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The Effect of Exercise, Prewrap, and Athletic Tape on the Maximal Active and Passive Ankle Resistance to Ankle Inversion

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ABSTRACT

This investigation explored alternatives to the null hypotheses that maximal active and passive resistance to inversion developed by a near-maximally inverted and weightbearing ankle is not altered by 1) the use of prophylactic adhesive athletic tape, 2) the use of nonadhesive prewrap (underwrap), or 3) 40 minutes of vigorous exercise. Ten healthy men and 10 healthy women (mean age, 25 ± 3 years) with no recent ankle injuries underwent testing to determine maximal ankle resistance to inversion under unipedal, weightbearing conditions. Tests were performed with and without the support of athletic tape, and before and after 40 minutes of exercise. Half the testing sessions were performed with prewrap under the tape. At 15° of inversion, without any external ankle support, healthy young men and women could maximally resist a mean (SD) inversion moment of 52.9 (6.4) N-m and 28.3 (5.8) N-m, respectively. Although use of ankle tape provided a 10% increase in maximal resistance to inversion moments, this increase diminished to insignificant levels after 40 minutes of vigorous exercise. Use of prewrap improved maximal resistance to inversion by more than 10%.

The lateral ligament complex of the ankle is among the most frequently injured passive structures in an athlete,[10] accounting for up to 25% of all injury time lost in athletics.[25] The 1991 to 1992 NCAA Injury Surveillance Report identified the ankle as the most commonly injured body part in 9 of 15 sports, with a significant percentage of those injuries becoming chronic conditions.[3]

In an attempt to reduce ankle injuries and their severity, physicians, trainers, and coaches often institute aggressive prophylactic measures. For example, athletic programs frequently incur considerable costs by taping athletes' ankles before each practice and game, with some football teams spending as much as $50,000 per annum taping ankles.[6]

Is taping worth the cost? According to some investigators, ankle taping appears to lower injury rates[11] and does not hinder athletic performance.[1,14,21] Yet other studies have reported that taping does not lower ankle injury rates[4] and it can adversely affect athletic performance.[7,18,27] Unfortunately, little is known quantitatively about how tape affects the ability of the ankle to resist injury-producing forces and moments, despite the extensive literature on ankle taping. Resistance to such external loads is afforded by passive, and sometimes active, muscular mechanisms during weightbearing. The effect of tape on the passive resistance to ankle inversion under nonweightbearing conditions is known.[8,9,14–16,23,26,28,29,33,36] It has also been proposed that tape can shorten the reaction time of the peroneal muscles to inversion by increasing sensory input.[13,19] What is not known is the effect of tape on the total resistance to inversion provided by the combination of passive mechanisms and maximal voluntary ankle muscle activity under weightbearing conditions.

Unfortunately, the repeated daily application of athletic tape to the skin can cause significant irritation and skin loss. To minimize these adverse effects, it has become popular to use a layer of nonadhesive prewrap between the skin and athletic tape. It is currently unknown, however, whether the use of prewrap adversely affects the

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external ankle support provided by the athletic tape by eliminating its adherence to skin.

The goals of this investigation, therefore, were to test the null hypotheses that the maximal active and passive resistance to inversion developed in a weightbearing ankle at 15° of inversion is not altered by 1) the presence of prophylactic adhesive athletic tape, 2) the use of a nonadhesive layer of prewrap under the adhesive tape, or 3) 40 minutes of vigorous exercise.

MATERIALS AND METHODS

Subjects

Ten healthy young men and 10 healthy young women (mean age, 25 ± 3 years) were recruited for testing. Subject inclusion criteria included no ankle injuries in the 6 months before testing and no history of severe ankle or foot injury or surgery, balance problems, cardiac conditions, or lower extremity arthrosis. Participants ranged from recreational athletes to Division I collegiate athletes.

Statistical Design

This randomized controlled study was designed to be analyzed using a four-way 2 × 2 × 2 × 2 analysis of variance (ANOVA) with one between-groups factor (sex) and three repeated measures (tape/no-tape, prewrap/no-prewrap, and before/after 40 minutes of exercise).

Materials

Testing was completed over two 1-hour sessions (Sessions A and B) using one of two taping conditions (A or B). The method used in Session A incorporated tape adherent ("Q.D.A." Quick-Drying Adherent, Cramer Products Inc., Gardner, Kansas), three heel and lace pads (Mueller Sports Medicine Inc., Prairie Du Sac, Wisconsin) lubricated with petroleum jelly (York Pharmacal Co., Bucklin, Missouri), foam prewrap (Johnson & Johnson Products Inc., New Brunswick, New Jersey), and 1.5-inch athletic tape (Zonas Athletic Tape, Johnson & Johnson, New Brunswick, New Jersey). The method used in Session B used all of the aforementioned materials *except* the foam prewrap, in this case the adhesive tape was directly applied to the preshaven skin. A professional athletic trainer with 12 years of ankle taping experience applied the tape as consistently as possible using a closed basket weave with two "figure-of-8s," two "heel locks," four "horseshoes," and four "stirrups."

Unipedal Strength Test

The maximal ankle resistance to inversion for each subject was tested under unipedal weightbearing conditions using a specially designed testing apparatus (Fig. 1). Because the testing apparatus and methods are similar to those described by Videla and Ashton-Miller[37] and used by Ottaviani et al.[30] in a study of ankle inversion and eversion strengths in the neutral ankle position, only a brief description will be given here. The apparatus consisted of a shoe securely fastened to a 1.5-cm thick, 36 × 20 cm footplate with a track accommodating a 40-cm long, 5 × 10 mm steel bar. This track was positioned transversely under the fifth metatarsophalangeal joint. A centimeter scale was located on top of the steel bar and the bottom of the bar had a 13-mm diameter circular recess at a 15° angle to accommodate the top end of a 15-mm high, 12.5-mm diameter, vertical, fixed peg screwed firmly into a large steel base plate.

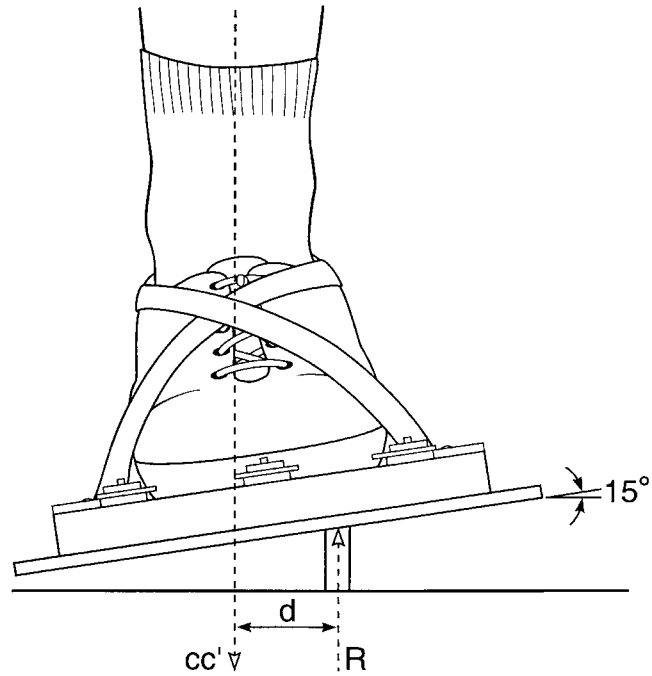

Figure 1. Schematic showing the method for testing ankle strength during unipedal stance; d is the moment arm of the ground-reaction force, R, acting through the peg and about the ankle subtalar joint center, which lies on the line marked, CC'.

After the bar was positioned under the fifth metatarsophalangeal joint, each participant placed his or her right foot in the shoe of the apparatus. The laces were then tightened in a controlled manner to 45 N of tension. The steel peg was initially positioned 7 cm medial to the subtalar ankle axis in the frontal plane. With the foot at 15° of inversion, each participant was asked to balance unipedally on the device for a minimum of 2 seconds. Initially, use of finger support was allowed. Once balance was achieved, finger support was removed and participants attempted to maintain the ankle in 15° of inversion (±5°) for 2 seconds. The peg height was set so that once the initial 15° of inversion was established deviation by more than 5° would cause the testing device to touch the ground and signal electronically a loss of balance. The test began when the participant released the finger support and ended when either the testing device or any part of the subject touched the ground or the support. Maintaining the required ankle position for 2 seconds was considered a

successful test. Failure to balance on the device for 2 seconds was noted as an unsuccessful test.

Three attempts were allowed and, if still unsuccessful, the steel peg was then moved in 1-cm increments toward the center of the ankle until a successful trial was completed. After the first successful trial, adjustments of 0.5 cm and, finally, 0.25 cm were made in the medial peg direction until the most medial test position tolerated was identified. Because of its design, the low-top shoe does not provide passive resistance to inversion; therefore, the without-tape trials performed in the low-top shoe acted as the control for the other tests performed before and after exercise.

The total resistance to inversion was calculated from the externally imposed moment of the body weight ground-reaction force about the subtalar-ankle joint center. In the equilibrium state, this was expressed in newton-meters (N-m) and calculated as the product of body weight (in newtons) acting through the peg and its horizontal lever arm (in meters) about the mechanical center of the subtalar ankle joint.[37]

Test Procedure

Half of the participants were randomly assigned to complete Session A first (tape applied over prewrap) and half were assigned to complete Session B first (tape applied directly to the skin). Subjects were allowed several "practice" trials with the testing device to lessen learning effects during testing. Whether in Session A or B, testing began with a baseline without-tape measurement of maximal total (active and passive) ankle resistance to inversion. The participant's ankle was then taped and the measurement was repeated in that condition. This was followed by a strictly standardized, vigorous 40-minute exercise session.

Exercises began with predetermined stretches of the quadriceps, hamstring, gluteal, groin, and calf muscles. Next, a 10-minute treadmill run was performed at 6 mph, followed by agility drills including, in order, figure-of-8 runs (4 sets of 5 repetitions), carriocas (2 sets of 10 repetitions), unipedal rotational hops (4 sets of 5 repetitions), a directional change drill (4 repetitions), toe raises (2 sets of 10 repetitions), backward weave (4 repetitions), and a shuttle run (2 repetitions). All performances were timed for intrasubject comparison of effort levels between the two sessions. Within 5 minutes of completing the exercises, total resistance to ankle inversion was assessed a third time. The tape was removed and an immediate post-exercise baseline measurement was taken. To estimate the amount of sweat absorbed by the taping materials, the tape was weighed on removal, then weighed again a minimum of 2 days later, after the moisture content had returned to baseline values. Subjects generally underwent the second testing session from 2 to 7 days after completion of the first. After commencement of the second session, subjects were asked for their subjective assessment of which tape-underwrap condition, if any, they thought provided more support, before and after exercise.

One could argue that the smaller female body mass and height should be associated with correspondingly smaller ankle strengths; however, when those strengths are expressed per unit of body "size," defined here as mass $\times$ height, their ankle strength-to-size ratio may be similar to that of men. To test this hypothesis, the mean total moments developed in resisting ankle inversion were normalized by body size using the factor body weight $\times$ height and the resulting normalized moments (which are dimensionless quantities) were compared by sex.

Statistical Analyses

Descriptive statistics were calculated for all variables. After examining the main effect for sex, we used a repeated measures ANOVA (rm-ANOVA) to perform the analysis of the three main effects: tape, prewrap, and exercise effects and their interactions. In this rm-ANOVA, the main effect for tape corresponds to testing the first hypothesis (see "Introduction"); the main effect for prewrap corresponds to testing the second hypothesis; and the main effect for exercise corresponds to testing the third hypothesis. Because we found changes in baseline measurements with exercise that could affect interpretation of the rm-ANOVA results, we ran a second statistical analysis that avoided direct comparisons of pre- and post-exercise moment values. Instead, the effect of tape was determined by comparing the difference between taped and untaped baseline values measured before exercise with the difference between taped and untaped baseline values measured after exercise. Differences were again analyzed by rm-ANOVA used to determine prewrap performance with exercise. Correlations were assessed using a Pearson correlation matrix. Differences with $P < 0.05$ were considered statistically significant.

Repeatability and Resolution

Eversion strength was measured to establish test variability between measurements within a day and also between three measurements on different days. The magnitude of the expected measurement variability was expressed by computing 95% confidence limits. These limits were used to establish statistical significance. Resolution of ankle strength measurements (2.5 mm) expressed as a percentage of full-scale values (32.9 mm) was 7.6%.

RESULTS

The healthy young male group maximally resisted a mean (SD) inversion moment of 52.9 (6.4) N-m at 15° of inversion without tape support, with a range from 38.0 to 65.1 N-m (Table 1). With the foot in quasistatic equilibrium, the mean maximal horizontal distance at which the male group could resist a one-body weight magnitude vertical ground-reaction force was 69.7 mm medial to the healthy unprotected ankle joint center, with a range from 56 to 87 mm. Similarly, the healthy young female group maximally resisted a mean (SD) inversion moment of 28.3 (5.8) N-m without shoe or tape support, with a range from 20.7 to 39.1 N-m (Table 1). The mean maximal horizontal dis-

TABLE 1
Mean (SD) Inversion Moments (in Newton-meters) Resisted Under Each Test Condition

Condition	Before exercise		After exercise	
	Untaped baseline	Taped	Taped	Untaped baseline
Men				
Tape-to-prewrap session	53.8 (5.5)	59.2 (6.5)	57.5 (7.1)	54.5 (6.3)
Tape-to-skin session	52.1 (7.5)	56.4 (8.1)	54.4 (8.1)	55.1 (5.6)
Women				
Tape-to-prewrap session	27.8 (6.2)	31.8 (6.8)	30.7 (6.6)	30.8 (6.9)
Tape-to-skin session	28.9 (5.8)	31.6 (7.3)	31.2 (5.9)	30.1 (5.6)

tance at which the female group could resist a one-body weight magnitude vertical ground-reaction force was 50.6 mm medial to the unprotected ankle joint center, with a range from 36 to 75 mm. Not surprisingly, women developed significantly smaller maximal moments in eversion than men did (Table 2).

The mean (SD) height and weight for the male and female participants was 1.70 (0.04) meters and 759.3 (47.5) N, and 1.64 (0.06) meters and 564.0 (53.0) N, respectively. The mean normalized inversion moment (see "Materials and Methods") that the young male group could maximally resist without tape support was 0.039, while the value for the healthy young female group was 0.031, or 79.5% of the mean male value. The mean normalized moments resisted by the female group were systematically and significantly smaller than those resisted by the male group for each of the eight measurement points ($P < 0.05$).

The primary rm-ANOVA showed a main effect for tape in that a significantly larger maximal moment was developed in resisting inversion with tape than without tape (Table 2). However, this advantage was found to be time-dependent. Before exercise, subjects with taped ankles resisted a significantly larger inversion moment than they did without tape (Table 3). Subjects with the ankle taped over prewrap resisted 4.69 N-m larger inversion moments than they did with the untaped ankle, an 11.5% increase over baseline (without-tape) values ($P < 0.001$). Ankles with tape directly on the skin resisted, on average, 3.52 N-m more than the baseline value, an 8.7% increase ($P = 0.002$) (Table 3). The primary rm-ANOVA also suggested that larger moments were developed with prewrap than without prewrap (Table 2), although we shall revisit this result again after taking into account the systematic effect of exercise on ankle strength results.

TABLE 2
Repeated Measures Analysis of Variance Results for Main Effects: Mean (SD) Group Values (in Newton-meters)

Variable	Mean (SD)		F value	P value
Sex	Men	Women		
	52.9 (6.4)	28.3 (5.8)	83.00	<0.001
Tape	Without	With		
	40.5 (13.5)	44.0 (15.5)	13.55	0.002
Exercise	Before	After		
	40.5 (13.5)	42.6 (13.9)	7.04	0.016
Prewrap	Without	With		
	40.8 (14.5)	45.5 (15.5)	33.98	<0.001

The primary rm-ANOVA demonstrated a significant main effect for exercise, with larger moments being developed after the 40-minute period of vigorous exercise than before it (Table 2). Comparison of the without-tape baseline measurements before and after exercise revealed that subjects resisted significantly larger inversion moments after exercise than before exercise, for both tape application methods. The taping-over-prewrap ankle condition demonstrated a 1.83 N-m, or 4.49%, postexercise gain ($P = 0.037$), and the taping-to-skin condition demonstrated a 2.12 N-m increment, or 5.39%, increase ($P = 0.017$). These exercise-related changes in baseline values necessitated running the secondary ANOVA (see the following section of text) to determine whether the effects of tape and prewrap would remain statistically significant when the change in baseline is taken into account by using only differences from the appropriate pre- or postexercise baseline in the analysis. Neither the tape × exercise nor the tape × prewrap interactions were significant. The tape × prewrap × exercise interaction was significant ($P = 0.031$).

The secondary ANOVA showed that after exercise neither the taping-over-prewrap nor the taping-to-skin condition provided the ankle with a significant increase in ankle protection over baseline at that time point (Table 3). For example, after exercise subjects with ankles taped over prewrap resisted an average of 1.44 N-m more than they did with the ankles untaped, for a 3.4% difference. Subjects whose ankles were protected with tape applied directly to skin resisted an average of 0.21 N-m more than they did with the tape removed, a nonsignificant increase of 0.40% (Table 3). There were no statistically significant differences in ankle protection provided by the taping-over-prewrap or the taping-to-skin ankle conditions, before or after exercise. No interactions reached statistical significance.

Apart from the differences in absolute and normalized inversion moments resisted, few significant sex differences in the effects of tape were found. Men with ankles supported by tape over prewrap were able to resist significantly larger (5.49%) inversion moments after exercise when compared with their untaped ankles ($P = 0.019$). When comparing the baselines before and after exercise, the men demonstrated greater resistance to inversion (5.90%, $P = 0.025$) when tape was applied to the skin, but not when it was applied over prewrap (1.20%). Women, however, showed the opposite results; they resisted 10.9%

TABLE 3
Absolute (in Newton-meters) and Percent Increase of Maximal Inversion Moment Resisted With and Without Tape Before and After 40 Minutes of Exercise

Condition	Before exercise	After exercise
Tape-to-Prewrap	4.69 (11.50%)[a]	1.44 (3.50%)
Tape-to-Skin	3.52 (8.70%)[a]	0.21 (0.40%)

[a] Statistically significant at $P < 0.01$.

greater moments after exercise when tape was used over prewrap ($P = 0.018$), and only 4.12% more when tape was applied to the skin (not statistically significant).

The exercise session was vigorous as demonstrated by two participants whose data were excluded in this study because they unfortunately had to drop out after the first testing session because of injuries sustained during the exercise protocol. One subject aggravated a preexisting case of Achilles tendinitis, and the other subject had swelling and dysesthesia at the site of the posterior tibialis tendon insertion. Both injuries resolved within 1 month.

Seventeen (84%) participants subjectively rated the taping-to-skin method superior for support before exercise, but the testing demonstrated that it provided the greatest resistance to inversion moments in only 7 (36.8%) participants. Similarly, after exercise, 12 (58.8%) subjects rated the taping-to-skin method as the most beneficial, but the results showed the taping-to-skin method provided the superior protection in only 7 (35.3%) subjects (Table 4).

There were no significant correlations between the amount of moisture in the tape after exercise and the postexercise performance with the tape.

DISCUSSION

The present study quantified, for the first time, the maximal total resistance to inversion developed by healthy young adults with the intact ankle under full weightbearing in a near-maximal inverted state; both are conditions that occur just before an ankle inversion injury. The secondary ANOVA showed that prewrap did not adversely affect the effectiveness of adhesive ankle tape in protecting the ankle when the evertor muscles were maximally active. After 40 minutes of vigorous exercise, however, the tape had lost its effectiveness. The study also shows that vigorous exercise increased the maximal measured evertor strength slightly.

Most studies of taping have examined its effect on nonweightbearing range of motion. Our results are consistent with those of Greene and Hillman [14] and those of Myburgh et al.[29] Myburgh et al. found that in the neutral position elastic tape initially restricted ankle range of motion (ROM) by 35%; however, the restriction of motion had significantly decreased after a 1-hour squash match to a 5.5% limitation. Interestingly, most research is not in agreement with these findings. The majority of studies on taping and exercise report that tape restricts ankle ROM during exercise, with the residual restriction after exercise remaining significant.[8,9,15,16,23,26,28,33,36] The total (active and passive) resistance during full weightbearing is likely a more relevant measure for evaluating ankle protective mechanisms than is the ankle ROM found under nonweightbearing conditions.

The prophylactic taping of ankles of elite athletes involved in vigorous team sports has become the medical standard in this country. Because taping can be irritating and abrasive to the skin, the use of underwrap or prewrap has become popular to use under the adhesive tape to protect the skin from undue irritation. However, application of a foam prewrap between the skin and adhesive tape is believed to reduce the effectiveness of ankle taping.[20] This was not substantiated by the results found in the present study. Our results are consistent with those of Delacerda,[8] who reported that taping over prewrap decreased ankle ROM significantly more than taping to skin. On the other hand, Malina et al.[26] reported that taping to skin restricted ROM significantly more than taping over a stockinette.

It is the magnitude of the total eversion moment developed by active and passive structures (found in this study) that will determine whether the inverted ankle will reach its maximal ROM in inversion under load. Results from the present study do lend support to the assertion by Laughman et al.[23] that the functional properties of athletic tape may be due more to the tensile stiffness of the tape construct when placed on the ankle than on its adhesion to the skin.

It is widely believed that the protective effect of tape is most important in maximal inversion. Because of the possibility of injuring a participant in full weightbearing at extreme inversion, we decided to make our measurements at 15° of inversion. This position is within 2° of the maximal voluntary active ROM,[30] and it is attained just before an ankle inversion sprain. Under the present test conditions at near-maximal inversion, more participants were afforded greater protection by the taping-over-prewrap method than the taping-to-skin method, a result that has considerable practical advantages concerning skin care. However, it is possible that the relative roles played by muscle and external support in generating an eversion moment may be altered when subjects are tested beyond

TABLE 4
Comparison of Subjective and Objective Findings as to which Tape Condition was Considered Superior or No Different ("Same")[a]

Category	Before exercise			After exercise		
	Prewrap	To skin	Same	Prewrap	To skin	Same
Subjective	2	13	4	3	10	4
Objective	12	7	0	9	6	4

[a] Data based on totals of 19 and 17 respondents for the before and after exercise sessions, respectively.

the maximal active ROM. That point is deserving of further research, but care is needed to avoid injuring healthy volunteers.

The present measurements of total inversion resistance at the ankle were quasistatic measures involving the maximal isometric strength of the evertor muscle group using a one-body weight provocative test. An ankle sprain seldom occurs in an isometric manner, however. Because muscles can exert 50% to 100% larger forces during an eccentric, lengthening contraction,[38] the present strength figures are systematically conservative estimates of the maximal active eversion moments that can be developed to protect the ankle under dynamic conditions. On the other hand, under those same dynamic conditions, vertical ground-reaction forces usually exceed one body weight at heel strike when running or landing from a jump, so the additional muscle force resulting from a lengthening contraction may well be required to prevent inversion injury on uneven surfaces.[2]

Relative to their body weight and height, the normalized results demonstrate that women were able to resist 25% smaller inversion moments than men. This interesting fact may well predispose women to incur more frequent inversion injuries than men under similar conditions. The fact that such a result is not yet supported in the literature[17,24] could merely reflect the inherent difficulty of performing a controlled prospective study in this regard. One would have to examine the effect of sex by using not only subjects with known ankle strength-to-body size ratios but also by using subjects under known ankle loading rates, magnitudes, and directions during the potentially injurious incidents.

A minor limitation of the present measurements is the possibility that systematic interindividual variations in effort levels by the 20 subjects during the exercise sessions and strength tests might have biased the results. To control against this possibility, individual effort levels between the two testing sessions were monitored with a stopwatch for all agility drills so we could document intrasubject differences in motivation. Efforts during treadmill running were controlled by having subjects run the same distance and speed. Although differences were observed among participants in the intensity of their workouts, these differences did not systematically affect any one test session.

A point of practical interest concerns the time point when the tape lost its effectiveness: was it after 5, 10, 20, or 30 minutes of exercise? Earlier studies using ROM parameters report that the effectiveness of athletic tape declines within the first 5 to 20 minutes.[13,14,26,29,31] Because the two measurement points were more than 40 minutes apart in the present study, we could not resolve the time course of any short-term changes in resistance. However, the support provided by the taping-over-prewrap method declined 69% with 40 minutes of exercise, whereas the support provided by the taping-to-skin application declined 94%.

Two other important factors to consider in this data analysis are the reproducibility of the results obtained with this type of device and whether unipedal balance is affected by wearing tape. The reproducibility of this measuring device and method has been shown previously to be satisfactory.[30] Despite intraindividual variation, the average baseline inversion moment resisted before exercise was 40.8 N-m in both the taping-over-prewrap and the taping-to-skin sessions. After exercise, the average baselines were both 42.6 N-m. With regard to the second point, one study has shown athletic taping of the ankle to neither help nor hinder balance,[21] while another showed that postural control is adversely affected by wearing ankle tape.[5] Thus, any differences found were likely conservative estimates and are not due to systematic errors associated with our test methods.

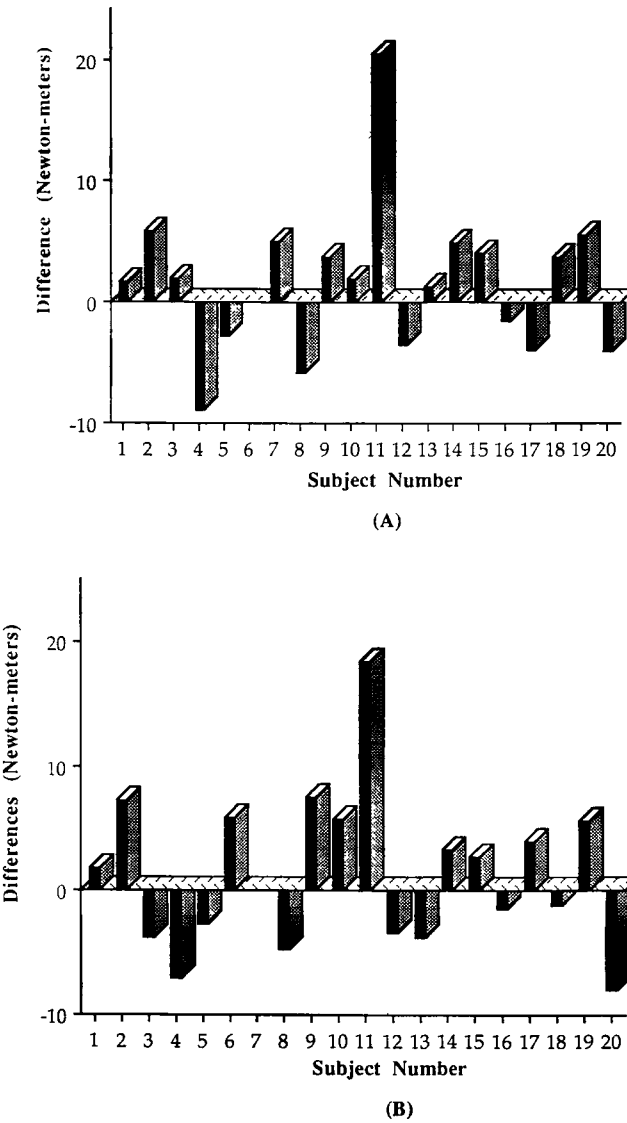

Figure 2. Interindividual differences in moments (in newton-meters) developed under the taping-over-prewrap and taping-to-skin conditions before (A) and after (B) exercise. A positive difference denotes a higher value for the taping-over-prewrap condition, and a negative difference denotes a higher value for the tape-to-skin condition.

Finally, the last point is the changing baseline of performance in this study in the without-tape condition. We attributed the 5% average increase in untaped ankle performance with exercise to a "warm-up" effect. The mechanism underlying this improved performance is unclear. The effect may be attributed to peripheral factors within the muscle[22,32] or central factors or both, such as an increase in endorphin levels.[34,35]

When trying to decide if ankle support is needed by the athlete, the psychological impact of taping should not be ignored. Athletes who believe a certain type of orthosis or tape method will protect them from injury will participate in that sport with greater confidence. It should be noted, however, that both before and after exercise, the majority of participants reported that the taping-to-skin application method felt as though it gave them superior "support." This support may reflect a perception of greater passive ROM restriction when the tape was applied to the skin; as discussed above, however, passive ROM is not likely to be a reliable indicator of maximal inversion moment resistance at near-maximal inversion under large loads. Under dynamic inversion, it is possible that the maximal skin contact when taping to skin may enhance proprioceptive reflexes, but even without tape the threshold for detecting inversion is so small ($<0.3°$)[12] that any further enhancement would seem meaningless unless a peripheral neuropathy is involved. It is possible that when the demands of the sport divert attention elsewhere, the skin strain associated with fresh adhesive tape may help force the athlete to attend to the fact that his or her ankle is approaching near-maximal ROM in inversion. Whether sufficient time remains for an effective corrective response is open to question, however.[2] Finally, although the results of this paper concern protection offered by athletic tape when the evertor muscles are fully active, the protection offered by athletic tape in the unhappy event that the evertor muscles are inactive on ground recontact is not inconsequential.[2]

One participant exhibited decreased testing performance with the application of tape and recovered these capabilities with the removal of the tape after exercise (Fig. 2). In 40 tape applications, this was the only such occurrence, and it may be attributed to variable motivation. Excluding this outlier did not significantly alter the results.

SUMMARY

Fresh athletic tape was found to be effective immediately after application in modestly augmenting resistance to ankle inversion moments, but this research confirms such protection is short-lived. Tape may be most appropriate for sports with short bursts of "at-risk" activity such as high jumping. For endurance sports like soccer or basketball, ankle braces may be as effective as ankle taping.[2] The reapplication of tape periodically during a sporting event is a viable option, if practicality, time, and budget constraints allow. However, the cost of repeatedly taping an ankle over the course of a season may be difficult to justify. Therefore, ankle taping may not be the best option for all athletic programs.

CONCLUSIONS

1. An ankle protected by the application of athletic tape could initially actively resist a significantly larger inversion moment than an untaped ankle.
2. After 40 minutes of vigorous exercise, there was a significant decrease in the magnitude of the maximal inversion moment that the taped ankle could actively resist. After exercise, the largest inversion moment that the taped ankle could actively resist was not significantly larger than that resisted with the untaped ankle.
3. There were no significant differences in the support provided by the taping-over-prewrap or the taping-to-skin conditions, before or after exercise.
4. After 40 minutes of exercise, the untaped ankle could actively resist, on average, a 5% larger inversion moment than before exercise.

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