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GENDER DIFFERENCES IN TECHNICAL FEATURES OF ELITE JUNIOR TENNIS PLAYERS AND IN THE TECHNOLOGICAL CHARACTERISTICS OF THEIR RACKETS

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ABSTRACT. Introduction: The more precise observation of tennis players is essential to reach the best competitive performance in junior level as well. **Objective:** The aim of the research was to test the hypothesis that the majority of elite junior tennis players are right-handed and most of them use the two-handed backhand stroke and modern forehand and backhand grips. Furthermore the technical characteristics of the rackets used well reflect the differences in gender. **Method:** 40 elite male (15.92 age) and 40 elite female (16.34 age) tennis players participated in our research. Testing was carried out with calibrated means and equipment based on standard protocols. **Results:** 92.5% of the males and 95% of the females are right-handed. 65% of the females and 72.5% of the males use the modern semi-western forehand grip. As far as backhand groundstrokes are concerned, the frequency of the two-handed backhand stroke is 95% for females and 80% for males. 40% of the males and females used the modern two-handed backhand grip. The males used a significantly longer and heavier racket of greater swing weight than the females ($p<0.05$). On the other hand, females tennis players used a significantly bigger head size with a stiffer and wider frame racket than the males ($p<0.05$). **Conclusions:** The results draw attention to that the dominant arm, grips, backhand type and used rackets' characteristic give useful information for the trends in the preparation of the elite junior tennis players.

Key words: *tennis, dominant and non-dominant hand, grip, backhand stroke, technological changes*

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Introduction – Objective

Elite junior tennis players have to play against excellently-trained opponents who are increasing in number both at the national and international levels. Thanks to modern equipment, court surfaces and modern training methods, play is becoming faster in the junior level as well. Furthermore, one can talk about a whole-year competition period already at the junior level, not to mention the fact that these age-category players will provide the future generation of tennis players. To have a better competition performance, more precise observation and preparation is essential, part of which consists of gathering data and analysing the dominant hand, different racket grips, technical elements, height of the player and technical characteristics of the racket used.

Smooth, powerful and accurate strokes are based on proper racket grips (Levey, 2005, 2012). This is especially true for the junior tennis players. The racket grip has an effect on the angle of the racket surface at the contact point, thus influencing the speed of the ball, its spin and direction. The selection of a proper racket grip is difficult as certain racket grips are more favourable than other ones in terms of different technical elements and game situations (Levey, 2005, 2012). Furthermore, the dominant hand (the more skilful one) has an influence on the technical, tactical and conditional preparation of the junior tennis player as well as on the formation of his/her game style. Modern rackets are lighter, have a wider frame, have bigger heads size, are stiffer and have longer duration than the older, wooden and metal rackets (Bolettieri, 2001; Dobos, 2013; Crespo & Reid, 2009; Miller & Cross, 2003). These technological changes have revolutionised changes in stroke technique, even at the junior level. Modern grips (semi-western, western grip), footworks (split-step, gravity step), new hitting stances (open, half-open), the two-handed backhand stroke, and faster spins and strokes have appeared. As a result of these, the trends in preparing elite junior players have gone through great changes.

The role of height is also not negligible in junior tennis, but there are some other significant factors of successful performance. It is obvious that taller players have longer arm extension than their partners. Taller professional tennis players have much better biomechanical conditions for faster service speed than their shorter partners (Martin, Kulpa, Delamarche & Bideau, 2013). Furthermore, in professional players a significant relationship can be observed between height and the average speed of the first and second serves (Cross & Pollard, 2009; Vaverka & Cernosek, 2013, 2016). In our opinion these facts are true for junior tennis players as well, thus, their height provides an advantage, mainly in the longer extension of the arm. Height also has an effect on racket selection, playing style and player footwork.

Based on all these, the aim of this research is to examine the hypothesis, according to which the majority of the under-16 and -18 elite junior Hungarian tennis players are right-handed, most of them apply modern forehand and backhand grips, a majority of them use two-handed backhand strokes, the males are generally taller, and the technological characteristics of their rackets well reflect the difference in gender. A further aim of this study is to help in the more effective preparation of junior tennis players based on the information obtained.

Methods

Participants

The best Hungarian tennis players from the under-16 and -18 age group (the first 40 players) participated in the research. The stratified random sampling method was used; 20 boys and 20 girls from each age category were tested (altogether, 80 people). In addition, 30% of the investigated tennis players had ETA or ITF rankings besides the Hungarian one, and 10% were among the top hundred. The selected sample represented the total male and female population of the best Hungarian under-16 and -18 age-category tennis players: they had 3-7 years of competition experience and played 40-90 stake matches a year on average. From the point of view of the research, two groups were formed: 1) male tennis players; 2) female tennis players. Their average chronological age was: 15.92 and 16.34, respectively, for the males and females.

The ethical norms (Harriss & Atkinson, 2011) of the research were in harmony with the principles formulated in the Helsinki declaration. Also, professional-ethical permission was granted for the research (7878/2014), issued by the Public Health Organization of the Budapest Government Office.

Experimental procedures

The determination of the subjects' calendar age, height and racket grip and the main parameters of their rackets were carried out based on a standard protocol (Mészáros, 1990a,b; Levey, 2005, 2012; Bollettieri, 2001).

Examined variables

The dominant hand: is the more skilled upper extremity of tennis players which holds the racket and drives it during the different executions of the stroke.

Racket grip: position of the hand of the player on the grip.

One-handed backhand groundstroke: this is the technical element which is initiated with one hand from the left side of the body (in the case of a right-handed player), and after contact the ball finishes on the right side of the body.

Two-handed backhand groundstroke: this is the technical element which is launched with two hands from the left side of the body (in the case of a right-handed player) and finishes on the right side of the body after contact with the ball.

Height: (m): This is the difference between the plane of the sole and the highest point of the top of the head in metres (Mészáros, 1990a).

Parameters of the racket used:

Weight (g): full mass of the racket without the strings in grams.

Length (cm): distance between the two ends of the racket in cm.

Stiffness (RA): is the number that shows to what extent the racket bends as a result of the given force (Bollettieri, 2001).

Swing weight (kg·cm^2): character of the racket manifested in the dynamic movement of the racket, which is nothing more than the manoeuvrability of the racket.

Head size (cm^2): size of the racket's head in cm^2

Frame beam (mm): Thickness of the outer edge of the racket in mm.

Statistical analyses

First, the dispersion of the data was carried out with an investigation of the statistical data, during which the Shapiro-Wilk–W test was used. The data did not meet the demands of normal dispersion, thus, height and the basic statistical indices of the main parameters of the racket used were given by the median and quartile range. The non-parametric Mann-Whitney U test was applied in examining the difference in gender. The significance level was determined at value $p<0.05$.

The frequency of grips, the type of backhand stroke, the dominant (hitting arm) and non-dominant hand were given as a percentage with the percentile value. The statistical analysis was carried out with SPSS 12.0 software.

Results

92.5% of the males were right-handed, and 7.5% were left-handed. For females, the number of right-handed players was 95%, with 5% being left-handed (Figure 1).65% of elite junior female tennis players used the semi-western grip, with 35% using the eastern forehand grip for the forehand groundstroke. In the case of males it was 72.5% for the semi-western, 25% for the eastern forehand and 2.5 % for the western forehand grip (Figure 2). As far as the backhand

strokes are concerned, the frequency of the two-handed backhand groundstroke was 95% for the females and 80% for the males. 5% of the females and 20% of the males used a one-hand groundstroke (Figure 3). 55% of the females used the so-called traditional grip, and 40% of the females used the modern two-handed backhand grip in executing backhand groundstrokes. The rate of the traditional and that of the modern two-handed backhand grip was 37.5% and 40%, respectively, in males. Another 2.5% used the extreme two-handed grip. 17.5% of the males used the one-handed eastern grip, and 2.5% used the one-handed semi-western grip, while 2.5% of the females used the eastern grip and 2.5%, the semi-western one-handed backhand grip (Figure 4).

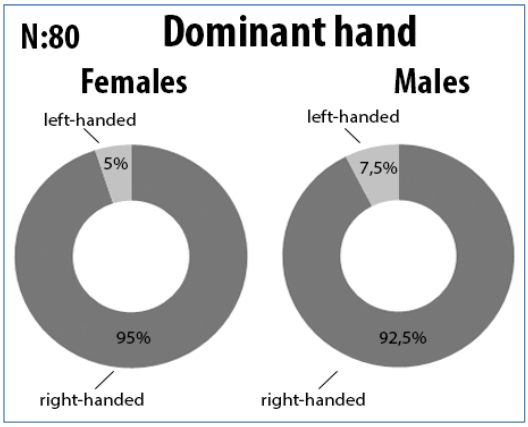

Figure 1. Frequency of dominant and non-dominant hand in elite junior tennis players

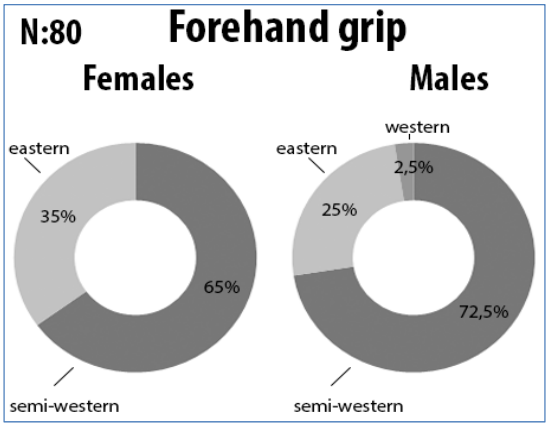

Figure 2. Frequency of forehand grip in elite junior tennis players

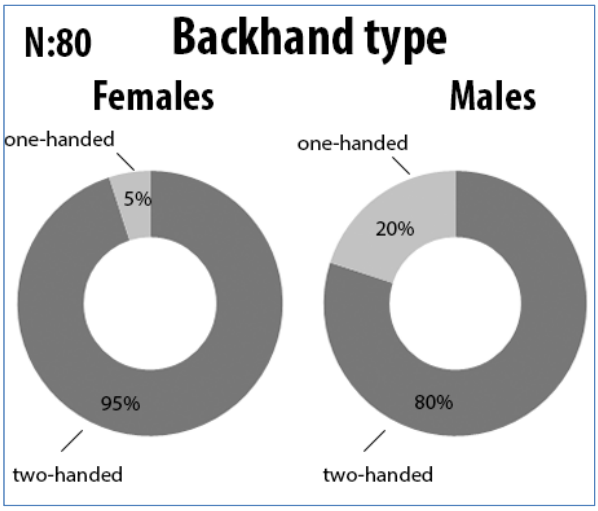

Figure 3. Frequency of backhand stroke in elite junior tennis players

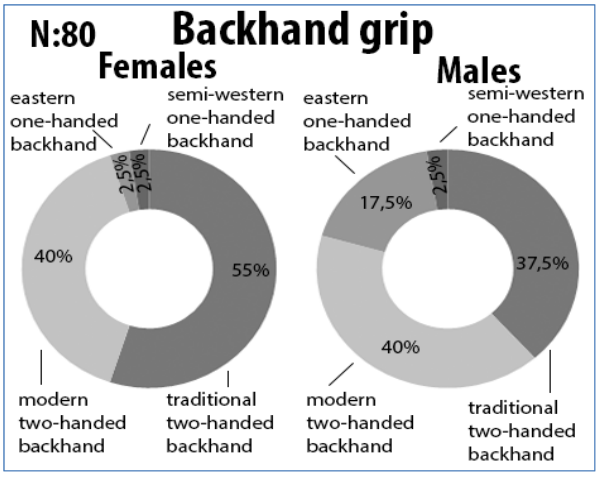

Figure 4. Frequency of backhand grip in elite junior tennis players

The males used significantly longer and heavier rackets of greater swing weight compared to the females ($p<0.05$). The females used a racket with a significantly larger head size with a stiffer and thicker frame compared to the males ($p<0.05$) (Table 1). Male tennis players were significantly taller than the females ($p<0.05$) (Table 1).

Table 1. Basic statistics and differences of used tennis racket and body height in elite junior tennis players. N:80

Variables	Males N:40		Females N:40	
	Median	Quartile Range	Median	Quartile Range
Weight (g)	305.00*	20.00	295.00	10.5
Length (cm)	69.00*	0.42	68.58	0.5
Stiffness (RA)	64.00*	6.00	68.00	11.00
Swing weight (kg·cm^2)	320.00*	12.50	312.50	11.00
Head size (cm^2)	632.00*	15.00	645.00	0.00
Frame beam (mm)	21.41*	0.75	23.66	2.33
Body height (cm)	177.70*	7.9	168.80	9.08

Asterisks indicates significant differences $p<0.05$*.

Discussion

Importance of dominant hand and gender differences of its frequency (percentage)

The majority of the tested elite junior tennis players are right-handed (males 92,5%, females 95%). The frequency of left-handed players is insignificant (males 7,5%, females 5%). According to TE, ITF, ATP and WTA official websites the right-handed dominance can be observed in the best junior and professional (best 40) players in the world. The percentages males, 87.5%; and females 95% in the case of professional men it is 80% and for women, 85%.

It can be seen from the data that the percentage frequency of the right-handed players is significantly higher than that of the left-handed ones in both genders, thus, the tennis players play many more matches against the right-handed partners both at the junior and professional levels. So the majority of professional and junior tennis players have more match experience, technical preparedness, tactical plans and repertoires when playing against right-handed players. These mean a kind of advantage for left-handed players. We think this statement is true for the tested elite junior tennis players as well.

Importance of forehand grip and gender differences of its frequency (percentage)

The dominance of the semi-western racket grip can be observed by comparing the frequency of the eastern and western grip in the elite junior males and females tennis players (males, 72.5%; females, 65%). The semi-western forehand grip ensures faster spin and greater control of the execution of spin of forehand groundstrokes and lobs compared to the eastern forehand grip. Furthermore, it can be applied in handling the flat, slightly spinned finishing and defensive forehand stroke, as well as in the case of high-bouncing balls. The highest spin can be generated with the western handgrip (Levey, 2005, 2012). According to our opinion the majority of the tested junior players of both genders possess the modern forehand technique and good physical condition, allowing them to give a spin to the ball while considering the speed as well. The complete lack of western grip use in females can be found in only 2.5% of the males. But it shows that the examined elite junior tennis players hardly or very rarely use high-rising forceful spins. Regarding the eastern forehand grip, 25% of the males and 35% of the females play flat balls with less spin which result from this type of grip.

Backhand strokes and their importance and percentage frequency in different genders

In analysing the frequency of backhand strokes of elite junior male and female tennis players, the considerable dominance of the two-handed backhand stroke can be observed (males, 80%; females, 95%). The frequency of the one-handed backhand stroke was 20% for the males and only 5% for the females. In comparison, according to ETA, ITF, ATP and WTA official websites 95% of elite junior male tennis players (the best 40) and 98% of the females use two-handed backhand strokes 75% of the best male professional tennis players and 90% of the women use a two-handed backhand stroke. The measured data in this research reinforces the international trend which shows a drastic pushing forward of the two-handed backhand stroke in both genders.

During play junior tennis players are able to generate faster and more spinned balls thanks to modern handgrips and equipment. So it is a basic requirement for the players to have such a backhand stroke with which they can handle and generate these faster and more spinned balls. Based on the observations, this double requirement can be fulfilled much easier with the use of the two-handed backhand stroke. The majority of the tested junior players use the two-handed backhand stroke in both genders.

The swing radius of the racket is shorter in a two-handed backhand stroke than in the one-handed one, so the time elapsed between the swing and the contact point is shorter (0.09s) for the former than the latter (0.13s) (Reid, 2001; Reid &

Elliott, 2002). The short backswing makes for easier timing, better control, shorter preparation of the racket and better hiding of the stroke (Reid, 2001). The spin of the two-handed backhand stroke demands less physically and coordination-wise of the tennis player, as the less skilful arm can aid the horizontal and vertical movement of the racket at the contact point. This stroke provides a huge advantage in handling the high-bouncing ball (up to shoulder level) and can ease the handling of balls rising to different heights as well. In the early phases of the teaching-learning process, the two-handed backhand stroke creates less of a challenge in terms of coordination (two hands aid the execution of the stroke), thus learning the basics requires a shorter time. The biomechanical characteristics make the execution possible from various hitting stances. The vibration resulting from the contact point is divided between the two upper extremities in the case of a two-handed backhand stroke, thus decreasing the load on one arm (Elliott, 2003). Tennis elbow in players using the two-handed backhand stroke is less frequent than for players using the one-handed stroke (Roetert, Brody, Dillman, Groppel & Schultheis, 1995).

The one-handed backhand stroke ensures a longer path to the speeding up of the racket. Its contact point is about 20-30 cm ahead, and its distance of extension is greater than that of the two-handed backhand stroke (Reid, 2001). Thus, the reaching and handling of balls hit with the one-handed backhand stroke and bouncing outward can be well solved. Furthermore, the hit does not force the player to hit the ball with spin. The execution of hitting the backhand volley with one hand is not a problem for the player either. It ensures an easier adjustment to the racket grip while running to the net.

Importance of backhand grip and gender differences of its frequency (percentage)

Regarding the two-handed backhand grip, it can be observed that a greater percentage of elite girl tennis players (55%) apply the traditional racket hold instead of the modern one (40%). The percentage of two-handed backhand grip for the males is more equal (traditional, 37.5%; modern, 40%). Of the males, 2.5% used the extreme two-handed grip. The modern two-handed backhand grip *(*when the dominant hand holds the racket with the eastern backhand grip and the non-dominant hand with eastern or semi- western grip*)* places the wrist of the dominant and non-dominant arm in such a position that players are aided in generating greater spin than with the traditional backhand grip, without placing a huge load on the wrist of the dominant arm. The handling of high balls is also more comfortable with it. On the other hand, the traditional two-handed backhand grip (when the dominant hand holds the racket with the continental and the non-dominant hand with the eastern or semi- western grip) places a huge load on the dominant arm. It is true that low-bouncing balls are more comfortable to

hit with this grip, which is why a great percentage of the tested players use the modern two-handed backhand stroke. But the use of the traditional two-handed backhand stroke is more significant with the females, although it is not negligible with the males either (females, 55%; males, 37.5%). The reason can be found in the freer movement of the wrist of the dominant arm.

In studying the one-handed backhand stroke of elite junior tennis players, it can be said that a great majority of the males (17.5%) use the eastern grip compared to the semi-western one (2.5%). Use of either the eastern or the semi-western one-handed grip is insignificant with the females (2.5%; 2.5%). The data show that 17.5% of the males use a one-handed backhand grip, allowing the ball to be well spinned while considering the speed of the ball as well. A negligible percentage (2.5%) uses the semi-western one-handed backhand grip. As a result of the application of higher trajectory, stronger one-handed backhand spins in the tested group are minimal. Furthermore, we think that only 5% of the tested elite girl tennis players have the kind of training orientation and tactical preparedness and such conditional and coordination abilities which allow one-handed backhand strokes to be applied steadily with the proper effectiveness. Thus, the use of the one-handed backhand grip is insignificant among them.

Differences in gender in the features of the racket used and body height (Table 2)

In analysing the median values of the rackets used, it can be said that the tested elite junior male tennis players used medium-weight (305 g) and medium stiff (64 RA) rackets of normal length (69 cm), a medium head (632 cm^2) and relatively high swing weight (320 $kg{\cdot}cm^2$). These rackets were significantly longer, heavier, have greater swing weight, a smaller head size, a narrower frame and were more flexible than those used by the females. In addition, the males were significantly taller as well. This is why we think that male tennis players, due to their higher level physical abilities, are also able to speed up the heavier and longer rackets properly. Therefore, they are able to reach a greater hitting force, return and receive balls arriving further from the body, have higher contact points at the serves and cover a greater area both on the baseline and at the net than the females. Furthermore according to our opinion the greater swing weight, smaller head, and narrower frame of the racket can show that male tennis players have special coordination features besides their physical abilities which allow them to manoeuvre the tennis racket properly and the more flexible frame ensures a better control and spin of the ball.

The elite females tennis players used medium weight (295 g), normal length (68.58 cm), specifically stiff (68 RA) rackets of a wider frame (23.66) and medium head (645 cm^2). Its swing weight (312 $kg.cm^2$) registered a medium

value. These rackets were significantly lighter, stiffer, have a bigger head, a wider frame and a smaller swing weight compared to those used by males. Besides these, their height was significantly shorter compared to the males. According to the author, the technical variables of the rackets used reflect the lower level physical abilities and anthropometric specialities of the female players. This is why they play with wider rackets with a bigger head and thicker frame, which increase the resistance of the racket head rotating along the longitudinal axis. Furthermore, the racket with a larger head ensures a larger sweet spot. All these help them in better controlling the ball and in the execution of successful strokes. The use of a stiffer racket also aids the females in creating a greater hitting force. This way enough ball speed can be obtained with a shorter swing, allowing the return of balls in case of a bad contact point (hits contacting the ball with the edge of the racket). The lighter rackets of smaller swing weight can be well-speeded up.

Finally we think that the shorter extension distance deriving from their lower body height and a shorter racket, the females use a different kind of footwork and playing style than the males. The use of a stiffer racket puts a greater load on their arm, and the controlling and spinning of the ball with a stiffer racket is more difficult for them, but this disadvantage can be compensated for by decreasing the firmness of the strings and using shorter and lighter tennis racket with larger head size.

Conclusions

In conclusion it can be said that the data draw attention to the following facts: the majority of the tested junior elite tennis players are right-handed, play with arched, proper and fast balls with normal spin as a result of modern rackets, modern grips and use the two-handed backhand, which basically determine the trends in the preparation of the players. In addition, gender differences – which are of key importance – also have to be considered in terms of preparation.

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