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Effect of Reduced Ankle Mobility on Jumping Performance in Young Athletes

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ORIGINAL ARTICLE

ABSTRACT

The objective of this study was to analyse the effects of the reduction of ankle mobility on the jumping performance of young soccer athletes, through a validated jump platform valued and test. Twenty-one soccer players (16.19±0.60 years old, 67.26±5.94 kg weight, 173.81±8.15cm height, 11.29±5.37% estimated body fat, and 8.76±2.70 years of soccer practice) were evaluated and tested for vertical jump performance. Goniometry and Knee-to-Wall tests were adopted in order to evaluate movement, and a jump platform was used to evaluate performance. The performance in Counter Movement Jump test correlated positively and significantly not only with right dorsiflexion test but also right Knee-to-Wall test (r = 0.576; p = 0.006, r = 0.513, p = 0.17, respectively). Right Knee-to-Wall is correlated with left Knee-to-Wall (r = 0,816 p = 0,001). Based on the presented data, the vertical jump is impaired by the ankles' mobility deficit.
Keywords: Mobility, Ankle, Performance, Jump

INTRODUCTION

For many years, the scientific community has been studying human performance and movement. In the past, researchers discovered that the efficiency of a vertical jump depended 49% on the knee's joint muscles, 28% on the hips muscles, and 23% on the ankles muscles. (Hubley & Wells, 1983). In contrast, different values were obtained in the study performed by Fukashiro and Komi (1987), being the vertical jump dependent 51% on the hips, 33% on the knees, and 16% on the ankles. In both studies, an important contribution of the ankle joint in jumping was observed.

The negative effect that ankle mobility deficits may have on high-performance athletes has been poorly investigated. Vanezis and Lees (2005) studied the reasons why some people are able to perform higher jumps than others. The predominant type of muscle fiber and the force generation capacity seem to be decisive in this respect.

There are many approaches to improving the range of motion(ROM) of ankle dorsiflexion; the most common of all is stretching (Page, 2014). A proper ROM of ankle dorsiflexion allows for better joint function in the activities of daily living (Lin, Moseley, Herbert, & Refshauge, 2009). In addition, a reduced ROM of ankle dorsiflexion seems to be a risk factor for knee injuries, achilles tendinitis, and plantar fasciitis.

Biomechanical changes that reduce the functional performance of joints, such as reduced ankle mobility, may, in some cases, impair the efficiency of movements in high-performance athletes and even lead to injuries (Cook, Burton, Hoogenboom, & Voight, 2014). Reduction of the ankle dorsiflexion angle, for example, is associated with a higher projection of the knee in the frontal plane during unilateral squatting, causing dynamic valgus, which is a risk factor for lesions of the anterior cruciate ligament (ACL) (Wyndow et al., 2015).

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According to Cook et al. (2014), reduced ankle mobility has a negative effect on other joints, such as the knee, hip, and spine, in a biomechanical chain. The authors also mention the concept of *joint by joint*, in which all joints are influenced, negatively or positively, upward or downward.

Some biomechanical changes caused by ankle mobility deficiency are: reduced movement when flexing the knee, increased dynamic valgus displacement and increased ground reaction force, caused by a longer contact period of the foot with the ground at the jump landing (Griffin et al., 2006; Hewett et al., 2005; Yu, Lin, & Garrett, 2006).

Additionally, it is known that changes in ankle mobility are a risk factor for anterior knee pain (Macrum, Bell, Boling, Lewek, & Padua, 2012). This is caused by a series of biomechanical compensations resulting from a deficit in ankle range of motion, as well as by the stiffening of the Gastrocnemius and Soleus muscles (Leardini, Stagni, & O'Connor, 2001).

Papaiakovou (2013) analysed vertical jumping kinetics and kinematics differences between people with good or bad ankle dorsiflexion angle. The main result was that movement performance was impaired by both reduced dorsiflexion and reduced plantarflexion and may lead to the enhanced performance of the vertical jump.

The vertical jump is an essential skill in many sports and, more specifically, in soccer. So, the relation of ankle mobility with jump performance is an obvious area for investigation. Therefore, the current study aimed to identify, from functional tests, ankle mobility deficits, and their possible correlation with performance loss.

METHOD

The individuals were submitted to three evaluation sessions, the first one destined to characterize the sample and the following to tests, Knee-to-Wall, Goniometry (for flexion angle and plantar dorsiflexion) and Countermovement Jump (CMJ) were carried out. The test sessions were held in a strength-training room and with a minimum of 24 hours between them. All athletes were instructed not to participate in any training during the survey.

Participants

The participants consisted of twenty-one young athletes of an Under-17 soccer team (see table 1 for participants' anthropometric characteristics). All participants and their legal guardians were informed of the objectives and the relevant procedures to the study, being assured of the data confidentiality and voluntarily participating by signing a consent form according to the Helsinki Declaration.

Table 1
Anthropometric variables - mean ± standard deviation.

Anthropometric Variables	Mean ± standard deviation
Age (years)	16.19 ± 0.60
Body mass (kg)	67.26 ± 5.94
Stature (cm)	173.81±8.15
Estimated body fat (%)	10,37 ± 3,24
Practice time (years)	8.76 ± 2.70

Instruments

Participant's characterization

To measure the height (m) and body mass (kg), a Micheletti MIC-300PPA digital scale (Filizola, Brazil, accuracy of 0.01 m and 0.1 kg) was used. The estimate body fat percentage was calculated according to the Pollock 7-site skinfold method, using a Cescorf scientific skinfold calliper (adipometer) (Cescorf, Brazil, precision of 1mm).

Tests

The tests were performed the joint mobility using a measuring an SR-A006 model goniometer apparatus (SURE, China) and a 102 cm metal tape measure with a 5 mm scale.

The performance evaluation was carried out using a 50 x 60 cm Jumptest® contact mat (Hidrofit Ltda, Brazil) connected to Multisprint® software (Hidrofit Ltda, Brazil), which determines jump flight time from two pressure-sensitive conductive surfaces.

Procedures

In the first evaluation session (1st day), the characterization of the participants was performed. Height, body mass, and estimate body fat percentage were measured. An ISAK level 1 professional conducted the tests, and the athletes were wearing only training uniform shorts.

In the second evaluation session (2nd day), goniometry was executed in order to obtain the angles of dorsiflexion and plantarflexion of both ankles. The individuals were evaluated barefoot, lying in dorsal decubitus with knees flexed between 25-30º and with the feet in anatomical position, being the axis of the goniometer near the lateral malleolus, the arm fixed parallel to the lateral aspect of the fibula and the movable arm parallel to the lateral surface of the fifth metatarsal. The third test performed was the Knee-to-Wall Ankle Mobility Test, in which the individual is placed in the half-kneeling position with one knee on the floor and one foot forward, and then executes a movement intending to bring the knee as close as possible to the wall in front of him. The test begins with a 14 centimetres distance, measured from the tip of the hallux to the wall. If the test was not successful, the athlete is instructed to bring the hallux closer to the wall 1 centimetre at a time until he succeeds in touching the knee in the wall. The last successful measurement is recorded, and then the procedure is repeated for the other foot.

In the last evaluation session (3rd day), the athletes were submitted to the CMJ test for performance assessment. CMJ consisted of maximal concentric action preceded by high-velocity eccentric action until approximately 90° knee flexion was achieved. The tests were conducted by two experienced professionals who instructed the volunteers to keep knees extended, ankles in plantar flexion, and hands-on the hips during all the jumping movement. All jumps were performed with maximum effort, and the feet should touch the ground simultaneously on landing. Each individual jumped three times with a 2 minutes interval between each jump, being taken into consideration only the best performed jumping. The volunteers were also instructed to freely determine the amplitude in the CMJ test, avoiding changes in the coordination of the movement (Herrero, Izquierdo, Maffiuletti, & García-López, 2006).

Statistical analysis

All data were analysed using the SPSS software for data treatment and statistical analysis, version 21 (Statistical Package for the Social Sciences, SPSS Science, Chicago, USA).

The values of the different variables studied were characterized in terms of central tendency and dispersion through an exploratory analysis of all data. A graphical depiction was conducted in order to identify and exclude possible outliers and incorrect data insertions. Data mean values and standard deviations are shown in this study. A Shapiro-Wilk test was accomplished to analyze the distribution type. After guaranteed the assumptions of the parametric tests, Pearson's correlation coefficient was calculated for observing if there is or not a relationship between the different variables studied. A significance level of 5% was adopted.

RESULTS

Table 2 shows the results for plantar dorsiflexion and plantar flexion goniometry, Knee-to-Wall test and vertical jump performance.

Table 2

Plantar flexion and dorsiflegoniometry, Knee Knee-to-Wall, and Countermovement jump (CMJ) results - mean ± standard deviation.

Tests	Results (mean ± standard deviation)
Left Knee-to-Wall (cm)	9.33 ± 2.52
Right Knee-to-Wall (cm)	9.19 ± 2.52
Right plantar dorsiflexion (degrees)	14.52 ± 4.19
Left plantar dorsiflexion (degrees)	13.00 ± 5.22
Right plantar flexion (degrees)	41.23±6.57
Left plantar flexion (degrees)	41.14±6.85
CMJ (cm)	36.03 ± 3.62

Table 3

Correlations between Left and right Knee-to-Wall, Left and right dorsiflexion and plantar flexion and Countermovement jump.

Variables	KW (right)	KW (left)	DF (right)	DF (left)	FP (right)	FP (left)	CMJ
KW (right)	-	0.739*	0.720*	0.593*	0,30	0,108	0,513*
KW (left)	0.739*	-	0.381	0.730*	0,297	0,310	0.330
DF (right)	0.720*	0.381	-	0.469*	0,086	-0,026	0.573**
DF (left)	0.593*	0.730*	0.469*	-	-0,026	-0,160	0.273
FP (right)	0,30	0,297	0,086	-0,026	-	0,807**	-0,205
FP (left)	0,108	0,310	0,261	-0,160	0,877**	-	-0,205
CMJ	0.646*	0.330	0.658*	0.273	-0,205	-0,205	-

KW – Knee Wall test; DF – Dorsiflexion test; FP – Plantar Flexion test; CMJ – Countermovemnt Jump;
*p<0,05
** p<0,01

Right dorsiflexion goniometry tests correlated positively and significantly with right Knee-to-Wall test, left dorsiflexion test and CMJ test (r = 0.720, p = 0.002, r = 0.460, p = 0.036, r = 0.469, p = 0.032 and r = 0.658, p = 0.001, respectively). On the other hand, left dorsiflexion test correlated positively with right dorsiflexion (r = 0.469, p = 0.032). The performance in CMJ test correlated positively and significantly not only with right dorsiflexion test but also right Knee-to-Wall test (r = 0.576; p = 0.006, r = 0.513, p = 0.17, respectively). Right Knee-to-Wall is correlated with left Knee-to-Wall (r = 0,816 p = 0,001) he previously described correlations can be observed in the table 3.

DISCUSSION

This research aimed to verify if a reduction in ankle mobility in young athletes could affect their performance in vertical jump capacity. From the results obtained by the goniometry and knee to wall tests, it was possible to identify a positive and significant correlation of the reduction of ankle mobility, especially the right, with the lower jump performance. It should be noted that some research shows that joint stiffness may be a byproduct of the injury and reduce athletic performance, which corroborates with the data found in our study. (Cook et al., 2014).

There are methodological discrepancies between the few studies that investigate the contribution of the knee, ankle, and hip joints in the counter-movement jump (CMJ). In the present study, the CMJ was analyzed bilaterally and without the help of the arms; however, some studies analyzed the leap unilaterally (Driller & Overmayer, 2017) and using the upper limbs (Yaggie & Kinzey, 2001), and comparing the data between these researches. Other important biomechanical aspects may influence CMJ performance, including movement technique, better plantar and shoulder flexion during the jump (McErlain-Naylor, King & Pain, 2014). In addition to the biomechanical factors, the type of information used in the test (internal or external focus) also seems to affect jump performance (Wulf & Dufek, 2009).

Nakagawa et al. (2018), in his research, showed that increased joint amplitude of the ankle dorsiflexion movement is related to the improvement of the dynamic balance and the strength of the trunk muscles. In addition, the researchers found that the range of motion (ROM) of the ankle may be associated with the frontal projection angle of the knee. These results are similar to the data found in the present study, in which we found a positive and significant correlation in the projection angle of the knee to the front, in the knee to wall test, with the highest jumping capacity. These data are in line with previous findings that the mobility deficit may also impair movement (Cook et al., 2014), and expose athletes to the potential risks of injury to the Anterior Cruciate Ligament (ACL) (Hewett et al., 2005).

One of the most important results found in our study was the correlation between the lower ankle mobility and the reduction in the athletic performance of the jump. Thinking about this purpose, strategies that increase this ankle amplitude may be worth trying to improve this performance.

For this purpose, Driller and Overmayer, (2017), used Band Flossing (BF) to try to improve ankle ADM and increase performance in recreational athletes. The authors suggested that the inclusion of BF prior to any sports activity involving jumping actions can improve the performance of the jump and, also, may serve as a new approach to injury prevention by increasing joint ROM.

The use of rigid bandages or orthoses to stabilize the ankle has been prevalent in recreational and high-performance athletes, in sports with changes of direction and sudden stop. However, the use of these bandages may restrict the mobility of the joint in the frontal plane and consequently reduce the jumping ability (Parsley et al. 2013). However, contrary to our research and studies that the restriction of ankle mobility affects jumping ability, the study by Yaggie and Kinzey (2001) did not observe a decrease in the performance of sprints and vertical jumps. However, jump performance in this study was evaluated using the Sargent Jump Test (SJT) protocol (MacKean, Bell, & Burnham, 1995), and possibly the use of different technological resources to measure jump height may justify the difference between the results.

Another important finding in the present research was the significant asymmetry of lower limbs found in athletes, between dorsiflexion ROM and plantar flexion in the right and left limbs. According to Cook et al. (2014), the asymmetry between lower limbs may negatively affect muscle activity, which may further impact mobility and joint stability. This compensation can also increase energy expenditure and reduce muscle control as the activity performed progresses.

Finally, the results of this study allow us to conclude that it is possible to correlate reduced ankle mobility (assessed through the tests, Goniometry and Knee-to-Wall) to CMJ performance, and that may be an influencing factor. However, additional surveys with a larger and more heterogeneous sample are required so that a direct correlation can be established.

CONCLUSION

The results of this study allow us to conclude that it is possible to correlate reduced ankle mobility (assessed through tests such as Goniometry and Knee-to-Wall) to CMJ performance, which may be an influencing factor.

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