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## The toss of tennis serves: professional vs. amateur

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### Abstract

We compared a serve toss of different types of serve. Tennis players use different spin on the ball and various ball placements in opponent's service box. Our aim is to compare the serve toss in different types of serve between the amateur and professional player from the view of receiving player. This is a case study. One professional tennis player and one amateur tennis player were observed while serving different types of serve. The participants served different types of the serve to various locations of opponent's service box. We use high-speed camera, which was placed opposite to the server in the position of a receiving player. The results showed the players don't use the same toss for each type of serve. Except individual serving style, there was no difference between the professional and amateur player. Second serves wide and to "T" or kick serve had similar toss characteristics. In some cases, the receiving players can anticipate from the server's toss the type of the serve, therefore the tennis coaches should teach the players to use the same toss. This is very important especially in professional tennis.

**Keywords:** tennis, anticipation, visual perception, receiving player

### 1. Introduction

Every point in tennis begins with a serve. If player miss the first serve (make a fault) he can hit the second serve. If he miss the second serve too, it is a double fault and he loses a point. The serve is one of the most difficult strokes in tennis and has already been researched (e.g. Abrams *et al.* 2011; Carboch *et al.* 2014; Chow *et al.* 2003; Cross, 2011; Sakurai *et al.*, 2013) [1, 4, 6, 7, 12]. The serve motion starts with the ball toss, which is crucial for the whole stroke. The players need to toss the ball stably and need to control the toss. Gilet *et al.* (2009) [9] say the serve and the return are the strokes that most affect the results of the matches in tennis, even on the clay courts (the slowest surface). The ball speed after the serve can often reach over 200 kph in professional tournaments. That means the receiving player has to react very quickly. Even though the ball decelerates on the way to the receiver, the ball travels to him 0,5-1,2 s depending on the serve quality, ball spin and surface (Dunlop, 2000; Kleinöder, 1997) [8, 10]. Vaverka (2010) [14] compares the serve speed between the genders in professional tennis. He says the men reach average speed of the first serve 183,6 kph and 148,5 kph of the second serve. However women's first serves reach the average speed only 154,9 kph or 132,2 kph of the second serve respectively. The Australian Open winner in the men's tournament in 2015 served the first serve on the average 190 kph and the second serve 158 kph (Australian Open, 2015) [2]. According to Crespo and Miley (2002) [5] women have less muscle mass, relatively narrow shoulders, wider hips and short legs. For women that means less favorable biomechanical conditions for many physical activities compared to men, on which depends the total force that can be developed (Crespo & Miley, 2002) [5]. Similar to women, male amateur tennis players are expected not to be so physically fit and prepared as professional players and therefore amateur players can't develop such force and serve speed as the professionals.

We have different types of serve in tennis. Players can hit a flat serve (no or minimum spin on the ball), a slice serve (side spin) or kick serve (topspin) (Crespo and Miley, 2002) [5]. According to Cross (2011) [6], when a player serves the kick serve (KS) a side spin is also generated together with the topspin. The KS is relatively slower however the ball bounces very quickly and very high. The KS is usually served to opponent's backhand. The flat serve (FS) is about the highest speed. The ball trajectory during the slice serve (SS) is curved. The ball turns to the side, from right to left (in case of right-handed server). The second serve is slower because players use more spin to control the ball. The players need to reach high efficiency of the second serve too.

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The receiving player needs 0,2 s to estimate the ball trajectory (Crespo and Miley, 2002) [5]. After that, he has very short time for his motion to return the ball. However, the receiving player can gain more time, if he anticipates correctly. Experienced players focus their vision on opponent's shoulder-racket area (Singer *et al.*, 1996) [13]. Crespo and Miley (2002) [5] say advanced players should use the same toss for every type of serve to hide their intentions.

The aim of this study is to compare toss in different types of serve between the amateur and professional player from the view of receiving player.

**2. Materials and methods**

This is a case study. We observed one amateur and one professional tennis player. The amateur player was a club level player. He was 20 years old, right-handed and ranked in Czech Republic 462 (national ranking). At the time of measuring his weight was 68 kg and he was 179 cm tall. The professional player was regularly playing ITF (International Tennis Federation) and ATP (Association of Tennis Professionals) Challenger events. He was 27 years old, right-handed player and his ATP ranking was 296. He was 184 cm tall and his weight was 76 kg at the time of measuring.

After finishing standard match warm-up, the participant was told to serve with maximum effort, exactly the same way like

in a match. Every serve was made from the same place. The participant began to serve from the right side of the court. There was a mark on the court. This was a starting position for each trial. The mark was placed on the baseline 1 m to the right of the center service mark. The participant started every serve from this mark by touching this mark with the tip of his front leg. First, he served a FS serve wide (FSW) – that means in the direction of side line of the service box on receiver's end of the court. After 3 successful trials, he served a FS to "T" (FST). "T" or "T-line" is junction of center service line and service line (figure 1). Next, the participant served a second serve wide (2W), followed by a second serve to T (2T), followed by the SS wide and KS to T. Target area was 1 m wide 3 m long. It corresponded to the zones where players normally place the serve (wide and T). In total, the participant reached 18 successful serves from the right side of the court. The action was recorded by a high-speed camera (Basler GenICam piA640-210gc) with a frequency of 200 Hz. The location of high-speed camera was at the point where the receiver stands on the opposite end of the court. The camera was placed 1 m behind the baseline, 0.5 m from the side line for singles towards the center of the court and at the height of 1.6 m, so that we could see server's action. The serve speed was measured by radar (Stalker Pro II), which was placed next to the high-speed camera.

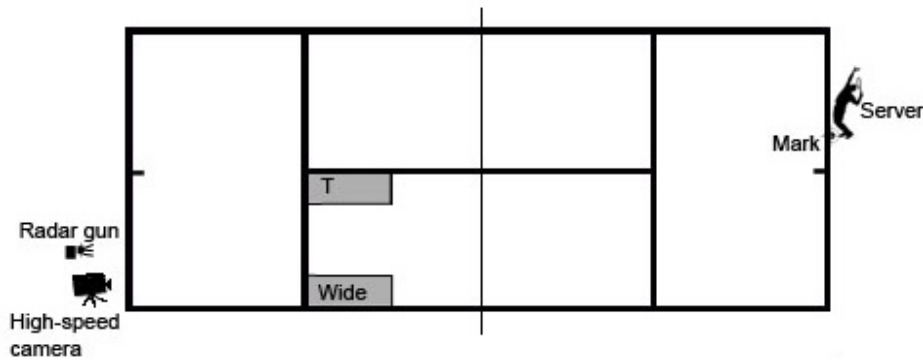


Fig 1: Experiment set-up

The records were analyzed using 2D analysis. Cartesian coordinate system was defined prior to each trial to prevent foot displacement, even though they started their motion from the same place. Horizontal axis X and vertical axis Y was used from the view of receiving player (figure 2). Point 0 of these

axes was set at the server's tip of his front leg. Using software *Dartfish 7*, we analyzed the ball toss 1) at the ball release point from the server's hand; 2) at the highest point of toss; 3) at the point of the racket-ball contact. The data were analyzed using descriptive statistics.



Fig 2: Orientation of global coordinate system

**3. Results**

Altogether, we analyzed 18 serves of professional and 18 serves of amateur player. We evaluated 6 types of the serve (6×3). Mean values and standard deviation of all observed variables from 3 successful trials for each type of the serve are presented in table 1. The ball release point was at similar height of both players. The mean toss height was 6 cm higher

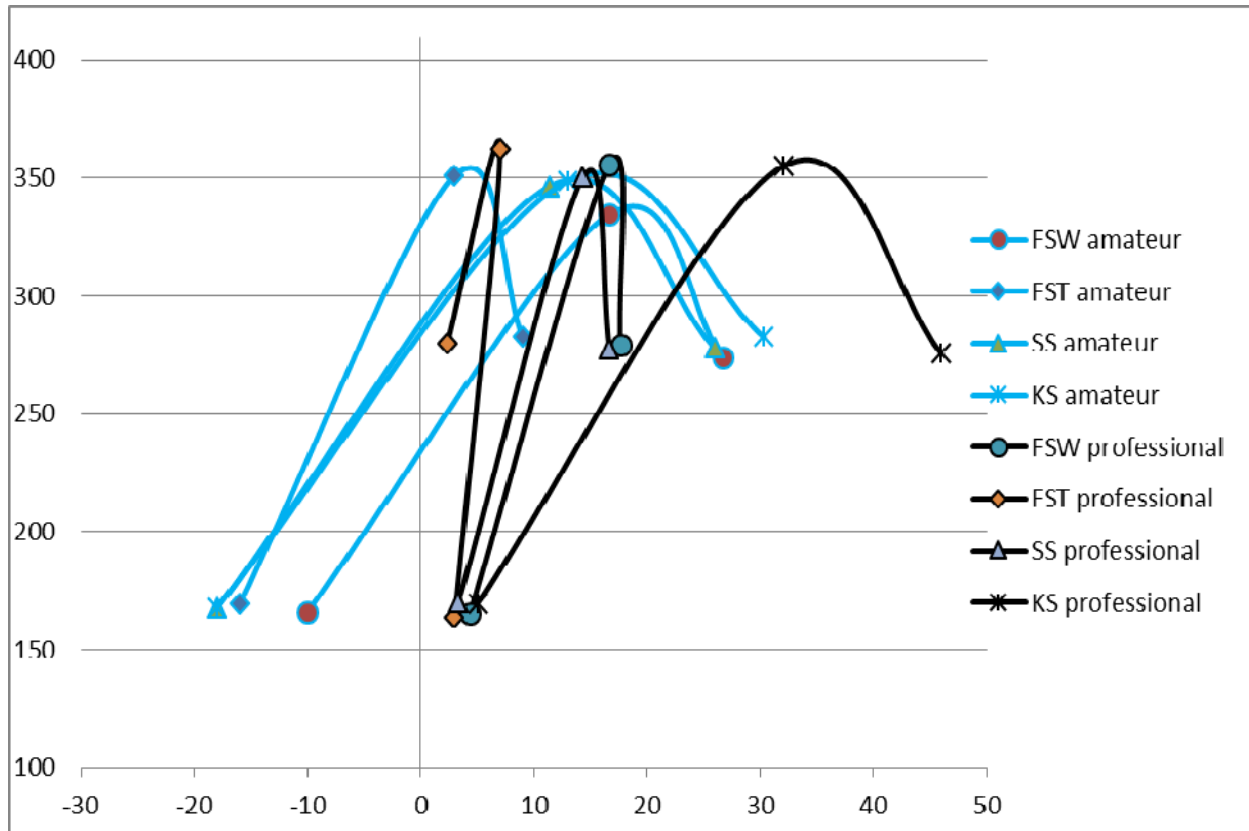
by the professional player comparing to amateur player. Only the FSW of amateur player was 14 cm lower to the mean value of toss height. The mean height of racket-ball contact was almost the same at both players i.e. 280 cm by the amateur or 278 cm by the professional player respectively. The mean of the serve speed of amateur player was 21 kph lower comparing to the professional player.

**Table 1:** Mean values of all observed variables

	Type of serve	Ball release		Toss maximum		Racket-ball contact		Serve speed (km/h)	Speed difference
		(cm)		(cm)		(cm)			
		X	Y	X	Y	X	Y		
Amateur	FSW	-10±2,6	-166±1,2	17±1,5	335±8,1	27±3,5	274±4,6	166±2,1	-25
	FST	-16±1,0	-170±1,5	3±10,6	351±5,6	9±15,7	283±2,9	171±4,2	-25
	2W	-16±3,1	-169±3,0	17±8,0	354±9,3	33±11,4	286±2,0	132±2,6	-23
	2T	-17±2,9	-168±0,6	16±2,6	352±11,5	30±0,6	279±4,6	134±6,0	-20
	SS	-18±4,0	-168±2,5	11±10,3	346±8,3	26±12,5	278±1,0	136±5,2	-28
	KS	-18±1,0	-168±0,0	13±0,0	349±1,5	30±5,1	283±4,6	134±4,9	-9
Professional	FSW	4±2,1	166±2,5	17±6,5	356±4,0	18±12,1	279±3,2	191±2,6	25
	FST	3±1,0	164±1,5	7±2,6	362±5,9	2±3,2	280±1,0	196±4,0	25
	2W	4±0,6	168±3,1	21±6,1	352±2,3	27±7,8	280±2,9	155±3,2	23
	2T	3±2,5	169±2,6	22±2,6	352±5,8	29±3,1	273±5,3	154±4,7	20
	SS	3±2,5	170±6,7	14±9,5	350±7,1	17±16,3	278±1,2	164±19,3	28
	KS	5±3,0	170±1,5	32±5,0	355±6,2	46±12,1	276±2,9	143±4,5	9

However, the amateur player released the ball more to left from the receiver’s view. He also had the ball release point of KS much more to the right comparing to all other types of the serves. The ball motion during the toss of first serves is shown in figure 3. We can see differences between the participants

and among the types of the first serve. The toss trajectories are different. The KS racket-ball contact point was the most to the right from all the serves at both players. The same happened during the FST, however on the left side.



**Fig 3:** Serve toss comparison among different types of first serve

The toss trajectory of second serve is shown in figure 4. Similar to the first serves, the ball release point of amateur player is starting more to the left (individual style difference).

We can't see any differences in the toss between the serve directions. The only difference is both players had 2T racket-ball contact 7 cm lower in comparison to the 2W.

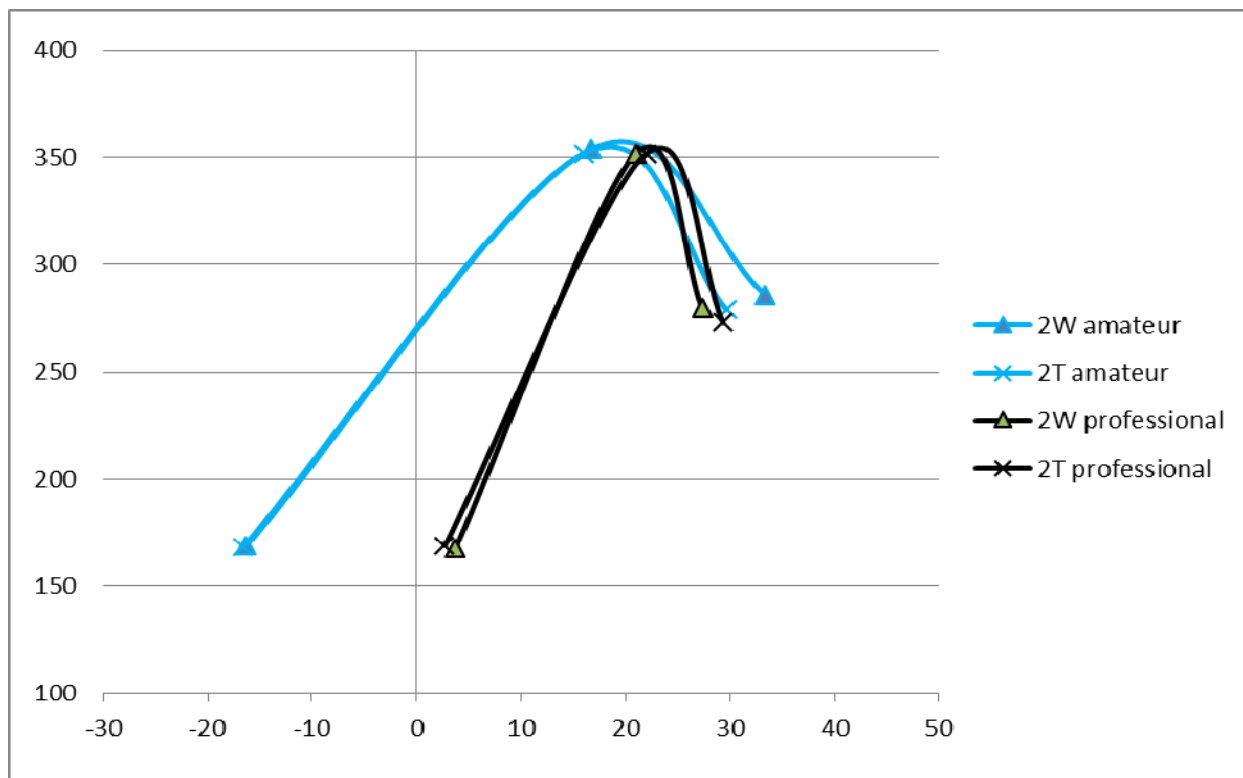


Fig 4: Serve toss comparison among different directions of second serve

Interesting values between participants and among serve types provides horizontal X axis. The ball moves during toss (shift on X axis from the ball release point to the racket-ball contact) among different serve types (table 2). Both players had similar values when they served the KS.

Table 2: Horizontal ball move between the ball release and racquet-ball contact

Type of serve	Amateur	Professional
FSW	37	14
FST	25	-1
2W	49	23
2T	47	26
SS	44	14
KS	48	41

4. Discussion

The aim of this study was to compare toss in different types of serve between the amateur and the professional player from the view of receiving player. Even though Crespo and Miley (2002) [5] say, the players should use the same toss for every serve to hide the intention, we could observe this only during the second serves. The toss for the first serves varies a lot at both players.

We showed some differences in toss execution. Carboch and Süss (2015) [3] show toss differences between the KS and the SS. They found the racket-ball contact point of KS was 30 cm more to the right comparing to SS. This supports only the professional player in our study. We have not found any toss differences between the directions of the second serves. Similar results obtained Reid *et al.* (2011) [11] when they observed 6 professional players (average ATP ranking 1539). They haven't found any toss differences between FSW and FST; and between 2T and 2W (only 2 cm difference on horizontal axis - the same as we found). There are contradictory results, as Reid *et al.* (2011) [11] say the players

use the same toss, however Carboch and Süss (2015) [3] suggest the players don't use the same toss even though both studies examined different type of serves. Our study suggests players use the same toss only for the second serves and not for the first serves. Next studies should examine more participants.

The speed of the serves was as we expected. The professional player reached higher speed then the amateur player in all observed types of the serves. The professional had similar speed of all serves as is the average by professional players as shows Vaverka (2010) [14].

If we compare both players, we can see similar characteristics of the ball toss in some types of serves. E.g. the KS toss trajectory was similar, and the racket-ball contact was most to the right from all the serves. However, we can observe individual differences in style of the serve. The amateur player releases the ball much more to the left. This is because of biomechanical factors and individual serve technique. This serve technique determines the serve execution including the toss.

This case study had some limitations. We observed only two directions of the serves – T and wide. Players can also serve into the middle of the service box – in the “body” direction of an opponent. Next research should also observe the toss execution from the ad-court and more participants are necessary to reach more accurate results.

5. Conclusion

We found toss differences among serve types, but we did not find significant differences between professional and amateur player. We can see individual differences in toss execution, for instance professional player used the same toss for FSW and SS, and both players used the same toss for 2T and 2W. However, we can conclude, both players didn't use the same toss for each type of serve as we could mostly see differences on horizontal X axis. We expected the professional player to

use the same toss; however it didn't come true at this level of tennis. As we observed, players hadn't put emphasis to use the same toss for each type of serve. That means receiving players can anticipate from server's toss the type of the serve in some cases. Coaches should teach the players to use the same toss for every type of serve.

## 6. Acknowledgement

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