

Effect of Low Dye Calcaneal Taping on Angle of Pelvic Tilt in Individuals with Excessive Calcaneal Eversion

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Abstract

Background: The pelvic girdle forms a closed kinematic chain with upper and lower quadrants of human musculoskeletal system of which the foot is an integral component. Individuals with excessive calcaneal pronation are susceptible to low back pain due to an exaggerated lumbar lordosis that can result from an internal rotation of tibia & femur. In order to treat this low back pain it becomes essential to correct foot posture. Literature shows the efficacy of low dye calcaneal taping in the correction of excessive calcaneal eversion. There is however scarce evidence available regarding this effect on angle of pelvic tilt & thereby on low back. Hence this study is undertaken.

Objectives: To compare the angles of pelvic tilt in individuals with excessive calcaneal pronation before and after Low dye calcaneal taping. **Methodology:** Angle of pelvic tilt of 30 females with a calcaneal eversion of more than 6 degrees was measured prior to the application of tape. Low dye calcaneal taping was then applied following which the angle of pelvic tilt was were measured again.

Data Analysis: Paired t-test was used to compare the mean values of pelvic tilt angle pre and post taping.

Results: Significant change in mean pelvic tilt angle was found pre and post calcaneal taping. **Conclusion:** Immediate change in the angle of pelvic tilt can be obtained by correction of excessive calcaneal eversion with Low dye calcaneal taping.

Key words: Low back pain; Pelvic tilt; Pronation of foot.

Introduction

The pelvic girdle forms a closed kinematic chain with upper and lower quadrants of human musculoskeletal system of which the foot is an integral component.[1] The subtalar joint being an integral component of the foot compensates to changes in the upper and lower quadrants through excessive calcaneal supination or pronation.[2] According to biomechanical principles, an increase in the calcaneal pronation by a degree can lead to an

increase in the internal rotation of the tibia and femur. This internal rotation of tibia and femur results in tension of the iliopsoas muscle causing an increase in the pelvic anteversion torque. Excessive internal rotation of the femur also leads to the posterior location of the femoral head causing an increase in anterior tilt of the pelvis.[3,4,5,6] All the above mentioned factors can exaggerate the lumbar lordosis and make an individual susceptible to back pain.[7] Sam Khamis *et al* conducted a study on normal individuals and assessed the angle of pelvic tilt by inducing hyperpronation in the foot. They concluded that hyperpronation of the foot causes an increase in internal rotation of the tibia which in turn causes increase in internal rotation of the femur thus causing increase in angle of anterior pelvic tilt.[8] Levine D and Whittle MW conducted a study on normal individuals and concluded that there is significant change in lumbar lordosis when there is a change in

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angle of pelvic tilt.[9]

As calcaneal eversion can be a source of back pain it is necessary to decide on the method of intervention which helps in controlling the excessive calcaneal eversion during weight bearing.[10]

Various methods have been incorporated for correcting the excessive calcaneal eversion which includes foot orthoses and therapeutic taping. Therapeutic taping of the foot has been shown to realign the calcaneum in neutral position while supporting the medial arch.[11-15] The most common method used in antipronation taping is Low-Dye calcaneal taping. The technique includes calcaneal slings and reverses sixes which helps in controlling the calcaneal eversion in weight bearing. In addition, to positioning the calcaneum in neutral position, taping also increases the proprioception of the foot.[10] B.Vincezino *et al* investigated the effect of low dye calcaneal taping versus orthosis for correction of hyperpronation of foot and found low dye calcaneal taping to be effective.[16]

The above literature showed the relation between excessive calcaneal eversion and angle of pelvic tilt, and the efficacy of calcaneal taping in the correction of calcaneal eversion. There is however scarce literature regarding the change in the angle of pelvic tilt through correction of excessive calcaneal eversion, hence the study is undertaken.

Hypothesis

Research Hypothesis

Low dye calcaneal taping reduces the angle of anterior pelvic tilt in individuals with excessive calcaneal eversion

Null Hypothesis

Low dye calcaneal taping does not reduce the angle of anterior pelvic tilt in individuals with excessive calcaneal eversion

Objectives of the study

- a) To measure the angle of pelvic tilt in individuals with excessive calcaneal eversion before and after low dye calcaneal taping.
- b) To compare the angles of pelvic tilt in individuals with excessive calcaneal eversion before and after taping.

Methodology

Inclusion criteria

1. Asymptomatic individuals with calcaneal eversion > 6.[7]
2. Males and females aged between 18-30 yrs.

Exclusion criteria

1. History of lower limb injuries
2. Lower limb deformities / spinal deformities
3. Neurological deficits in the lower limbs
4. Limb length discrepancies
5. History of low back pain.

Materials

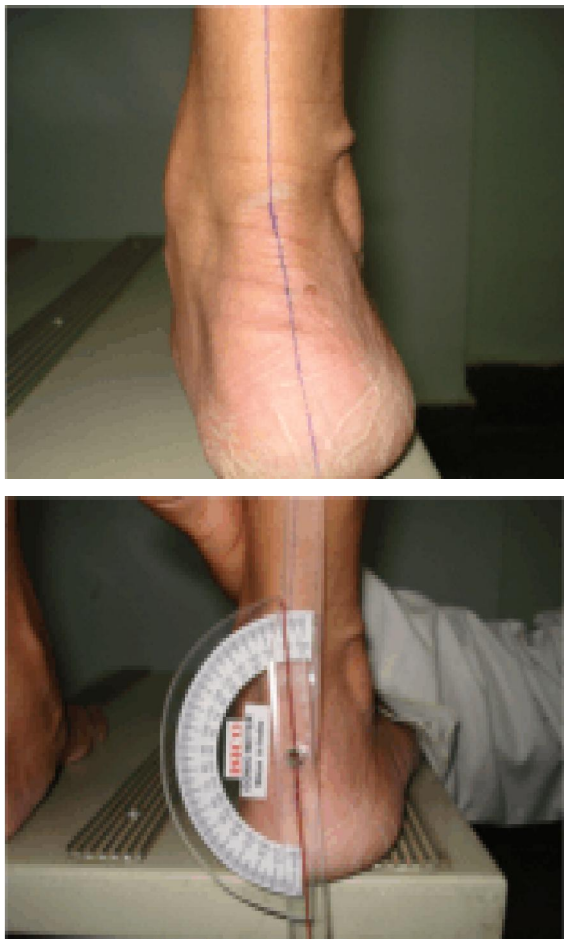
1. SP 2 - Rigid Adhesive Tape of 1and1/2 inches width
2. Milk of magnesia
3. Scissors
4. Goniometer
5. Fluid Level
6. 100 cm scale
7. Calipers
8. Marker Pen
9. Half meter scale

Procedure:

An ethical clearance was obtained from the ethical committee of M.S.Ramaiah Medical College. Both males and females of M.S.Ramaiah Medical College and Nursing college were screened by the researcher for the eligibility of the study. 30 female participants from M.S. Ramaiah Medical and Nursing College who fulfilled the inclusion criteria and exclusion criteria were taken for the study through purposive sampling. A control group was not taken as it was a pre and post design. An informed consent was obtained from the subjects prior to the study (Annexure 1).

A brief assessment of the subjects which included the demographic data was taken prior to the initiation of the study. The Calcaneal eversion and angle of pelvic tilt of each subject was then measured prior to the application of the tape.

Figure 1 & 2: Measurement of calcaneal eversion

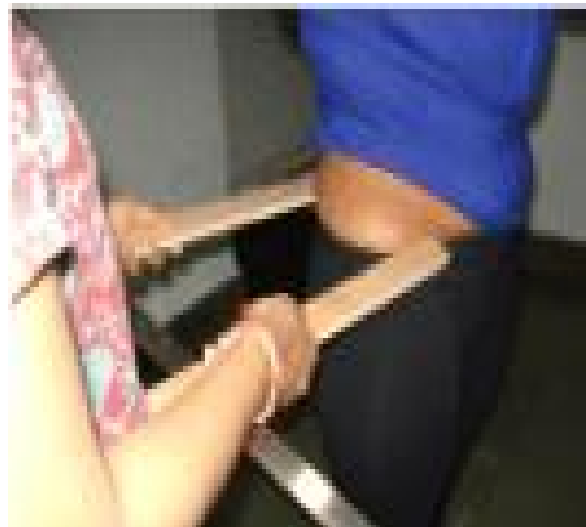


Measurement of calcaneal eversion: In prone lying position a line was drawn to bisect the gastrocnemius and calcaneum. The individual was then made to stand on a stepper in bilateral stance. The angle formed between the line bisecting the gastrocnemius and the line bisecting the calcaneum was measured using goniometer. (Figure 1 and 2)

Measurement of Pelvic tilt: To measure the pelvic tilt an instrument was constructed for the study. The instrument was devised to measure the distance from Posterior Superior Iliac (PSIS) and Anterior Superior Iliac Spine (ASIS) to ground and the distance between ASIS and PSIS. To measure the distance from ASIS and PSIS to ground a 100 cm scale, half meter scale and a fluid level was used. The 100 cm scale was placed vertically, half a meter scale was placed perpendicular to the vertical scale and fluid level was placed on the horizontal scale to check the alignment of the scale placed horizontally. To measure the distance between the ASIS and PSIS a scale of 24 cms and two long wooden rods were used. One rod was fixed at the PSIS and the other movable rod was kept at the ASIS. The device was calibrated and the inter and intra rater reliability that was assessed prior to the commencement of the study. Pearson's correlation coefficient was used to assess the inter rater and intra rater reliability. The inter rater reliability was 0.95 ($p < 0.05$) and was measured at an interval of 2 days. The intra rater reliability was 0.9 ($p < 0.05$) and was assessed by two Physical therapists. The subjects were then asked to stand with feet apart. The PSIS and ASIS were marked by a marker pen. The distance from PSIS and ASIS to ground and the distance between ASIS and PSIS was then measured (Figure 3, 4 and 5).[17]

Three measurements of angle of pelvic tilt were taken and the average of three was selected for the analysis. Pelvic tilt angle was then calculated using a trigonometric equation

$$\sin \theta = \frac{A - B}{C}$$

Figure 3: Measurement of ASIS to Ground**Figure 4: Measurement of PSIS to Ground****Figure 5: Measurement of distance between ASIS and PSIS****Figure 6: Low Dye Calcaneal Taping with mini stirrups, calcaneal slings & reverse sixes**

Where, A - Distance from PSIS to ground

B - Distance from ASIS to ground

C - Distance between ASIS and PSIS

Following the pre measurement of calcaneal eversion and angle of pelvic tilt the subjects' foot was taped in long sitting position. The taping technique used is mentioned below:

Taping Technique: The subject was seated in long sitting position with the lower one third of the leg out of the couch. The ankle and foot were maintained in neutral position. A strip of tape was applied over the first metatarsal along the medial side of the foot; a longitudinal traction was applied and then placed on the lateral side on the fifth metatarsal. Mini stirrups were applied from lateral to medial direction until the calcaneum was covered with traction applied medially to oppose pronation. A locking anchor was applied. An anchor was applied at the junction between the upper two-third and lower one-third of the leg. Calcaneal sling began from the anterior center part of the anchor, coursed distally in an oblique orientation towards medial malleolus, passed beneath the calcaneum and continued laterally and posterior to the

calcaneum. Traction was given to maintain the calcaneum in inversion and inserted at its origin. Reverse sixes were applied beginning from the medial malleolus, passed over the dorsum of the foot and beneath the midfoot, a traction was given at this point in an upward direction to gain inversion of the midfoot and inserted at the anterior aspect of the anchor over the leg. Three such reverse sixes were applied. A closing anchor was then given at the end of the taping. (Figure 6).[18]

The subjects were again asked to stand with the tape on and feet apart. The angle of pelvic tilt was reassessed with the instrument constructed for the study. Three readings were taken and the average of three was selected for the analysis.

Data Analysis

Statistical Methods

Descriptive statistical analysis has been carried out in the present study. A measurement of angle of pelvic tilt was measured before taping and immediately after taping. The pre and post values were compared and mean value, standard error, confidence interval and effect size was obtained.

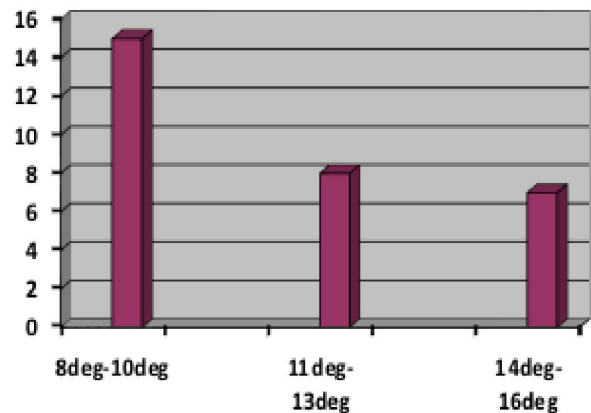
Statistical tests:

Paired t-test was used to compare the degree of pelvic tilt both pre taping and immediately after taping was done. The precision considered was 5% as alpha error and 5% as beta error. The statistical software namely SPSS 15.0 was used for analysis of the data and Microsoft Excel has been used to generate graphs and tables.

Table I: Demographic characteristics

Basic Characteristics	Study Group (Mean)
Number of subjects	30
Age in years	22.4 ± 1.8
Height	158 ± 4.869
Weight	56.9 ± 5.792
Calcaneal eversion	11.333 ± 2.425
Gender	
Males	0
Females	30

Figure 7: Angle of Calcaneal eversion of the subjects



Results

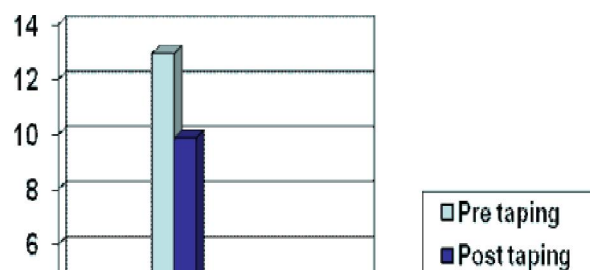
The total number of subjects who volunteered for the study was thirty consisting of only females. Thirty subjects in the age group of 18-30 years were taken for the study. The mean age group of the subjects in the study was 22.4 ± 1.8 years. Males were not

Table II: Comparison of the mean of pelvic tilt angle before and after taping

PELVIC TILT	N	Mean	Std. Deviation	Std. Error Mean
PRE_DEG	30	12.9387	1.96370	0.35852
POST_DEG	30	9.8550	2.09579	0.38264

Comparison Pelvic tilt	t-value	p-value	Effect Size
Pre Taping And post Taping	16.724	p<0.001	1.519

Figure 8: Comparison of the mean of pelvic tilt angle before and after taping



included as none of the males screened through purposive sampling had a calcaneal eversion of more than six degrees. The mean of degrees of calcaneal eversion prior to the application of the tape was 11.333 ± 2.425 degrees. This infers that the maximum of subjects studied presented with calcaneal eversion ranging from 8° - 10° .

The pre taping and post taping values of pelvic tilt angle were compared using paired t-test. The t-value obtained was 16.724 ($p < 0.001$). The result showed that there was significant decrease in the mean of the pelvic tilt angle after taping in comparison with mean of the pelvic tilt angle before taping.

The effect size for mean of pre and post values of pelvic tilt angle was calculated using Cohen's d formula and the value obtained was 1.519. This shows that the effect size obtained in the present study was clinically significant.

The above graph shows that the maximum number of subjects studied presented with calcaneal eversion ranging from 8 degrees to 10 degrees.

Analysis of the angles of pelvic tilt before and after low dye calcaneal taping showed a significant difference in the angle of pelvic tilt between the two groups ($p < 0.001$). It showed that the angle of pelvic tilt reduced significantly post calcaneal taping.

The above graph shows the reduction in the angle of pelvic tilt after the application of low dye calcaneal taping.

Discussion

The present study evaluated the angle of pelvic tilt immediately after low dye calcaneal taping in individuals with excessive calcaneal eversion.

The results of the study showed that the correction of excessive calcaneal eversion by Low dye calcaneal taping helps in immediate reduction of the angle of pelvic tilt in individuals with excessive calcaneal eversion. The effect size showed large size difference which infers that the reduction in angle of

pelvic tilt is clinically significant.

The reduction in the angle of pelvic tilt could have probably occurred due to the correction of the position of the calcaneum by the tape. As the calcaneum position was corrected approximately to the neutral position, the plantar condyles of calcaneum was placed on the surface. This would then cause a reduction in the internal rotation of the tibia and femur. This internal rotation of the femur decreases the tension in the iliopsoas muscle thereby causing a pelvic anterversion torque and causing the anterior pelvic tilt. This can be supported by a study conducted by A Hadley *et al* who found that Low dye calcaneal taping is an effective method in controlling the excessive calcaneal eversion which in turn controls excessive internal rotation of the tibia. The effect produced by the tape was present even after ten minutes of exercise.[19]

Blinding could have been done to assess the angle of pelvic tilt pre and post calcaneal taping. Future studies could be done to assess the long term effects of taping on the angle of pelvic tilt.

Conclusion

In the present study, it was seen that the correction of excessive calcaneal eversion by low dye calcaneal taping causes an immediate reduction in the pelvic tilt angle in individuals with excessive calcaneal eversion.

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