# THE IMPACT OF THERAPEUTIC ANKLE TAPING ON THE KINEMATICS OF THE LOWER EXTREMITY WHILE RUNNING: A PILOT STUDY

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Overpronation is a misalignment of the calcaneus resulting from flattening of the medial longitudinal arch, which may lead to an overuse injury in runners. It is suggested that taping may control the position of the calcaneus to correct foot pathologies associated with overpronation. This pilot study explored the effect of ankle taping on the kinematics of the lower extremity while running. Fifteen healthy participants ran on a treadmill with a Kinesio Tape®, Leuko Tape®, and a no tape condition while being video recorded for 3D analysis. No significant changes in the selected lower extremity kinematic variables were seen among the tape and no tape conditions. Participants demonstrated an average Foot Posture Index score of 2.2±1.5, which is considered neutral. Ankle taping may be more beneficial in altering lower extremity kinematics in runners with higher values of pronation and at faster running speeds.

**KEYWORDS:** Running injuries, Leuko Tape®, Kinesio Tape®, calcaneal taping, running gait.

**INTRODUCTION:** Due to the cyclic nature of running, overuse injuries are one of the most common running related injuries (Novacheck, 1998). These injuries are caused by the repetitive application of relatively small loads over many cycles. Overpronation is often cited as a misalignment of the calcaneus resulting from flattening of the medial longitudinal arch (Luque-Suarez, Gijon-Nogueron, Baron-Lopez, Labajos-Manzanares, Hush, & Hancock, 2013). It has been proposed that a flattening of the arch may alter the alignment of the lower extremity resulting in an overuse injury. Alterations in mechanics may cause increased ranges in hip flexion and adduction, knee flexion and abduction, femoral and tibial internal rotation, as well as, plantarflexion and dorsiflexion at the ankle (Dugan & Bhat, 2005; Lattanza, Gray, & Kantner, 1988). Hyland, Webber-Gaffney, Cohen, and Lichtman (2006) suggested that therapeutic taping may be beneficial in controlling the position and the alignment of the calcaneus to further correct foot pathologies associated with overpronation.

Research has explored the proposed effects of Kinesio Tape® when applied to the ankle and foot region. The primary purpose of Kinesio Tape® is to aid in pain inhibition, improve circulation and lymphatic drainage, and reduce the delayed onset of muscle soreness (Csapo & Alegre, 2014). It has also been suggested that Kinesio Tape® may increase tactile input and muscular strength of the surrounding area (Fu et al., 2008). Hyland et al. (2006) examined the effect of calcaneal taping on plantar heel pain symptoms through the use of self-report pain questionnaires. Results suggested that that the application of calcaneal taping significantly reduced pain when compared to stretching and the use of sham taping. Luque-Suarez et al. (2013) examined the effects of Kinesio Tape® on pronation in a static position using the Foot Posture Index scale (Redmond, 1998). The participant's Foot Posture Index score was taken 10 minutes, 60 minutes, and 24 hours after the application of tape to explore the effect of Kinesio Tape® on foot pronation over time. Results indicated there was no significant increase in pronation due to the Kinesio Tape®.

Another type of tape that is commonly used to affect the lower extremity biomechanics is Leuko Tape®. Leuko Tape® is a type of non-elastic sports tape that has been used widely in injury rehabilitation and prevention settings due to its rigid properties. As a result of Leuko Tape®'s unyielding nature, the concept of applying the tape to the calcaneus is to achieve instant pain relief and alter range of motion, thereby reducing stress on the plantar fascia (Agrawal & Deshpande, 2015). Agrawal and Deshpande (2015) explored the effects of calcaneal taping,

ultrasound therapy, and plantar heel stretching in individuals who reported pain located on the heel or plantar surface, and pain with the first few steps of walking. Significant reductions in pain with all three conditions were reported. Leuko Tape® was concluded to be a good supplement to physical therapy in reducing pain caused by plantar fasciitis.
There is limited research examining the mechanical effects of applying therapeutic tape to the calcaneus while running. Examining the effects of therapeutic tape on foot pronation throughout the running stride may allow clinicians to gain insight into the most effective type of tape and technique to control excessive ranges of pronation. Correcting these excessive ranges may further decrease the risk of an overuse running related injury. Therefore, the purpose of this pilot study was to determine if the application of different types of tape compared to no tape impacts on the kinematics of the lower extremity while running.

**METHODS:** After ethical approval was received from the academic institution, 7 healthy males (age=22 ± 0.9 years; height=181 ± 7.4 cm; weight=76 ± 7.2 kg) and 8 females (age=22 ± 2.75 years; height=173 ± 6.1 cm; weight=61 ± 3.0 kg) were recruited to participate in this study. A healthy population was selected as opposed to individuals with injuries as injured runners have been found to compensate their gait mechanisms to avoid pain (Novacheck, 1998). Exploring the influence of the effects of therapeutic ankle taping using a healthy population may provide better insights to the effects of the tape.
After obtaining consent, participants were asked to complete a demographic questionnaire and the Foot Posture Index. The purpose of the Foot Posture Index was to quantify the degree to which a foot was considered to be in a pronated, supinated, or neutral position (Redmond, 1998). Reflective markers were then placed on the participant's lower extremity on the head of the second metatarsal, lateral malleolus, calcaneus, femoral epicondyle, and greater trochanter of the right leg to facilitate the kinematic analysis of the lower extremity during the treadmill running trials.
The participant was then asked to perform a warm up on the treadmill. The warm up included a slow run at a self-selected speed at a 0% grade for five minutes. After the warm up was completed, he/she was assigned his/her first of three taping conditions. The three taping conditions included a Kinesio Tape®, Leuko Tape®, and no tape condition.
For the Kinesio Tape® condition, a strip of tape was applied 5 cm above the inferior border of the lateral malleolus and wrapped around the calcaneus to the medial aspect of the tibia with 100% stretch of the tape (Luque-Suarez et al., 2013; Figure 1a). The Leuko Tape® was applied 5 cm above the inferior border of the lateral malleolus and laid diagonally across the lateral surface of the calcaneus. The calcaneus was held in an externally rotated and adducted position while the tape was pulled up and wrapped around the ankle medially anchoring on the lateral aspect of the tibia (Agrawal & Deshpande, 2015; Figure 1b).

(a) (b)

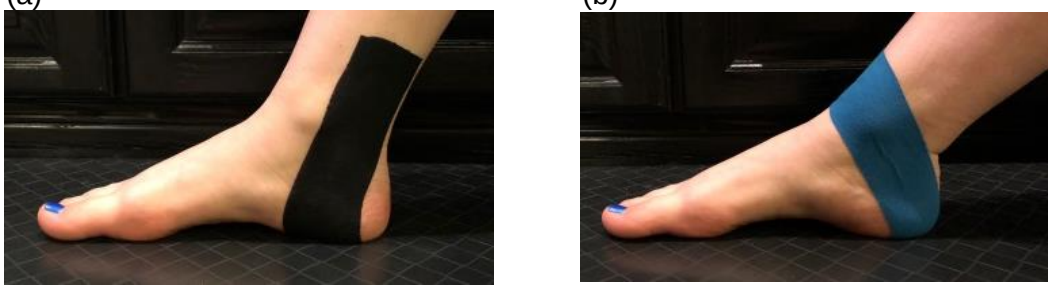

**Figure 1: Taping Techniques. (a) Kinesio Tape® condition; (b) Leuko Tape® condition.**

The order of conditions was predetermined using a Latin Square technique. Based on the first condition selected, the tape was applied to the participant's right leg before beginning the first

trial. If the no tape condition was selected first, the participant was asked to begin his/her first trial without the application of tape. Each trial consisted of five minutes of running with video data collected in the last 30 seconds (Vincent et al., 2014). Three Basler acA1300 digital cameras were set up adjacent to the right side of the treadmill. Video was recorded using the Contemplas Templo motion capture system at a sampling rate of 100 Hz and shutter speed of 1/1000. All trials were performed at a speed that was self-selected by each participant which represented a comfortable pace for a 5 km run. For the second and third trials, the same methodology was used but with a new taping condition. After the data collection was completed, the participant remained on the treadmill and performed a two-minute cool down while walking at a comfortable speed.

Data was analyzed using the Vicon Motus motion analysis program. Although video data was collected from three cameras which would have allowed for 3D analysis, this pilot study only included a 2D planar analysis of the running stride. The lower extremity kinematic variables included hip angle at initial contact, knee angle at initial contact, maximum knee flexion during the stance phase, hip angle at toe off, knee angle at toe off, and ankle plantarflexion angle at toe off. Hip angle was measured as the angle of the thigh segment relative to the vertical, with positive values representing angles of hip flexion and negative values representing angles of hip extension. Knee angle was measured between the thigh and lower leg segments. Full knee extension was zero degrees, with larger angles indicating increased angles of knee flexion. The angle at the ankle was measured between the lower leg and foot segments. A neutral ankle position was zero degrees, with positive angles representing ankle plantarflexion and negative values representing ankle dorsiflexion. Three consecutive running strides were digitized for each participant, with the average of these strides being included in the analysis. The data was smoothed with a cubic spline filter before extraction occurred. Descriptive statistics (M ± SD) were calculated for each kinematic variable. For each kinematic measure, a between-subjects one-way ANOVA was conducted to determine if significant differences were seen among the three taping conditions. Alpha was set at $p \leq 0.05$.

**RESULTS/DISCUSSION:** There were no significant differences between the application of Kinesio Tape® and Leuko Tape® compared to the no tape condition in any of the variables included in the analysis (Table 1).

**Table 1**
**Participant Results**

| Variable (degrees) | Kinesio Tape® (M ± SD) | Leuko Tape® (M ± SD) | No Tape (M ± SD) |
|---|---|---|---|
| Hip Angle at Initial Contact | 27.8 ± 4.5 | 27.5 ± 5.8 | 27.6 ± 5.1 |
| Knee Angle at Initial Contact | 22 ± 5.1 | 21.7 ± 4.9 | 22.5 ± 5.08 |
| Ankle Dorsiflexion at Initial Contact | -3 ± 14.9 | 3.8 ± 13.8 | 2.3 ± 11.2 |
| Maximum Knee Flexion During Stance Phase | 49.8 ± 5.7 | 50.7 ± 7.5 | 49.5 ± 5.8 |
| Hip Angle at Toe Off | -17.7 ± 2.9 | -18.5 ± 6.1 | -17.7 ± 4.6 |
| Knee Angle at Toe Off | 31.7 ± 7.8 | 31.1 ± 6.7 | 31 ± 6.4 |
| Ankle Plantarflexion at Toe Off | -1.4 ± 8.3 | 1.2 ± 12.5 | .8 ± 8.4 |

It was anticipated that changes in ankle range of motion would be seen under the taping conditions as this was the site of the tape application. In particular, Leuko Tape® applied to the ankle was expected to influence the kinematics of the lower extremity due to its rigid nature. Pelletier, Sanzo, Kivi, and Zerpa (2017) found that Leuko Tape® applied to the to the knee led

to significant changes at the hip and knee at initial contact, and peak hip flexion angles during the swing phase; however, injured and non-injured groups were both included in their analysis. The location of the tape may have also made a difference as the current study applied the tape to the ankle, which is a more distal segment, rather than at the knee. This suggests that correcting lower extremity running mechanics with therapeutic tape applied to a more proximal location may be more effective.

Results from the Foot Posture Index scale (M=2.2, SD=1.5) revealed that the majority of the participants demonstrated a foot posture rating that was neutral (close to 0). Since the proposed effects of the taping techniques used were to hold the calcaneus in a neutral position and control for overpronation, the results of this study suggest that ankle taping has no impact on the lower extremity kinematics during running in individuals with a neutral foot type.

As the speed was self-selected at a conversational, long distance running pace, a higher running speed in this study may have led to significant results. Novacheck (1998) stated that as speed increases, forces increase as well further increasing joint range of motion. With increased ground reaction forces and joint range of motion, both the elastic and rigid properties of each type of tape may have made a more significant effect. Pelletier, Sanzo, Kivi, and Zerpa (2017) had participants run at a faster running speed (3.22 m/s) than the speed included in this current study, suggesting that the effects from the tape may be more evident with faster running speeds.

**CONCLUSION:** Based on the results of this pilot study, there was no significant effect of the application of therapeutic tape to the calcaneus on the lower extremity sagittal plane kinematics of the hip, knee, and foot. Previous research has explored the effects of therapeutic tape in decreasing pain in an injured population but has not explored the mechanical effects of applying tape. Therefore, future research should explore the possible mechanical effects of tape in participants with higher levels of pronation and higher running speeds.

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