Influence of ankle devices in the jump and landing biomechanical responses in basketball

Isabel de C.N. Sacco[1], Henrique Yuji Takahasi[1], Ângela Agostini Vasconcellos[1], Eneida Yuri Suda[1], Tatiana de Almeida Bacarin[1], Carla Sonsino Pereira[1], Linamara Rizzo Battistella[2], Cristianne Kavamoto[2], José Augusto Fernandes Lopes[2] and Jeane Cintra Peixoto de Vasconcelos[2]

ABSTRACT

Bases and objective: The segment most frequently injured in basketball is the ankle, being the inversion sprain the most common lesion. In order to avoid it, ankle devices are frequently used. The objective of this study was to evaluate the ground reaction force (GRF) in basketball players during jump performance in three situations: use of basketball sport shoes, sport shoes with bracing and sport shoes with Aircast-type orthosis. **Methods:** Eight athletes were analyzed during jump through a force platform in the three situations mentioned for the analysis of the medial-lateral vertical and horizontal components of the ground reaction force. **Results and conclusion:** No significant statistical differences between the three situations were verified in the vertical ground reaction force during jump, although the use of bracing trends to present, during impulsion, higher peak values of the vertical force (3.10 ± 0.46PC; 3.01 ± 0.39PC; 3.03 ± 0.41PC) and the growth gradient (GC) (12.33 ± 12.21PC; 8.16 ± 3.89PC; 8.46 ± 3.85PC), and during landing, lower peak values of the vertical force (5.18 ± 1.35PC; 5.56 ± 1.31PC; 5.49 ± 1.44PC) and the GC (88.83 ± 33.85PC; 95.63 ± 42.64PC; 94.53 ± 31.69PC). During impulsion, the jump medial force with Aircast was significantly lower than with sport shoes ($p = 0.0249$) and presented values similar to values obtained with the use of bracing, while the lateral force was significantly higher with bracing than with the use of the sport shoes ($p = 0.0485$) and trended to be higher than with the use of the Aircast. In the landing, the medial-lateral component of the ground reaction force remained unchanged in the three situations. One concludes that the use of bracing has potentialized the force towards the vertical jump during impulsion, however, it did not stabilize the foot inversion and eversion movements as much as the Aircast. During landing, the devices were not effective to reduce the medial-lateral force, however, with the use of the bracing, a longer time for the impact absorption was verified.

Key words: Ground reaction force. Bracing. Aircast. Sport shoes. Vertical jump.

INTRODUCTION

Basketball is considered as a sport modality composed of a succession of intense and short efforts performed in different rhythms. It is a game that requires great motor coordination and movements of great intensity that allow the development of many physical capacities that modern life requires from each individual[1]. The abilities involved in the practice of basketball are throws, passes, jumps, runs, dribbles, rebounds and the solid execution of offensive and defensive plays[2].

Basketball is practiced by million athletes worldwide and has become a sport modality more and more popular in Brazil probably due to the good performance of the Brazilian teams in international competitions. However, this sport is the one causing the largest number of sportive lesions in the United Sates[3]. These lesions make basketball players to remain from days to months away from trainings and competitions, this way impairing the team's performance and leading to higher costs for the association. One may affirm that the lower limbs receive the highest overload due to the constant dislocations and jumps.

The segment more frequently injured in basketball players is the ankle, being the inversion sprain the lesion of highest incidence. This condition ranges from a simple distension to the rupture of ligaments with or without avulsion fractures of the bones to which ligaments are fixed[4].

The word sprain is literally defined as an articular lesion in which some fibers of the sustentation ligament are broken, but the ligament continuity remains untouched with no displacement or rupture[5].

The most common sprain is given by an inversion effort, when the ankle is in light extension, resulting in distension of the lateral collateral ligaments. The anterior talofibular ligament is the most frequently affected. If the inversion tension is given with ankle at right angle, the calcaneofibular ligament undergoes distension impact.

Mckay *et al.*[4] observed 10,393 participations of basketball players in competitions in Australia. They found a rate of 3.85 ankle lesions in 1,000 participations with approximately half (45.9%) of the athletes away from competitions for one week or more.

It is common to observe the use of prophylactic measures such as leather anklets, bracings and orthoses by athletes in the attempt to avoid ankle lesions. These procedures may be used in any rehabilitation stage and also in the prevention of sprains in healthy athletes.

A large number of studies[6-9] investigated the use of bracings and orthoses as prophylactic measures, generally with results supporting the use of these devices for the reduction of lesions.

According to Hopper *et al.*[6], the incidence of ankle lesions is of 30.4/1,000 games in basketball players who do not use bracing and of 6.5/1,000 in players who make use of it. Still according to the author, the frequency of lesions in basketball players who used an Aircast-type orthosis was of 1.6/1,000 games in comparison with 5.2/1,000 games in those who did not make use of it. The orthoses reduced the recurrence frequency of a lesion and its seriousness, however the orthoses were not effective in the reduc-

1. Department of Physiotherapy, Phonoaudiology and Occupational Therapy, Medical School – University of São Paulo, São Paulo, Brazil.
2. Gait Laboratory, Rehabilitation Medicine Division – General hospital – Medical School – USP, São Paulo, Brazil.

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Correspondence to: Profa. Dra. Isabel de C.N. Sacco, Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional – Faculdade de Medicina – USP, Rua Cipotânia, 51, Cidade Universitária – 05360-000 – São Paulo, SP, Brazil. Tel.: (11) 3091-7464; fax: (11) 3091-7462; e-mail: icnsacco@usp.br

tion of the incidence and seriousness of lesions in individuals with no lesion history.

One of the factors through which lesions may be reduced by means of an external ankle support is the increase of the mechanical stability. The biomechanical analysis indicates that bracings and orthoses may limit the range of motion especially of the foot inversion and eversion being able, however, to increase the longitudinal mechanical solicitations. One should consider that the mechanical stability decreases significantly after a short period of exercise, especially with regard to the bracing.

Hopper *et al.*[6] reported in his study that with regard to the gastrocnemic and long fibular muscles, a significant decrease on their electromyographic activity was verified when ankle orthosis was used in the landing situation, what could reflect a lower necessity of these muscles to promote a mechanical stabilization of this joint with the use of the orthosis. These authors also reported no significant differences in the ground reaction forces and in the foot position when individuals performed the landing with or without the use of devices.

Cordova *et al.*[10] investigated the effects of two types of orthoses: Aircast Sport-Stirrup e Active Ankle on the ground reaction force and on the electromyographic activity of the ankle muscles during running in lateral dislocation. The subjects performed lateral dislocations at a rate of 80-90% of their maximal speeds under three conditions: (control, Aircast Sport-Stirrup and Active Ankle). They verified that the use of orthoses did not change medial-lateral force peak at the impact moment or the propulsion force peak in relation to the control condition. The orthoses reduced the EMG activity of the long fibular muscle only during the impact force peak.

It is emphasized that the muscular activity and the mobility of the lower limbs may influence the magnitude of the impact forces and the resulting force in the joints. It is also underscored the importance of the plantar flexor muscles to reduce the ground reaction forces associated to the landing, which would be minimized with the use of the orthoses.

Despite some studies have verified that the use of ankle devices reduces the lesions rate[6-9], Surve *et al.*[11] verified that the use of orthoses did not reduce the incidence and seriousness of lesions in healthy players. The orthoses were only effective in the reduction of the lesions rate in athletes with previous lesion history.

In his study, Mckean *et al.*[12] verified that the performance of some basketball movements is impaired when external ankle devices are used when compared with the performance without the use of the device. Four types of devices were analyzed: Bracing, Swede-O-Universal, Active Ankle and Aircast. The vertical jump is lower with bracing while the throwing accuracy is higher with bracing than with Swede-O-Universal. The oxygen intake and the energy expenditure are higher with Aircast when compared with bracing. The total performance was less impaired with Active Ankle in relation to the other ankle devices tested. According to Canavan[9] the use of bracing and orthoses by healthy athletes are not justified. However, external ankle support is recommended for high-level athletes with ankle lesion history. The ankle device provides comfort and aids on the edema control during the sprain acute phase.

Other studies show that these devices reduce the lesion rate[7,8]. This may be a result of the decrease on the muscular reaction time of the short fibular muscle of unstable ankles[13] and also a result of the ankle mechanoreceptor stimulation[14]. The proprioceptive role of bracings and orthoses seems to be higher than their limitation on the total ankle range of motion.

Callaghan[15] performed a literature review about the effect of several ankle supports on edema, instability, range of motion, proprioception, muscular function, gait and performance tests. The author yet verified that there are still contradictions with regard to the effect of bracings and stabilizers on the ankle acute and chronic ligament sprains. The author also verified that the use of rigid and non-rigid orthoses in healthy athletes reduces significantly the ankle movements, especially the inversion. The orthoses restrict less the ankle movement if compared with bracings, however, their effect lasts longer after exercise.

Pienkowski *et al.*[16] studied three types of ankle stabilizers in basketball players with no lesion history or ankle or foot surgery in the last six months. His data showed that these ankle stabilizers did not affect the performance significantly in jumps, runs or agility.

Verbugge[17] conducted agility test, 40-yard runs and vertical jump with male athletes with ages ranging from 18 to 28 years from several modalities, comparing the effect of the use of an Aircast-type semirigid ankle stabilizer with bracing in the athletic performance. The athletes reported higher comfort when using the semirigid ankle stabilizer. The results also suggest that both devices do not interfere on the performance.

On the other hand, Burks *et al.*[18] verified decrease on the performance of athletes who made use of the bracing and two ankle stabilizers (Swede-O and Kalassy). Thirty volunteers performed four selected tasks: distance jump from static position, vertical jump, 10-yard zigzag running and 40-yard running. Only 22 subjects answered correctly to a questionnaire about how they felt in relation to the orthoses and bracing. From this total, 17 athletes selected the Kalassy orthosis as the most comfortable and it was verified that this device was the one which less affected their performance and showed decrease statistically significant only for the vertical jump (3.4%). Now, the Swede-O orthosis impaired the performance of the vertical jump (4.6%), distance jump (3.6%) and the time of the 40-yard running (3.2%). The bracing presented significant decrease in the vertical jump (4%), 40-yard running (3.5%) and zigzag running (1.6%).

Riemann *et al.*[19] investigated the effects of the prophylactic ankle stabilization on the ground reaction forces before and after treadmill 20-minute running. Fourteen subjects performed rigid landings (with minimum knee flexion) and deadening (with maximum knee flexion and keeping heels in contact with the force platform) before and after treadmill running under three different conditions (with bracing, with Aircast and without ankle stabilizer). The other authors verified that the time required to reach the force peaks was significantly shorter with the use of the orthosis and bracing in relation to the control condition. However, no significant differences were verified on the magnitude of the vertical force peaks between the three conditions and the exercise also caused no effect on the variables.

In this context, the objective of the present study is to evaluate the dynamic responses of ground reaction forces in basketball players during jump and landing performances with and without the use of ankle devices frequently used by basketball players, where three conditions were analyzed: bracing, Aircast-type orthosis and adequate sport shoes used in the basketball practice.

METHODS

The sample was composed of a group of eight basketball players who have practiced for at least five years with ages ranging from 17 and 25 years, healthy and with no osteo-myo-articular lesion at the moment of the evaluation and with no ankle mechanical or functional instabilities. These subjects were informed of the experimental protocol stages through an informed consent form and as they agreed with the description, they participated on the research.

The experimental protocol was composed of two stages: (1) interview with the athlete through questionnaire adapted from Baptista *et al.*[20] and Ribeiro *et al.*[21] and ankle clinical and functional evaluation; (2) vertical jump biomechanical evaluation through force platform.

In the first stage, the questionnaire included questions about anthropometrical data from each athlete, position in which he plays, time of practice, time of training, previous lesions and persistent sequels; these data were used to characterize the athletes. The clinical tests used were: the ankle anterior drawer test[22-25] and the talar inclination test[23,24]. The results were always compared with the contralateral side. The functional test consisted of stepping down on a 44-steps stair with approximately each step measuring 18 cm in length and 22 cm in depth. The time required to step down the entire stair was recorded and the results, according to Kaikkonen[26] are: less than 18 seconds for the best results, from 18 to 20 seconds for the intermediate group and more than 20 seconds for the group with the worst results.

The athletes presenting complaints well characterized in the interview or through the functional test or with positive result for the ankle anterior drawer and the talar inclination tests were considered to be with functional or mechanical instability. The athletes who presented mechanical or functional instability were excluded from the study.

For the second stage of the experimental protocol, the jump and landing movement were evaluated due to the fact that it is the most common ankle sprain mechanism[4]. This movement was performed by the athletes with and without the use of the three ankle devices: Air-Stirrup type leather anklet (Aircast Inc), bracing and sport shoes commonly used by athletes in the basketball practice. Such ankle devices were selected by being the most frequently used by basketball players[12]. The bracing technique consists of the application of non-elastic adhesive tape on the skin of the individual. This technique has been considered as the most effective in the articular stabilization[27] and primarily consists of the application of two bands of adhesive tape around the ankle at about five and ten centimeters above the lateral and medial malleolus, respectively, being used as supporting bases. Later, other bands of adhesive tape are fastened on the medial malleolus, retrofoot and lateral malleolus, thus maintaining the ankle in dorsiflexion and eversion, and their tips are fixed to the supporting bases. Two other bands are fixed to the back of the foot, diagonally passing around the middle foot, also maintaining the ankle in dorsiflexion and eversion. Another band is also fastened to the back of the foot, passing around the middle foot and by the lateral malleolus, being fixed to the supporting bases. Finally, two other bands of adhesive tape are fixed on both supporting bases.

An AMTI force platform was used for the attainment and analysis of the vertical, anterior-posterior horizontal and medial-lateral horizontal components of the ground reaction force. This platform was situated at the ground level in an environment with approximately 20 linear meters for the locomotion movements. The subjects were evaluated when performing jump with both limbs on the force platform for five times with duration of six seconds with each ankle device analyzed, from which the average of each condition was extracted. The sampling frequency was of 500 Hz, compatible with this type of movement[28]. Table 1 and figures 1 and 2 describe the vertical and medial-lateral variables of the ground reaction force analyzed during the movement analyzed.

TABLE 1
Definition of the medial-lateral and vertical ground reaction force variables of jump and landing movements analyzed

Symbol	Description
Fymax 1	Maximal vertical force in impulsion
Fymax 2	Maximal vertical force in landing
GC Fymax 1	Growth gradient of the maximal vertical force in impulsion
GC Fymax 2	Growth gradient of the maximal vertical force in landing
Fz med 1	Maximal medial force in impulsion
Fz lat 1	Maximal lateral force in impulsion
Fz med 2	Maximal medial force in landing
Fz lat 2	Maximal lateral force in landing

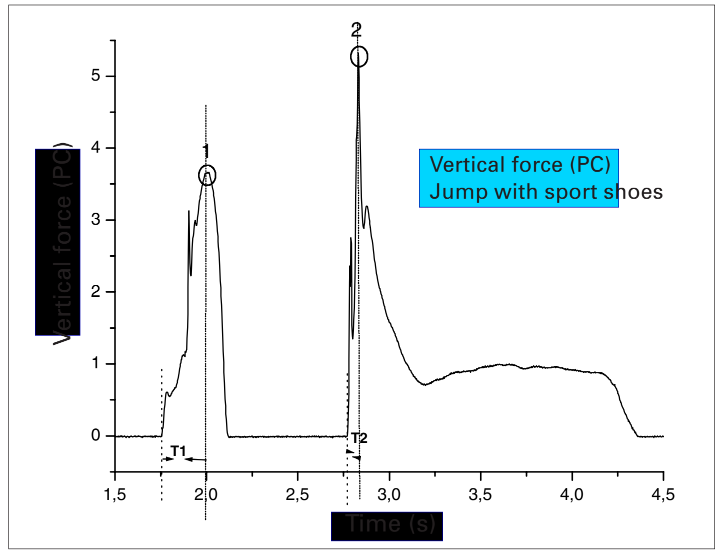

Fig. 1 *– Graphic representation of variables ground reaction force vertical component of the vertical jump with sport shoes: (1) Fymax 1, (2) Fymax 2, (T1) time to reach Fymax 1, (T2) time to reach Fymax 2.*

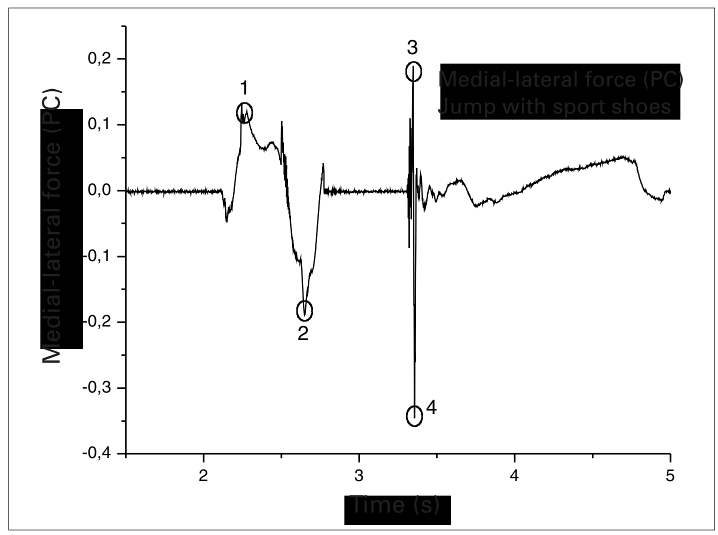

Fig. 2 *– Graphic representation of variables ground reaction force medial-lateral component of the vertical jump with sport shoes: (1) Fz med 1, (2) Fz lat 1, (3) Fz med 2, (4) Fz lat 2.*

The vertical and medial-lateral variables of the ground reaction force for each movement and condition were normalized by the body weight of each subject and later filtered with butherworth low pass filter with cut frequency of 200 Hz, as suggested by Roesler *et al.*[28].

The biomechanical variables studied were initially analyzed to verify the statistical distribution of data through Shapiro Wilks W test, verifying the abnormality of the data and, therefore, the results were compared between the three experimental conditions of the Kruskal-Wallis non-parametrical inferential test using the Mann-Whitney test as the *Post hoc* test, being sufficiently robust to show individual differences. Differences with significance level (p) below 0.05 were considered as significant.

RESULTS

All athletes who participated on the present study were male, with average age of 22.4 ± 1.7 (mean ± SD) years, body mass of 78.8 ± 9.1 kg and height of 1.9 ± 0.1 m. The basketball average practice time was of 10.8 ± 2.8 years. The average frequency to trainings was of 3 ± 1 times a week with duration of two hours on average. Twenty-five per cent of the athletes played professionally and 75% played university level.

It was observed that 50% of the athletes reported the use of some type of device to play and/or to train. From this total, 50% use bracing, 25%, leather anklet and 25%, kneepad.

Six athletes reported some ankle sprains. The average of ankle sprain suffered by these subjects was of 7.0 ± 6.9 ankle sprains. The average time of dismissal from the modality practice due to ankle sprains was of 3 ± 1.4 month. The subjects reported other lesions of lower limbs: 50% reported some tendonitis, 12.5% reported fracture and 12.5% reported luxation. It is important to emphasize that some subjects suffered more than one type of lesion in lower limbs. With regard to subjects who suffered some type of lesion in lower limbs, 66% related these lesions occurred in basketball practice.

No statistically significant difference was verified between the three situations in the vertical component of the ground reaction force during vertical jump ($p > 0.05$) (table 2). Figure 3 represents the average curves and standard deviations of the ground reaction force vertical component during jump with sport shoes, with bracing and with Aircast of one of the subjects.

TABLE 2
Averages and standard deviations of vertical ground reaction force variables during vertical jump with the use of ankle devices: sport shoes, bracing and Aircast for basketball in the subjects evaluated (n = 8)

Variables	Sport shoes	Aircast	Bracing	p
Fymax 1 (PC)	3.01 ± 0.39	3.03 ± 0.41	3.10 ± 0.46	> 0.05
Fymax 2 (PC)	5.56 ± 1.31	5.49 ± 1.44	5.18 ± 1.35	> 0.05
GC Fymax1 (PC/s)	8.16 ± 3.89	8.46 ± 3.85	12.33 ± 12.21	> 0.05
GC Fymax2 (PC/s)	95.63 ± 42.64	94.53 ± 31.69	88.83 ± 33.85	> 0.05

The maximal medial force was significantly higher in the situation with sport shoes than in the situation with Aircast ($p = 0.0249$) and the maximal lateral force in the situation with sport shoes was statistically higher than the situation with bracing ($p = 0.0485$) (table 3).

TABLE 3
Averages and standard deviations of medial-lateral ground reaction force variables during vertical jump with the use of ankle devices: sport shoes, bracing and Aircast for basketball in the subjects evaluated (n = 8)

Variables	Sport shoes	Aircast	Bracing	p
Fz med 1 (PC)*	*0.16 ± 0.08*	*0.12 ± 0.06*	0.16 ± 0.10	0.0249
Fz lat 1 (PC)*	*–0.11 ± 0.09*–	–0.12 ± 0.08–	*–0.15 ± 0.07*–	0.0485
Fz med 2 (PC)	0.18 ± 0.08	0.20 ± 0.09	0.19 ± 0.09	> 0.05
Fz lat 2 (PC)	–0.19 ± 0.08–	–0.19 ± 0.16–	–0.19 ± 0.09–	> 0.05

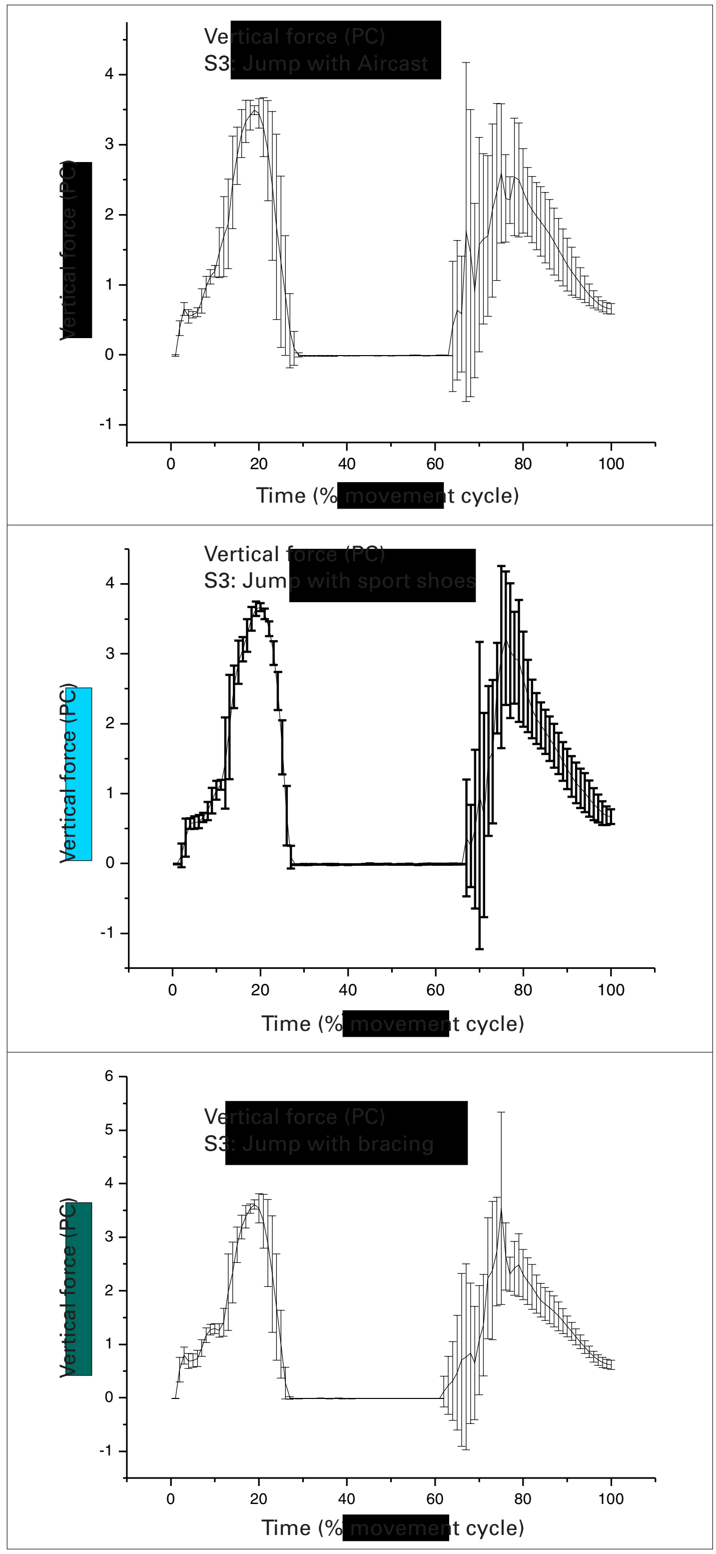

Fig. 3 *– Average curves and standard deviations of the ground reaction force vertical component during jump with sport shoes, with bracing and with Aircast of subject 3*

DISCUSSION

Most athletes studied (75%) already suffered ankle sprains and, from this total, 66% suffered these lesions in both ankles. This demonstrates that ankle sprains are a type of lesion very common among basketball players and a better understanding in regards to the prevention of this type of lesion and the relationship of this lesion with the types of movement performed by athletes is required. The form of landing during a jump in basketball, either stepping on other player's foot or due to some imbalance, compose the main cause of sprains in the modality[4]. It was verified that the use of ankle devices reduces the lesion rate especially in individuals with previous lesion history, besides being useful in the prevention and control of the inflammatory manifestations at the sprain acute phase. This is applied to basketball players, considering the high incidence of lesions related to its practice[6-9,11].

Mckay *et al.*[4] in his study found no relation between gender, age, body mass, height and training frequency with the incidence of ankle lesions, however, it is important to observe that the training overload of the athletes evaluated, typical of the modality, would increase the muscle-skeletal overload and hence its wearing, thus furthering the incidence of ankle lesions.

Twenty-five percent of the subjects made use of bracing during games and trains to prevent ankle sprains. However, the present study could demonstrate through the biomechanical evaluation that this form of prevention is not so effective as many believed it would be. Further studies using electromyography techniques, for example, are necessary to prove its action on the prevention of this lesion.

Some authors demonstrated that the bracing efficiency decreases rapidly with exercise (12% to 50% of its efficiency on the ankle stabilization is lost after 10 minutes of exercise) and its removal and replacement is required in order to recover its efficiency[29]. For this reason, many basketball coaches would rather select orthoses instead of bracing, since it may be rapidly readjusted with no need of being replaced; although the bracing is still a method presenting low costs if compared to the other methods. Besides, the orthoses cause less skin irritation and may be applied and reapplied by the own athletes[30].

Some studies analyzed the ground reaction force at the landing moment and verified no differences between the control situation and situations with the use of orthoses and bracings[6,19]. In the present study, although no statistically significant differences with regard to the vertical component of the ground reaction force were verified, for the medial-lateral components significant differences were observed in relation to the devices studied.

Despite no differences statistically significant were observed, we emphasize on tendencies of the vertical component such as, during the jump movement, the situation with bracing trends to present higher value in both the vertical force peak at the impulsion moment (Fymax1) and its growth gradient (GC Fymax1) in relation to the two other conditions. This means that the use of bracing results in a higher vertical force at the impulsion in a shorter interval of time. This could be interpreted as if this reaction force results from an impulsion force which would optimize the jump in a faster way, thus improving its performance.

Now during landing, the condition with bracing trends to present a lower vertical force peak value (Fymax2) and its growth gradient (GC Fymax2) in relation to the situation with sport shoes and Aircast. In this case, the bracing would be playing a more effective role in the impact weakening, once the ground reaction force increases more slowly during the landing. Thus, the overload is distributed more uniformly between segments of the lower limbs; the muscle-skeletal system adapts itself and better responds to overloads.

Riemann *et al.*[19] also found no differences in the vertical force between bracing, Aircast and control situations during landing, but as well as in the present study, he observed decrease on the time in which the vertical force peaks are reached with the use of the ankle devices.

The mechanism through which the bracing reduces the Fymax1 and its respective GC remains unknown, once both devices do not restrict the ankle flexion-extension, which are vital movements for the reduction or increase on the vertical forces. Maybe bracing is more effective in the increase on the proprioceptive afferences if compared to the orthosis, allowing a better muscular response to the overload increase common in landings, leading to its decrease[13-15].

Considering the analysis of the medial-lateral component of the ground reaction force, the medial force at the jump impulsion moment (Fzmed1) in the Aircast situation was significantly lower that in the sport shoes situation ($p = 0.0249$) and presented value similar to the bracing situation. Now, the impulsion lateral force (Fzlat1) was significantly higher in the bracing situation than in the sport shoes situation ($p = 0.0485$) and trended to be higher than in the Aircast situation. Unlike the vertical component that a high value of the first force peak (impulsion) with the use of bracing presented a beneficial effect on the athlete's performance, a high value of the lateral medial force obtained with the same ankle device also in the impulsion may be harmful, once it means higher mobility in the foot inversion and eversion and less energy spent with the ankle flexion-extension. Therefore, besides impairing performance, bracing would be restricting less the inversion and eversion movements in relation to the Aircast, resulting in higher mechanical instability and higher risk of sprains during impulsion.

The medial-lateral ground reaction force component in landing during jump remained unchanged in the three situations. The devices did not play their role effectively, in other words, they did not decrease the medial-lateral force in the contact with the ground as expected when we compare with the control situation with the use of sport shoes. The medial-lateral force in landing is the main indicative of the inversion and eversion movements responsible for the ankle sprain. If ankle devices make no difference in the ground reaction force in movements in which most lesions occur, their prevention and performance effects are questionable.

Works that describe the improvement on the performance[14], worsening on the performance[12,18] and performance unchanged[16,17] with the use of ankle devices can be found in literature. Maybe, with the reproduction of a movement more reliable to what actually occurs in a game, significant differences could be found in the medial-lateral component of the ground reaction force between ankle devices and control situations.

These results previously described, if analyzed as a whole, show that bracing generates a higher vertical and medial-lateral ground reaction force at the jump impulsion moment, in other words, the bracing has potentialized the force aimed at the vertical jump, even increasing the overload in the muscle-skeletal system. However, bracing did not stabilize the foot inversion and eversion movements as much as the Aircast, resulting in higher instability of the subtalar joint and higher loss of energy aimed at the jump, suggesting that the bracing may not be restricting these foot movements as expected. However, in landing the situation is the opposite. A lower vertical ground reaction force with the use of bracing is distributed within a longer time interval if compared with the two other situations. This indicates that the growth curve of the bracing vertical force is less steep, in other words, the muscle-skeletal system disposes of a longer time to absorb the impact and to respond to the external forces.

In short, in the vertical jump, the bracing produced higher vertical and medial-lateral force in the impulsion and lower vertical force in the landing.

CONCLUSION

Despite none of the athletes studied presented functional or mechanical ankle instability, half of the subjects used some type of ankle device with the objective of stabilizing this joint. Reasonable percentage of these subjects reported to use bracing as one of these ankle devices even without evidences of its effectiveness with regard to the prevention of lesions and articular stabilization. Therefore, further studies about the actual effectiveness of these ankle devices, which have been used without scientific corroboration of their possible beneficial effects, should be conducted.

The search for the decrease on the medial-lateral forces would lead to an increase on the other components of the ground reaction force, in other words, for example, an increase on the vertical component of this force. This fact would lead to an increase on the compressive forces in the skeletal system[10], and at medium and long term, to lesions in the locomotor system. However, aspects a little different from the hypotheses were observed.

The prophylactic effects on the sprain prevention and the use in its treatment have been exhaustedly described in literature. Few are the studies that analyzed the ground reaction force during dynamic activities with ankle devices and most of them found no differences between the studied and the control situations. It was observed in the present study that the ankle devices generated alterations on the vertical and medial-lateral ground reaction forces between bracing, Aircast and control situations. As expected, the ankle devices attenuated the vertical or medial-lateral components of the ground reaction force in some moments, but increase in others, what would lead to the increase of the compressive and inversion and eversion forces in the skeletal system due to the restriction of the articular movement. Therefore, despite the frequent use of this type of ankle device by athletes, its indication must be careful, considering the risks of possible complications at medium and long term.

The literature describes several studies with ambiguous evidences in regards to the effect of the ankle devices on the ground reaction force, on performance, on balance and on the muscular activity[30]. The mechanism through which external ankle supports act is yet unknown and further studies should be conducted to enlighten their effects in sport activities.

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