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The Synchronism of hands' movement during the serve process on professional tennis players

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Abstract
The present study deals with the recording of the synchronism of the movement of the two hands during serve, from the moment the ball leaves the athlete's hand up to the moment the ball contacts the racquet with the other hand. The participants consisted of 48 (23 men and 25 women) athletes who ranked in the first 50 positions according to the official world classification. The results revealed that the mean time of synchronism of the first serve is higher than that of the second serve (0.9514/0.9257 sec for men and 1.0168/1.0072 sec for women) with this difference being statistically significant (p<.05). Furthermore, although a gender effect exists, it was not statistically significant at the timing of the first serve, while it was close to the statistically significant difference at the second serve (p=.055).

Keywords: World class tennis players, gender differences

1. Introduction

In recent years the speed of the serve has considerably increased. For instance, at Roland Garros in 2002 and 2009 the mean average speed increased from 165.1 to 188.9 km/h. Furthermore, the percentage of successful serves augmented from 60.2% to 64.2% and the corresponding improvement in aces escalated to 8.6% from 2.2% [3]. Based on the assumption that no changes have been observed in the anthropometric characteristics of the players during these years, it could be argued that the speed of a serve depends more on the proper technical execution of the movement of the bump, rather than on the applied force or the superiority in anthropometric characteristics of the players [16, 18, 10, 12]. The serve is the most important and critical stroke in tennis. It is well known that fast serves can dominate the game at elite levels [8, 1]. However, it is the most complex stroke as there are several factors involved in the time period between the maximum knee flexion until the contact with the racket [4, 19] in order to produce a fast serve.

Serve is also one of the most difficult strokes to execute due to the fact that the act of throwing the ball and then hitting it on its downward route, requires a complex, multi segment co-ordination among the ball, the hitting body segments, the trunk and the lower limbs [1]. It is the only stroke in tennis where the player depends solely on himself (closed feedback task). It is the fit of the movements that constitutes the main factor to determine the effectiveness of the serve [7, 5, 20]. In addition, the muscles' participation into the throwing of the ball, as well as the movement of the two hands is very important [11, 2, 10].

However, the achievement of maximal potential results originates from the correct synchronized movement of the limbs that participate in the serve [14, 6, 20]. The optimal coordination of kinetic chains in high speed movement activities, like tennis, uses coordinated sequential movements of the body's segments to build force from the ground through the hips and trunk to the shoulder and into the arm, hand and racquet. For example, approximately 50% of the energy needed to hit a forehand is generated from the legs and trunk and is transferred through the kinetic chain to the racket. "Good" use of kinetic chains has common characteristics that allow them to be efficient, even though they may vary in overall appearance due to individual stylistic variations. When these characteristics are not present, or the sequential timing is altered, the transfer of energy in the kinetic chain is said to be "broken". In a broken kinetic chain the energy that must normally be developed within many segments is altered and other body parts must make up for these changes when attempting to create the same performance.

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When the chain is broken, there is either a greater load placed on other body segments to achieve the desired result, or the athlete must accept a lower level of performance [15]. Some authors have described the kinetic chain at the tennis serve based on the angular velocities at the lower limbs, trunk and racquet-arm [9, 12] and which of them are the major contributors [13].

According to the relevant research studies, there is a gap in the literature concerning this particular subject. Hence, the purpose of the present research was to examine if the relative time between the two hands has an effect on the effectiveness of serve. More specifically, it refers to the recording of synchronism of the movement of two hands during serve, from the moment where the ball leaves the athlete's hand, up to the moment where the other hand, with the racquet, meets the ball in the point of contact, in order to locate differences in the highly skilled players.

2. Method

This investigation was designed to assess the effect of synchronism of the movement of two handseffect on the effectiveness of serve.

2.1. Sample

The sample of the study consisted of 48 (23 men and 25 women) athletes (men: age= 27, 80 ±3, 18 years, height= 187± 6, 63 cm, women: age= 25, 54 ±3, 44 years, height= 173± 6,84 cm) that ranked within the first 50 positions in the world classification (ATP - Association of Tennis Professional and WTA - Women's Tennis Association), at the time of recording the data of the present study.

2.2. Procedures

For the recording of hands' synchronization official tennis matches via video were observed and the first and second serve timing data were processed with the special software "kinovea". Official statistical elements of ATP and WTA were added and compared to the above data. Namely, the synchronization of hands was recorded for the 48 participants in their first and second serve. The time duration of twenty serves, ten first and ten second serves, was calculated for each player from at least 2 official matches. By time duration is meant the time between the moments that the ball leaves the hand and the moment when the other hand with the racquet contacts the ball (figure 1).
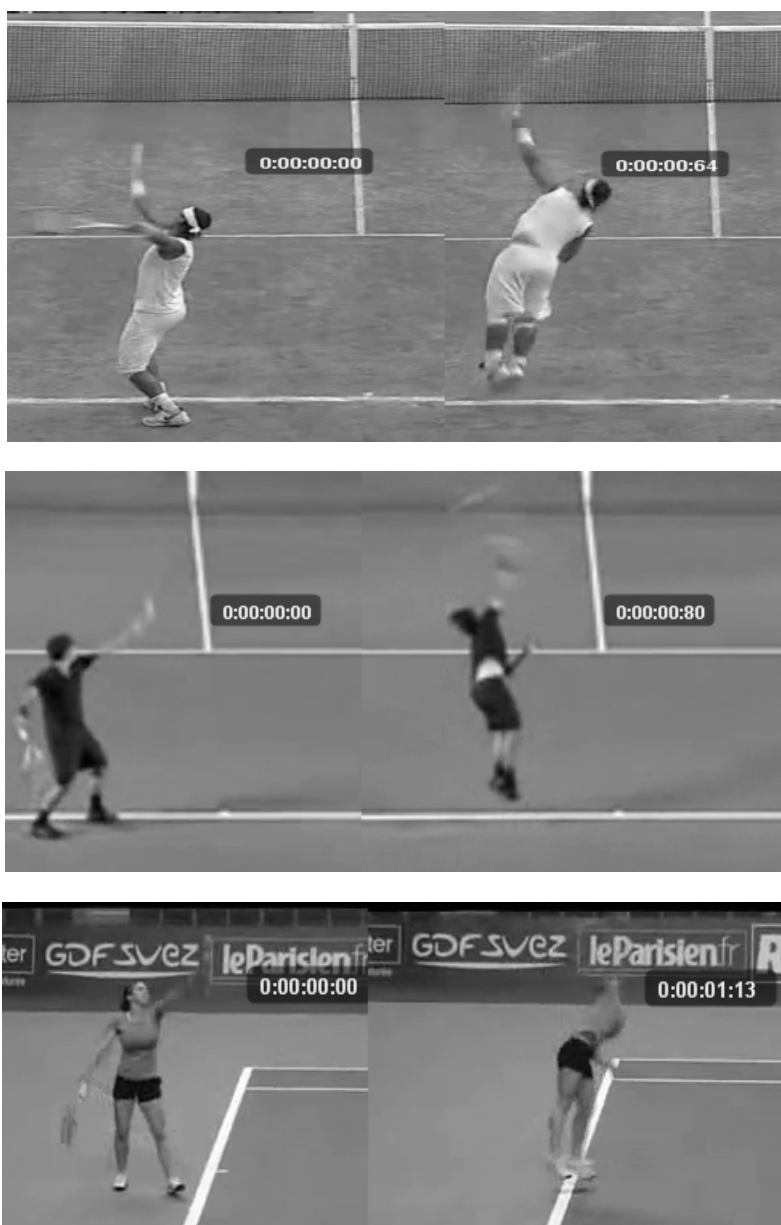

Fig 1: Hands' synchronism (time) during serve, from the moment the ball leaves the athlete's hand until the moment it contacts the racket at paradigm of three players

The mean value was calculated from the 10 serves and represented the value of timing of the two hands. In addition, the rate of success of the first and second serve, as well as the ball speed were also recorded (the statistical elements derived from the ATP and WTA 2011-2012 in the grand slams that the research sample participated).

2.3. Statistical Analyses

The time difference of hands' synchronization between first and second serve was checked using the ANOVA method for no correlated mean values. The cross-correlation of data was checked using Pearson correlations.

3. Results and Discussion

The reliability of data, according to program analysis was statistically significant (r=0.91, p=.000). The mean time of synchronism of the first serve is higher than that of the second serve (0.9514/ 0.9257 sec for men and 1.0168/1.0072 sec for women) (table 1), with this difference being statistically significant at p<.05. The results also revealed that there is no gender effect at the first serve, while at the second serve the effect was close to the statistically significant difference p=.055 (21).

Table 1: Descriptive data of serve in the 50 leaders in ATP and WTA leading [athletes] in tennis

	Gender	N	Mean	Std. Deviation
Time of synchronism of two arms in the 1st serve (sec)	men	23	0.9514	0.1673
	women	25	1.0168	0.1281
Time of synchronism of two arms in the 2nd serve (sec)	men	23	0.9257	0.1769
	women	25	1.0072	0.1028
Accuracy Percentage in the 1st Serve (%)	men	23	63.13	7.77
	women	25	64.68	8.62

The rate of success of the first serve was on average 63.13% and 64.68% for men and women respectively. The rate of success of the first serve for both genders does not relate either with timing, or with the classification of players in the particular sample. However, the correlation coefficient of the time of hands' synchronism between the first and second serve was found to be very high (r=.925, p=.000)

It is obvious that the speed by which both hands are synchronized is less statistically significant in men because they have a faster kinematic chain compared to women, due to greater amount of muscular strength and better somatometrical qualifications [15]. According to the results, the timing of the two hands in serve in leading players does not play any role either in the success of the first serve, or in their classification, at least for the first 50 places of world classification. It is reasonable not to notice any differences in such specialized subjects of technique in players of this level, when their differences are a combination of other parameters like mental stability, game tactic, and supremacy or disadvantages in the rest strokes, beyond the serve [17]. It would be interesting to investigate whether considering a bigger sample, e.g. athletes below number 100 of the world classification, would result in differences in the timing of serve compared to the first ten players of the classification. Unfortunately this is not feasible for the time being, since there are neither statistical elements, nor videos from these players to analyze.

Moreover, the serve's timing seems not to affect the effectiveness of the serve, which means that this effectiveness is not differentiated by the synchronization time i.e. if this synchronization will be great or small. Perhaps, it would be important for each player individually in the stage of practice and the perfecting of the serve technique, to investigate which synchronization time (high or low) suits (his or) her own individual technique for better results. Through the present research it was found that there are players with high, as well as others with low synchronization time, who have appreciable serve. However, more important is the fact that the players do not differ in the timing of the first and second serve.

This finding constitutes the main contribution of the present study to the coaching process. This time also constitutes the personal style of each athlete for his/her own technique. The adoption of a personal serve style, with precise synchronization time that will differentiate each athlete from the other and will achieve minimal deviation between the first and second serve, appears to be the key in order to achieve more effective serves. If, for example, a coach detects big difference between the time duration of the two serves, he must intervene in order to reduce the gap between them, especially when one of the serves is not effective. If, for instance, the first serve has very low rates of success (<30%), while the second serve has regular percentages of success (least double faults) and a great deviation in synchronization is observed, then the synchronization time of the two hands of the first serve should approach the timing of the second serve.

It will be interesting in a future study to investigate whether this change of serve's velocity has been differentiated diachronically. Furthermore, as a future suggestion it could be examined if the unsuccessful serves of players reveal a different synchronization time compared to the successful ones. From a practical point of view this may be an alternative method to correct the serve's technique.

4. Limitations and Further Study

In studies like this, in which the athletes cannot be subjected to certain tests by the author/researcher, the author cannot extend his research to examine additional parameters, such as for instance to examine the serve effectiveness of individual athletes when they vary their serve synchronization. The above would be feasible in the case that the author/researcher could have a sample consisting of several athletes of this level and get them to execute serves with varying synchronization.

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