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Effect of Ankle Taping and Bandaging on Proprioception in Healthy Volunteers

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ABSTRACT

Objectives: To establish whether proprioception is modified by ankle taping and bandaging or not.

Study design: Repeated-measures experimental design.

Setting: Ankle joint taping and bandaging seem promising for the increasing proprioception.

Participants: 74 healthy Participants (37 male and 37 female). Participant's age range was 18-30 years old. Participants were divided randomly into two groups (Taping group n=37) and (Bandaging group n=37).

Main outcome measure: Goniometer

Results: In both groups (bandaging group and taping group) when the absolute error were compared between the four occasions (before using the external support, after 20 minutes while using the external support, after 24 hours while using the external support, and immediately after removing the external support), we found that, there were a significant differences between the values of standard error at the occasions (after 20 minutes while using the external support, after 24 hours while using the external support) in comparison to the occasion before using the external supports in the four ROM angles $P < 0.05$.

Conclusion: Ankle tape and bandage significantly improved ankle joint proprioception in the uninjured ankle during the entire interval of their use.

Keywords Ankle taping, Ankle bandaging, Proprioception, Sport injuries, Ankle sprain.

INTRODUCTION

Ankle sprains are one of the most frequent injuries between athletes. 90-95% of ankle injuries are inversions, which are rupture of the anterior talofibular ligament or the calcaneofibular ligament [1,2]. Proprioception and balance are essential elements for the activities of daily living, the ankle joint affects the functioning of balance, and performs to keeping the body upright against gravity or maintaining posture during movement [3]. After ankle injury, 72% of patients will experience impaired function (proprioception, ankle stability, and balance), that lead to changes in sporting and occupational activities [4].

For the functional success of rehabilitation and surgical treatments, proprioception is a critical issue. Following ankle injuries, physical therapists, athletic trainers, and other rehabilitation professionals emphasize the importance of proprioception re-education during the rehabilitation process [5-8].

Elastic taping may reduce pain, increases circulation of the blood, lymph, and tissue fluids, improves reflexive inhibition of the Golgi tendon organ, alleviates excessive tension of the muscles and supports the stability of the ankle joints that lead to improvement of proprioception, balance and gait ability [9].

The effect of taping on different issues had been studied. Some researchers studied the effect of ankle taping on ground reaction forces, functional performance, muscle activities, ankle joint biomechanics, kinematics, movement, ankle joint laxity, and ankle joint stability [10-18]. Also, the effect of ankle taping on proprioception had been studied in comparison to brace and Kinesio Tape [19-23].

Halseth et al., [24] found that Kinesio TM tape does not appear to enhance proprioception in healthy individuals. While Simoneau et al., [25] found that strips of athletic tape can improve ankle joint position perception in non-weight bearing movements, especially for a midrange plantar-flexed ankle position. And Miralles et al., [26] found that ankle taping can improve proprioception in healthy volunteers.

Medical practitioners often use elastic bandage in the treatment of musculoskeletal conditions, they believe that elastic bandage supports the joint and increased sense of security during physical activity. But there is no insufficient scientific support to this practice [27-34]. Barrett et al., [31] found that elastic bandage improves knee joints proprioception in patients with osteoarthritis but has no effect in healthy people.

Perlau et al., [30] found that during open-chain passive-motion testing, elastic bandage improves knee joint proprioception and provides increased feedback pertaining to the knee at risk for reinjury or overuse. Also, the application of an elastic bandage improved position sense, suggesting that tactile cues from cutaneous or other extra-articular receptors may play a role in elbow proprioception.

Sikka et al., [33] found that the effect of bandage thickness and the geometry of the limb on pressure produced by multi-layers of the bandage are significant. Another study done by Hassan, et al, reported that, in subjects with knee OA, application of an elastic bandage around the knee can reduce knee pain and improve static postural sway. Also, Atkin et al., [35] found that bandages appear to restrict ROM more than hosiery when used in conjunction with a variety of footwear types.

The effect of external support methods (taping, bandaging, bracing, etc...) on mechanoreceptors and proprioception hadn't been studied before. Some previous studies had tested the effect of ankle joint taping and bracing on proprioception [19-23], the results of these studies were conflicting. Also, the effect of knee and ankle bandaging on proprioception had been studied [30,34], these studies report a conflict results.

To the author's knowledge, there are no studies about the effect of ankle joint elastic bandaging on proprioception. However, the effects of ankle joint tape on proprioception still not clear. Whereas some authors claim that the use of tape improves proprioception, others have not found any beneficial effects.

Considering the variability of the results, the aim of the present study was to establish whether proprioception is modified by ankle taping and bandaging.

METHODOLOGY

Subjects

Before starting this study, the power test was done to determine the number of participants in this study. 74 healthy subjects participated in this study (37 male and 37 female). Participant's age range was 18-30 years old. Participants were recruited from the university population, and divided randomly into two groups (Taping group n=37) and (Bandaging group n=37). Participants were excluded if he/she reports.

(a) Previous hip/pelvis, knee, ankle, or foot surgery within the past year; (b) lower extremity amputation; (c) injury to the lower extremities six months; (d) known balance impairment due to neurological disorder, vestibular disorder, medication use, or other

(f) Pregnancy; or (g) concussion within the previous three months. Standard clinical stability testing of the ankle ligamentous structures was performed in order to rule out anterior and lateral talocrural joint instability and lower extremity injuries during the previous 6 months. Each volunteer signed an informed consent form prior to participation. This study was approved by an authorized ethics committee

Procedures

Leg length was measured (right and left leg) while participant lying supine, from the anterior superior iliac spine to the inferior border of the ipsilateral medial malleoli by using a standard measure tape. Dominant leg was determined according to Vauhnik and ark modified version, the limb that used in at least 2 of the 3 following activities: (1) Kicking a ball, (2) Drawing a diamond figure on the ground and (3) Using his leg and step over a spider toy, was considered as the dominant leg [27].

Ankle taping procedures

Zinc oxide tape will be applied; its hard-preventive tape was used. Taping procedure consists of three separate steps: The first step involved the application of the anchor tape, which was achieved by applying the tape circumferentially just, above the malleolar level at the lower end of the shank.

The second step involved the application of the stirrup, during this step, the foot was held in neutral position, and the tape was applied passing from the medial side of the ankle, under the foot just over the heel area (posterior one third of the foot) and up along the lateral side of the ankle. The second step was repeated to apply the second stirrup.

The 2 ends of the stirrups were firmly attached to the anchor tape applied during the first step and this attachment was reinforced with a locking tape during the third and final step by once again applying the tape circumferentially just above the malleolar level at the lower end of the shank.

The taping process was applied by a physical therapist according to the health association requirements [26].

Ankle bandaging procedures

Standard 10 cm width elastic bandage was used. The elastic bandage was wrapped around the ankle joint to form an 8-shape starting from the soles of the feet.

Proprioception measurement procedures

The first step: volunteers were seated in high chair, and while their eyes are closed, the researcher consecutively on different graduated surfaces (10° dorsiflexion, neutral position, 10° plantarflexion and 20° plantarflexion) respectively, each position will be

done for just one time and will be held for 5 seconds. The researcher told the volunteers that they have to remember these positions and they have to memorize the positions because they have to do it again later by themselves. Simultaneously, each joint position was recorded in order to obtain the target angle using the universal goniometer. This was the angle that the volunteer was instructed to reproduce during the testing part of the study.

The second step: The volunteer was then encouraged to walk freely next to the researcher for 10 minutes, still blindfolded.

The third step: Then the volunteer sat on a high chair that did not allow his or her feet to touch the floor (to avoid any information from the sole). Finally, the researcher encouraged the subject to reproduce the four memorized positions, starting from and finishing in the neutral position each time. The volunteer maintained each ankle position, announced by the researcher at random, for five seconds. The volunteer's ankle movement was recorded using the universal goniometer, and this reproduced ankle angle was called the estimated angle.

The difference between the learned positions and the positions that are done by the volunteer was calculated and documented. Deviation from the learned angle (degrees) described the direction of Error when subjects tried to reproduce the requested position. The deviation was obtained by coding net Error, which was based on the correct position occurring when the learned and estimated angle were equal (± 5 degrees).

The position (ROM) measurements were done in four occasions, (before ankle external support, after 20 minutes while using external support, after 24 hours while using external support and immediately after removing the external support (after 24 hours)) [28].

Statistical analysis

SPSS 14.0 version for Windows was used for all statistical analyses. Independent T-tests were performed to compare the two groups. Repeated measures-ANOVA tests were performed to compare the reaching distance between the 8 directions.

RESULTS

The difference between the learned angle and the estimated angle was calculated, the difference between the two angles (Absolute Error) used in the statistical analysis. Table 1 summarizes the results by listing the mean absolute Error observed and the standard deviation. Note that all numbers are non-negative since the Error was defined as an absolute difference.

In both groups (bandaging group and taping group) when the absolute error were compared between the four occasions (before using the external support, after 20 minutes while using the external support, after 24 hours while using the external support, and immediately after removing the external support), we found that, there were a significant differences between the values of standard error at the occasions (after 20 minutes while using the external support, after 24 hours while using the external support) in comparison to the occasion before using the external supports in the four ROM angles $P < 0.05$.

Table 1: Error (Degrees) taping group and bandaging group: Mean Degrees (Standard Deviation). The error is the Absolute Difference between the Estimated and the Target Angle.

	Taping group n=35				Bandaging group n=35				Difference Between groups			
	Before using tap	20 min after using tap	24 hour after using tap	After removing the tap	before using bandage	20 min after using a bandage	24 hour after using a bandage	After removing the bandage	before using tap	20 min after using tap	24 hour after using tap	After removing the tap
10°	4,73	0,68	4,14	5,01	5,14	0,76	1,65	5,14	-0,41	-0,08	2,49	-0,13
dorsiflexion	(1,68)	(0,75)	(0,67)	(1,01)	(0,67)	(0,64)	(0,75)	(0,67)	P>0.05	P>0.05	P<0.05	P>0.05
Neutral	4,38	0,08	3,46	4,2	4,46	0,27	0,89	4,27	-0,08	-0,19	2,57	-0,07
position	(0,89)	(0,28)	(0,51)	(0,88)	(0,51)	(0,61)	(0,57)	(0,65)	P>0.05	P>0.05	P<0.05	P>0.05
10°	6,03	1,03	4,41	5,31	5,41	1,19	2,05	5,41	0,62	-0,16	2,36	-0,1
Plantarflexion	(0,96)	(0,83)	(1,04)	(1,28)	(1,04)	(0,97)	(1,15)	(1,04)	P>0.05	P>0.05	P<0.05	P>0.05
20°	8,59	3,19	6,65	7,5	8,54	3,24	4,03	7,62	0,05	-0,05	2,62	-0,12
plantarflexion	(1,48)	(1,08)	(1,18)	(2,1)	(1,26)	(1,75)	(2,06)	(1,21)	P>0.05	P>0.05	P<0.05	P>0.05

At the occasion (after 20 minutes while using the external support) we found that the absolute error was the least. At this occasion, the best improvement was in neutral position, then 10° dorsiflexion, then 10° plantarflexion, then 20° plantarflexion, these improvements was significant at $P < 0.05$, (Figures 1 and 2).

The second least absolute error was at the occasion (after 24 hours while using the external support), at this occasion the improvement order was the same as the previous occasion improvement order, these improvements were also significant as $P < 0.05$, (Figures 1 and 2). The highest absolute error was at the occasion (immediately after removing the external support), it was almost the same as before using the external support as $P > 0.05$.

In comparing the two groups, the proprioception had improved during the entire interval of tape and bandage use; there was a significant difference between the two groups at the occasion (after 24 hours while using the external support) in the four ROM angles, as the absolute error was higher in the taping group $P < 0.05$. There were no significant differences between the groups at the other occasions (before using the external support, after 20 minutes while using the external support, and immediately after

removing the external support), as the standard error values were close to each others for all positions $P > 0.05$.

In both groups, we found that proprioception has been reduced in the occasion immediately after removing the tape and bandage in comparison with the occasion before using the tape and bandage.

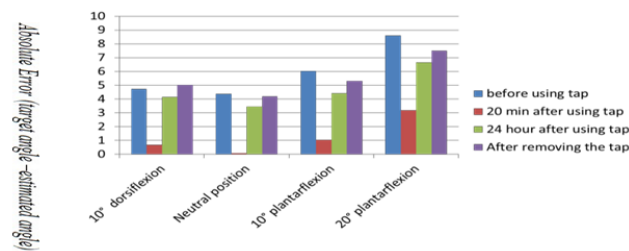


Figure 1: The changes in the absolute error values (Taping group).

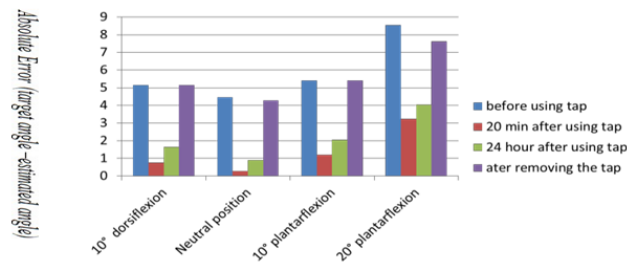


Figure 2: The changes in the absolute error values (Bandaging group).

DISCUSSION

The results of this study are of particular importance because ankle taping and bandaging are often used in preventing ankle sprains in sports, [36-38] and it is a very common method of treatment after ankle injuries [36,39,40].

Our results indicate that tape and bandage significantly improved ankle joint proprioception in the uninjured ankle during the entire interval of their use. The best improvement of joint proprioception was at the occasion (after 20 minutes while using tape and bandage), this results are the same with the results that indicated Simoneau et al, as they concluded that increased cutaneous sensory feedback provided by strips of athletic tape applied across the ankle joint of healthy individuals, can help improve ankle joint position perception in non-weight bearing, especially for a midrange plantar-flexed ankle position [25]. Also, the result that found by Miralles et al., [26] was in agreement with our results as they found that ankle taping improved proprioception in healthy volunteers. After 20 minutes while using tape and bandage the improvement of proprioception was better than the improvement of proprioception after 24 hours while using tape and bandage, this may be because with time and movement ta and bandage lose their tightness, and the body gets used to tape and bandage.

Previous studies that test the effect of elasticated bandage on proprioception had the same results of our studies as Barrett et al; found that wearing an elasticated bandage around the knee improves joint position sense where this is deficient [31]. And Khabie et al., [32] found that bandage increase elbow proprioception. And Hassan et al., [34] found that in subjects with knee OA application of an elastic bandage around the knee can reduce knee pain and improve static postural sway and proprioception.

There were some previous studies who found that ankle taping doesn't improve proprioception as Raymond et al., [20], found that using an ankle brace or ankle tape has no effect on proprioceptive acuity in participants with a recurrent ankle sprain or who have functional ankle instability. And Halseth et al., [24] found that tape does not appear to enhance proprioception in healthy individuals at the ankle in the motions of plantar flexion and 20° of plantar flexion with inversion.

After removing the tape and bandage there were no proprioception improvements in comparison to the proprioception before using tape and bandage, this result shows us that tape and bandage significantly improved ankle joint proprioception in the uninjured ankle during the entire interval of their use [25].

To the author's knowledge, there were no previous studies that compare the effect of ankle tape and bandage on proprioception. In this study, we found that the proprioception had improved during the entire interval of tape and bandage use. The bandage group has less absolute error than the taping group at the occasion (after 24 hours while using the external support) for all positions, which means that, the proprioception improved better in bandaging

group than in taping group at this occasion, that lead us to say that, with time the bandage has a better effect on proprioception than tape. As we noticed during this study that bandages keep the pressure at a longer time than tape, while tape loses its tightness more than bandage after 24 hours.

There was no significant difference between the two groups at two occasions (before using the external support, and immediately after removing the external support), as there was no improvement in proprioception after removing the tape and bandage in comparison with the proprioception before using the tape and the bandage. Again this result shows us that tape and bandages significantly improved ankle joint proprioception in the uninjured ankle during the entire interval of their use [25].

All groups showed greater degrees of Error in plantarflexion than in the other positions. This result is the same with the result that indicated by Miralles et al., [26]. Also the same with the result indicated by Sekizawa et al., [41] as they studied the effect of shoe sole thickness on joint position sense and also reported that the Error in reproducing the ankle position was greater in plantarflexion than in the other movements [41]. Plantarflexion is a position that is more prone to functional decline, which could explain why more Error was observed in plantarflexion. It is also important to consider that physical therapy programs should reinforce this direction of movement when restoring proprioception [26].

The present study found that taping improved proprioception in healthy volunteers. The improvement was statistically significant in dorsiflexion, Miralles et al., [26], and Sekizawa et al., [41] also reported statistical differences only in dorsiflexion. Therefore, it seems that dorsiflexion was more sensitive to proprioceptive changes and therefore may be easier to rehabilitate with the use of external supports. When the position was not correctly reproduced, the direction of Error could be either above or below the requested position, so the position could be overestimated or underestimated. Trends towards overestimation of the required position were observed in both groups for all positions except for the neutral position. When trying to reproduce the ankle positions, our volunteers easily reproduced the neutral position but overestimated the other ones.

Because age has been linked to impairment of proprioception the sample of the present study was limited to a young healthy group between 18 and 30 years old. Therefore, our study established the basis for future work on pathological subjects treated with functional ankle taping by providing reference values.

Several reports have suggested that rehabilitation may help restore proprioception [8,14]. The rehabilitation process could benefit from the use of ankle taping when trying to improve proprioception. Future studies could apply this model to injured ankles and explore modifications in proprioception achieved by ankle tape and bandage in addition to rehabilitation techniques. As the results of this study showed that ankle joint taping and bandaging can improve the proprioception, ankle tape and bandage can be used clinically during the ankle joint rehabilitation process to increase proprioception and prevent ankle injuries. Also as ankle tape and bandage are cheap and can be applied by the patient himself it can be effectively used clinically during the ankle joint rehabilitation process.

The present study incorporated with the findings of Conti et al., [42], which established that the sole of the shoe offered tactile feedback about ankle position. For this reason, volunteers were barefoot during the entire intervention process. For the same reason, volunteers were also blindfolded to prevent any visual information from distorting the test [43].

CONCLUSION

Ankle tape and bandage significantly improved ankle joint proprioception in the uninjured ankle during the entire interval of their use.

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