KINEMATIC AND ELECTROMYOGRAPHIC BEHAVIOUR OF BASKETBALL PLAYERS' INJURED AND HEALTHY ANKLES DURING THE JUMP ONTO AN UNSTABLE BOARD

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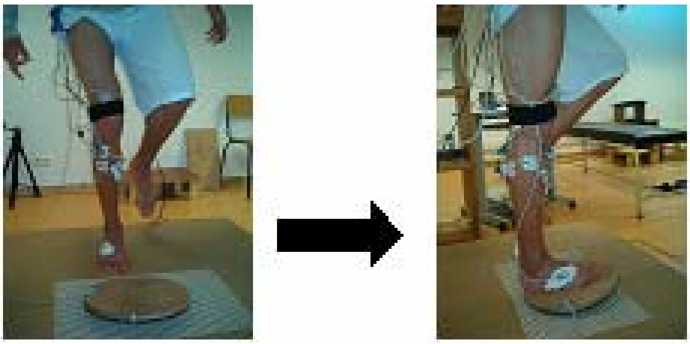
The purpose of this study was to identify kinematic and electromyographic differences of jumps performed by basketball players with healthy and previously sprained ankles. 25 elite basketball players with healthy (n=17) and already sprained ankles (n=28) jumped five times in unipodal support from a stable surface onto a round Freeman board. During the jump the flight phase of those athletes with already sprained ankles was shorter which may indicate less preparation time for the moment of contact with the surface and for the respective load. When landing, they also positioned their ankle in a more plantar flexion and generally, the contraction of their foot musles was stronger than that of the healthy athletes. The groups' differing movement behaviour of the lower leg possibly explains resulting ankle injuries. These results indicate that it might be necessary to train athletes to jump in "safe positions" in order to prevent ankle sprains.

KEY WORDS: basketball, ankle sprain, jumps.

INTRODUCTION: Lateral ankle sprains are very common among basketball players, and they are responsible for most of their compulsory breaks. Many professionals basketball players think that training should focus on the prevention of ankle sprain because once it has occurred athletes are much more susceptible to reinjury. Predicting accurately the probability of occurrence of this injury is still beyond our capacities but, in recent years, much research on this topic has been conducted. Nevertheless, Beynnon et al. (2002) assessed that there were very few prospective studies focusing on identifying risk factors that predispose athletes to this ankle ligament trauma; thus it remains a controversial issue. The aim of this study is to investigate the kinematic and electromyographic differences among basketball players in terms of muscular activity and kinetic behavior during a dynamic activity which has been closely linked to ankle sprains, and to thereby identify possible risk factors for this injury.

METHOD:

Data Collection: 25 elite basketball players (13 females, and 12 males) underwent the same test procedures consisting of five consecutive jumps in unipodal support. Barefoot athletes with healthy (NS) (n=17) and already sprained (S) ankles (n=28) were asked to jump from the floor onto an unstable surface (round Freeman board) placed 50 cm in front of them. Three experimental jumps were executed before data collection to familiarize the subject with the protocol and to maximize the height of the jump (figs 1 a b). This design aimed to reproduce the most common cause of ankle sprain among Portuguese basketball players: landing on another player's foot, which temporarily becomes an unstable surface.



Figs 1 a) and b): Show athletes jumping a) from a stable surface onto b) an unstable board.

The EMG (1600 Hz) and motion (100 Hz) signals of the subjects who volunteered to participate in this study were collected. According to the standards of the International Society of Electrophysiology and Kinesiology, the Surface EMG was recorded using bipolar, pre-amplified surface EMG electrodes with the Daisy Lab system, placed over four lower leg muscles (Tibialis Anterior –TA, Peroneus Longus –PR, Lateral and Medial Gastrocnemius - GG). The EMG signals were filtered using a bandwidth of 5-500 Hz, full-wave rectification, smoothing a low pass filtered (12 hz) and normalized in amplitude using as reference the EMG of the maximal voluntary contraction (MVC). The motion data was recorded using an electromagnetic tracking device with 3 sensors located on each segment (foot, shank and thigh) of the lower limb and another on a round Freeman board.

Data Analysis: Data was analyzed in four phases of movement: 1. preparation to jump; 2. take-off; 3. ascending flight; 4. and descending flight which culminates in the contact moment.

RESULTS AND DISCUSSION: The magnitudes of flight time showed significant differences between the groups p<0,01, especially in the descending phase. However, the flight time of athletes with previously sprained ankles was shorter during both phases (ascending and descending) of the jump (table 1)

Table 1 Duration of flying time (sec) on both groups

	Time of Flying phase (sec)	
	Ascending	**Descending**
Healthy	0,099±0,032	0,111±0,043
Sprained	0,098±0,028	0,103±0,030
p (Ancova)	p > 0, 05	p < 0,01

Results indicate a different landing strategy depending on the condition of the athlete`s ankle (healthy or sprained) which suggests less preparation for the contact moment among subjects with previous ankle sprain. In fact, healthy athletes take more time to get ready for the landing moment, which might prepare the lower leg to absorb all the impact of the landing more efficiently, and consequently prevent damage to ankle joint structures. The differences in timing could be the result of less accurate anticipatory postural adjustments by the central nervous system of athletes that already sprained their ankle, who then would not anticipate the equilibrium disturbance caused by the whole sequence of movements (Le Pellec & Maton, 2000). Noronha et al. (2004) measured the time needed to return to baseline inversion/eversion steadiness after landing and discovered that subjects with functional ankle instability took longer to return to baseline stability.

Konradsen (2002) findings suggest a risk for ankle sprains when there is an ankle-position error. Regarding landing kinematics, we found that knee and ankle angles of the group with previous ankle sprain changed significantly at the moment of contact (table 2).

Table 2 - Knee and Ankle angles on landing (deg)

	Healthy	**Sprained**	**p (Ancova)**
Knee Flexion (deg)	17,49±12,52	14,63±10,77	p < 0,05
Ankle plantar flexion (deg)	-3,38±10,04	-9,75±14,18	p < 0,01

Although the ankle is the primary indicator for differences at the moment of contact, knee flexion is also significant. Healthy subjects showed more knee flexion and less ankle plantar flexion at the moment of contact which allows them to prepare for lower limb impact absorption and creates a safer position for ankle load. Conversely, the knee flexion degree of the subjects with already sprained ankles was lower at the moment of contact with the surface which leads to a higher impact energy not only for the lower limbs but for the whole body (Devita & Skelly, 1992). At the ankle level, they showed a higher degree of plantar flexion, which exposes their ankle to possible injury (Konradsen, 2005).

Examinations of the energy absorption contributiors revealed that the knee was the primary shock absorber, whereas the ankle plantar-flexors muscles were the second largest contributor to energy absorption among the females and the hip extensors muscles among the males (Decker et al., 2003). In our study muscle activity in both groups (athletes with healthy and sprained ankle) only showed minor differences for the TA in the first phase of the jump (preparation), and for Medial GG during the phases of preparation and ascending (Fig 2).

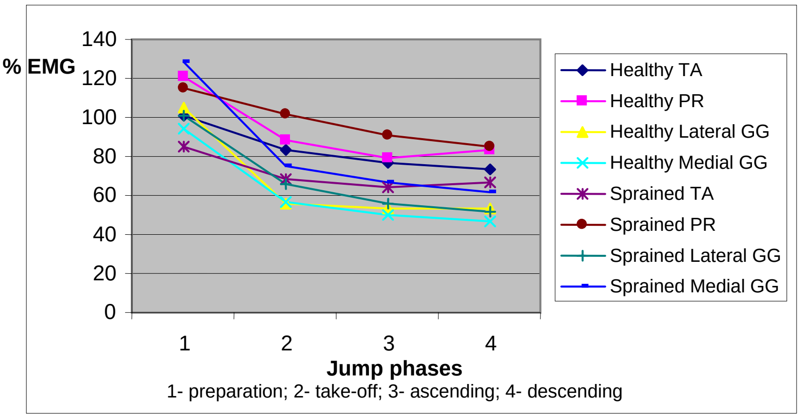


Fig. 2– illustrates muscle activity in both groups during all phases of jump.

However, we generally found higher muscle activity for all muscles in our study with the exception of Anterior Tibialis among athletes that already sprained their ankle. This might suggest an increase in leg stiffness all through the jump movement, which could be due to insufficient time for preparing the contact moment (Arampatzis et al, 2001).

CONCLUSIONS: This study identified different movement behaviour of the lower leg of healthy versus previously sprained ankles during the jump. Results indicate that healthy athletes take more time preparing their lower limb for the contact moment and for further load. These findings also suggest that healthy athletes manage to arrange a better position for landing. This difference in movement behavior could possibly prevent the athlete from having sufficient time preparing for the contact and supporting moment, leading to an ankle sprain, especially because of a risky ankle position. These results indicate that it might be necessary to train athletes to jump in "safe positions" in order to prevent ankle sprains. Results from a small number of studies suggest that balance and coordination training can restore the increased uncertainty of joint positioning to normal levels, and prevent ankle sprains (Fu & Hui-Chan, 2005; Verhagen et al., 2004; Konradsen, 2002; Verhagen et al., 2000; Sheth et al., 1997).

REFERENCES:

Arampatzis, A., Bruggemann, G. P. e Klapsing, G. M. (2001). "Leg stiffness and mechanical energetic processes during jumping on a sprung surface." Med Sci Sports Exerc 33(6): 923-31.

Beynnon, B. D., Murphy, D. F. e Alosa, D. M. (2002). "Predictive Factors for Lateral Ankle Sprains: A Literature Review." J Athl Train 37(4): 376-380.

Decker, M. J., Torry, M. R., Wyland, D. J., Sterett, W. I. e Richard Steadman, J. (2003). "Gender differences in lower extremity kinematics, kinetics and energy absorption during landing." Clin Biomech (Bristol, Avon) 18(7): 662-9.

Devita, P. e Skelly, W. A. (1992). "Effect of landing stiffness on joint kinetics and energetics in the lower extremity." Med Sci Sports Exerc 24(1): 108-15.

Fu, A. S. e Hui-Chan, C. W. (2005). "Ankle joint proprioception and postural control in basketball players with bilateral ankle sprains." Am J Sports Med 33(8): 1174-82.

Konradsen, L. (2002). "Factors Contributing to Chronic Ankle Instability: Kinesthesia and Joint Position Sense." J Athl Train 37(4): 381-385.

Konradsen, L. (2005). Ankle inversion injury biomechanics as a guide for ankle injury prevention 1st World Congress on sports injury prevention, Oslo.

Le Pellec, A. e Maton, B. (2000). "Anticipatory postural adjustments depend on final equilibrium and task complexity in vertical high jump movements." J Electromyogr Kinesiol 10(3): 171-8.

Noronha, M., Refshauge, K., Kilbreath, S., Crosbie, J. e Herbert, R. (2004). Landing from a jump - Pilot of a new jump test. 2nd International Ankle Symposium Delaware.

Sheth, P., Yu, B., Laskowski, E. R. e An, K. N. (1997). "Ankle disk training influences reaction times of selected muscles in a simulated ankle sprain." Am J Sports Med 25(4): 538-43.

Verhagen, E., van der Beek, A., Twisk, J., Bouter, L., Bahr, R. e van Mechelen, W. (2004). "The effect of a proprioceptive balance board training program for the prevention of ankle sprains: a prospective controlled trial." Am J Sports Med 32(6): 1385-93.

Verhagen, E. A., van Mechelen, W. e de Vente, W. (2000). "The effect of preventive measures on the incidence of ankle sprains." Clin J Sport Med 10(4): 291-6.

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