Original Article

Kinetic effect of the taping on the ankle during a change of direction in basketball players

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ABSTRACT

The purpose of this study was to compare the kinetic effect, with (WT) and without (WoT) the use of ankle taping, during a change of direction in basketball players. Twenty-two players were evaluated (11 men, 11 women; age = 21.50 ± 1.74 years, mass = 72.80 ± 13.14 kg, height = 1.71 ± 0.11 m). The functional task of "*change of direction in 60°*" was registered with a 3D motion analysis system and a force plate. The torques of eversion, plantarflexion, and ankle joint reaction force were evaluated during the braking phase, using an inverse dynamics method. To compare between conditions a t-student or Wilcoxon tests were used. The results revealed that the use of ankle taping yield a decrease in the anterior joint reaction force (WoT = 4.21 ± 1.36 N/kg vs WT = 2.92 ± 1.07 N/kg, p < .0001) and the eversion torque (WoT = 0.56 ± 0.24 Nm/kg vs WT = 0.51 ± 0.20 Nm/kg, p = .02) during a change of direction in 60º. In conclusion, according to the sample of assessed basketball players, the use of this bandage could contribute to the functional stability of the ankle, decreasing the torque of fibularis muscles and the shear anterior-posterior between the shank-foot segments.
Keywords: Torque; Joint reaction force; Braking phase; Athletic tape.

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INTRODUCTION

Ankle injuries are one of the most common in the sports field, accounting for about 10% to 30% of all the body areas (Fong, Hong, Chan, Yung, & Chan, 2007). Furthermore previous reports indicate that ankle sprain is the most frequent injury, representing approximately 70% of the injuries associated with this joint (Fong et al., 2007). In basketball, 62.4% of all the injuries occur in the lower limb; being the ankle the most affected joint (14.7%) and the anterior talofibular ligament with the highest incidence (Kaminski et al., 2013).

In addition, the most frequent sports movements associated with the production of ankle sprains (Ferran & Maffulli, 2006) is landing (45%), followed by abrupt changes of direction (30%). Due to the high prevalence and recurrence of this injury, series of preventive measures for ankle sprains have been proposed in the literature, such as specific functional training, use of orthosis and functional bandages (Hall, Docherty, Simon, Kingma, & Klossner, 2015; Kaminski et al., 2013; Mickel et al., 2006). These methods have shown to be highly effective in reducing the frequency of ankle injuries (Mickel et al., 2006), decreasing the incidence rate in athletes (Kaminski et al., 2013), especially in those with history of previous injuries (Olmsted, Vela, Denegar, & Hertel, 2004).

Some studies emphasize the effects of taping during the performance of functional tests, resulting in favourable changes in the agility developed by some athletes (Ambegaonkar et al., 2011). Nevertheless, the effect of this type of bandage is still a matter of controversy in the sport area. For example, in football players the abrupt directional changes modify the kinematics and kinetics of the ankle with the use of taping, increasing the mechanical stability of the joint (Stoffel et al., 2010). In other sports such as the basketball, Meana et al. (2005, 2008) investigated the effect of this bandage on the ankle, and the kinematics modification during a change of direction in 60°. Their results indicated a significant decrease in the range of motion (ROM), but not in the kinetic variables, where it was only observed tendency to increase of ground reaction force (GRF) in the vertical direction was observed. However, if the force magnitudes are compared during the braking and impulse phases, the anterior-posterior GRF shows great variations (braking phase = 422.73 ± 73.18N; impulse phase = 151.92 ± 53.54N), being approximately 2.8 times greater in the braking phase (Meana, López Elvira, Grande, & Aguado, 2005). Consequently, this difference could directly influence the anterior joint reaction force of the ankle and the development of torques, especially in the braking phase during an abrupt directional change. However, few studies are describing the kinetics of the ankle with the use of taping in functional tasks associated with the sport. Therefore, the purpose of this study was to compare the kinetic effect, with (WT) and without (WoT) the use of ankle taping, during a change of direction in basketball players.

MATERIAL AND METHODS

Participants

Firstly, the sample size was calculated (G-Power 3.1.9.2, Universität Kiel, Germany) using the values of the eversion torque described by Stoffel et al., (2010). Considering a power of 80% and an alpha of .05, obtaining a minimum sample of 22 volunteers. Finally, 131 amateur basketball players were recruited, of which 11 women (age: 21.27 ± 1.68 years) and 11 men (age: 21.73 ± 1.85 years) were evaluated (belonging to different university teams). All players had from three to seven years of experience in the practice of basketball, with a minimum of four hours of training per week.

The volunteers with musculoskeletal lesions in the hip, knee, ankle, or any other area of the lower limb, during the last 6 months, were not considered. The ankle stability was determined using two instruments: the

Cumberland Ankle Instability Tool (CAIT) questionnaire, considering a score higher than 27.5 (Hiller, Refshauge, Bundy, Herbert, & Kilbreath, 2006), and the Star Excursion Balance Test (SEBT), considering a score higher than 94% among the three evaluated directions (Plisky, Rauh, Kaminski, & Underwood, 2006). The selection process of basketball players is shown in Figure 1. All volunteers previously signed an informed consent, approved by a local bioethics committee.

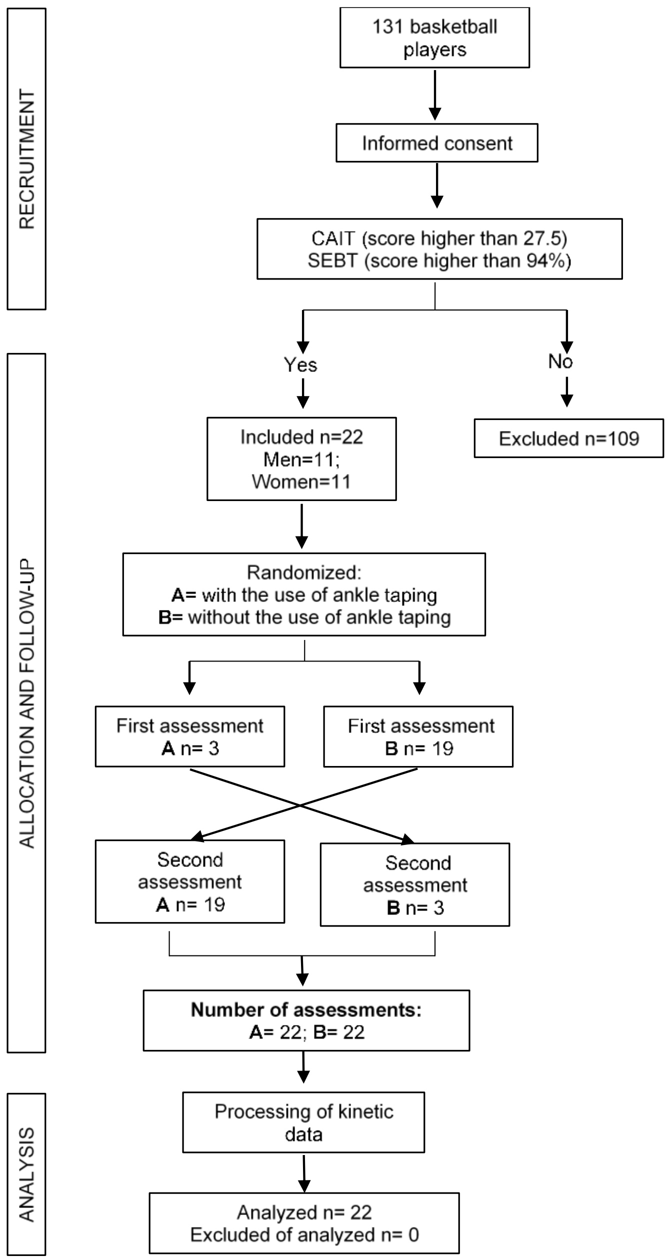

Figure 1. Flowchart of the study design. Assessment tools used: Cumberland Ankle Instability Tool (CAIT) and Star Excursion Balance Test (SEBT).

Equipment

Kinematic and kinetic data were captured using a 3D motion analysis system with eight infrared cameras (T-Series, Vicon Motion Systems, Oxford, UK), recording the movement at 200 Hz and one force plate (FP4060-

05-PT-1000, Bertec, USA), measuring the ground reaction forces at a frequency of 1000 Hz. In addition, 16 reflective markers measuring 14 mm diameter were used to represent the segments of the lower limbs located according to the Plug-in gait model (Davis, Õunpuu, Tyburski, & Gage, 1991). Data were obtained by the Nexus software (Vicon Motion Systems, version 1.8.5, UK).

Experimental procedure

The dominance of each athlete's lower limb was determined by a dynamic test, which consisted of stepping up and down a 30 cm high step (Sadeghi, Allard, Prince, & Labelle, 2000). The markers were placed on the following anatomic landmarks: i.- second metatarsal head, ii.- fibular malleolus and iii.- calcaneus apex. Each anatomic landmark was outlined on the skin with a marker; additionally, their positions were recorded using the following measurements: i.- length between the distal limit of the second toe and the head of the second metatarsal of the same toe. ii- length of the vertical line drawn from the lateral malleolus to the lateral edge of the foot sole. iii.- length of the vertical line from the calcaneus to the posterior plantar edge. These measures allowed us to reproduce the position of the landmarks WT and WoT. Then, each participant performed a 5 minute warm-up on a stationary bike at 60 rpm and 70 Watts. Subsequently, the participant was instructed in the execution of the functional task. The test consisted of running three meters from the established starting point at maximum speed in the force plate direction. The volunteer touched the plate with the dominant foot developing a change of direction in 60°, guided by a mark on the floor (see Figure 2). To become familiarized with the test, each subject performed the same task three times. Then, seven repetitions were recorded for each condition (WT or WoT).

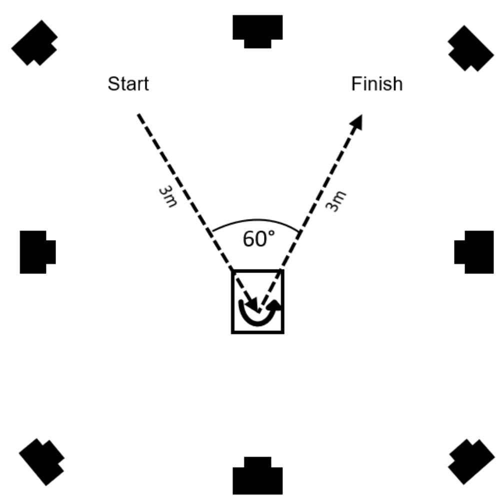

Figure 2: Experiment setup, overhead view. The discontinue line illustrates the route developed by the subjects, considering a change of direction in 60º.

Furthermore, an ankle taping was applied to each volunteer according to the Bové's recommendations (Bové, 2000). The technique was performed by a certified professional, who applied a pre-bandage (Dream Mousse Salvapelle Sixtus®, Italy) and a rigid tape (Sixtus Dream Tape, Italy).

The group that started WoT (group B), waited 30 minutes before installing the bandage and performing the tests under the second condition. The players who started WT (group A) performed the test in two sessions, separated by at least 24 hours. This was carried out to "*cleanse*" the described proprioceptive effects that remain after removing the bandage (Hughes & Rochester, 2008).

Data processing

The analysis of the variables was determined in a window defined according to the ground reaction force in the anterior-posterior direction (GRFx), considering the initial 50% of the task (equivalent to the braking phase). All data were extracted from the Polygon software (VICON®, UK). The eversion and plantarflexion torque of ankle, as well as the anterior joint reaction force were determined applying a method of inverse dynamics and described with positive values. Finally, each kinetic variable was normalized to body weight.

Statistical analysis

Each condition (WT and WoT) was characterized with the median as the representative measure of seven tests developed by the basketball players (considering torques and anterior-posterior joint reaction force). Subsequently, the data distribution was assessed with the Shapiro-Wilk test. Following this, the t-student test was applied to compare the kinetic variables of the ankle, WT and WoT. Besides, the Cohen's d was considered to inform the effect size between both conditions (< 0.50 = small, 0.50 - 0.80 = small to moderate, > 0.8 = large). All data were analysed considering one-tailed, with a confidence interval of 95% (IC) using the STATA software (12.0 version, StataCorp LP, USA).

RESULTS

The demographic characteristics of the players are shown in Table 1. The mean value of the CAIT score was 28.91 ± 0.81 points, while the percentage of the SEBT was 102.29 ± 5.35%. The description by sex is indicated in Table 1.

Table 1. Demographic characteristics and scores obtained in two tests that assess the ankle stability.

	Men (n = 11)	**Women (n = 11)**	**All (n = 22)**
Age (years)	21.73 ± 1.85	21.27 ± 1.68	21.50 ± 1.74
Mass (kg)	81.82 ± 10.20	63.78 ± 8.92	72.80 ± 13.14
Height (m)	1.80 ± 0.06	1.63 ± 0.08	1.71 ± 0.11
IMC (kg/m^2)	25.17 ± 2.17	24.02 ± 2.37	24.60 ± 2.29
CAIT (score)	28.95 ± 0.79	28.86 ± 0.87	28.91 ± 0.81
SEBT (%)	102.97 ± 5.75	99.15 ± 8.25	102.29 ± 5.35

Note: (CAIT: Cumberland Ankle Instability Tool. SEBT: Star Excursion Balance Test), considering n = 22 players (Mean ± standard deviation).

In regard to the dominant lower limb, only four basketball players (2 women and 2 men) were left-handed. Considering the total assessed sample, during the braking phase, only the eversion torque of ankle showed significant differences between the two conditions (without taping = 0.57± 0.24 Nm/kg vs with taping = 0.51 ± 0.19 Nm/kg; IC 95% = 0.01 - 0.10; d = 0.27; p = .01), being lower with the use of taping (Figure 3).

On the other hand, the antero-posterior joint reaction force only showed anterior components during the braking phase, which decreased significantly with the use of taping (without taping = 4.21 ± 1.36 N/kg vs with taping = 2.92 ± 1.07 N/kg; IC 95% = 0.79 - 1.78; d = 1.04; p < .0001, see Figure 4).

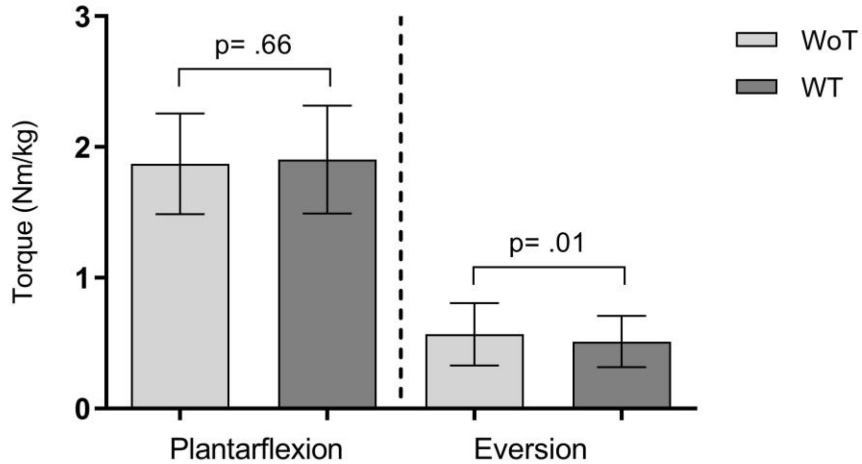

Figure 3. Change in the eversion and plantarflexion torque in the ankle, normalized to the body weight (considering two conditions: WoT and WT).

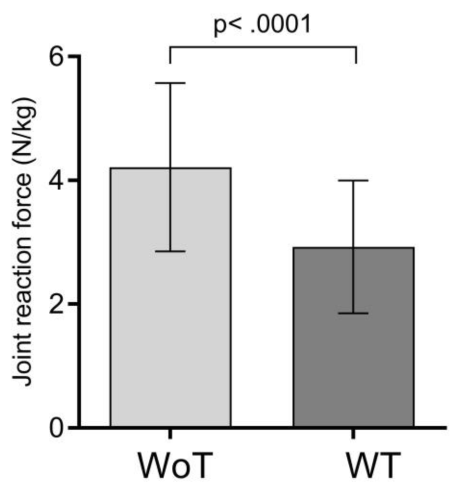

Figure 4. Change of the anterior joint reaction force in the ankle, normalized to the body weight (considering two conditions: WoT and WT).

DISCUSSION

Several studies have measured the kinematic and kinetic behaviour of taping in the ankle joint (Hong et al., 2019; Meana, Alegre, Elvira, & Aguado, 2008; Meana et al., 2005; Stoffel et al., 2010), assessing its preventive effect in injuries as frequent as the sprain (Mickel et al., 2006). In addition, special emphasis has been placed on movements involving abrupt directional changes, given their relationship with the etiology in the ankle injuries, generated by the solicitation of combined movements (Raymond, Nicholson, Hiller, & Refshauge, 2012). Currently, the use of the taping has served as a preventive method to reduce this type of sports injury (Merino, Fernández, Iglesias, & Mayorga, 2011; Sato, Nunome, Hopper, & Ikegami, 2017; Williams, Ng, Stephens, Klem, & Wild, 2018). As stated above, this research searched to compare the ankle joint reaction forces and internal torques, during a change of direction in 60°, WT and WoT in basketball players. The main findings were related to the significant reduction of the anterior joint reaction force (AJRF with a large effect size) and the eversion torque (ET with a small effect size) of the ankle by the action of the taping. The first change on the AJRF could relate to shearing between the shank-foot segments. This could be due to a great mechanical demand of both structures during the braking phase, which decreased with the use of the taping. Based on this fact, previous studies have reported a restriction in the movement generated by using this type of bandage (Meana et al., 2008; Williams et al., 2018), which could be reducing the acceleration component between the shank-foot segments during a change of direction. Another relevant finding can be associated with a decrease in demand on the main ligaments that stabilize the tibiofibular mortise (Levangie & Norkin, 2005), such as: anterior talofibular, calcaneofibular, posterior tibiotalar and posterior talofibular (Attarian, McCrackin, DeVito, McElhaney, & Garrett, 1985). Additionally, the effect produced by the taping on the AJRF during the braking phase could help to decreases the magnitude of one of the mechanical factors associated with the development of ankle sprains.

Furthermore, different researches have associated the mechanical instability with the incidence of sprain, where the anterior-posterior laxity of the ankle is one of the most common factors (Hertel, Denegar, Monroe, & Stokes, 1999; Kjaersgaard-Andersen et al., 1991; Kobayashi & Gamada, 2014). Consequently, and according to our data, a reduction of the AJRF generated by the use of taping could provide greater anterior-posterior stability in basketball players. However, further research are needed to analyse the behaviour of this variable in players with ankle functional instability.

Another relevant finding of this research shows a decrease of the ET in the ankle, with the use of taping in the breaking phase, describing possibly a greater control in the frontal plane of this joint, which has already been reported in some studies (Stoffel et al., 2010; West, Ng, & Campbell, 2014). Furthermore, similar results were obtained by Stoffel et al. (2010), who described a decrease in the ET during a change of direction (45º) in soccer players. As a result, this finding could represent a reduction of the work developed by the fibular muscles. This theory could be related with the decrease in the eversion and inversion movements as a consequence of the bandage, increasing the joint stability and reducing the work of the muscles that control the inversion. However, it is necessary to develop new studies that will evaluate the myoelectric activity of the fibularis muscles during a change of direction, describing the behaviour of the electromyographic amplitude during the braking phase. Besides, future studies could search the relationship between the activation time of periarticular musculature of the ankle and the AJRF during a change of direction, with the use of taping. This would allow us to discuss its preventive role, as well as the recurrence and early player's reincorporation.

One limitation of the study was the place to develop the change of direction, considering that these athletes have a greater space to execute this task in the quotidian practice. This could modify the impact acceleration of the shank-foot segments on the ground, affecting the kinetics magnitudes.

CONCLUSIONS

In conclusion, considering the assessed sample, the use of taping applied on the ankle in basketball players decrease the AJRF and the ET during the braking phase in a direction change of 60º. This bandage could contribute to the functional stability of the ankle, maybe reducing the injuries in these players, and providing a decrease of the joint stress during gestures with a high risk of damage such as direction changes.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Oscar Valencia, Camila Saka and Carlos Ramos. The first and the last draft of the manuscript was written by all authors. All authors read and approved the final manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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