The Effect of High-Dye and Low-Dye Taping on Rearfoot Motion

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High-Dye and low-Dye taping are commonly used by clinicians to treat a variety of foot and ankle pathologies, particularly those associated with excessive rearfoot pronation. While the effects of taping on end range of motion have been extensively studied, relatively little is understood about the effect of the two styles of taping on rearfoot motion. Eighteen participants were analyzed in three conditions: 1) barefoot, 2) with high-Dye taping, and 3) with low-Dye taping. Two-dimensional motion of the rearfoot was assessed for each condition. The results indicated maximum inversion was increased with both high-Dye and low-Dye taping as compared with no taping. Only high-Dye taping, however, significantly reduced the maximum eversion of the rearfoot. The results suggest that high-Dye taping is an appropriate taping choice when control of eversion of the rearfoot is desired. (J Am Podiatr Med Assoc 91(5): 255-261, 2001)

Practitioners have used taping of the ankle and rearfoot for a long time to treat a wide variety of foot problems. Historically, a variety of methods of ankle taping have been used to treat1-3 and prevent4-6 lateral and collateral ligament damage by mechanically limiting end range of motion. Recently, however, taping has also become popular for controlling rearfoot motion that may result in pain and pathology. While numerous studies have evaluated the effect of rearfoot taping on preventing end range of motion, relatively little research has investigated the effect of taping on controlling total range of motion during activity.

Two of the most common forms of taping are high-Dye and low-Dye taping, first described by Dr. Ralph Dye.7 Low-Dye taping was developed to support the medial longitudinal arch of the foot and to reduce stresses associated with an excessively pronated foot.4, 5 In high-Dye taping, stirrup straps extend from the foot onto the leg and surround the medial and lateral aspects of the ankle. The aim of high-Dye taping is to offer support to the ankle and to resist medial forces associated with excessive pronation.7 While several different techniques have been termed low-Dye or high-Dye taping and several modifications described,2, 7-9 there appears to be universal agreement that low-Dye taping is intrinsic to the foot, whereas high-Dye taping extends up over the ankle onto the lower aspect of the leg.

Although there has been widespread agreement that ankle taping restricts end-range ankle-joint motion, the exact mechanism of support remains controversial. Some authors believe that the control of excessive motion is associated with mechanical control of end range of motion,10-14 while others have more recently proposed that it is associated with neurophysiological mechanisms, including proprioceptive acuity5, 15-19 and muscle activation.17, 18-22

Regardless of the mechanism of action, taping has gained widespread support for a variety of conditions, including plantar fasciitis,23-26 tibialis posterior dysfunction syndrome,2, 27 and other conditions associated with excessive rearfoot pronation.28 It is apparent that the key rationale for such taping is to attempt to control frontal plane motion of the rearfoot.
However, while there has been at least some attempt to assess the effect of taping on static indicators of rearfoot pronation,8, 9 few authors have attempted to address the control of taping on the restriction of frontal plane motion during walking. Laughman et al29 evaluated the dynamic effect that taping had on end range of motion before and after exercise using a triaxial electrogoniometer. Although the authors found that taping was effective in restricting the range of motion, the study has been criticized for using measurement equipment that may have interfered with the outcome.30 The aim, therefore, of this study was to evaluate the effect of two commonly used forms of taping, high-Dye and low-Dye, on frontal plane motion of the rearfoot during walking with the use of a system that would not interfere with normal walking.

Methods

Eighteen volunteers (16 females, 2 males) were recruited from the staff and students of the Division of Podiatry, La Trobe University, Melbourne, Australia. Participant characteristics are presented in Table 1. Participants were excluded from the study if they exhibited any recent or history of lower-limb pathology or a history of hypersensitivity to tape. All participants signed an informed consent form that had been approved by the La Trobe University Faculty of Health Ethics Committee.

Reflective markers were placed on the posterior aspect of the leg and heel to reduce skin and soft-tissue movement. Several authors have expressed concern about the reliability of marker placement.31, 32 Therefore, to reduce error associated with variability of the marker placement, bisections of the posterior aspect of the calcaneus and lower third of the leg of the right limb were taken as described by Elveru et al.33 Markers were placed along the bisection lines, after Cornwall and McPoil.34

To further reduce artifact error associated with marker movement,31, 35-37 tape was applied to the skin over the bisection lines, and marker sites were identified. Each marker site was bisected superio-inferiorly and mediolaterally to ensure that when markers were removed, they could be replaced as close to the original position as possible (Fig. 1).

Prior to measurement, all participants were given time to become acclimated to the treadmill.38 Recording of data began only after the participant, according to self-report, walked at a comfortable velocity. Once the participant and the investigator established that the gait pattern appeared unaffected by the treadmill, the individual’s comfortable walking velocity was determined. All measurements were then performed at this speed.

Two-dimensional spatial motion analysis was undertaken using the MacReflex (Qualisys AB, Gothenburg, Sweden) system, which was considered to be an appropriate instrument for the purpose of this study. The MacReflex is a computer-assisted motion-tracking system that allows for analysis of kinematic information.39 Two-dimensional motion analysis has often been used to evaluate lower-limb motion.40-43 The validity and reliability of two- and three-dimensional analysis systems have been established in the literature.44-46 Furthermore, Cornwall and McPoil34 have established a strong relationship between two- and three-dimensional analysis of rearfoot motion.

The MacReflex camera was positioned approximately 30 cm from the weightbearing surface of the supporting limb (Fig. 2). The measurement frequency for data collection was 50 Hz. Each participant was

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<tr>
<td>Characteristic</td>
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<tr>
<td>Age (years)</td>
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<td>Height (cm)</td>
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<td>Weight (kg)</td>
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Figure 1. Marker placement on the lower leg and rearfoot.
analyzed in three conditions: 1) barefoot, 2) with high-Dye taping, and 3) with low-Dye taping. To minimize antecedent effects, the order of these conditions was randomized by means of a Latin square design.

**Taping Methods**

The taping techniques used in this study were as follows:

**Low-Dye Taping.** With the patient in a supine position, anchor straps were applied with 2.5-cm rigid sports tape. The first strap covered the plantar area of the metatarsal heads, progressing just onto the dorsal surface of the foot (Fig. 3). The second strap began from the lateral side of the fifth metatarsal and progressed around the heel and the foot onto the medial side of the first metatarsal head (Fig. 4). Both of these straps were applied firmly.

The support straps were then applied to the plantar area of the foot with 5-cm straps. The first support strap started at the superior edge of the long anchor strap and at a point where it approximately bisected a line from the lateral malleolus; it then traveled plantarly around the foot to a point that approximately bisected a line from the medial malleolus (Fig. 4). Further straps were applied at approximately 1-cm intervals on the plantar surface, with the second strap in this series progressing over to the dorsum of the foot just distal to the insertion of the tibialis anterior tendon and circumducting the foot (Fig. 5). All other straps were applied only to the margins of the initial support tape. Locking straps were then applied over the support tape following the same progression as the initial support tape (Fig. 6). Once again, 2.5-cm taping was used.

**Figure 2.** Participant during dynamic analysis.

**Figure 3.** Anchor straps for taping.

**Figure 4.** Support straps for low-Dye taping.
High-Dye Taping. The high-Dye taping technique was identical in every respect to the low-Dye method, with the exception of the anchor tape, which was on a point on the lower third of the leg, and an extension of the first support straps. The first support strap continued up over the medial and lateral ankle and extended to the leg ankle strap, approximately 12 cm above the ankle (Fig. 7). A locking strap was then firmly applied around the leg, but in a way that was not uncomfortable for the participant.

Data Analysis

Ten-second trials of each condition were recorded. The data were then converted by means of Wingz software (Investment Intelligence Systems Group, Overland Park, Kansas), interpolated, and filtered with a Butterworth Filter (Texas Instruments Inc, Dallas, Texas) at 8 MHz. Heel contact was estimated from the lowest vertical coordinates of the marker placed on the distal aspect of the leg. This estimation of heel contact was confirmed by a pilot test using a heel switch that indicated the time of heel contact. The estimate of heel contact based on the vertical coordinates was within one frame of that calculated by the heel switch. The data were ensemble averaged and rearfoot angles were calculated.

The first 60% of the data after heel strike was taken as a reliable representation of the stance phase of gait.47 Average values were calculated to provide the following for each condition: maximum inversion, maximum eversion, total range of motion, and maximum instantaneous velocity.

A single-factor repeated measures analysis of variance was performed on each of the data sets with a
Fisher’s Protected Least Significant Difference (PLSD) post-hoc test to ascertain the source of difference in comparisons that indicated a statistical significance.

Results

The range of motion of the barefoot condition (mean [±SD], 12.1° ± 5.4°) compared well with frontal plane rearfoot motion reported in previous studies.\(^34, 40, 41\) Analysis indicated a significant difference between the barefoot condition and both taping conditions for maximum inversion (F = 10.6; df = 34; P = .001); maximum eversion (F = 7.9; df = 34; P = .02); and total range of motion (F = 4.3; df = 34; P = .03). There was no significant effect for instantaneous velocity (F = 0.33; df = 34; P = .97) (Tables 2 and 3).

Post-hoc analyses indicated that low-Dye and high-Dye taping increased the inversion position of the rearfoot to 6.2° and 7.1°, respectively. This was a significantly more inverted position than the average maximum of 3.3° seen in the barefoot condition (PLSD = 1.75; P < .05). There was no significant difference between the amount of inversion influenced by either taping technique.

There was significantly less eversion with high-Dye taping (6.6° maximum eversion) compared with both low-Dye taping (9.2°) and the barefoot condition (9.8°) (PLSD = 1.15; P < .05). Interestingly, there was no significant difference between the amount of eversion with low-Dye taping and no taping (barefoot). Therefore, while the total range of motion showed no significant difference between high-Dye taping and no taping, there was a statistically significant increase in the total range of motion of 2.3° from low-Dye taping to no taping (PLSD = 1.64; P < .05).

Discussion

Given the small range of motion,\(^48\) the limitations of using two-dimensional analysis,\(^47\) and skin-movement artifact issues,\(^35, 37\) it is difficult to assess motion of the rearfoot. Nonetheless, this study has attempted to evaluate the effect of two commonly used taping techniques on rearfoot motion.

Both high-Dye and low-Dye taping appeared to be effective in holding the foot in an inverted position, which was reported at, or just prior to, heel contact. The high-Dye taping also decreased the maximum amount of eversion, suggesting that high-Dye taping appeared to offer a greater restriction, not in total range of motion, but in maximum eversion. This is to be expected, given that the stirrup straps of the high-Dye tape extend from the foot up onto the leg, passing along the medial and lateral aspects of the rearfoot complex.

Low-Dye taping, however, demonstrated no significant difference in maximum eversion when com-

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<tr>
<td>Maximum inversion</td>
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<td>Barefoot versus low-Dye(^a)</td>
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<td>Barefoot versus high-Dye(^a)</td>
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<td>Low-Dye versus high-Dye</td>
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<td>Maximum eversion</td>
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<td>Barefoot versus high-Dye(^a)</td>
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Abbreviation: PLSD, Protected Least Significant Difference.

\(^a\)Denotes statistical significance at P < .05.

Table 2. Summary of the Average Rearfoot Motion Across Subjects

<table>
<thead>
<tr>
<th>Factor</th>
<th>Barefoot (Degrees)</th>
<th>Low-Dye Taping (Degrees)</th>
<th>High-Dye Taping (Degrees)</th>
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<tr>
<td>Maximum inversion(^a)</td>
<td>3.3</td>
<td>6.2</td>
<td>7.1</td>
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<tr>
<td>Maximum eversion(^a)</td>
<td>9.8</td>
<td>9.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Total range of motion(^a)</td>
<td>12.1</td>
<td>14.4</td>
<td>13.7</td>
</tr>
<tr>
<td>Instantaneous velocity</td>
<td>–2.5</td>
<td>–2.6</td>
<td>–2.6</td>
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\(^a\)Denotes statistical significance at P < .05.
pared with going barefoot. With low-Dye taping, the foot was in an increased inverted position at heel contact and everted to the same position that was demonstrated in feet with no taping. Consequently, there was a statistically significant increase in the total range of frontal plane motion in the rearfoot with low-Dye taping. However, while this result was statistically significant, it represented a difference of only 2.3°.

This 2.3° difference offers an insight into the importance of statistical versus clinical significance, an issue often confronted in studies such as these. A statistical significance can be described as a difference that, because of the rigor of appropriate analyses, is not likely to be due to chance. Clinical significance describes the degree to which there is a difference between two groups that is relevant to the clinician.49 This study has found some statistical differences. Yet with little evidence to ascertain what magnitude of rearfoot motion might result in pathology, the clinician must decide whether the results are clinically significant.

This study evaluated the effect of taping on a group of nonpathological participants. It is important to acknowledge that taping may have different effects on patients who present with specific pathologies. This study offers an insight into the effect of taping, but results may differ in populations with different symptoms or foot function. Clearly, further research is necessary in order to establish effects within such groups and determine whether there are changes under different conditions, such as with exercise, as noted in end range of motion5 20, 39, 51 or position studies.

**Conclusion**

While both high-Dye and low-Dye taping were effective in increasing the inversion of the heel at heel contact, only high-Dye taping was effective at reducing the maximum eversion of the rearfoot. The results suggest that while further research is necessary to evaluate the efficacy of low-Dye taping on control of foot motion, high-Dye taping can be used when a resistance to eversion of the rearfoot is the desired clinical outcome.

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**References**