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Muscular imbalances and their impact on the health of the tennis player: Assessments of explosive strength in the lower limbs by means of jumps

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ABSTRACT

This paper discusses the existence of asymmetry in tennis players lower limbs, if these asymmetries impact on determining capabilities as Explosive Strength and Elastic Explosive Strength, and if so, how they are affected by fatigue. This paper holds the hypothesis that there exist differences in the capabilities of useful strength in the lower limb muscles, and that these muscular differences or asymmetries are the source of injury for developing tennis players.

Key words: tennis, asymmetry, jumps, injury prevention, health
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INTRODUCTION

In order to continue being successful in competition, players must accelerate, decelerate, change direction, move quickly, and keep balance while repeatedly producing optimal strokes until the end (Girard, Millet, 2008). As a consequence of these characteristics, literature shows the presence of injuries. Even asymmetry, another essential characteristic of tennis, is admitted to be a source of injury. Pluim, Staal, Windler, Jayanthi (2006) express in their revision that tennis is characterized by varied injuries, most of them in the lower limbs. Confirming this, Hjelm, Werner, Renstrom (2012) literature states that lower limb injuries are the most frequent, reaching 51% of the total. As to asymmetry, we have found papers dealing with torso and upper limb asymmetry, but not lower limb related. Even so, we can infer the existence of lower limb asymmetry, Carpes, Mota, Faria (2010) explain the bilateral asymmetry even in cyclic activities such as continuous sprinting and pedalling, and its risk of injuries in healthy athletes. This makes us think that if in cyclic sports there is asymmetry in lower limbs, in acyclic and asymmetric sports such as tennis, this situation has to be valid too.
Within this context, the objective of the following research is a) to prove the existence of of lower limb imbalance in developing tennis players, and, b) if so, to reflect on the consequences of muscular imbalance of the lower limbs and their possible impact on the health of the tennis player.

METHODOLOGY

Sample

There were 5 participants in the study, all of them were males, with media values in age between 14,2 (0,84), height 170,2 (6,06) and weight 59 (8,89). Their weekly training volume was 26 hours, from Monday to Friday, divided into three sessions, two in the morning and one in the afternoon. The morning sessions included 2h30' of on-court training, and 1h30' of physical training. The afternoon session included on-court training for 1h30'. There was no afternoon session on Wednesday.

Procedure

The subjects were analyzed in December 2012. All of them warmed- up for 10 minutes, 5 minutes of continuous running and dynamic movement exercises (Meylan, Nosaka, Green, Cronin, 2010). No static stretching due to the negative impact demonstrated in previous studies in the different variables of the jumps (Meylan et al., 2010).
The exercises were SJ (squat jump) to evaluate explosive strength and CMJ (counter-movement jump) to evaluate the elastic explosive strength.
Each exercise consisted of 9 attempts (18 jumps total), which were distributed as follows: 3 attempts with the non-dominant leg (ND), 3 attempts with the dominant leg (D) and 3 with both legs simultaneously (2PR). The recovery time between each jump of the same type was 30s. The recovery time between 3 jump blocks was 120s. (Meylan et al., 2010).
The test was made just before beginning the morning tennis training and was repeated after finishing it. This second time there was no warming-up.
Each participant received a questionnaire so as to know age, sex, type and degree of the injury they could have suffered during the previous year.

Data treatment and analysis

The tests were evaluated by means of photoelectric cells (Optojump next, Micrograte Srl, Bolzano, Italy) and the data gathered were entered into SPSS.20 for statistics, setting (pre test and post test) fatigue, kinetic chain (non-dominant leg jump, dominant leg jump and both leg jumps), and the type of jump (SJ and CMJ) as independent intra subject variables. On the other hand, the athlete´s health was taken as an independent inter subject variable. Height (cm) was taken as a dependant variable.
The statistic treatment that was used was an analysis of the variance (anova) for inter group comparisons. The greatest jumps per exercise, and per athlete were analysed. The significance level was set at $p<0.05$.

RESULTS

Figure 1 shows the differences of the effect on fatigue, considering explosive strength and elastic explosive strength.

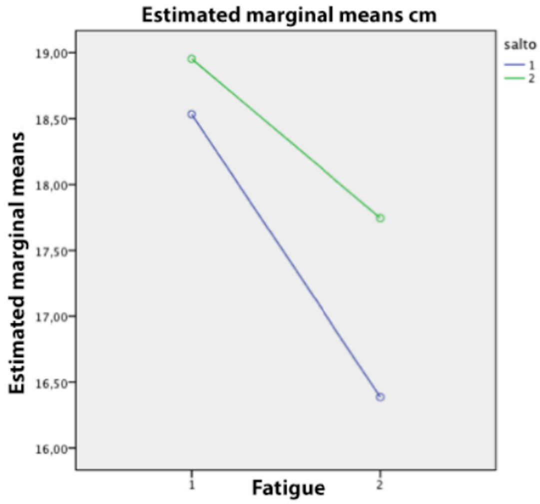

Figure 1. Graphic representation of the impact of fatigue on the type of jump. 1=SJ; 2=CMJ

After making the normality test (Kolgomorov-Smirnov) and sphericity test (Mauchly) the results of the anova intrasubject contrast test with repeated measurements, show significance for all factors analysed and their interactions.

Table 1 demonstrates that this significance is in favour of the pre- test, by comparing the differences between the total jumps prior to training with the same number of jumps when at the end of training. It also compares the difference between both types of jumps. Finally, it permits the analysis of the difference depending on the muscles involved.

		Media differences (I-J)	Error t.	P	IC (95 %) Lower lim.	Upper lim.
Jump						
Total pre SJ	Total Post CMJ	1.677 * -.890*	0.175 0.3	0.001 0.041	1.192 -1.1724	2.161 -0.056
Chain						
ND	D	-1.495*	0.174	0.003	-2.185	-0.805
	2PR	-12.200*	1.044	0.001	-16.335	-8.065
D	2PR	-10.705*	1.094	0.002	-15.036	-6.374

Table 1. Results of the comparison per pairs (Bonferroni adjustment) for the fatigue factors, jump and chain, considered in isolation.

When analysing the effect of fatigue on jumps, we observe that both exercises show training very significantly. And when analysing the chain, we note that both, for the non-dominant leg and for the two feet exercise, there were significant differences, while in the case of the dominant leg, the loss, though important, is not significant (table 2).

	Pre	Post	Media Differences (I-J)	Error t.	P	IC (95 %) Lower lim.	Upper lim.
SJ	1	2	2.147*	0.241	0.001	1.478	2.816
CMJ	1	2	1.207*	0.207	0.004	0.632	1.781
ND	1	2	1.040*	0.315	0.03	0.165	1.915
D	1	2	0.85	0.378	0.088	-0.199	1.899
2PR	1	2	3.140*	0.213	0.000	2.549	3.731

*Table 2. Results of the comparison per pairs (Bonferroni adjustment) for the fatigue*jump; fatigue*chain interactions.*

Table 3 relates the interactions between fatigue, chain and jump, observing that for the SJ there is significance depending on fatigue for all kinetic chains proposed, however, for CMJ fatigue is only significant when jumping on two feet.

	Chain	(I)fatigue	(I)fatigue	Media differences (I-J)	Error típ.	p	IC (95%) Lower lim.	Upper lim.
SJ	ND	pre	post	1,380*	0,292	0,009	0.569	2,191
	D	pre	post	1,860*	0,445	0,014	0.626	3,094
	2PR	pre	post	3,200*	0,305	0,000	2,353	4,047
CMJ	ND	pre	post	0,7	0,454	0,198	-0,56	1,96
	D	pre	post	-0,16	0,518	0,773	-1,599	1,279
	2PR	pre	post	3,080*	0,146	0,000	2,674	3,486

*Table 3. Results of the comparison per pairs (Bonferroni adjustment) for the fatigue*chain* jump interactions.*

DISCUSSION

In spite of the limitations of the sample, this paper confirms the hypothesis of the existence of asymmetry in the tennis players lower limbs. From our bibliographic search, it seems that this pilot study is the first one to show that asymmetry, since previous studies centred on tennis players have studied the assessment of the trunk (Ellenbecker, Roetert, 2004) (Sanchis-Moysi, Idoate, Dorado, Alayon, Calbet, 2010). Some of these papers, Sanchis-Moysi et al. (2010) already say that the asymmetry of the trunk may be due to differences in the kinetic chain of the lower limbs, but none has evaluated those muscles directly. LaterSanchis-Moysi, Idoate, Izquierdo, Calbet, Dorado (2011) verified the existence of asymmetry in lower limbs for the muscles of the gluteus and iliopsoas but using magnetic resonance.

This functional muscular asymmetry has been related to the health of the athletes and their future risk of injuries (Menzel et al., 2012); the level of fatigue has been confirmed to be directly related to this risk (Goodall, Pope, Coyle, Neumayer, 2012). The results of our study confirm the loss of the explosive strength (SJ) and the elastic explosive strength (CMJ), after finishing training, either considering the jumps in isolation or together. This confirms that fatigue reduces the response capability of young players, increasing the risk of injury in the final part of training, or greater duration and intensity efforts.

What interested us most was what happened when comparing the dominant with the non-dominant leg. In this sense, we have found that when considering the total number of jumps with each modality, the loss of height has been significant, both, for the jump with the non-dominant leg, as well as for the jump with both legs, while there have been no significant differences for the dominant leg, when measuring pre- and post training. This makes us think that the fatigue of the non-dominant leg may be determining and may affect directly the jump with two legs . This disturbance in the application of the strength could be related to the injuries that occur as a consequence of the explosive actions in tennis.

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