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THE EFFECT OF MANIPULATION ON RANGE OF MOVEMENT AT THE ANKLE JOINT

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ABSTRACT. Manipulation is commonly used by physiotherapists in the treatment of musculoskeletal disorders; however, there have been few studies evaluating its use in peripheral joints. The purpose of this study was to investigate the effect of manipulation on dorsiflexion range of movement at the ankle joint. Twenty asymptomatic subjects participated, one ankle acting as the experimental ankle and receiving the manipulation intervention, while the other ankle acted as the control. The manipulation studied was a longitudinal talocrural manipulation. Dorsiflexion range of movement was measured at 5 consecutive torque levels pre and post manipulation intervention in the experimental ankle and pre and post no intervention in the control ankle. These values were compared using analysis of trend within an analysis of variance framework. There was no statistically significant change in dorsiflexion range of movement following manipulation. It was concluded that in the case of asymptomatic subjects these results did not provide support for the experimental hypothesis that a single talocrural manipulation alters dorsiflexion range of movement. It was suggested that future research investigate the effects of manipulation in a symptomatic population.

Key words: manipulation, ankle joint, physical therapy.

For many years manipulation has been used in the treatment of spinal and peripheral musculoskeletal disorders. Clinical observation suggests that manipulation is effective in improving function, pain and range of movement (10). However, a review of the literature reveals a lack of research validating the use of peripheral manipulation to increase range. Specifically, no studies have addressed the effect of manipulation on dorsiflexion range of movement at the ankle joint.

Dorsiflexion occurs primarily at the talocrural joint with a relatively small contribution from the subtalar joint (18). Both muscle/tendon units and periarticular tissues offer significant resistance to movement and thus contribute to joint stiffness (24). Sequential sectioning studies of periarticular tissues of the ankle suggest that the posterior tibiotalar, posterior talofibular, calcaneofibular and anterior talofibular ligaments limit dorsiflexion (15, 7). Other structures which are likely to offer resistance to dorsiflexion include the articular configuration, posterior and lateral crural muscles, capsule, skin and fascia (8, 22).

Adequate dorsiflexion is necessary for performance of daily functional activities such as ambulation, stair climbing and rising from a chair. For optimal performance of sporting activities at least 20–30° of dorsiflexion is required (9). Restriction of dorsiflexion range may lead to ankle pain (11).

As previously stated, there have been no studies examining the effect of ankle manipulation on range of movement. However, Raupach et al. (17) studied the effect of manipulation on stiffness at the third metacarpophalangeal joint. Whilst their results were not statistically significant a trend towards manipulation being associated with an increase in flexion range was observed at higher forces. The authors note the low power of their statistical analysis (mean power 31%) and acknowledge the possibility of a Type II error. Had a more powerful analysis been employed a statistically significant effect may have been found (3).

Whilst there are few studies on peripheral joint manipulation there are over 20 recent studies that have investigated the effect of spinal manipulation. Of those investigating range of motion, several have found that manipulation was associated with increased movement in both symptomatic and asymptomatic subjects (6, 13, 14, 16). These results however, may not apply to manipulation of peripheral joints due to the obvious differences in anatomical structure. This study therefore, aimed to investigate the effect of a single longitudinal caudal talocrural manipulation on ankle dorsiflexion range of movement in normal subjects.

MATERIAL AND METHODS

Research design

Twenty subjects with no history of recent ankle trauma or pain took part in the study. With each subject 1 ankle acted as the experimental ankle, undergoing dorsiflexion measurement, manipulation and remeasurement. The opposite ankle received no intervention, undergoing measurement procedures only (Fig. 1).

Subjects

The 20 subjects comprised 7 males and 13 females between the age of 25–40 years (mean 30 years). Subjects were volunteers from a sample of University academic staff and students. Subjects were excluded from the study if they had a history of ankle trauma within the preceding 2 months, contraindication to manipulation or pain during the testing procedure. Written informed consent was obtained from each subject. The protocol was approved by the University of Sydney Human Ethics Committee.

Measurement tools

Passive range of ankle dorsiflexion was measured using a procedure adapted from that described by Moseley & Adams (12). To standardise the torque applied to the ankle when measuring ankle dorsiflexion, Moseley and Adams developed a device called the Lidcombe Template. This device consisted of a spring balance and a perspex sheet ruled with parallel lines. The spring balance was used to apply a force to the ankle via a footplate at the level of the head of the fifth metatarsal. The perpendicular distance between the line of force was kept constant using the lines ruled on the perspex sheet. In order to reliably apply larger torques the following modifications to this measurement device were made. A handle was attached to the foot plate and a load cell and transducer incorporated to obtain a more accurate readout of the applied force (Fig. 2). A Nikon 35 mm camera was used to photograph the ankle position and simultaneous force readout on the load cell transducer.

A pilot study using 10 subjects found the test-retest reliability of the measurement procedure to be high. The intraclass correlation coefficient (ICC 2,1) value was 0.97. This compared well with the reliability found by Moseley & Adams (12) for their measurement procedure (ICC 2,1 = 0.91 for normal subjects).

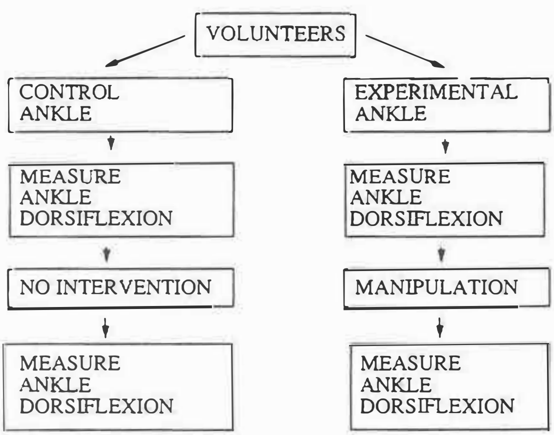

Fig. 1. Experimental design.

Procedure

Each subject was positioned supine with the hip and knee flexed to 90° and the lower leg supported on a stool (see Fig. 3). Three bony landmarks (head of fibula, tip of the lateral malleolus and head of the fifth metatarsal) were palpated and marked with ink. To precondition the ankle prior to measurement, passive ankle dorsiflexion was performed by applying a torque of 23 Newton meters (N.m) on 3 successive occasions. Preconditioning is commonly performed prior to mechanical testing of viscoelastic tissues to achieve repeatable results. Twenty three N.m was chosen because it was the maximum torque that could be practically applied. The actual dorsiflexion measurement procedure involved the application of 5 consecutive torques of increasing magnitude. These torques were determined as 5 equal divisions of the maximum value. A photograph of the angular displacement of the ankle was taken at each torque value. This photograph included the readout of the load cell transducer (see Fig. 3). The preconditioning and measurement procedure was then repeated on the opposite ankle.

With each subject one ankle was randomly allocated to the experimental group and a longitudinal caudal manipulation was performed on this ankle. This manipulation has been described in detail elsewhere (4). Briefly, the manipulative procedure involved the physiotherapist interlocking their hands over the dorsum of the subject's foot, close to the talocrural joint line. Tension was taken up in a caudal direction, then the thrust effected by a further, quick distraction of the foot. The manipulation was deemed successful if the joint gapped or a cracking sound was elicited. The control ankle received no intervention. Both ankles were then remeasured using the procedure described above.

Negatives of each photograph showing the dorsiflexion position of the ankle at the five different torques were obtained. These were then inserted into a Canon reader and the angle of dorsiflexion measured from the enlarged image (Fig. 4). The investigators responsible for data collection were blind to treatment intervention until all results were collated.

Data analysis

The variable torque level was a repeated measures variable (i.e. all subjects experienced all 5 torque levels) so contrasts for trend (23) were written across the 5 torque levels to test for the presence of different trend components relating ankle angle to force level. This was done within an analysis of variance framework which looked for the effects of manipulation over non-manipulation on the ankle angle.

RESULTS

The mean changes in ankle dorsiflexion range across

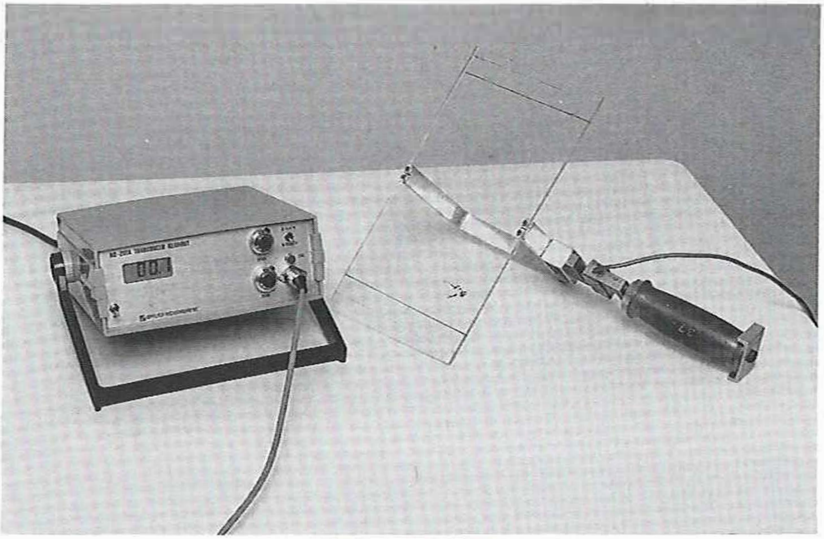

Fig. 2. The modified Lidcombe template.

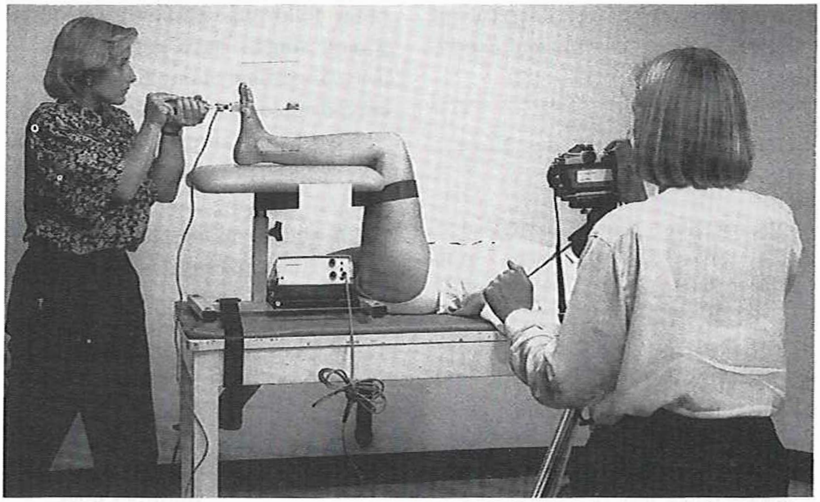

Fig. 3. Measurement procedure.

the varying torques for both the control and experimental ankles are shown in Table I. The mean change in dorsiflexion angle varied between $-1.45°$ and $0.7°$ for the experimental group and -2.0 and -0.55 in the control group. The mean change across all torques in the experimental group was $-0.2°$, while in the control group the mean change was $-1.1°$. The difference between these two was not statistically significant. This is unlikely to be a Type II error (where the null hypothesis is falsely accepted) as the statistical power of our analysis to detect a treatment effect of 5° or greater was 89%. The estimate obtained from the data of the population standard deviation in ankle angle measurements was 6.96°, and a 5° difference in angle due to manipulation therefore represented an effect size of 0.72 standard deviation units. Five degrees was chosen as this was thought to represent the minimum change which could be reliably observed in clinical practice using a universal goniometer.

The torque level had a significant effect on the ankle angle. The relationship is increasing curvilinear with significant linear $F(1,19) = 1,182.29$; and quadratic $F(1,19) = 333.04$ components. The nature of this relationship can be seen in Fig. 5 where the ankle angle

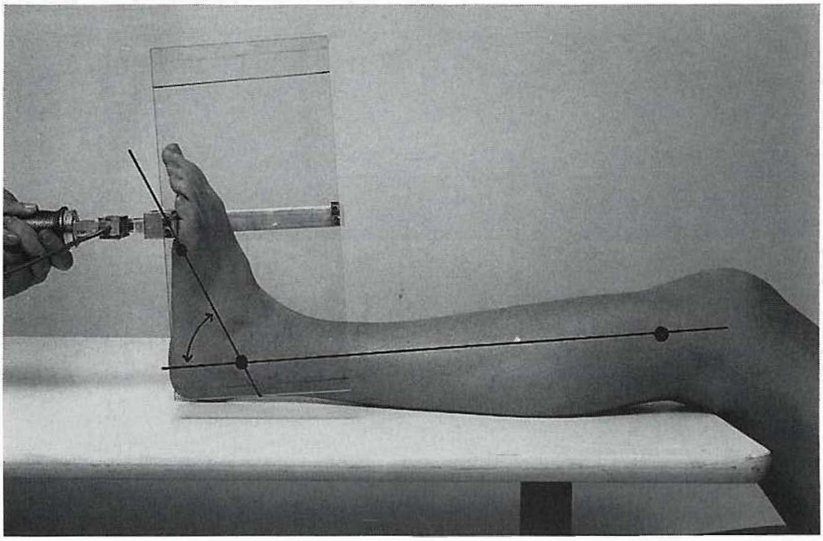

Fig. 4. Measurement of dorsiflexion angle.

Table I. *Mean change in dorsiflexion angle (degrees) at the five different torque levels for control and experimental interventions*

	Torque levels				
Level:	1	2	3	4	5
Newton. Meters	*4.6*	*9.2*	*13.8*	*18.4*	*23.0*
Control	−2.00	−1.50	−1.00	−0.75	−0.55
Experimental	−1.45	−0.90	0.30	0.40	0.70
Difference	0.55	0.60	1.30	1.15	1.25

increases with increasing torque level but with diminishing returns at the higher torque levels hence the significant linear and quadratic trend components. There was no significant interaction between the trend components and whether or not the manipulation took place, i.e.: the effects of ankle manipulation in relation to non-manipulation were the same at all torque levels.

DISCUSSION

The main finding of this study was that there was no statistically significant change in ankle dorsiflexion range following a single talocrural manipulation in a group of asymptomatic subjects. These results accord with those found by Raupach et al. (17) who demonstrated no significant change in flexion range following manipulation of the metacarpophalangeal joints.

While no studies have demonstrated an increase in range following manipulation of peripheral joints, several studies have demonstrated increased range following spinal manipulation (6, 13, 14). This difference in outcome may be due to the obvious differences that exist in anatomical structure between the spine and the extremity joints, or simply reflect the lack of research into the conditions and subpopulation for whom peripheral manipulation is effective.

This study investigated the effect of manipulation in

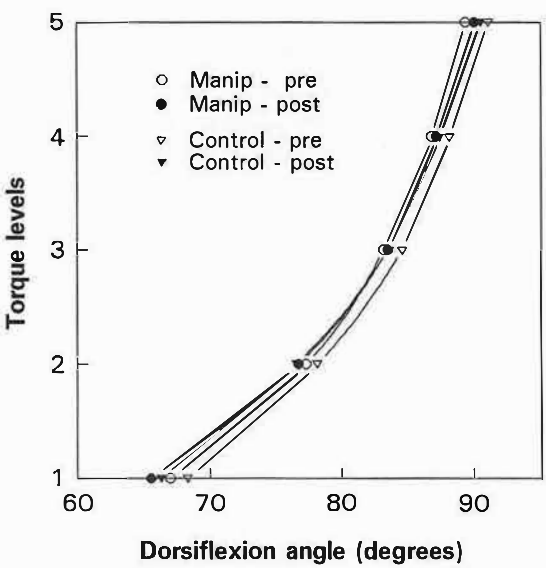

Fig. 5. Torque-angular displacement curves pre- and post-intervention for experimental and control ankles.

asymptomatic subjects. While it may be possible that symptomatic subjects will respond differently to manipulation, examination of studies of spinal manipulation would not support this view. These studies have demonstrated that increases in range of movement following manipulation may occur in both symptomatic and asymptomatic subjects.

This study measured ankle dorsiflexion range at five different torques. The procedure used a static measure of the passive mechanical properties of the ankle. This is similar to the static goniometric measures used in clinical practice to document the effects of manipulation. However, patients often report a "feeling" of reduced stiffness during functional activities such as walking or stair climbing following manipulation, and physiotherapists may use this patient report data to establish the effectiveness of their intervention. It may be that some dynamic measure of passive and active ankle joint mechanics changes following manipulation. Future study needs to examine this area of dynamic measurement further.

A strong curvilinear relationship between the applied torque and the resultant ankle displacement was demonstrated in the study. This finding is in agreement with the results of Toft et al. (19), Weiss et al. (20), Chesworth & Vandervort (2) and Weiss et al. (21). This relationship means that there is no point that can be identified as the end of range, dorsiflexion angular displacement being dependent on the applied torque. Ada & Herbert (1) have suggested that this curvilinear relationship may be one reason why clinical measurement of ankle joint range can be unreliable. Elveru et al. (5) report an ICC value of 0.5 for intertester reliability for ankle dorsiflexion passive range of motion. If one therapist pushes harder than another when measuring joint range the resultant "end of range" will be different. Ada & Herbert (1) have argued that this problem could be solved if the therapist applied a standardised torque. This suggestion was taken up by Moseley & Adams (12) when designing the Lidcombe Template and is thought to be one of the reasons for their report of higher intertester reliability for measurements taken with this instrument (ICC = 0.91).

In conclusion, this study investigated the effect of a single talocrural manipulation on ankle dorsiflexion range in normal subjects and found no significant effect on ankle angle due to manipulation. A follow up study looking at the effect of manipulation in a symptomatic group is underway.

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