
Spatting Restricts Ankle Motion more Effectively than Taping During Exercise

BRIAN E. UDERMANN^{†1}, KEVIN C. MILLER^{†2}, SCOTT T. DOBERSTEIN^{†1},
DAVID M. REINEKE^{†1}, STEVEN R. MURRAY^{‡3}, ROBERT W. PETTITT^{‡4}

¹University of Wisconsin-La Crosse; ²Brigham Young University; ³Mesa State College; ⁴Minnesota State University, Mankato

[†]Denotes graduate student author, [‡]denotes professional author

ABSTRACT

Int J Exerc Sci 2(2) : 72-82, 2009. Ankle injuries, via plantarflexion (PF) and inversion, are commonplace today. To reduce ankle injuries, restrictive appliances such as taping and bracing have been employed. These appliances, however, have the disadvantage of potentially loosening considerably with mild activity. Spatting—applying tape over the shoe and sock—has been suggested as a viable alternative, yet its efficacy has not been researched widely. We examined the effects of taping or spatting the ankles on 17 men (age = 20.7 ± 2.1 years; height = 185.7 ± 5.7 cm; mass = 93.6 ± 16.2 kg) before, during, and after 60 minutes of exercise involving multi-directional activity. Active range of motion (ROM) for PF and inversion was measured via goniometry for each subject's dominant leg to establish baseline values. ROM was measured after the appliances were applied, then following a five-minute warm-up period, and after each of three, 20-minute exercise periods. The subjects also completed a 5-item, 5-point Likert-type scale survey regarding their perceptions of each ankle appliance with respect to comfort, effectiveness, and protective ability. Separate, two-way ANOVAs with repeated measures were used to assess differences in PF and inversion ROM relative to time. A series of Wilcoxon tests were used to assess the Likert-type scale survey. In comparison to spatting, taping loosened by $\sim 5^\circ$ for PF at 40 minutes and by $\sim 3^\circ$ for inversion at 20 minutes (both significant interactions, $p < 0.01$). Thus indicating that spatting is more restrictive than taping after 20 minutes of exercise. Interestingly, taping was perceived as more comfortable than spatting ($Z = 2.03$, $p = 0.04$); nonetheless, the perceived protection along with the perceived ability to move before, during, and after exercise was rated similarly between the appliances ($p > 0.05$). Despite an advantage of restricting PF and inversion during exercise with spatting, it is not known if the loss of tape-skin contact underscores the potential benefits associated with the neuromuscular reactivity that have been reported with taping. Additional research is needed to clarify this issue.

KEY WORDS: Taping, spatting, ankle, range of motion

INTRODUCTION

Ankle injuries are common sports injuries today (3, 8, 25), with lateral ankle sprains occurring most frequently (12, 24). Ankle injuries also tend to be recurring injuries, as it is believed that once the ligamentous

structures are injured, the propensity for future injury is higher (13, 25).

To decrease the risk of ankle injuries, ankle-restrictive appliances such as taping (1, 10, 11, 14-16, 18, 20, 29, 31-32) and bracing (14, 15, 29, 36) have been used. Taping is purported to prevent ankle injuries by limiting the ankle's range of motion (ROM)

(11, 14-15, 19, 29, 35), specifically plantarflexion (PF) and inversion—the two motions placing the greatest amount of tension on the lateral, ankle ligaments (7). A potential disadvantage with taping, however, is its questionable ability to maintain restriction in ankle ROM during exercise. Although taping limits ankle ROM immediately after application (11, 14-15, 21), many (14, 21, 26) have observed that its restriction during exercise is minimal because of the movement of the underlying tissues, the loss of the tensile force of the tape, and the accumulation of moisture on the skin and within the tape itself (11). Thus, athletes may be protected inadequately for the entire duration of their practice or competition by using taping.

The loosening characteristics of taping during exercise have prompted clinicians to use other restrictive appliances. One such appliance, spinting, is a technique characterized by the application of adhesive athletic tape over the shoe and sock; however, its efficacy has not been researched widely (17, 30, 33, 35). To our knowledge, only two studies have examined the effects of spinting on restricting ankle ROM (30, 35). Pederson et al. (30) reported spinting restricted inversion more than taping, whereas Trower et al. reported no restrictive differences between the two appliances. Both groups used shorter exercise bouts—i.e., 30 minutes of rugby drills (30) and three 40-yard dashes and one 40-yard cone drill (35)—which has limited applicability for longer sporting events. Therefore, we investigated how either spinting or taping were effective at restricting ankle ROM after a 60-minute exercise period, consisting of actions stressing both the ankle and the

foot in multiple planes of motions. Additionally, we assessed the perceived comfort and perceived restriction of both appliances because we wanted to address the question: Why do athletes generally prefer taping, when other, more restrictive appliances may be available?

METHOD

Design

We employed a 2 x 6 factorial design with repeated measures on time. The independent variables were type of ankle-restricting appliance (taping versus spinting) and time (bare ankle measurement, baseline, or immediately posttape application, and after 5, 20, 40, and 60 minutes of exercise). The dependent variables were ankle PF and inversion active ROM. The taping and spinting conditions were counterbalanced to avoid an order-effect.

Subjects

Based on *a priori* power analysis (effect size of 1.0, $1-\beta$ of 0.80, and α of 0.05), seventeen men (Mean \pm SD; age = 20.7 \pm 2.1 years; height = 185.7 \pm 5.7 cm; mass = 93.6 \pm 16.2 kg) were recruited to complete a standardized warm-up of conditioning exercises followed by 60 minutes of “touch” American football wearing two different ankle restricting appliances: taping and spinting. Exclusion criteria included injury to the dominant leg within the last 6 months along with any history of neurological, cardiovascular, or neuromuscular diseases. Seven of the subjects had familiarity with being taped, as they were collegiate, varsity athletes; the remaining ten subjects had no experience with taping or spinting. Subjects

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participated in this study on a voluntary basis without compensation and provided a signed, informed consent. The research protocol was approved by the sponsoring university's institutional review board for the protection of human subjects.

Description of Ankle Restricting Appliances

White athletic tape (Coach, 3.8 cm x 13.7 m, Johnson and Johnson, New Brunswick, NJ) was used for the taping and spating techniques. Preparation for taping included the application of a quick-drying adherent along with heel and lace pads. A closed basket weave taping method was used and consisted of two continuous figure-of-eights and two medial and lateral heel locks. To our knowledge, a standardized method for spating has not been described in athletic training textbooks or within the scientific literature; thus, the same ankle taping technique was performed as a spat over the subjects' cleats (30) (Figure 1). The cleat used for each trial was a low-top style to minimize any stabilizing effect of the shoe (28). Prewrap was used to both tape and spat the ankles. The spating tape was positioned to avoid covering any spikes. Each taping technique was applied uniformly and consistently by the same certified athletic trainer. Application of each appliance occurred on the playing field to minimize ankle motions beyond those occurring within our exercise intervention.

Goniometric Measurements

Active ROM for PF and inversion was evaluated using a hand-held goniometer (Sammons' Preston, Bolingbrook, IL) on the dominant leg. Bovens et al. (2) reported high intraclass correlation coefficients (ICC) of 0.75 and 0.93 for goniometric assessment of PF and inversion, respectively. In our

study, goniometric measurement of PF and inversion was taken three times by the same examiner (a certified athletic trainer); however, a second examiner (also a certified athletic trainer) read and recorded the measurement in an effort to "blind" the investigator operating the goniometer. Average scores of the three trials were determined and used for both summary and inferential statistics. To evaluate test-retest measurement efficacy for our data, differences between trials were examined with univariate analysis of variance (ANOVA) with repeated measures along with average measures ICC using a two-way fixed effects model, as recommended by Weir (37).



Figure 1. Photograph of the spating technique used.

A single beginning position angle (i.e., average of three trials) was measured with the subtalar positioned neutral, as verified with palpation by the certified athletic trainer operating the goniometer. These angles were subtracted by the PF and inversion angles, respectively, to calculate PF and inversion ROM values. Permanent ink markings were made over the head of the fibula, middle of the lateral malleolus, mid-calcaneous (i.e., center of heel cup on

cleat), and mid-calf to ensure consistent measurement locations. For PF, subjects were placed supine on a table. The stationary arm of the goniometer was maintained in line with the head of the fibula, the fulcrum was placed in line with the middle of the lateral malleolus, and the movement arm was placed firmly against the lateral aspect of the cleat. With the subject prone, inversion was measured with the stationary arm aligned down the middle of the posterior calf, the fulcrum in the center of the calcaneus, and the movement arm placed against the center of the heel cup. An unprotected or "bare" ROM was assessed, with the cleat worn, in order to gather a reference measure for evaluating the immediate effect on ROM for each ankle restricting appliance.

Testing Procedures

Initial measures were taken to determine the ROM of each subject's dominant bare ankle. After applying the respective appliance, measures of PF and inversion were taken to establish a baseline value. The subjects then underwent a 5-minute, standardized warm-up bout consisting of forward and backward jogging, carioca jogging, high-knee extensions, and butt kicks. Following the warm-up bout, goniometric measures of PF and inversion were taken. Next, the subjects began the first of three 20-minute periods of 4-on-4 touch American football exercise. Positions during play were changed consistently to ensure that each subject exercised in similar cardinal planes of motion. After each 20-minute period, the subjects were given 10-minutes of rest during which time ankle ROM was measured again. If the subjects were not being measured, they were instructed to remain seated and to avoid

movement of their dominant ankle in an effort to minimize any loosening of the ankle appliance not related to our exercise intervention.

Following the third 20-minute period of exercise, the subjects responded to a 5-item, 5-point Likert-type scale survey. The intent of the survey was to gather information regarding the subjects' perceptions about the effects of each restricting appliance. Items on the survey inquired about their comfort, the amount of protection perceived, and the ability to move immediately before, during, and after exercise. Scaling for each item ranged as "1" indicating, "very uncomfortable, no restriction, not at all protected" to "5" indicating "most comfortable, very restricted, very protected." The subjects were instructed to select a single score for each item (N.B.: the survey did not permit half scoring of any items).

All exercise and rest periods were monitored using a stopwatch. Testing of each appliance was separated by a minimum of 72 hours. Finally, all activities took place on a dry, natural grass playing surface.

Statistical Analyses

Descriptive statistics for PF and inversion are reported as Mean \pm SD. Alpha level for inferential statistics was set at $p < 0.05$. Separate, two-way ANOVAs with repeated measures on time were used to evaluate the efficacy of each restricting appliance on PF and inversion, respectively. Significant main effects and interactions were examined using a series of appropriate t-tests with Bonferonni adjustment. A series of Wilcoxon tests were used to analyze the

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Table 1. Internal consistency of goniometric measures in the present study

		F value	p value	Average Measures ICC	Standard Error of Mean (deg)
<i>Plantarflexion</i>					
	Bare measurement	0.70	0.51	0.98	1.44
Tape	Baseline	2.25	0.14	0.99	1.16
	5-minutes	9.48	0.00*	0.97	1.08
	20-minutes	1.27	0.31	0.98	1.14
	40-minutes	0.24	0.79	0.97	1.16
	60-minutes	1.61	0.23	0.99	1.39
Spat	Baseline	3.30	0.07	0.99	1.70
	5-minutes	1.82	0.20	0.98	1.52
	20-minutes	0.93	0.42	0.99	1.69
	40-minutes	0.58	0.57	0.99	1.65
	60-minutes	0.41	0.67	0.99	1.92
<i>Inversion</i>					
	Bare measurement	0.60	0.56	0.87	0.76
Tape	Baseline	5.78	0.01*	0.98	0.83
	5-minutes	4.98	0.02*	0.97	0.65
	20-minutes	1.81	0.20	0.96	0.58
	40-minutes	0.71	0.51	0.95	0.68
	60-minutes	0.68	0.52	0.93	0.52
Spat	Baseline	0.65	0.54	0.98	0.93
	5-minutes	0.03	0.97	0.99	0.99
	20-minutes	0.78	0.48	0.98	0.78
	40-minutes	3.57	0.06	0.99	1.08
	60-minutes	0.55	0.59	0.99	1.16

*denotes significant measurement difference between trials

subjects' perceptions regarding the comfort, effectiveness, and protective abilities of taping and spating before, during, and after exercise.

RESULTS

Measurement Consistency

A series of univariate ANOVAs with repeated measures were used to evaluate any potential differences between each of the three goniometric measurement trials. In most instances, no significant differences were observed between trials (refer to p

values in Table 1), and thus, we opted to use average values for inferential statistics. Also, indicated in Table 1, high ICCs were observed for the PF and inversion measures taken in this study.

Efficacy of Each Ankle Restricting Appliance to Limit Plantarflexion

Figure 2 depicts summary statistics for PF. A significant interaction for PF between the two appliances ($F = 6.40, p < 0.01, \eta^2 = 0.29$) was found, indicating that spating, relative to taping, limited PF additionally by ~4 to 5° when measured after 40 (independent $t =$

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5.61, $p < 0.01$) and 60-minutes (independent $t = 4.80$, $p < 0.01$) of exercise. Upon immediate application, both appliances limited PF by $\sim 7^\circ$ (main effect: $F = 32.9$, $p < 0.01$, $\eta^2 = 0.67$; see blue bar, Figure 1). By 40-minutes exercise, ankle taping reached a point where PF was not significantly different (paired $t = 1.85$, $p = 0.08$) from the bare ankle ROM measurement. Conversely, spattling restricted PF, relative to the bare ankle ROM, for the entire 60-minutes. A separate 2×5 ANOVA with repeated measures (i.e., not inclusive of the bare ankle PF measurement) indicated both appliances loosened at some point during the exercise protocol relative to baseline measurements (main effect: $F = 9.20$, $p < 0.01$, $\eta^2 = 0.74$). Results of post hoc testing for this main effect are noted in Figure 2 (denoted by letter *b*).

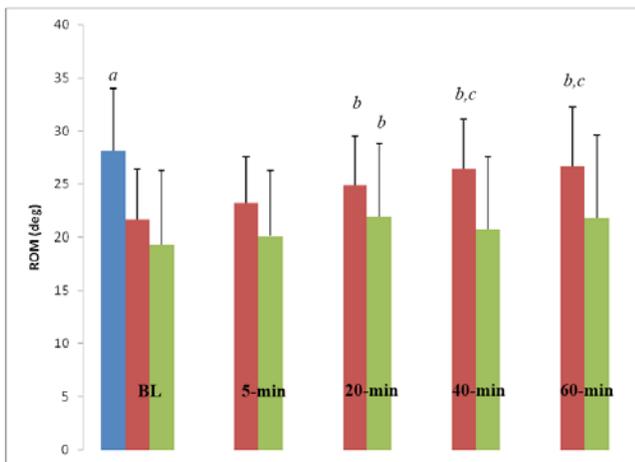


Figure 2. Plantarflexion ROM (Mean \pm SD) for bare (blue), ankle taped (red), and spatted (green) measurements. Baseline (BL) measures were determined immediately following application of each ankle appliance. The letter *a* denotes a significantly higher value relative to BL (main effect, $p < 0.01$). The letter *b* denotes when differences ($p < 0.01$) between baseline measures for each condition occurred relative to time. The letter *c* denotes significant differences between conditions (interaction, $p < 0.01$).

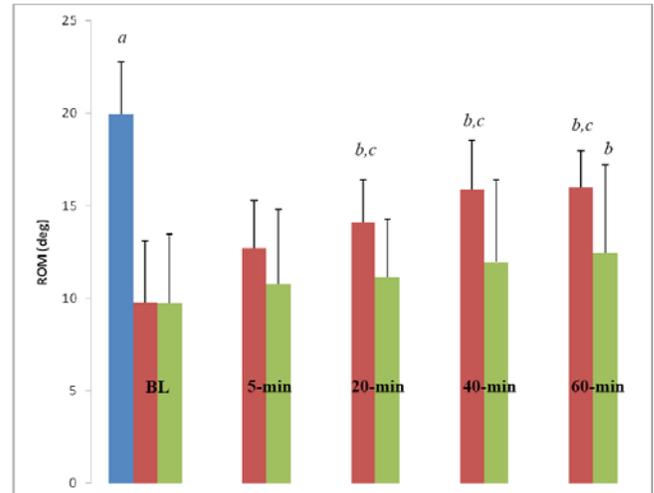


Figure 3. Inversion ROM (Mean \pm SD) for bare (blue), ankle taped (red), and spatted (green) measurements. Baseline (BL) measurements were determined immediately following application each ankle appliance. The letter *a* denotes a significantly higher value relative to BL measurements (main effect, $p < 0.01$). The letter *b* denotes when differences ($p < 0.01$) between baseline measurements for each condition occurred relative to time. The letter *c* denotes significant differences between conditions (interaction, $p < 0.01$).

Efficacy of Each Ankle Restricting Appliance to Limit Inversion

Figure 2 depicts summary statistics for inversion. A significant interaction for inversion between the two appliances ($F = 6.76$, $p < 0.01$, $\eta^2 = 0.30$) was found, indicating that spattling, relative to taping, limited inversion additionally by $\sim 3^\circ$ when measured after 20 (independent $t = 3.14$, $p < 0.01$), 40 (independent $t = 3.09$, $p < 0.01$), and 60-minutes (independent $t = 2.84$, $p < 0.01$) of exercise. Upon immediate application, both appliances limited inversion by $\sim 8^\circ$ (main effect: $F = 73.23$, $p < 0.01$, $\eta^2 = 0.82$; see blue bar, Figure 2), and both appliances restricted inversion, relative to the bare ankle ROM measurement, for the entire exercise protocol ($p > 0.01$). A separate 2×5 ANOVA with repeated measures (i.e., not

inclusive of the bare ankle inversion measurement) indicated that both appliances loosened at some point during the exercise protocol relative to their baseline measurements (main effect: $F = 18.98$, $p < 0.01$, $\eta^2 = 0.85$). Results of post hoc testing for this main effect are noted in Figure 3 (denoted by letter c).

Perceived Effects of Each Ankle Appliance

The results of the Wilcoxon tests on the self report items indicated that subjects rated ankle taping as more comfortable than spatting ($Z = 2.03$, $p = 0.04$). No difference ($Z = 1.83$, $p = 0.07$) in perceived protection was reported between appliances. Similarly, no differences were reported on how subjects rated each appliance's ability to restrict movement before ($Z = 0.58$, $p = 0.56$), during ($Z = 0.64$, $p = 0.52$), or after ($Z = 1.45$, $p = 0.14$) exercise.

DISCUSSION

The primary finding of our study was that taping loosened more considerably than spatting during exercise. We observed that both taping and spatting reduced ankle PF and inversion immediately following their application. An orderly effect of tape loosening, as measured by increased change in ROM relative to time, occurred for both PF (Figure 2) and inversion (Figure 3). The finding that taping lost its restricting abilities, relative to baseline, within a short period of time (i.e., within 20 minutes or less) is consistent with previous research (13, 27, 33).

Spatting, in comparison to taping, provided superior restriction to ROM based upon comparisons of PF and inversion measurements relative to baseline. For both

PF and inversion, spatting maintained restricted ROM relative to the bare ankle measurement, whereas taping did not (Figure 2). Spatting did loosen relative to the baseline value at 60 minutes of exercise for the inversion measurement (green bar, letter b, Figure 3); however, this change in ROM at 60 minutes was not observed for the PF measurement. We did observe a significant increase in PF ROM in the spatting condition for the measurement taken following 20 minutes of exercise (see Figure 2), but not 40 or 60 minutes of exercise. As the goniometer used in this study was sensitive to the nearest whole degree, and the standard error of mean was typically higher than a whole degree for PF (see Table 1), we submit this is most likely an artifact of measurement variability. The alternative explanation that PF ROM was actually higher from baseline then diminished from 20 to 40 minutes of exercise related to a tightening of the spatting appliance, does not seem plausible. Conversely, the 60-minute inversion measure in the spatting condition was higher relative to baseline. Given that the preceding measures at 20 and 40 minutes were elevated, although not statistically higher relative to the baseline value (Figure 3), we conclude that the spatting appliance lost some of its resilience across the span of 60 minutes. However, in comparison to bare ankle measures (blue bars in Figures 2 and 3), spatting still limited ankle ROM. In short, spatting in comparison to taping appears to provide superior restriction in ankle ROM.

When inquired about the perceived effects of each appliance, the subjects indicated that ankle taping provided superior comfort. One explanation for this finding is

that the application of taping directly to the skin may heighten joint position sense (34). The subjects, however, indicated that perceived restriction and protection between the two different appliances did not differ once the exercise intervention had commenced. Thus, any enhanced position sense from the tape-skin interface may have been lost because of the previously reported issues associated with tape in an exercising limb, e.g., movement of underlying tissues, accumulation of moisture (9).

Although we examined taping versus spitting, we did not examine the combined effects. Pederson et al. (30) examined the isolated and combined effects of these two restricting appliances in response to 30 minutes of exercise by examining inversion ROM and inversion velocity evoked by a tilting platform. Their kinematic findings indicated collectively that taping combined with spitting provided superior inversion restriction than either individual appliance exclusively. Any restricting effects on PF were not made. In addition, our study was limited to exploring adhesive taping, specifically for our ankle taping procedure. It is possible the addition of a different style of tape may have enabled the tape to restrict as much as the spat; however, Metcalfe et al. (23) found that adding moleskin stirrups to adhesive athletic tape provided no additional restriction.

One reservation of taping and spitting is that such appliances may deleteriously affect neuromuscular responses and thus predispose one to injury. This concern of "neuromuscular dependence" on the ankle appliance is anecdotal. To examine this concern, Cordova et al. (4) evaluated

peroneal reactivity in a group of healthy subjects. Based on non-significant differences in peroneal reactivity, these investigators concluded that the chronic use of various ankle bracing appliances had no deleterious effects on neuromuscular reflexes. Moreover, a later meta-analysis by Cordova et al. (6) summarized that most research of ankle appliances indicated small effect size reductions (i.e., > 0.20) in vertical jump, sprint, and agility performance. Their analysis included an assessment of studies using lace-up and semi-rigid appliances which were not examined in our study.

A second reservation for the use of taping or spitting or both is one of the cost-to-benefit. Such concern was recently examined (27). These investigators systematically evaluated previous research to calculate the number of applications of taping or bracing, respectively, that were required to prevent ankle sprain incidence in healthy and previously sprained individuals. Their conclusions were that greater benefits were obtained by taping and bracing previously sprained individuals. Moreover, they concluded that ankle bracing was three times more cost-effective than ankle taping; however, the cost effectiveness of spitting was not reported. Our assertion that spitting provides superior restriction to ankle taping refocuses the question on spitting and its cost effectiveness in comparison to bracing.

The issue that spitting may augment taping warrants exploration. Previous investigators (30) have reported that the combined effects of the two appliances provide superior restriction to inversion. In our study, taping provided superior

comfort to spitting, and we attribute this to the potential kinesthetic benefits provided by the tape-skin interface. Further, it is possible spitting provides no enhancement of cutaneous feedback because of the absence of tape in direct contact with the skin; however, this is speculative, as we did not acquire such measurements in our study. In that taping reportedly causes enhanced neuromuscular reflexes (38), and that such reflexes may be related to enhanced feedback from the tape-skin contact (34), the hypothesis that spitting may help preserve the proprioceptive benefits of taping for a longer duration is worthy of exploration.

Several researchers have reported that taping may restrict ankle dorsiflexion (5). Specifically, McCaw and Cerullo (22), based on kinematic analysis, purported that limiting of dorsiflexion with taping has the potential to adversely affect the shock absorbing capacity of lower extremity. While this topic is beyond the scope of our study, as our measures were delimited to non-weight-bearing measures of PF and inversion, this is a concern which should be addressed in future research on taping and spitting.

Finally, the results of our study raise questions about current practices. It has been our collective experience that athletes prefer ankle taping to spitting, or other ankle restricting appliances, and that ankle taping perhaps is the most common ankle restricting appliance used. Whether this is a preference out of routine or a perception that taping provides the "best" protection is unknown. Our finding that taping is more comfortable than spitting may lend some explanation to the preference of taping;

however, our design was repeated measurement on different days and the ratings of one appliance versus the other in terms of perceived comfort, restrictiveness, and ability to limit movement may have differed if each appliance were applied on the same day (i.e., if subjects were permitted to rate each appliance with minimal time in between their application). Conversely, there are several alternative explanations for lack of preference for spitting. One explanation is that spitting takes longer to remove and therefore may be viewed as a nuisance. A second explanation may be that practitioners lack formal education in how to apply a spat and are therefore uncomfortable using this technique in practice. As mentioned previously, a standard description for applying a spat does not seem to exist. However, a standardized taping technique is readily available. The issue of why athletes or practitioners, or both, prefer taping in lieu of other ankle restricting appliances, reported to restrict ROM better, is a curious topic and worthy of exploration.

With respect to the ankles, our data indicate that spitting is more restrictive than taping during exercise. After a brief amount of exercise, however, the ability of taping to restrict PF and inversion is diminished greatly. This finding contradicts the prevailing notion that taping is the "best" restrictive appliance. Prior investigators have reported that the tape-skin interface can augment various reflexes that lead to the prevention of ankle sprains. Thus, combining spitting with taping may lengthen the duration of enhanced proprioception brought about by the tape-

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skin interface, and this is a topic worthy of further exploration.

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