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Original Research Article

Application of Neuromuscular Bandage on the Peroneus Muscles and its Influence on the Risk of Ankle Sprain Injuries Performing Star Test

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Abstract: Context: In the last decade, the use of adhesive elastic bandages have become much more common. However, evidence indicates it prevents injuries has not been demonstrated. Purpose: Application of NMB (Kinesio-Tape) in the lateral group of the leg increases dynamic postural control of the inferior extremity in unipodal support. Results: Exits a statistically significant difference in the simplified SEBT performance that is achieved in the 3 reach directions under assessment when it is evaluated immediately after application of the bandage. Conclusions: Neuromuscular bandage has demonstrated significantly increased stability of the joint**.**
Keywords: NMB = neuromuscular bandage, SEBT = start excursion balance test, sports injuries, ankle sprain.

INTRODUCTION

In the past years, there has been an increase in the number of people engaging in physical activity and sports. It has become common knowledge that in order to be healthy, it is fundamental to engage in physical activity on a regular basis. In sports (whatever the competitive level may be) there has been a marked tendency to intervene a sports injury once it has occurred, focusing efforts on the treatment of anatomical trauma but with virtually no preventive action. Nevertheless, a shift has recently begun to occur aimed at developing strategies and multidisciplinary intervention proposals related to the prevention and rehabilitation of sports injuries and the athlete (Briem K *et al.*, 2011; Carrafa A *et al.*, 1996; Casais L, 2008). Proprioception is a complex neuromuscular process concerned with the internal awareness of body position and movement. It is reliant on appropriate afferent and efferent signaling and plays an important role in joint stability and injury prevention; within this context, and knowing that Ankle sprain is the most common sports injury (Schiftan, G.S *et al.*,2015), the neuromuscular (NMB) bandage has been presented lately as an alternative with a sharp increase in its use in sports. The use of the different taping method is based on the impaired postural control (especially during the single leg stance) that has been described in athletes prone to have acute ankle sprains or chronic ankle instability (Hertel J, 2002). The advantages of the Kinesio Tape is that it can stretch up to 140% of the original length, the proposed beneficial effects presented by the manufacturer are: correct the misaligned joint, by relieving muscle spam; improve range of motion (by increasing blood irrigation); improve proprioception by stimulating cutaneous mechanoreceptors. All of this being hypothesis with limited scientific evidence evaluating its efficacy (Thelen M. *et al.*, 2008; Tsai HJ *et al*,.2009; Williams S *et al.*,2012).

Questions arise with regards to what are the limits of NMB application not only due to its announced effectiveness for pain relief, increased lymphatic drainage, increased subcutaneous space, decreased edema, muscle activation, etc. But also due to the duration of its effect (3-5 days according to the literature) (Kase K *et al*.,2003; Kase K *et al.*,2005; Slupik A *et al.*,2007) or if the bandage really provides any of the effects the dealers have obtained. The aim of this study is to evaluate the influence of the neuromuscular bandage on the appearance of injuries in the lower extremities and dynamic postural control, evaluating muscle activation, objectifying through the utilization of the Simplified Star Excursion Balance Test (SEBT) (Gribble PA *et al.*,2003; Gribble PA *et al.*,2012; Plisky PJ *et al.*,2006)

METHOD

Participants: Students from the Metropolitan University of Educational Sciences (MEST), regardless of their academic majors, who were physically fit to meet the criteria for inclusion and exclusion. 32 patients, both sexes between 18 and 22 years old, who

were members of the university basketball team. Of the 32 subjects, 14 were women and 18 men. One woman was injured during the investigation and one man did not use the NMB during specified days, and therefore, the final number of subjects who were tested was 30. The selection of samples was intentional and a single group was obtained that was used as the study group and the control group as well since the comparison of the results obtained during repeated measurements was compared to the same subjects. (Table 1). Participants in this group were excluded if they have one or more of the following conditions.

- Back or lower extremity injury within the last 6 months, or anyone undergoing physiotherapy treatment for any pathology of these segments.
- Currently participating in any kind of training aimed at improving balance and/or proprioception.
- Use of bandage or other physical means aimed at improving proprioception, balance or joint stability.
- Alteration or disease of the peripheral or central nervous system.
- Vestibular disorders, balance disorders, vertigo, dizziness.
- Performance of high-intensity exercises on the day before the test.
- Less than six hours of sleep the night before the test run.
- History of loss of consciousness or fainting for no apparent reason.
- Allergies, burns, wounds, scars or skin alterations in the area where the bandage would be applied.

TASKS

In order to conduct this study, three variables were considered:

1) **Throw Distance**:
a) Values of standardized reach: understood as the distance that was achieved measured in centimeters, divided by the length of the supporting leg and the aforementioned was multiplied by 100 (expressed in percentage)
b) Values of compounded reach: defined as the sum of the distances achieved in all three directions of simplified SEBT, divided by 3 times the length of the supporting leg under evaluation, and with the aforementioned multiplied by 100 (expressed in percentage).

2) **Risk of Injury**: the difference in the previous reach distance (left extremity v / s right extremity) obtained in SEBT (or its simplified form) greater than or equal to 4 cm. (men). Additionally, in the case of women, a compounded standardized distance reach of less than 94% of the length of the lower extremities is added.

3) **Neuromuscular Bandage**: Application of NMB. No application of NMB. Biases of the study and their respective control.

Biases	**Control**
Corporal composition	BMI was measured and it was found that all subjects had mesomorphic characteristics.
NMB application	Application by a single subject.
NMB- custom cut for a specific application.	Pre-cut NMB
Laterality of the leg	No control.
The position of the player on the court	No control.
Selection of sample	Intentional; not randomly.
Parallel training	No control

PROCEDURES

The first step was to create a medical record of general background information about each athlete, in which the weight and height were measured in accordance with the Protocol for Measuring Height and Weight of the National Health and Nutrition Examination Survey III (NHANES III). Subsequently, due to the influence of the length of the legs and the SEBT result(Gribble PA *et al.*,2003), the Gribble and Hertel protocol was carried out in order to measure the length of the inferior extremities from the superior part of the anterior superior iliac spine to the most distal part of the medial malleolus(Gribble PA *et al.*,2003; Gribble PA *et al.*,2012). All measurements were performed by the same examiner in order to decrease bias (Hertel J *et al.*,2000). A second measurement was performed, and the average of both measurements was recorded (Plisky PJ *et al.*,2006). After the data was collected, the athletes were requested to participate in a new round of assessment.

Simplified SEBT Assessment: Visual demonstration of the test by video on a personal computer. Afterwards, one of the reviewers made a verbal and visual demonstration of the simplified SEBT, explaining that they had to position themselves in unipodal support with the limb which was going to be assessed (sole of the foot) on the common point of the 3 directions, and the opposite limb (oscillating) to achieve the maximum possible distance. Once the instructions were

understood, the athletes performed warm-up exercises, accompanied by one of the reviewers, which consisted of 10 minutes of light jogging followed by 5 minutes of stretching the inferior limb muscles. Then, each athlete made six test attempts in each of the 3 directions to be studied, with fifteen seconds rest between each attempt performed by each lower extremity. Subsequently, each athlete had a five-minute break and then made three additional attempts in each direction (fifteen-second pause between each attempt), recording the best of the three attempts. The rest period between each limb was 3 minutes(Gribble PA *et al.*,2003; Gribble PA *wt al.*,2004; Gribble PA *et al.*,2012; Halseth T *et al.*,2004; Hertel J *et al.*,2000).

After the first simplified SEBT, the area where the bandage would be applied was cleaned with alcohol in order to ensure better adhesion.

Application of NMB: A pre-cut Spider Tech^{tm} brand NMB was used and applied on the shaved skin of the athletes by the same evaluator in individual strips, from the origin to the insertion of the peroneus longus and brevis muscles. When applying the KT in a proximal to the distal manner, it stimulates the muscle fibers to contract and facilitate motion by providing tactile input through the skin and stimulates type 2 cutaneous mechanoreceptors, increasing the recruitment of motor units. It is also argued that KT stimulates the fascia providing higher tension to the muscle. The taping technique is in accordance with the guides provided by the Kinesio Taping Association and based on the text "Clinical Therapeutic Applications of the Kinesio taping method" (Kase K *et al.*,2003; Kase K *et al.*,2005).

- Patient in the supine position, knee slightly flexed at about 30 ° with the ankle in eversion.
- Adhere the base of the tape to the insertion of the peroneus brevis at the base of the 5th metatarsal, or through the medial forefoot right in front of the calcaneus for the peroneus longus.
- Apply the base of the tape and place the rest of the application posterior to the lateral malleolus.
- Apply the tape along the lateral surface of the leg following the path of the peroneus muscles while the ankle is inverted and the foot is dorsiflexed and finish placing the anchor with 0% tension.

After applying the NMB, each athlete was given 2 minutes to walk around the test site in order to get comfortable with the position of the dressing, and then proceeded to do the test once again as was previously mentioned.

After performing SEBT for the second time, the measurements for the day were concluded for each athlete. Each subject was given instructions not to remove the bandage, and a new and one-time only testing session was scheduled for 72 hours after the first day of simplified SEBT evaluation.

After 72 hours, the second round of measurements was carried out. The position of the dressing and its condition were verified, and then the measurement process was performed once again with the same precision as in the previous assessment.

STATISTICAL ANALYSES

Standardization of collected data: Once the data had been collected, and for purposes of further analyses, the Gribble and Hertel standardization criteria were applied using the following formula and then subjected to a statistical analysis (Gribble PA *et al.*,2003).

$$\frac{\text{Reach Distance}}{\text{Length of extremity}} \times 100$$

a) **Men**: the values obtained in previous tests were analyzed, and a difference greater than 4 cm. between legs was an indicator of a risk of injury.

b) **Women**: the compounded value was calculated for each leg (with standardized values) in which a compound less than 94% of the length of the leg indicated a risk of injury.

Those players (men and women) who have a difference (distance in centimeters) of previous range greater than 4 centimeters, have 2.5 times more likely to suffer an injury to the lower extremity ($P < 0.05$) and women with distances of less than 94% of the length of lower extremities compound range (sum of the distances achieved in the three directions of simplified SEBT divided by 3 times the length of the leg to evaluate the above multiplied by 100) have 6.5 times more likely to have an injury to the lower extremities(Plisky PJ *et al.*,2006).

Anterior distance range + Posteromedial distance range + Posterolateral distance range

Length of supporting leg X 3

RESULTS

After analyzing the data the following results were obtained.

a) Distances
b) Risk of injury

The greatest standardized distance obtained (on average) was observed in the length post NMB medial (95.90% post NMB left posteromedial and 96.30% post NMB right posteromedial) and lowest in the anterior pre - NMB lengths (78.91% left anterior pre – NMB and 78.43% right anterior pre NMB) (Table 2), (Table 3), (Table 4), (Table 5).

Table 1

Characteristics of sample, study and control group.

Sample Characteristics	Study and Control Group (n=30)
Age (Average and Sd) • **Male** • **Female**	 20.7 years (Sd:1.83) 20.69 years (Sd:1.65)
Heightcms. (Average and Sd) • **Male** • **Female**	 181.8 cms. (Sd: 7.8) 165.5 cms. (Sd: 5.32)
Weight Kg (Average and Sd) • **Male** • **Female**	 79.6 kg (Sd: 8.7) 60.8 kg (Sd: 5.1)
BMI kg/cms2(Averageand Sd) • **Male** • **Female**	 24.1 kg/cms2 (Sd: 1.37) 23.08 kg/cms2 (Sd:1.38)
Length of Right Leg (cms.) • **Male** • **Female**	 96.2 cms (Sd: 7.36) 82.85 cms (Sd: 9.61)
Length of Left leg (cms.) • **Male** • **Female**	 95.88 cms (Sd:7.47) 82.71 cms (Sd: 9.41)

Table 2

Standardized average distance obtained (%) pre NMB - immediately post NMB - 3 days post NMB, right (R) and left (L), with p <0.05 for all comparisons.

DISTANCES:	PreNMB		Post NMB		Post3NMB			
	D	I	D	I	D	I	D	I
Anterior	78.43	78.91	83.44	84.03	81.42	84.03	p<0.05	p<0.05
Posteromedial	91.02	91.53	96.30	95.90	92.16	92.13	p<0.05	p<0.05
Posterolateral	86.21	83.01	91.56	88.93	88.12	85.96	p<0,05	p<0,05

Table 3

Comparison of standardized distances Pre NMB / Post NMB and Pre NMB / three days Post NMB in each of the 3 directions expressed in centimeters. Significant differences (*).

	Right Posteromedial	**Left Posteromedial**	**Right Posteromedial**	**Left Posteromedial**
	Pre NMB	Pre NMB	Post NMB	Post NMB
Post NMB	5.2794*	4.3687*		
3 days Post NMB	1.14	0.60	4.1424*	3.7669*

Table 4

Comparison of standardized distances Pre NMB / Post NMB and Pre NMB / three days Post NMB in each of the 3 directions expressed in centimeters. Significant differences (*).

	Right Posterolateral	**Left Posterolateral**	**Right Posterolateral**	**Left Posterolateral**
	Pre NMB	Pre NMB	Post NMB	Post NMB
Post NMB	5.3438*	5.8663*		
3 days Post NMB	1.91	2.89	3.44	2.98

Table 5

Comparison of standardized distances Pre NMB / Post NMB and Pre NMB / three days Post NMB in each of the 3 directions expressed in centimeters. Significant differences (*).

	Right Anterior	**Left Anterior**	**Right Anterior**	**Left Anterior**
	Pre NMB	Pre NMB	Post NMB	Post NMB
Post NMB	5.0038*	5.1259*		
3 daysPost NMB	2.98	5.1259*	2.02	0

The risk of injury decreases when using Kinesio taping in all subjects, and separately in men and women as well. However, given that the IC of each RR includes the value 1, it is not possible to reject the null hypothesis (RR = 1) and therefore it is not possible to assert that the risk of injury decreases statistically significantly. There is a tendency towards a decrease and this presents the NMB as a possible protective factor.

The relative risk of suffering an injury is lower in men than in women and in both cases, the risk of injury decreases when using a neuromuscular bandage. However, it is not possible to ensure that the NMB is a statistically significant protective factor due to the IC of each of the tests.

DISCUSSION

Due to the ever-increasing use of NMB, mainly in sports, it is necessary to have on hand as much evidence as possible in order to carry out its application based on the results of different studies. Ankle sprains results from an excessive supination of the rearfoot about an externally rotated lower soon after the initial contact of the rearfoot. When the supination moment exceed the compensatory pronation moment (peroneus muscles and lateral ligaments), excessive inversion and internal rotation occurs. (Fuller EA.,1999). Proprioception and proprioceptive training are known to reduce the risk of ankle sprain in athletes(Schiftan, G. S *et al.*,2015). The taping method in this study is used in a fashion that it applies tension along the tape, and placing the target muscles in a stretch position, theoretically increasing ankle proprioception and range of motion. From this point of view, the Neuromuscular Bandage theory sustains that its effects last for up to five days if applied and taken care of correctly (Kase K *et al.*,2003; Kase K *et al.*,2005: Slupik A *et al*.,2007). However, during the study and analysis afterwards, the data indicated that application of the bandage only has an immediate effect and once the three day period has passed (little more than half the theoretical functional time) there are no significant differences in the indicator that has been used, in this case, the risk of injury measured by the simplified SEBT. This information is clinically relevant

since it is far from the data obtained by the authors quoted in the previous paragraph(Kase K *et al.*,2003; Kase K *et al.*,2005: Slupik A *et al.*,2007). Therefore, NMB use should be kept to the indicated period of time in its use as a safe practice for muscle activation. The fact that this technique provides immediate post application results allows for its use as a tool for ankle stability support(Gribble PA *et al.*,2003; Gribble PA *et al.*,2004). It can be used during sports or training with the goal of activating muscles and as a complement to other strategies and injury prevention programs. Nevertheless, the exact amount of time the NMB effects last as an application for muscle activation has not been defined in the literature and thus it is open as a future field for study. With regards to the difference in obtaining significant results only in some variables and not others, it is noteworthy to mention that training varies depending on the sex of the subjects under study. Furthermore, since the assessments are conducted as per the protocols imposed by the instruments that are being used, the laterality of the leg was also not evaluated. Recent studies have shown that Non-Elastic Bandages are more effective in stabilizing ankles in functional tests when compared to the Elastic Bandage or Neuromuscular Bandage (NMB). This is practically predictable and logical if we consider that the Non-Elastic Bandage contains the joint and restricts its movement while the NMB seeks to increase its stability while influencing muscle activation. We believe that this is not a valid comparison since in spite of having the same objective, the principle upon which they act is different. The literature describes that there are differences in the amount of sports injuries basketball players present depending on the position they play on the court and therefore (Sánchez Jover F & Gómez Conesa A.,2008), it would be beneficial that in future studies this would be a factor to be considered as a variable in the data analysis. The differences obtained between men and women in the reach distances as well as the risk of injury(Meeuwisse WH *et al.*,2007) could be attributed to other factors that do not seem to be affected by the application of Neuromuscular Bandage such as differences in Q angle, decreased muscle flexibility, among others, in addition to some factors which Neuromuscular Bandages could affect such as differences in neuromuscular control (men vs. women). However, this last factor was not studied. (Gribble PA *et al.*,2003; Gribble PA *et al.*,2004; Gribble PA *et al.*,2012; Halseth T *et al.*,2004; Hertel J *et al.*,2000).

In general, it was observed that there is an influence of NMB in the risk of an ankle injury in the subjects pertaining to the university male and female basketball team when analyzing the data obtained from the simplified SEBTs that were performed. However, it was not possible to determine whether this influence significantly contributed to the athlete.

CLINICAL IMPLICATIONS

The risk of ankle injury is determined by multiple factors, among which there are modifiable and non-modifiable factors; this study shows how the use of neuromuscular bandage can have a part in preventing such injuries. Although more studies are needed to show a cause-effect relationship, this is the first step towards a preventive application and not palliation of the lesions, where the focus of long-term training can influence the final performance of these athletes.

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