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Original Article

The effect of ankle prophylactic bracing and taping in healthy basketball players performance during Lay-up

EVAGGELOS SYKARAS[1], PANAGIOTIS PSARRIANOS[2], DIMITRIOS LYTRAS[3]
[1,2,3]Laboratory of Sports Injuries, Department of Physical Education and Sports Sciences, Aristotle University of Thessaloniki, 57001 Thermi Thessaloniki GREECE.

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Abstract:
Ankle bracing and functional taping are used from basketball players as a means of ankle injury prevention. Even though their use has been proven to be effective in reducing ankle sprains, they have been accused by many for negatively affecting the performance of athletes. The purpose of this study was to examine how the different ankle external stabilizers affects the ground reaction forces that are developed in the ankle during the lay-up as well as the ankles dorsiflexion range of motion (ROM). 11 healthy male basketball athletes (Age 26+/-2,2) tried 3 different external stabilizers: a lace-up brace, a aircast-stirrup brace and taping, in comparison to simple shoes, while doing 3 lay-ups using each type of stabilizer. The maximum ground reaction forces on the lateral, anterior-posterior, and vertical axes was measured with a force platform, while the maximum angle of ankle dorsiflexion was measured with the Vicon motion analysis system. For the statistical analysis of the results, the non-parametric Friedman test was selected while pairwise comparisons were made with the Wilcoxon Rank Test. The level of statistical significance was set at $p < 0.05$, while the personal impression of the players on how they felt about their performance with each type was also taken into account in order to examine psychological factors. The results showed statistically significant differences in the ground reaction force in the lateral ($p = 0.006$) and the vertical axis ($p = 0.045$) between the lace-up brace and the shoe and between the tape and the shoe while there were no statistically significant differences of the different types in dorsiflexion range of motion. In conclusion, none of the three external stabilizers appeared to negatively affect the performance of the athletes. In contrast, the lace-up brace and the tape improved the performance of the athletes in the lay-up as with them the ground reaction force was increased, without, however, limiting the motion range. This specific issue requires further research.
Key words: prophylactic braces, tape, sports performance

Introduction

For basketball players, the ankle is the most commonly injured area with the ankle sprain showing the highest incidence of injury. According to Neces Sacco et al (2006) and McKay et al (2001), the percentage of an ankle injury is 3,85 per 100 participants, while about half (45,9%) of the players are excluded from playing for at least a week. Messina et al. (1999) report that 30% of all injuries in high school basketball players involve the ankle joint. Furthermore, the initial sprain has been shown to be a strong predisposing factor for recurrent sprains that can lead to chronic ankle instability and thus the prevention of the initial injury is very important (DiStefano et al, 2008).

It is very common for basketball athletes to uses prophylactic measures, such as braces or functional taping (Calllaghan, 1997; Hume and Gerrard, 1998; DiStefano et al, 2008) as a means of ankle sprain prevention, because there is some evidence that their use reduces the possibility of a sprain (Thacker et al, 2003; Abian-Vicen et al, 2009; Reuter et al, 2016).

Several researchers have compared the effectiveness of braces and taping in ankle injury prevention. Researchers report that the two external stabilizers show similar results in sprain protection (Garrick & Requa 1973; Sitler et al, 1994; Hume and Gerrard, 1998; Reuter et al, 2016; Mickel et al, 2006) reducing the frequency of injury or recurrence. Both the braces and the taping restrict the ROM of inversion and eversion movements of the foot. As a result, the ankle remains in a neutral position before landing from a jump, limiting the stressful inversion-eversion forces that tend to cause injuries in the ligaments of the area.

On the other hand, it is known that the braces, as well as the taping, are limiting the ankle dorsiflexion range of motion. According to many authors, this restriction is responsible for the change of the entire lower leg biomechanics and has been associated with limiting their functional performance (DiStefano et al, 2008; Riemann et al, 2002). As such, the question is posed as to whether the use of external ankle support as an injury prevention means can affect the performance of healthy athletes that do not have a history of injuries.

Several studies have studied the effect of supportive gear in sports performance. Some of them concluded that external support affects activities such as jumping and running (Bot et al, 2003; Bot & Mechelen

Corresponding Author DIMITRIOS LYTRAS, E-mail: lytrasde@gmail.com

1999;), while other authors relate the preventative use of the brace even to injury (Mason-Mackay et al, 2017). However, DiStefano et al (2008) found that long-term use of the ankle brace did not cause any changes in lower extremity kinematics or vertical ground reaction forces in healthy volleyball and basketball athletes, while Riemann et al (2002) report that the use of both the brace and the taping reduce the time required to reach the peak impact forces during dynamic activities. Researchers note, however, that the topic remains to be elucidated. Another issue regarding the use of ankle support instruments is the impression the athletes themselves have on their use. The notion that the ankle support makes them less functional can discourage athletes, coaches and physiotherapists from using them as a means of preventing the ankle injuries. According to Barkoukis et al (2002), the impression that athletes themselves have on the different preventative ankle stabilizers, as well as the lack of familiarity, may affect their performance due to caution or insecurity.

Reasonably, the question is posed as to whether the aforementioned prevention and support ways truly affect the factors that determine the performance, such as the ground reaction forces that develop during an effort made by a basketball athlete.

The purpose of this study was to examine whether the different ankles external stabilizers affect athletic performance, through the ground reaction forces as well as ankle dorsiflexion ROM. 11 healthy basketball players performed the dynamic lay-up movement with each one of the following support instruments: lace-up, air-cast brace, tape and without support (just the shoe) in random order. The ground reaction forces of the ankle to the 3 movement axes and the maximum ankle dorsiflexion angle were recorded with the different external stabilizers and the results were compared with each other. The impression of the athletes on how theses different support ways affect their performance was also recorded.

Material & methods

Participants

11 healthy male basketball players aged 26 ± 2,2 participated in this study. They all competed in the national championship B' and C' categories, with at least 6 training sessions and a game per week. Their training age was 18,5 ± 2,7 years (table 1).

Table 1. Somatometric characteristics of participants

N	Age (years) (mean & sd)	Weight (Kg) (mean & sd)	Height (m) (mean & sd)	Training Age (years) (mean & sd)
11	26 ± 2,2	82 ± 9,5	185 ± 7,6	18,5 ± 2,7

Inclusion criteria of participants were to be active athletes with no history of ankle functional instability, while the exclusion criteria included a history of lower leg injury, prior leg surgery and the use of any leg braces or taping in the last 3 months.

Outcomes measures

All measurements were performed in laboratory conditions with the use of the Bertec force platform (Force Plate FP4060-084060 USA) and the Vicon motion analysis system (612 Oxford metrics, UK) that included 6 120 HZ frequency cameras.

The maximum ground response forces on the three axes of motion (lateral x, anterior-posterior y and vertical z) were measured in four different lay-up conditions (lace-up brace, air-cast brace, taping and no support) using the Bertec force platform. Additionally, the maximum ankle dorsiflexion angle for each lay-up was measured with the Vicon system, in order to determine the degree of range of movement (ROM) limitation of the ankle dorsiflexion with each support type.

Procedure

Each athlete, after pre-warming for 10' by running and test jumping, then performed 3 lay-ups without support and 3 with each type of functional brace or taping (lace-up, air-cast, inelastic adhesive tape). The average of the 3 efforts with each type was selected for the analysis. A lay-up constitutes of two steps and a jump that is performed using one leg. The measurements were taken on the leg that was on the ground before the jump and which should step on the centre of the force platform. The individual could take as many steps as they liked just before recording this sequence. Furthermore, before the start of each effort that the participants used a different stabilizer, their opinion was asked on whether the specific type improved or reduced their performance. After taking the measurements, they were asked to determine how comfortable they felt with each support type.

Statistical analysis

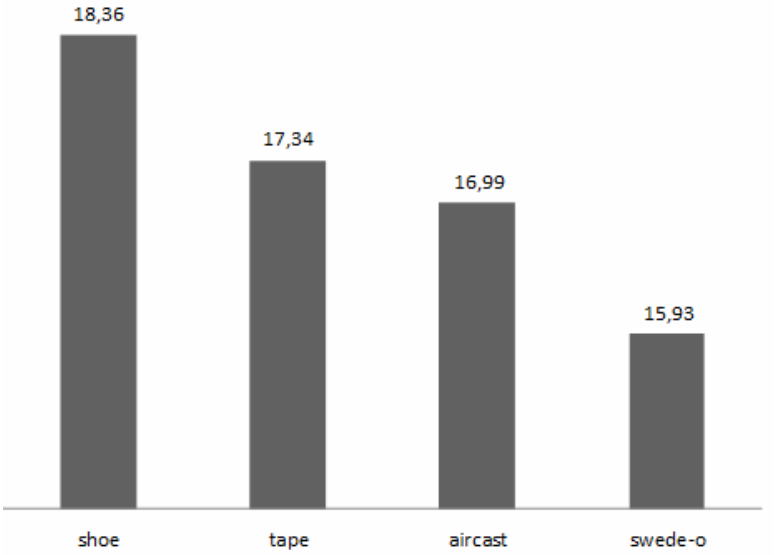
The data was analysed using SPSS for Windows, Version 21.0 (SPSS Inc., Chicago, IL, USA). For the quantitative analysis of the data, the independent variables were the four different test performance conditions and the dependent variables were the maximum ground reaction forces on the three movement axes (x, y and z) and the maximum ankle dorsiflexion angle. A distribution normality test (Kolmogorof-Smirnof test) and a test for the equality of variances (Levene's test) were performed and the non-parametric Friedman test was chosen, while for the variables in which statistically significant variance between the groups was found, pairwise comparisons through the Wilcoxon Rank Test were performed afterwards. The level of significance was set at $p < .05$.

Results

As far as the ROM of the ankle dorsiflexion is concerned, the Friedman test results showed no significant differences between the groups (p=0.42). More specifically, the largest range of the ankle dorsiflexion was noted with the shoe at 18,36°. The next largest range were with the tape at 17,34° . The air-cast followed at 16,99° and last came the lace-up brace at 15,92° (table 2, graph 1).

Table 2. Mean values and standard deviations of the ankle dorsiflextion range of movement with each support type.

	shoe	tape	air-cast	lace-up
Dorsiflexion ROM	18,36 (4,7)	17,34 (4,1)	16,99 (3,8)	15,92 (3,9)

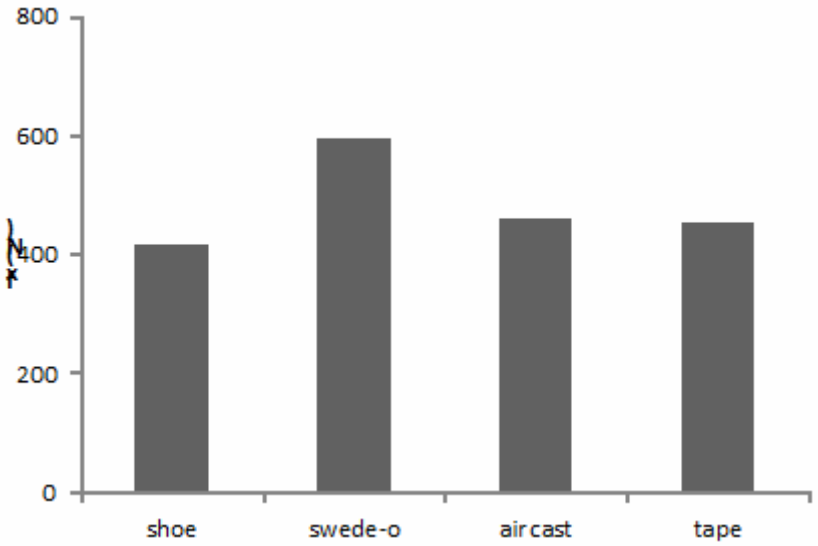


Graph 1. Ankle Dorsiflexion ROM (^{0}) with the different stabilizers.

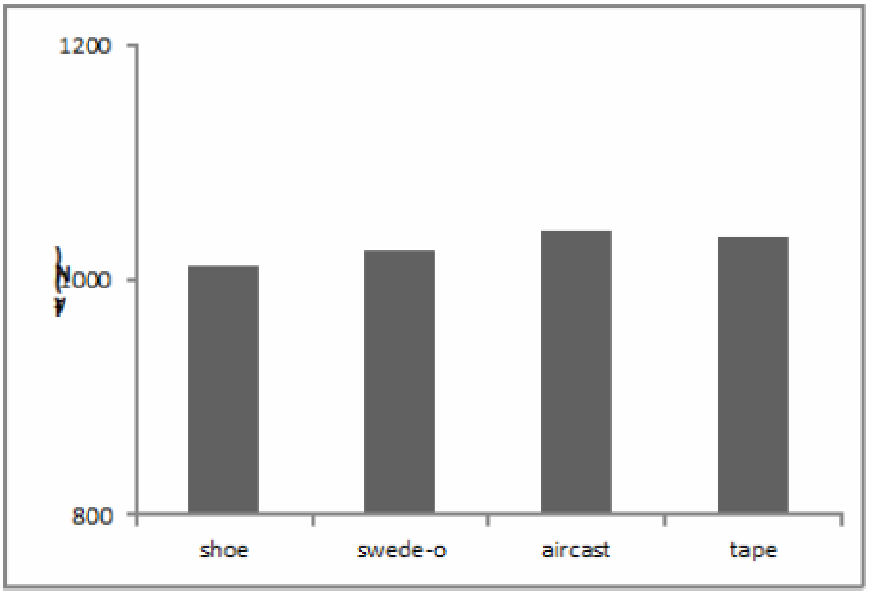
As far as the ground reaction forces on the three axes are concerned, from the results of the Friedman test statistically significant differences were found between the groups on the lateral x (p=0.006) and the vertical axis z (p=0.045), whereas no differences were found on the anterior-posterior axis y (p=0.445) (table 3 graphs 2-4).

Table 3. Average values and standard deviations of the ground reaction forces (N) on the 3 movement axes with each support type.

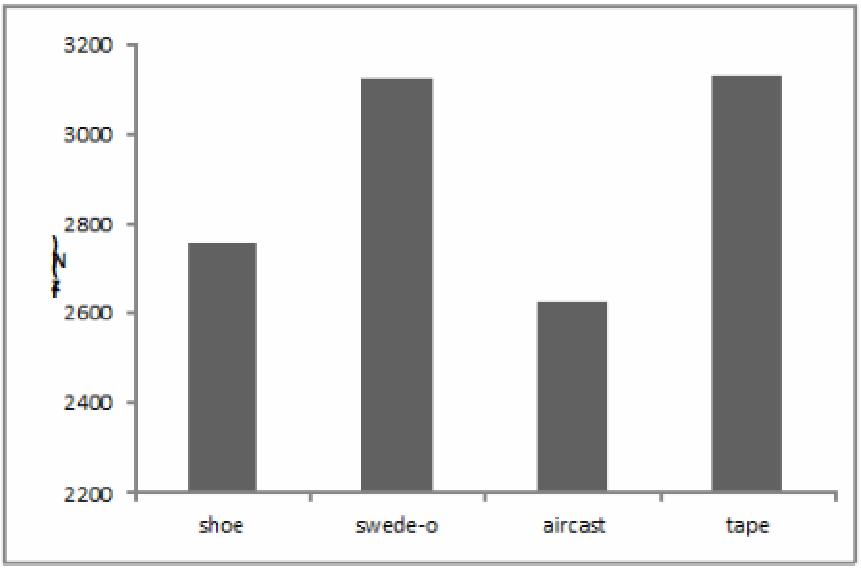
Forces (N)	Shoe	Lace-up	Air-cast	Tape
Lateral axis x *	417,2 (93,4)	594,8 (267,8)	463,7 (113,17)	454,0 (145,21)
Anterior-posterior axis y	1010,7 (244,7)	1024,4 (252,3)	1042,4 (237,5)	1036,3 (220,0)
Vertical axis z *	2757,8 (444,1)	3124,3 (1008,6)	2621,0 (463,2)	3130,3 (892,4)



Graph 2. Ground reaction force on the lateral axis (x) without support (shoe) and with 3 different stabilizers (tape, air-cast, lace-up).



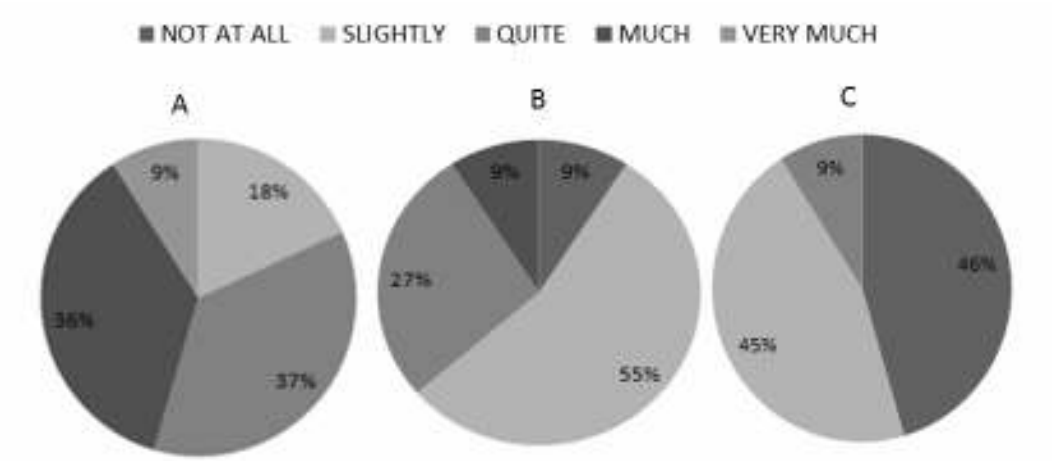
Graph 3. Ground reaction force on the anterior-posterior axis (y) without support (shoe) and with 3 different stabilizers (tape, air-cast, lace-up).



Graph 4. Ground reaction force on the vertical axis (z) without support (shoe) and with 3 different stabilizers (tape, air-cast, lace-up).

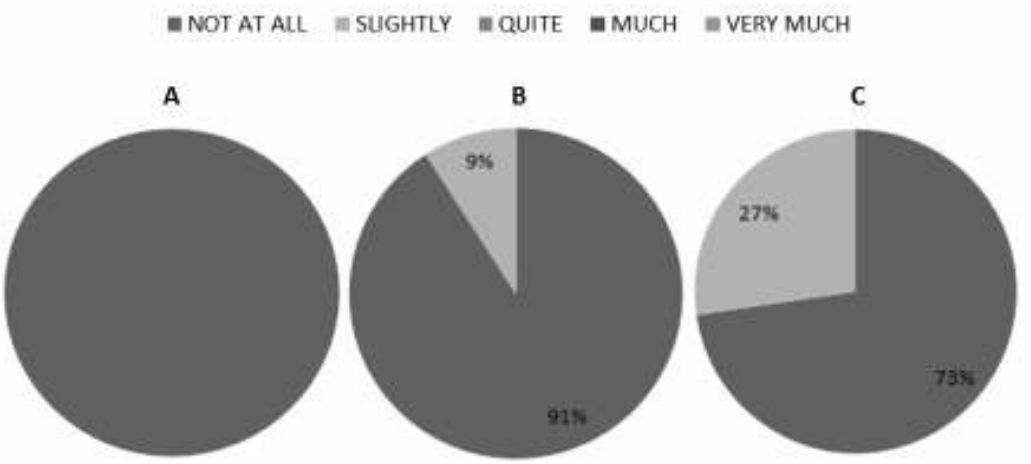
From the Wilcoxon Rank post hoc test, statistically significant differences were noted between the lace-up and the shoe (p=0.01) and between the tape and the shoe (p=0.033). On the vertical axis differences between the groups were found between the shoe and the lace-up (p=0.004), between the shoe and the tape (p=0.041), between the lace-up and the air-cast (p=0.029) and between the tape and the air-cast (p=0.031).
Concerning the recording of the subjective impression of the athletes on how much each support type affected their performance, frequency analysis showed the following:

To the question "Do you think that the lace-up brace reduced your performance?", revealed that when the lace-up brace was used 72,8% felt that it reduced their performance from quite (36,4%) to much (36,4%). A 9,1% reported that their performance was reduced by very much, while 18,2% felt a slight restriction (graph 5A). When using the air-cast brace, 54,5% felt a slight reduction in their performance. 27,3% felt they were quite reduced and 9,1% felt very much reduced. Finally, 9,1% reported that their performance was not affected at all (graph 5B). When applying taping 45,5% did not feel restricted, 45,5% felt a slight reduction and just 9,1% reported quite a reduction (graph 5C).



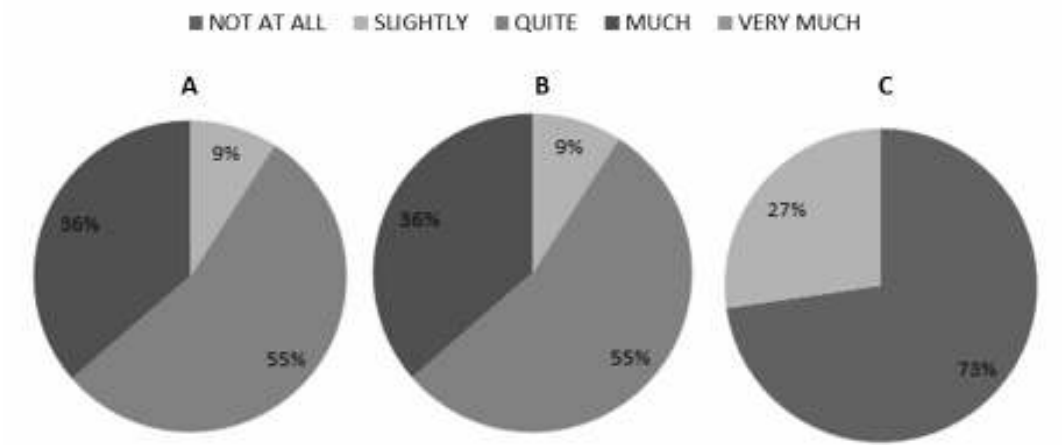
Graph 5. Responses of the athletes to the question "Do you think that the A) lace-up brace B) air-cast brace, C) taping reduced your performance?" Answer choices: Not at all, slightly, quite, much, very much.

To the question "Do you think that the lace-up brace increased your performance?" the entirety of the athletes (100%) answered not at all (graph 6A). The vast majority of the athletes also reported no improvement with the air-cast brace (90,9%), while only 9,1% reported a slight performance increase (graph 6B). By taping, 72,7% did not observe any performance increase, while 27,3% reported a slight improvement (graph 6C).



Graph 6. Responses of the athletes to the question "Do you think that the A) lace-up brace, B) air-cast brace, C) taping increased your performance?" Answer choices: Not at all, slightly, quite, much, very much.

When it comes to how comfortable each support type felt, for both types of brace (lace-up and air-cast) 90,9% reported from quite (54,5%) to much (36,4%), whereas only 9,1% reported that they were slightly bothered by them (graphs 7 A and B). Finally, 90,1% reported that they felt from much (46%) to very much (45%) comfortable with the tape, while 9,1% reported feeling quite comfortable (graph 7C).



Graph 7. Responses of the athletes to the question ""How comfortable did you feel with the A) lace-up brace, B) air-cast brace, C) taping?" Answer choices: Not at all, slightly, quite, much, very much.

As can be seen from frequency analysis, it seems that in terms of the limitation in performance, athletes felt that the lace-up brace limited them the most than all the other external stabilizers. Second in limitation came the air-cast brace, while the athletes felt the least amount of restriction with the application of taping.
As for the comfort level of each type, the athletes felt much comfortable with all three support types.

Discussion

This study wanted to examine the effect of different external stabilazers on the ground reaction forces and the range of the ankle dorsiflexion; factors that by many researchers have been related to the performance of basketball athletes (DiStefano et al, 2008; Neves Sacco et al, 2006; Ozer et al, 2009). However, it is worth noting that, contrary to other studies, in which the vertical ground reaction force is measured after a vertical jump using both legs (Ewing et al, 2016; DiStefano et al, 2008; Neves Sacco et al, 2006), in this specific study the dynamic basketball movement of lay-up was chosen. The lay-up is performed by jumping on one leg, whereas the ground reaction forces were measured on all 3 movement axes (lateral, anterior-posterior, vertical).

Although there has been much discussion about the impact of the lace-up and air-cast braces as well as taping on the range of the ankle dorsiflexion (Mason-Mackay et al, 2017; Abian-Vicen et al, 2009; Bot and Mechelen, 1999), the results of this study showed no statistically significant effect of the different ankle support types on the ankle dorsiflexion movement in comparison to the shoe. It should be noted that other studies that have found range limitation with the use of prophylactic bracing and taping (Pasley et al, 2013) conducted ROM measurement through passive tests, which cannot be representative of the true range during a dynamic movement. Krause et al (2011) report that the true limitation of the ankle ROM is not always the same in dynamic movements, in contrast to passive tasks (Mason-Mackay et al, 2017). As such, it is possible that the forces developed during the lay-up dynamic movement overcame the resistance of the brace or the resistance of the tape. Rieman et al (2002) report that the ankle brace limits the ankle dorsiflexion range during the impact phase of ground contact after a vertical jump. However, based on the results of this study, it would seem that during the lay-up lift no such limitation occurs.

As long as the ground reaction forces are concerned, the results showed differences between the shoe and the other external stabilizers, both on the lateral and the vertical axis. The greatest differences in the ground reaction force were found between the lace-up brace and the shoe, both on the lateral and the vertical axis (table 2, graph 9, graph 11). This increase in the force that was developed in the ankle with the use of the brace and the tape is possibly due to the fact that the athletes felt stability and certainty in the ankle joint for the performing of the specific lay-up movement when it was supported and as a result they applied greater force because of higher confidence and a feeling of stability. Other researchers also concluded that the prophylactic bracing and taping do not affect the vertical ground reaction forces (DiStefano et al, 2008; Barkoukis et al, 2002; +++). To the contrary, Neves Sacco et al (2006) found a reduction in the ground reaction forces on the vertical axis with the lace-up brace and the tape during sudden cutting maneuvers in basketball players.

So, it is possible that the effect of the prophylactic bracing and taping on the ground reaction forces depends on the type of activity. It seems that the reaction forces are reduced when these activities require great forces on the frontal plane.

Concerning the psychological factor, many athletes felt that wearing one of the two types of braces initially limited their performance; however, after the activity they felt comfortable with its use. This fact may be due to the athletes being unfamiliar with the braces (most of them had not worn them before), whereas after the measurement lay-ups they developed some level of familiarity. It could not be explained why this did not happen with the air-cast brace. Possibly the lace-up brace offered greater support and made the athletes feel more confident. In addition, the fact that they felt a smaller reduction in their performance when using the tape, may be caused by the fact that they had all in the past used some form of ankle functional taping and were more familiar with it.

Conclusions

The results of this study showed that the application of external stabilizers not only does not affect the performance of the basketball athletes in a lay-up, but it improves it, because the lace-up brace contributed to the development of greater ground reaction forces on the lateral and vertical axes, while at the same time does not restrict the ankle dorsiflexion ROM. It would so seem then, that the prophylactic bracing and taping does not affect performance since the task does not involve sharp lateral movements. The topic requires further research.

References

Abián-Vicén, J., Alegre, LM., Fernández-Rodríguez, JM. and Aguado, X. Prophylactic Ankle Taping: Elastic Versus Inelastic Taping. (2009) *Foot Ankle Int*. 30(3). 218-225.

Barkoukis, V., Sykaras, E., Costa, F. and Tsorbatzoudis, H. (2002). Effectiveness of taping and bracing in balance. *Percept Mot Skills* 94(2). 566-574.

Bot, S., Verhagen, E., and Van Mechelen, W. (2002)The effect of ankle bracing and taping on functional performance: A review of the literature. *Int Sport J*.4(5). 1-14.

Bot, S., & Mechelen, W. (1999). The effect of ankle bracing on athletic performance. *Sport Med*, 27(3). 171-178.

Callagnan Bot, S., & Van Mechelen, W. (1999). The effect of ankle bracing on athletic performance. *Sport Med*, 27(3). 171-178.

DiStefano, L.J., Padua D.A., Brown, C.N. and Guskiewicz, K.M. (2008). Lower extremity kinematics and ground reaction forces after prophylactic lace-up ankle bracing. *J Athl Train*. 43(3). 234-241.

Ewing, K.A., Begg, R.K., Galea, M.P., Lee, P.V.S. (2016). Effects of Prophylactic Knee Bracing on Lower Limb Kinematics, Kinetics, and Energetics during Double-Leg Drop Landing at 2 Heights. *Am J Sports Med*. 44(7). 1753-1761.

Hume, P.A. & Gerrard, D.F. (1998). Effectiveness of external ankle support: Bracing and taping in rugby union. *Sport Med*.;25(5). 285-312.

Garrick, J.G. & Requa, R.K. (1973). Role of external support in the prevention of ankle sprains. *Medicine and Science in Sport*. 3. 200-203.

Parsley, A., Chinn, L., Lee, S.Y. et al. (2013). Effect of 3 different ankle braces on functional performance and ankle range of motion. ATSHC, 5 (2). 69–75.

Kleipool, R.P., Natenstedt, J.J., Streekstra, G.J., et al. (2016). The Mechanical Functionality of the EXO-L Ankle Brace. *Am J Sports Med*. 44(1). 171-176.

Krause, D.A., Cloud, B.A., Forster, L.A., Schrank. J.A. & Hollman, J.H. (2011). Measurement of ankle dorsiflexion: a comparison of active and passive techniques in multiple positions. *J Sport Rehabil*. 20(3). 333-344.

Mason-Mackay, A.R., Whatman, C., & Reid, D. (2017). The effect of ankle bracing on lower extremity biomechanics during landing: A systematic review. *J Sci Med Sport*, 19(7). 531-540.

Mckay, G.D., Goldie, P.A., Payne, W.R. & Oakes, B,W. (2017). Ankle injuries in basketball□: injury rate and risk factors Ankle injuries in basketball. *Br J Sports Med.,* 35. 103-108.

Messina, D.F., Farney, W.C. & DeLee, J.C. (1999). The incidence of injury in Texas high school basketball: a prospective study among male and female athletes. *Am J Sports Med*.,27(3), 294-299.

Mickel, T.J., Bottoni, C.R., Tsuji. G., Chang, K., Baum, L. & Tokushige, K.A. (2006). Prophylactic Bracing Versus Taping for the Prevention of Ankle Sprains in High School Athletes: A Prospective, Randomized Trial. *J Foot Ankle Surg*. 45(6). 360-365.

Neves Sacco, I., Takahashi, H.Y., Suda, E.Y., et al. (2016). Ground reaction force in basketball cutting maneuvers with and without ankle bracing and taping. *Sao Paulo Med J*. 124(5). 245-252.

Ozer, D., Senbursa, G., Baltaci, G. & Hayran, M. (2009). The effect on neuromuscular stability, performance, multi-joint coordination and proprioception of barefoot, taping or preventative bracing. *Foot*. 19(4). 205-210.

Reuter, G.D., Dahl, A.R. & Senchina, D.S. (2011). Ankle Spatting Compared to Bracing or Taping during Maximal-Effort Sprint Drills. *Int J Exerc Sci*., 4(1). 49-64.

Riemann, B.L., Schmitz, R.J., Gale, M. & Mccaw, S.T. (2002). Vertical Ground Reaction Forces During Jogging. *J Orthopeadic Sport Phys Ther*., 32(12). 628-636.

Sitler, M., Ryan, J., Wheeler, B., et al. (1994). The Efficacy of a Semirigid Ankle Stabilizer to Reduce Acute Ankle Injuries in Basketball: A Randomized Clinical Study at West Point. *Am J Sports Med*., 22(4). 454-461.

Thacker, S.B., Stroup, D.F., Branche, C.M., Gilchrist, J, Goodman, R.A. & Kelling, E.P. (2003)Prevention of knee injuries in sports: A systematic review of the literature. *J Sports Med Phys Fitness*, 43(2). 165-179.