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Ankle Taping Effectiveness for the Decreasing Dorsiflexion Range of Motion in Elite Soccer and Basketball Players U18 in a Single Training Session: A Cross-Sectional Pilot Study

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Abstract: Ankle sprains have been defined as the most common injury in sports. The aim of the present study was to investigate the ankle taping for the reduction of ankle dorsiflexion range of motion (ROM) and inter-limb in elite soccer and basketball players U18 in a single training session. Methods: A cross-sectional pilot study was performed on 38 male healthy elite athletes divided into two groups: a soccer group and a basketball group. Ankle dorsiflexion ROM and inter-limb asymmetries in a weight-bearing lunge position were assessed in three points: with no-tape, before the practice and immediately after the practice. Results: For the soccer group, significant differences ($p < 0.05$) were observed for the right ankle, but no differences for the asymmetry variable. The basketball group reported significant differences ($p < 0.05$) for the right ankle and symmetry. Conclusions: Ankle taping decreased the ankle dorsiflexion ROM in youth elite soccer and basketball players U18. These results could be useful as a prophylactic approach for ankle sprain injury prevention. However, the ankle ROM restriction between individuals without taping and individuals immediately assessed when the tape was removed after the training was very low.

Keywords: ankle sprain; taping; range of motion; soccer; basketball; prevention; musculoskeletal disorders; personalized treatment

1. Introduction

Ankle sprains have been defined as the most common injury in sports [1]. Worldwide, soccer and basketball are some of the most popular sports for both participation and viewing. These athletes reported the highest injury incidence ratios [2,3]. Elite soccer players experienced between 13 and 55 injuries per 1000 competitive hours. In addition, the lower limb is most commonly affected as foot, and ankle injuries were the most prevalent diagnoses in training or competition [4]. Regarding the basketball athletes, McKay et al. reported an ankle incidence rate of 3.85 per 1000 participations,

landings being the most prevalent mechanism of injury [5]. Most cases of ankle sprain in basketball and soccer players occurred when the foot takes an over-plantar-flexed position during running or landing after a jump [6]. In addition, amateur and youth soccer players have a higher risk of suffering a lateral ankle sprain than professional players due to an increase of strength and training experience for the professional players [7].

Functional approaches, including prophylactic methods such as taping, bandaging, or bracing of the ankle to protect the ankle ligaments have been studied, with the aim of reducing the incidence rates of ankle sprain injuries since the 1990s [8].

In the past decade, several studies have been developed to assess the effectiveness of ankle taping for the protection of the ankle ligaments in maximal stress situations, such as an ankle sprain [9]. Ankle taping was associated with competition, rehabilitation, and prevention sport contexts over many years. Karlsson and Andreasson reported a restricted range of motion (ROM) for the ankle joint in individuals with ankle taping but with a decrease in the peroneus muscle reaction time assessed by electromyography [10]. Taping with or without pre-wrap has also been studied, i.e., Ricard et al. reported the effectiveness of the ankle taping to reduce the average inversion velocity, maximum inversion velocity, and time to maximum inversion velocity, but no differences between individuals with or without pre-wrap were observed [11]. Pederson et al. argued that ankle taping was effective in the reduction of inversion movement in a study carried out in rugby players. In addition, authors have also reported that there may be a functional restriction on inversion parameters after exercise with ankle taping [12]. Callaghan reported that the inversion-eversion ROM had been limited by up to 41% as ankle taping in a non-weight bearing position presented as a restriction of the frontal plane movements [13]. Kemler et al. reported in a systematic review that elastic bandages and ankle taping were effective for the ankle sprain episodes [14]. Kerkhoffs et al. conducted a systematic review regarding the different bandage approaches for ankle sprain situations, and they concluded that the taping method is effective to limit the ankle ROM. However, several complications have been observed, such as skin irritations and a longer time to return to work when compared with an elastic bandage [15]. Jeffries et al. reported that ankle taping should provide protection to the ankle joint without affecting the planned change-of-direction or reactive agility performance in basketball players [16].

Currently, research showed that ankle taping is often employed in elite sports in order to prevent the incidence and severity of lateral ankle sprains. Thus, the aim of the present study was to investigate in elite soccer and basketball players U18 the effectiveness of ankle taping in the reduction of ankle dorsiflexion ROM and inter-limb asymmetries throughout the training session. Thus, we assessed the ankle dorsiflexion ROM in a weight-bearing lunge position in three time-points: (1) with no-tape, (2) before the practice, and (3) immediately after the practice. Prior research concluded that the ankle taping would reduce the ankle joint dorsiflexion angle immediately after the taping. However, we hypothesized that the taping had lost the initial effectiveness for restricting the ankle dorsiflexion ROM at the end of the training session, as the last minutes of the training session were the period of time in which there was a high injury risk for the athletes.

2. Materials and Methods

2.1. Design

A cross-sectional observational study was performed in November 2019 following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.

2.2. Participants

A total sample of 38 healthy male individuals aged between 15 and 17 years was recruited from two elite sports and divided into two groups following their sports discipline: A group composed of elite soccer players ($n = 18$) and B group composed of elite basketball players ($n = 20$). All the players were taped in both ankle joints, usually for training and competitions with a prescription of the

medical doctors from their clubs. Elite U18 individuals followed a training schedule of 3 hours-per-day, 5 days-per-week and played 1 to 2 matches in a week [17]. In addition, both groups were composed of individuals who have played at least 1 time with the national team [18]. Subjects were excluded if: they underwent a physical therapy treatment, suffered any musculoskeletal injury the last 6 weeks, had skins allergy and any history of lower limb surgery, did not complete all the training sessions, and had other foot orthoses.

2.3. Ethical Considerations

The Research and Ethics Committee from the Universidad Europea de Madrid has been approved this research (Villaviciosa de Odón, Madrid, Spain. Record code: 10-04-2019. CIPI/19/157). Before participating in the study, the players and parents were fully informed about the protocol and written informed consent was obtained by the parents of the players. The Declaration of Helsinki was fully respected throughout the study.

2.4. Taping: Procedure and Materials

Ankle taping was performed by two physiotherapists—one for the soccer team and one for the basketball team—both with more than 5 years of experience in taping methods in accordance with Williams et al. [19] procedures and the Sports Medicine Australia [20] guidelines protocol. Before the taping, all of the ankles were covered with a pre-wrap (Rehabmedic, Barcelona, Spain) by the physiotherapist in order to prevent skin alterations for daily use [21]. For the ankle taping, two anchor strips were applied around the leg 10 cm above the malleoli with a 38-mm self-adhesive tape (Leukotape, BSN Medical, Stockholm, Sweden). Secondly, with the foot maintained in a neutral position, two strips were placed from the medial side of the anchor tape and fixing to the lateral side. [19] The “figure sixes” for the subtalar joint were initially placed onto the medial anchor through the plantar surface of the foot to attach back onto the medial anchor. Finally, all the free endings and spaces without tape were covered to complete the ankle taping [19].

2.5. Training Sessions

The training session, in which subjects were evaluated in both groups, consisted of a 90-min technical session and was structured in 3 phases: warm-up (15-min), tactical skills (15-min), and scrimmage (60-min). This session did not comprise of a pre-game or post-game session.

2.6. Outcome Measurements

Ankle ROM assessment was developed by the *Dorsiflex* app (v.2.0, Balsalobre-Fernández, 2017, Madrid, Spain) installed on an iPhone 8 (iOS 12.1, Apple Inc., Cupertino, CA, USA). To measure dorsiflexion ROM, the iPhone 8 was placed at the tibial tuberosity to assess the angle between the tibia and the ground in a weight-bearing lunge position. This procedure was repeated with both legs, and the *Dorsiflex* app reported the dorsiflexion angle for each leg and the percent of asymmetry between the legs. In addition, the *Dorsiflex* app was considered as a valid, reliable, rapid, and easy-to-use tool to assess the ankle ROM and asymmetries in a weight-bearing lunge position [22]. Measurements were made in 3 time periods: (1) baseline, before the practice without bandage; (2) pre-training, immediately after the baseline measurement and before the training session; post-training, immediately after the end of the training session.

2.7. Statistical Analysis

SPSS v.23.0 for macOS (IBM SPSS Statistics for macOS, NY: IBM Corp) was used for statistical analysis. The Shapiro-Wilk test was used to check the normality data distribution. For each group separately, one-way analysis of variance (ANOVA) and Bonferroni’s correction were developed to

assess significant differences between the three-time points (basal, pre-training and post-training) and check the multiple comparisons, respectively. The effect size was calculated with the Eta² coefficient.

In order to observe the difference between groups, the Student's *t*-test—parametric data—and *U* Mann-Whitney test—no parametric data—were applied to test sociodemographic data between groups. To assess the effects of intra-subjects (time) and inter-subject (treatment groups) values on the dependent variables, a two-way ANOVA for repeated measures was performed (considering the significance of the Greenhouse–Geisser correction when the Mauchly test rejected the sphericity). The Bonferroni post-hoc test was employed for multiple comparisons. Furthermore, the effect size was calculated by the Eta² coefficient. The level of significance was set at $p < 0.05$ with an α error of 0.05 (95% confidence interval) and the desired power of 80% (β error of 0.2).

3. Results

Regarding Table 1, the height and weight showed significant differences ($p < 0.05$) between groups. For the soccer group, significant differences were observed for the right ankle [F (2,32) = 7.558; $p = 0.002$ (0.321)] and left ankle [F (2,32) = 9.813; $p = 0.001$ (0.380)], but no differences for the asymmetry variable. The basketball group reported significant differences for the right ankle [F (2,36) = 17.687; $p = 0.001$ (0.496)], the left ankle [F (2,36) = 35.204; $p = 0.001$ (0.662)] and the symmetry [F (2, 36); $p = 0.001$ (0.247)]. (Table 2) The Bonferroni corrections showed significant differences ($p < 0.05$) in the soccer group's right and left ankle between the baseline and pre-training and between the baseline and post-training moments for the right ankle whereas for the basketball group significant differences ($p < 0.05$) were shown for the right and left ankle between baseline and pre-training and in the right and left ankle between pre-training and post-training (Table 3).

The statistical analysis to assess the comparison of the ankle taping between soccer and basketball players reported significant differences in all variables for the time: right ankle [F (2, 68) = 19.022; $p = 0.001$ (0.359)]; left ankle [F (2, 68) = 34.339; $p = 0.001$ (0.503)] and asymmetry [F (2,68) = 7.842; $p = 0.001$ (0.187)].

In addition, the interaction time x group showed significant differences for the asymmetry [F (2, 68) = 0.415; $p = 0.002$ (0.012)]. (Figures 1–3) The Bonferroni corrections for the interaction between groups reported significant differences ($p < 0.05$) for the right ankle, the left ankle and the asymmetry variables between baseline and pre-training moments and the left ankle as well as the asymmetry between pre-training and post-training moments (Table 4).

Table 1. Sociodemographic data of the sample.

Data	Soccer Group (n = 17)	Basketball Group (n = 19)	Total Sample (n = 38)	<i>p</i> Value
Age, years	16.00 ± 1.0 †	15.00 ± 1.00 †	16.00 ± 2.00 †	0.005 ††
Height, m	1.73 ± 0.1 *	1.92 ± 0.12 †	1.83 ± 0.12 *	0.001 ††
Weight, kg	68.45 ± 6.75 *	82.04 ± 11.06 *	75.62 ± 11.45 *	0.001 **
BMI (kg/m ²)	22.61 ± 1.63 *	21.93 ± 2.53 †	22.29 ± 1.83 †	0.332 ††

Abbreviations: BMI, body mass index. * Mean ± standard deviation (SD) was applied. ** The Student T-test was performed for independent samples. † Median ± interquartile range (IR) was used. †† The Mann-Whitney U-test was performed.

Table 2. One-way ANOVA for the ankle ROM and asymmetry variables.

Group	Baseline	Pre-Training	Post-Training	Time F (Df); p (Eta ²)
Soccer				
Right ankle	39.71 ± 5.33	36.00 ± 6.55	36.88 ± 5.32	F (2,32) = 7.558; p = 0.002 (0.321)
Left ankle	38.82 ± 4.87	34.58 ± 5.86	37.49 ± 5.10	F (2,32) = 9.813; p = 0.001 (0.380)
Asymmetry	6.44 ± 3.44	10.40 ± 6.90	6.25 ± 5.68	F (2,32) = 3.213; p = 0.057 (0.167)
Basketball				
Right ankle	41.00 ± 6.6	37.67 ± 6.4	40.58 ± 5.6	F (2,36) = 17.687; p = 0.001 (0.496)
Left ankle	39.56 ± 6.7	34.9 ± 5.3	38.70 ± 5.7	F (2,36) = 35.204; p = 0.001 (0.662)
Asymmetry	4.56 ± 3.9	8.7 ± 5.1	5.95 ± 4.5	F (2,36) = 5.913; p = 0.001 (0.247)

Abbreviations: ANOVA, analysis of variance; ROM, range of motion. Values are mean ± SD unless otherwise indicated.

Table 3. Bonferroni correction values for the intra-subject (time) effects.

Measure	Right Ankle p Value	Left Ankle p Value	Asymmetry p Value
<i>Soccer</i>			
Baseline			
Pre-training	0.007	0.001	0.116
Post-training	0.021	0.611	1.000
Pre-training			
Post-training	1.000	0.054	0.184
<i>Basketball</i>			
Baseline			
Pre-training	0.001	0.001	0.007
Post-training	1.000	0.575	0.361
Pre-training			
Post-training	0.001	0.001	0.286

Table 4. Two-way ANOVA and Bonferroni correction values for the intra-subject effects of the total sample.

<i>Two-Way ANOVA Values</i>			
	Time F (Df); p (Eta ²)		Time x Group F (Df); p (Eta ²)
Right ankle	F (2,68) = 19.022; p = 0.001 (0.359)		F (2,68) = 2.585; p = 0.083 (0.071)
Left ankle	F (2,68) = 34.393; p = 0.001 (0.503)		F (2,68) = 0.316; p = 0.730 (0.009)
Asymmetry	F (2,68) = 7.842; p = 0.001 (0.187)		F (2,68) = 0.415; p = 0.002 (0.012)
<i>Bonferroni correction values</i>			
Measure	Right ankle p value	Left ankle p value	Asymmetry p value
Baseline			
Pre-training	0.001	0.001	0.001
Post-training	0.009	0.206	1.000
Pre-training			
Post-training	0.009	0.001	0.032

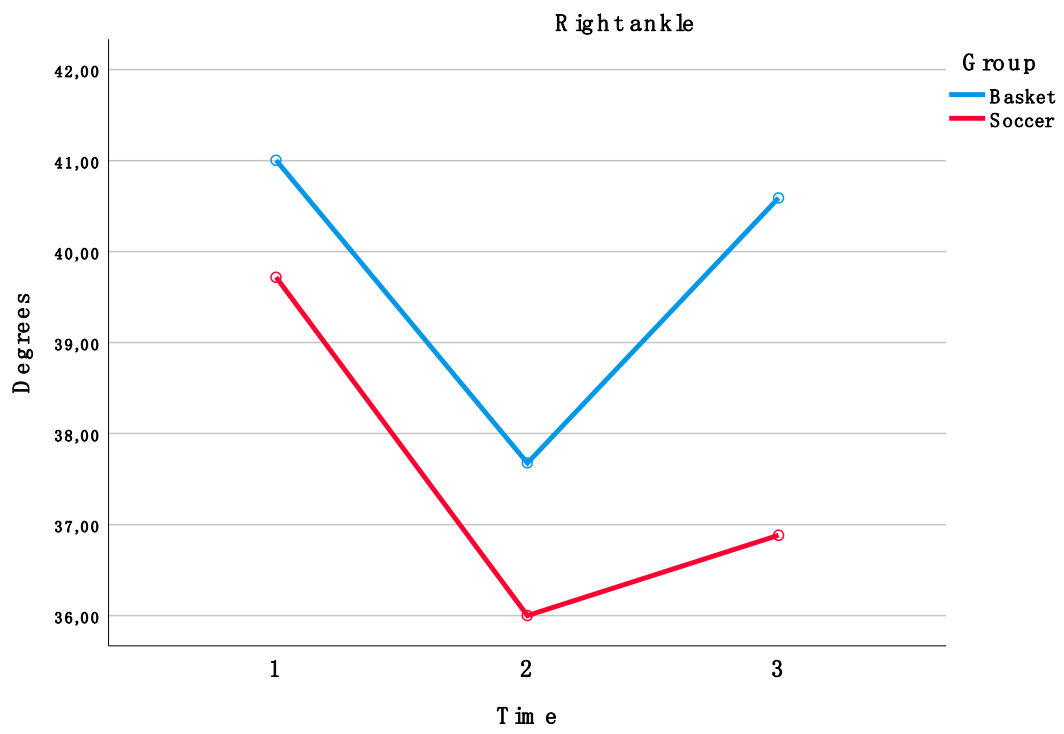


Figure 1. Right ankle ROM values for each group in three measurement times.

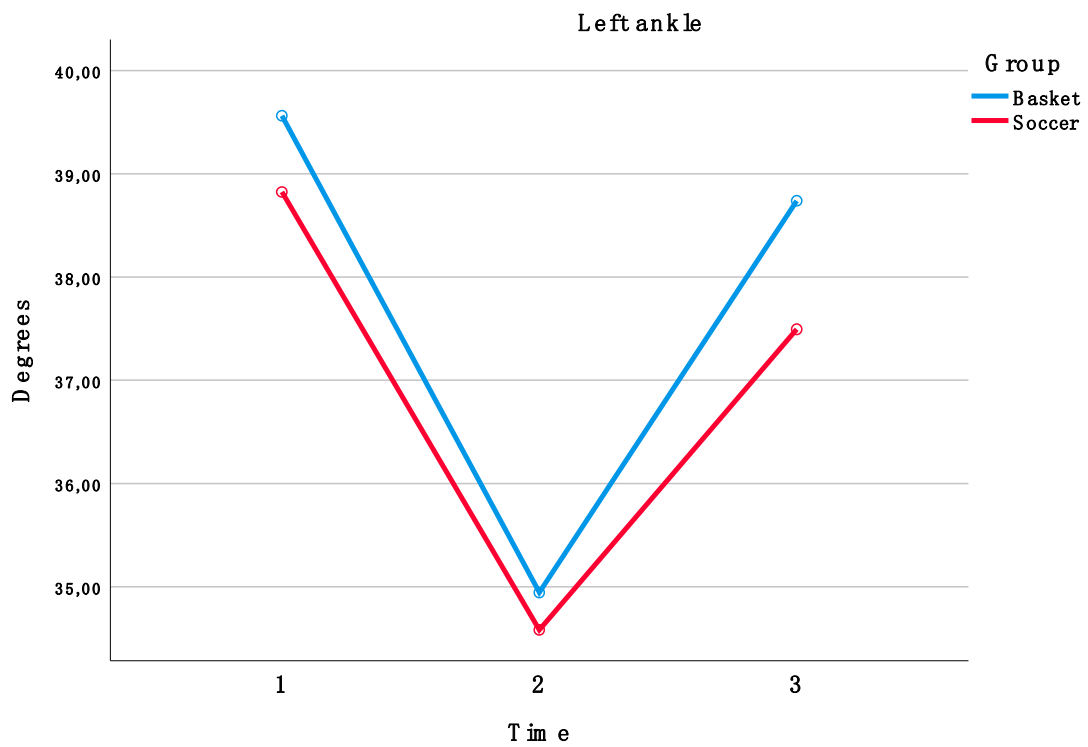


Figure 2. Left ankle ROM values for each group in three measurement times.

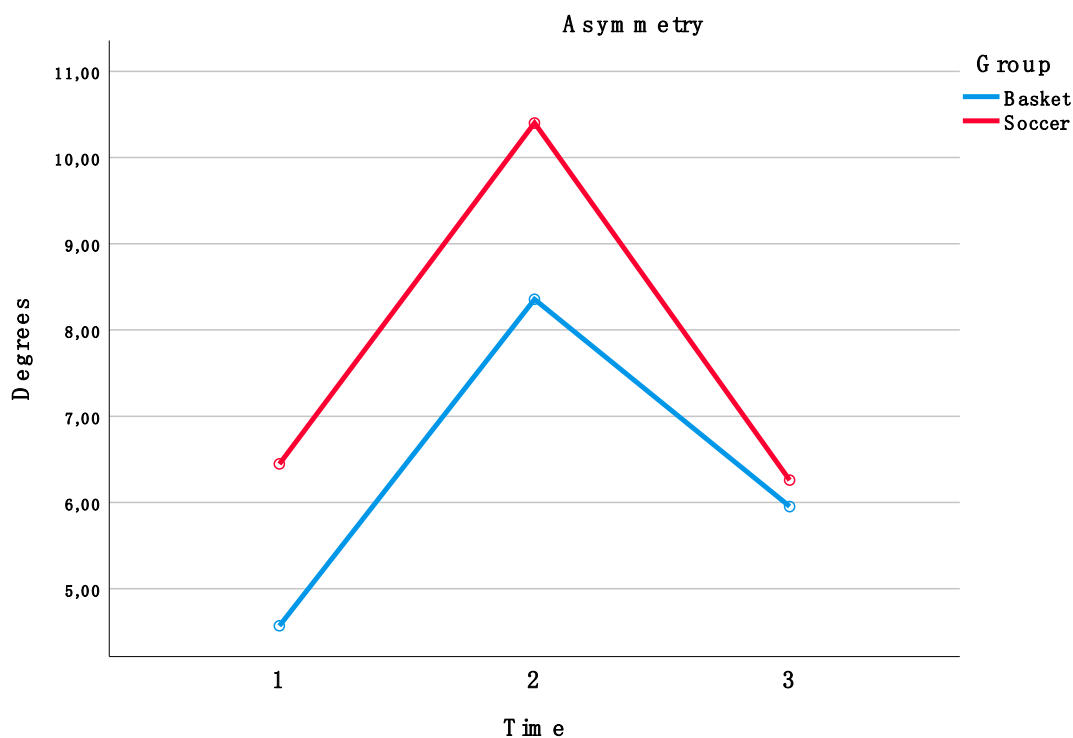


Figure 3. Asymmetry values for each group in three measurement times.

4. Discussion

This research compared the ankle taping on ankle mobility during three specific moments on a daily basis in youth elite soccer and basketball players. The results of the present study suggest that a prophylactic approach, such as ankle taping, is effective for the ROM restriction of the ankle joint immediately after the taping application in soccer and basketball players without differences between groups. However, in the final minutes of the session, where the intensity and the fatigue levels were at its highest peak [23], the ROM values were similar to the baseline values.

According to the findings of the present study, several authors reported the effectiveness of the ankle taping for the ankle ROM restriction [10,12]. For example, Quackenbush et al. argued that the ankle taping was an effective prophylactic method without decreasing jump performance in athletes. [24] Willeford et al. performed a study in collegiate football players and reported that with a bandage of the ankle joint—self-adherent and lace-up ankle brace—a ROM restriction was produced without affecting the dynamic balance [25]. According to the results of the present study, an ankle dorsiflexion ROM increase was observed immediately post-match in soccer players and basketball players—without a bandage [26,27]. However, in both groups, a decrease of ankle dorsiflexion ROM was observed 48 h post-match. Therefore, prevention and recovery strategies in order to minimize the ankle dorsiflexion restriction should be performed in soccer and basketball players. Regarding muscle fatigue and biomechanics, chronic ankle instability and fatigue were related to postural control by disturbances detected on sagittal-plane joints adjacent to the ankle, which may have influence in the ankle dorsiflexion ROM values after training sessions [28].

In addition to the above, landing mechanisms have been defined as a risk factor for ankle sprains in sports populations, De Ridder et al. argued that taping is able to stabilize the ankle joint prior to touch down, placing the ankle joint in a safe position before the landing phase [29]. In addition, Chinn et al. reported that the changes in the foot positioning in individuals with ankle taping could be a protective effect for the prevention of the lateral ankle sprains [30]. In addition, ankle taping increases the confident sense in dynamic-balance activities [31].

Regarding the ankle dorsiflexion asymmetry concept, Rabin et al. determined that weight-bearing ankle ROM should not be assumed to be bilaterally symmetrical [32]. However, the results of the present study reported an asymmetry increase when the taping was applied. Currently, research about the normative values for weight-bearing ankle ROM symmetries reported a dorsiflexion ROM increase of 23% in male military subjects for the dominant side with respect no-dominant side [32]. In the context of the ankle dorsiflexion asymmetry in professional soccer players, Moreno-Pérez et al. reported that ankle dorsiflexion ROM increased after a match in the dominant ankle but decreased 48 h post-match when the post-match assessments in both ankles—dominant and non-dominant—were compared [26]. In this line, a recent study reported that the ankle dorsiflexion ROM was increased post-match from pre-match in both dominant and non-dominant limbs and decreased 48 h post-game in semi-professional players [27]. An asymmetry increase immediately after the ankle tape application could be explained by the restriction of the musculoskeletal structures which surround the ankle joint or alterations of the sensitive proprioception mechanisms due to the taping application [33].

Other useful taping alternatives for ankle sprain prevention could be the kinesiology tape, [7] kinesiotape, [34], or distal fibular taping [35].

4.1. Clinical Considerations

Based on the prior literature and the findings of the present study, it could be supported that ankle taping was an effective and prophylactic method to reduce the ankle dorsiflexion ROM and, consequently, for the prevention of ankle sprain in sports populations. However, the fact that no differences were observed for the soccer left ankle, both basketball ankles from baseline to post-training values could be defined as the ankle taping having “dynamic effectiveness”. Therefore, further research is needed in order to develop new strategies to maintain the initial effectiveness throughout the training session and games. For example, the addition of active stripes or to intensify the ankle taping in the training pauses and games half-times.

4.2. Limitations and Future Lines

Some limitations should be acknowledged in the present study. Although the physical therapist had more than 5 years of experience in taping strategies and functional assessments, the fact that both teams had not been taped and assessed by the same therapist may be a limitation as a human bias for the ankle dorsiflexion ROM and asymmetry were variables. Another limitation could be the fact that just one session was evaluated for each group. Weight, height, and BMI variables were descriptive variables and were found obvious differences between groups. It would be interesting to take them into account for the comparison between groups. In addition, the differences between these two sports in training skills in the footwork and training sessions specific exercises could also be a limitation.

Further research is needed in order to evaluate dynamic balance, landing situations, and lower limb stability with a pressure platform. In addition, electromyography or ultrasound imaging assessments for the muscular activation and the muscle architecture of the muscles related to the ankle joint could be useful to explore the effects of the ankle taping in a deep manner. Several authors reported the effectiveness of ankle taping also in psychological aspects such as better perceptions of confidence and reassurance; thus, it would be interesting to study these variables in soccer and basketball populations.

5. Conclusions

Ankle taping decreased the ankle dorsiflexion ROM in youth elite soccer and basketball players U18. These results could be useful as a prophylactic approach for ankle sprain injury prevention. However, the ankle ROM restriction between individuals without taping, and individuals immediately assessed when the tape was removed after the training was very low. Thus, further research is needed in order to develop new strategies to maintain the initial effectiveness throughout the training session and games.

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