also stays within the normal range. With an effect size of 1, 20 subjects in each of two groups (treatment and non treatment), provides power of 80% to the study.

All participants were placed in a supine position on a treatment table with their hip and knee at 90 degrees of flexion. The lower leg was supported by a padded metal frame and was stabilized with the use of Velcro strapping. The foot was then placed into a footplate that allowed for movement of the ankle in the sagittal plane. The foot was also stabilized and held into the footplate with the aid of Velcro straps.

Ankle passive ROM was tested in the sagittal plane with the aid of a Nicholas hand-held dynamometer (Nicholas Manual Muscle Tester 1, Indiana, USA) to apply an accurate passive torque to each ankle complex for all pre and post treatment measurements. The Nicholas dynamometer has previously been shown to have high inter-rater and repeated measures reliability[19-21] (the tester had previously used and was familiar with the device). ROM was measured with the use of a 3DM Magnetometer (Proprietary software developed at Victoria University) that was attached to the footplate. The 3DM magnetometer measures angular motion (º) in all three planes. This system has previously been validated against digital video as a highly accurate measurement method free of human error[22]. All data from the magnetometer was recorded by an IBM laptop.

Testing procedure

Tester 1 applied a torque to the ankle complex in a cephalad direction from end range plantarflexion, along the sagittal plane, to end range dorsiflexion with the hand-held dynamometer. The dynamometer was used to ensure that equal passive torques were applied to all ankle complexes for the pre and post testing measurements. Once full pre-test ROM was reached, the applied torque and ROM data were documented.

Subjects then were taken in a wheelchair into a separate room where the practitioner (an Osteopath) randomly allocated them into either a treatment group (n=20; Males = 4, Females = 16) or a control group (n=20; Males = 5, Females = 15). This was achieved by tester 2 pulling one piece of paper from an envelope that contained 40 This was achieved by tester 2 pulling one piece of paper from an envelope that contained 40 pieces. The paper had either a number 1 or number 2 written on them. Number 1 indicated the treatment group and number 2 indicated the control group. Tester 1 was blinded to subject group allocation.

The practitioner then applied two indirect treatment techniques to the treatment group subjects, one to the restricted ankle complex and one to the fibula and interosseous membrane of the same leg. The control group received no treatment and were required to stay in the treatment room with the practitioner for the same amount of time required for treatment.

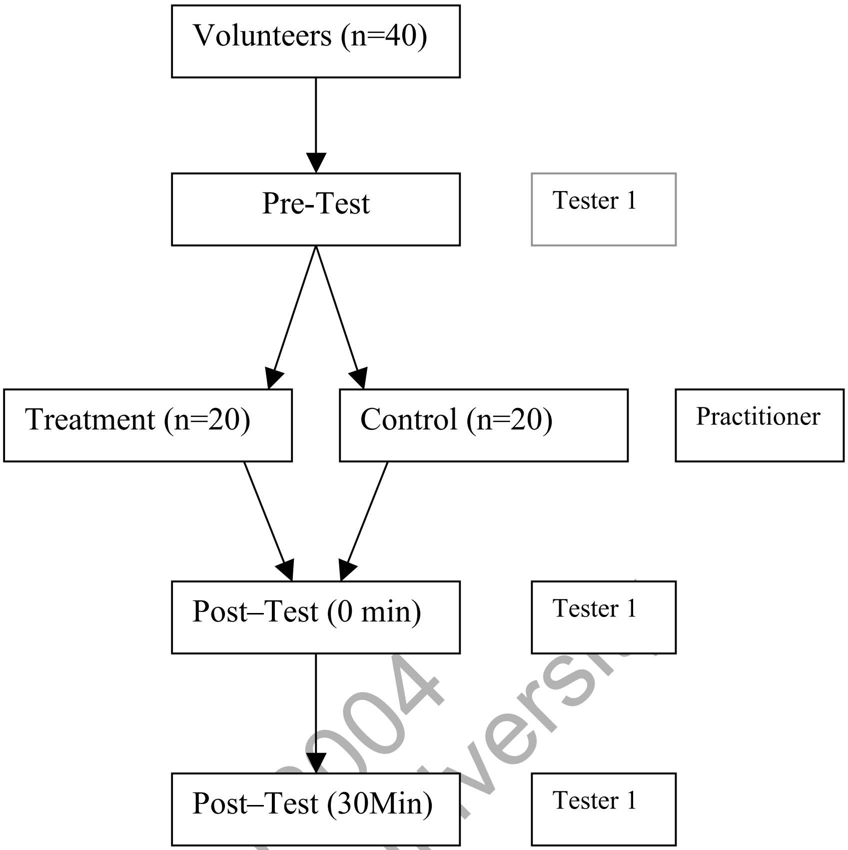

Figure 1: Study design

Indirect techniques

Treatment of the left ankle complex.[23] (Figure 2)

The practitioner's thumb of the left hand contacted the medial malleolus, whilst the lower leg (via the calcaneus) rested in the cupped left hand. The fingers then wrapped around the calcaneus to contact the lateral malleoli.

The right hand was placed around the sole and the lateral aspect of the foot. The thumb was positioned so that it came in contact over the site of the junction of the cuboid, navicular and calcaneus. The little finger was placed over the lateral malleolus, while the second, third and fourth fingers wrapped around the ankle joint over the site of the talus.

With the practitioners' fingers relaxed and their elbows' resting on the table so little pressure was applied to the subjects' foot and ankle, a slight distractive or compressive force was applied to the region in order to stimulate the ligaments of the foot.

The practitioner followed the movement into a position of least tension. Once a point of ease occurred (where little or no movement was felt at the joint), the ankle joint was assumed to be in a state of balanced ligamentous tension. When the practitioner felt a softening of the ligaments and tissues around the ankle joint, the technique was concluded. This was usually achieved between thirty seconds to three minutes.

If the treatment was conducted on the right foot, then the practitioner used the same technique but the left and right hands played opposite roles.

Figure 2: Balancing the ligamentous tension at the ankle complex.

Treatment for interosseous membrane of the left leg.[23] (Figure 3)

The left hand was kept in its original place from the ankle technique, and the right hand moved in a cephalad direction between the leg and the treatment table. With the thumb over the area of the fibula head, the fingers contacted the medial aspect of the tibia. The lower leg was held with a cupped left hand at the heel of the foot, while the right hand cupped the back of the lower leg just below the knee joint.

With arms resting on the table to allow for little or no pressure on the subjects' leg the practitioner felt the tension of the interosseous membrane. As with the ankle technique, the practitioner followed the movement until the least tension was felt. Once a point of balance was reached, and no motion felt, the tension of the interosseous membrane was assumed to be in a state of balance. When a softening of the tissues of the leg occurred, the technique for the interosseous membrane was concluded. This was usually achieved between thirty seconds to three minutes.

Figure 3: Balancing the ligamentous tension of the interosseous membrane.

To analyse data obtained, a SPANOVA will be used as there is one factor that is repeated (time) and one independent factor (treatment or control).

RESULTS

It was hypothesised that by applying an indirect treatment technique to the ankle and lower limb of the experimental group that they would receive an increase in their post treatment ROM when compared to the control group at both post testing times.

Table 1: Mean Pre Treatment ROM data for Treatment and Control Groups.

Pre Treatment		Mean	SD
Treatment Group			
Unrestricted Ankle		81.1º	10.7
Restricted Ankle		73.4º	10.5
	Diff.	7.7º	
Control Group			
Unrestricted Ankle		81.9º	9.7
Restricted Ankle		73.7º	8.5
	Diff.	8.2º	

Table 1 above demonstrates that a minimum of six degrees (6º) difference between the two ankles on all subjects being measured for both the treatment (7.7º) and control (8.2º) groups.

Table 2: Summary of all restricted left and right ankle ROM data for groups and times.

Group		Mean	SD
Pre Treatment			
	Treatment	73.4º	10.5
	Control	73.6º	8.4
Post Treatment			
	Treatment	77.1º	8.9
	Control	76.6º	8.9
Post Treatment 30mins.			
	Treatment	77.7º	9.1
	Control	75.9º	8.7

A summary of the data for all "treated" ankles included in the study, indicates a significant change for both groups (p=0.000) on the repeated measures factor. The mean ankle ROM values increased with time, specifically between the pre and post treatment measurements. However, closer examination of the results indicates no significant difference between the two groups on the independent factor (p=0.391, eta squared (η^2)= 0.024). Figure 6 highlights the similar trends in the data for both treatment groups. These data suggest no difference between the control and treatment groups across the measurement times.

Table 3: Difference data between restricted and unrestricted ankles for treatment and control groups.

	Group	Mean	Std. Deviation	N
Pre Treatment				
	Treatment	7.7	1.3	20
	Control	8.2	2.8	20
	Total	7.9	2.1	40
Post Treatment				
	Treatment	0.9	3.6	20
	Control	1.8	4.3	20
	Total	1.4	3.9	40
Post Treatment 30 mins.				
	Treatment	-1.1	4.7	20
	Control	1.8	4.9	20
	Total	0.3	4.9	40

Differences data for each subject were also calculated and analysed. There was a significant change for both groups ($p=0.000$) on the repeated measures factor, but as with the ROM data there was no significant difference between the two groups on the independent factor ($p=0.221$, eta squared (η^2) = 0.039). Figure 7 highlights the similar trends in the data for both treatment groups.

DISCUSSION

This study found that balancing the ligamentous tension of the talocrural joint and interosseous membrane did not produce a significantly greater increase in DFR compared to no treatment at all. These results are consistent with a number of studies conducted on the talocrural joint involving manipulation.[11,12,13,15]

Although there is no specific research on balancing ligamentous tension at the ankle, our results were consistent with Anderson et al.[11] and Nield et al.[12], who found there to be no significant increase in DFR after HVLA manipulation of the ankle joint.

Anderson et al.[11] used subjects (n=52) who had a history of lateral ankle sprain, with no current pain. The ankle complex was pre-conditioned by applying three successive dorsiflexion motions before testing. The lower limb was strapped to a biodex table and the results were recorded by digital photographic stills to determine DFR. A single HVLA technique was performed to the talocrural joint to increase the DFR. The present study concentrated on subjects that had one ankle with a restricted DFR compared to the other ankle, didn't pre-condition the ankle complex and involved the fibula in the treatment as its distal portion creates the lateral aspect of the talocrural joint.

In contrast, Nield et al.[12], had fewer subjects (n=20), who were all asymptomatic. Their study consisted of a single manipulation to the talocrural joint. Pre-conditioning of the ankle was implemented and consisted of applying three passive dorsiflexion torques of 23N.m. This was then followed by applying five consecutive torques of increasing magnitudes for both pre and post testing, with the results being recorded by photographic equipment.

Both Anderson et al.[11] and Nield et al.[12] differed in their measuring technique and apparatus to the present study. Anderson et al demonstrated a difference of 2.2˚ (mean = 0.18) for the control group and 3.1˚ (mean = 0.34) for the treatment group between the pre and post measurement. While Nield et al showed mean changes of 0.55˚, 0.60˚, 1.30˚, 1.15˚ and 1.25˚ between the five pre and post measurements for the treatment and control groups. In this study, the subjects were strapped into a footplate, which was mounted to a platform on a treatment table, recording degrees of motion with a 3DM magnetometer[22]. However, this study did not pre-condition the ankle joint as it was thought the pre-conditioning would have an influence on the outcome of the technique. Fryer et al[13] suggests that it may '...produce a small short-term viscoelastic change in either the triceps surae musculature or ankle ligaments that allowed for slightly greater ROM...' (p. 388).

Similar to the present study, Dananberg et al.[14] researched the effect of movement of the fibula and the talocrural joint on DFR. A goniometer was used to determine the degree of DFR and the subjects themselves applied the force until end range dorsiflexion was achieved. The outcome of this study produced instant significant increases in DFR. The left ankle showed a mean increase of 4.9˚ (SD = 3.11˚), while the right ankles' mean increase was 5.54˚ (SD = 4.01˚). However, there are some methodological questions. Subjects were not blinded to the treatment intervention that they received. This could have influenced the post treatment DFR as they applied their own "active assisted" ROM by pulling a cord that was placed around the foot. An "active assisted" force being applied in this manner by the subjects does not give an accurate force for both pre and post measurements. The use of an accurate passive torque to each ankle complex for all pre and post treatment measurements, which have been used in previous studies.[11-13, 24] This study used a Nicholas hand-held dynamometer (Nicholas Manual Muscle Tester 1, Indiana, USA) to obtain accurate passive torques (also used by Anderson et al[11] and Fryer et al[13]), which has previously been shown to have high inter-rater and repeated measures reliability.[19-21] There was also no control group allocated to the study. This would have allowed the results of the treatment to be validated in a comparison against subjects that didn't receive treatment, as used in previous studies.[11-13,15]

The 'Indirect Technique' of balancing the ligamentous tension is a very gentle technique that has a minimal amount of force applied to the area being treated. It is a technique that may be beneficial for an acute patient in an initial treatment when more direct techniques may cause discomfort. Other techniques can then be incorporated into subsequent treatments, as the patient is no longer in the acute phase.

However, in the present study it is unclear why both the treatment and control group showed a change in ROM. The author's assume that the application of the passive torque to the ankle joint may be a contributing factor to the change measured in ROM. Researchers in this field often ignore this factor; therefore further research should be conducted to investigate this phenomena.

Using a wheelchair to move the participants to and back from the treatment room eliminated the chance of any further stress being applied to the ankle. However, it is possible that when getting out of the chair that participants placed their foot on the ground, and this may have contributed to the increase ROM.

Whilst our results demonstrated that balancing the ligamentous tension of the talocrural joint and of the interosseous membrane did not show a significant increase in DFR in subjects with a difference in DFR between ankle joints, it is possible that in conjunction with other osteopathic treatment techniques this type of technique could be beneficial for the patient. This study did not attempt to measure the outcomes of comfort or stability, concentrating on increasing ROM as a positive outcome. This study involved a one-off technique, which by itself did not show a significant result.

However a one-off indirect technique is not representative of a normal, holistic osteopathic treatment approach.

CONCLUSION

This research considered the effects of an indirect osteopathic treatment technique involving balancing the ligamentous tension of the talocrural joint and interosseous membrane on DFR at the ankle complex. It found that the application of these techniques did not significantly increase DFR at the ankle complex at initial post treatment or thirty minutes post treatment compared to individuals who did not receive the same treatment.

This suggests further research is needed to investigate the longer-term effects of this technique on DFR as well as other therapeutic outcomes. In addition, subjects with either an acute or a previous history of ligamentous sprain should act as participants, as a greater effect may occur. The reader should also note that a one-off indirect technique is not indicative of a standard osteopathic treatment, and as such, the results presented in this study are indicative of only a small part of an overall treatment regime.

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