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A test battery to assess on court displacements of youth tennis players

Giovanni Catizone[1], Jeff Konin[2] & Giulio Sergio Roi[1,3]

[1]Italian Tennis Federation, Higher Education Institute Roberto Lombardi, Rome, Italy. [2]Florida International University, Miami, FL, USA. [3]University of Verona, Department of Neuroscience, Biomedicine and Movement Sciences, Verona, Italy.

ABSTRACT

This paper propose five tennis-specific tests performed on hardcourt to analyze coordination of lower limbs and laterality. Times to complete one 20 meters linear sprint and four 4 x 5 meters shuttle sprints (180° change of direction) in: a) open stance, b) neutral stance, c) forehand and d) backhand, were recorded in 342 youth tennis players aged 11-16 yrs. Differences between times in the 20 meters and 4 x 5 meters sprints in open stance greater than 3.13 and 2.91 seconds denote inadequate on-court displacement capacity of females and males respectively. The difference between open and neutral shuttle sprints assess the on-court coordination capacities of lower limbs with expected optimal result below 0.43 and 0.39 seconds for females and males respectively. The difference between forehand and backhand shuttle sprints should tend towards zero seconds in symmetric players indicating the capacity to move in the court with the same acceleration/deceleration capabilities regardless laterality. These tests can be proposed at any age as they give an idea of the coordination capacities of lower limbs and laterality related to specific tennis movements. The earlier age assessment may serve to address any coordination/laterality deficits sooner versus later.

Key words: change of direction, laterality, symmetry

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Corresponding author: Giulio Sergio Roi. Email: gs.roi@isokinetic.com

INTRODUCTION

Tennis players need to master the complex techniques and movement patterns on the court, requiring acceleration and deceleration in combination with changes of direction (Kovacs, 2006; Hoppe et al., 2014). It has been reported that approximately 70% of tennis movement is lateral (Weber et al., 2007). However, athletes may have identified differences in movement to either side which should be trained accordingly (Eng & Sundar, 2021).

In modern tennis, training must be personalized beginning at youth ages which are 5-7 yrs (Fitzpatrick et al., 2017). Thus, functional assessment should be initiated early and consider not only the physiological characteristics, but also tests that can give information to the trainers regarding speeds and changes of directions (COD) specific for tennis. Such tests include but are not limited to strength-speed training, technical training, and anticipation training (Eng & Sundar, 2021).

Strength-speed characteristics have been investigated by various authors, also focusing on lateral acceleration, as summarized in the recent paper of Eng & Sundar (2020). High ranked players typically run 0.25 to 0.50 meters more to the forehand side than the backhand side (Weber et al., 2007). Largest leg strength differences were found in lateral movement by single leg countermovement lateral jumps, and it was suggested that up to 15% difference was normal and acceptable (Hewit et al., 2012). That is, an athlete might be 15% weaker in one leg than the other without detrimental loss of speed (Eng & Sundar, 2021).

Eng & Sundar (2021) observed that in lateral movement, most force is generated by the outside leg which is farther from the intended direction. After the stroke, recovery to a favorable court position requires where the legs switch roles. The authors suggest that tennis players can be tested on the outside leg moving either to the forehand or backhand side. Using unilateral strength and plyometric training to train unilateral leg force production may improve athletes with weaker movement to one side (Eng & Sundar, 2021).

Aim

Considering the complexity of the topic, in this paper we want to contribute to the discussion about lateral movements, focusing on the analysis of the symmetry/asymmetry of lower limbs performances of youth players assessed by a new proposed battery of tennis specific tests.

METHODS

A test battery was developed considering that around 3-4 rallies are usually played to score. This implicates 3 to 4 COD, with an average distance lower than 5 meters each (Parson & Jones, 1998; Ferrauti et al., 2003). From this observation, a distance of 5 meters performed 4 times equates to 20 meters was chosen to measure the maximum linear speed (Test 1).

The 20 meters distance was then considered as reference and subdivided into four 5 meters subsequent sprints with three 180° COD, as indicative of both acceleration and COD capacities.

These shuttle sprints with COD were proposed both in open (Test 2) and in neutral stance (Test 3). Sprints with COD in open stance are aimed to measure the displacement capacity arriving with both feet parallel in front to the net at the moment of impact with the ball (Figure 1). This situation is utilised by top level players in most of the cases during the matches (Reid et al., 2013).

Figure 1. *Sprint with COD in open stance arriving with both feet parallel in front to the net.*

Sprints with COD in neutral stance are aimed to measure the displacement capacity arriving with both feet perpendicular to the net at the moment of impact of the ball (Figure 2), and it is utilized in the remaining few cases.

In both sprints with COD the lower limbs can assume the attitude to perform the forehand or the backhand shot. Thus, sprints with COD with forehand and backhand shot measures the displacement capacity only utilizing the forehand or the backhand shot respectively, without utilizing the racket, but only mimicking the technical movement.

Figure 2. *Sprints with COD in neutral stance arriving with both feet perpendicular to the net.*

In summary, the proposed test battery consist of five tests, all performed on synthetic courts:

- Test 1: 20m linear sprint.
- Test 2: shuttle 4 x 5m sprints with COD open stance.
- Test 3: shuttle 4 x 5m sprints with COD neutral stance.
- Test 4: shuttle 4 x 5m sprints with COD forehand.
- Test 5: shuttle 4 x 5m sprints with COD backhand.

In tests 2, 3, 4 and 5 players at COD must touch with the hand the summit of a cone of 50 cm height.

Each test was performed twice, with a minimum rest of one minute in between. Times between the starting movement and the crossing of the finish line in the 20 m sprint test, or the starting/finish line in the sprints with COD tests, were recorded with an electronic chronometer (Racetime2, Microgate, Italy).

Tests were performed indoor in hardcourts (Play Flex Cushion, Italy; ITF certified Class 3) after 15 minutes of warmup consisting in a sequence of running around the court, accelerations/decelerations and changes of directions, of increased speed. In the training session preceding the testing session, players performed some trials aimed to familiarize with the correct execution of tests.

Three hundred and forthy-one youth tennis players of different gender and age participated in the study after obtaining their affirmative agreement to participate from the Institutional Review Board and the signed informed consent from their parents/guardians, according with the Helsinky declaration of human rights. They were recruited during the training camps organized by the Italian Tennis Federation for selected youth players. Test were performed under the supervision of the same certified trainers.

The anthropometrical characteristics of the subjects are reported in Table 1.

Table 1

Anthropometrical characteristics of the subjects (mean±SD). BMI: Body Mass Index.

Age Category	Females				Males			
	n	Weight (kg)	Height (m)	BMI (kg/m^2)	n	Weight (kg)	Height (m)	BMI (kg/m^2)
U11	48	37.1±7.2	1.48±0.07	16.7±1.8	45	38.8±5.3	1.50±0.08	17.3±1.6
U12	65	43.3±5.1	1.53±0.08	18.5±1.8	72	44.1±5.1	1.57±0.07	17.9±1.8
U13	20	48.1±6.0	1.62±0.09	18.3±1.4	13	50.9±7.1	1.66±0.07	18.6±2.2
U14	9	58.2±9.6	1.72±0.11	19.6±1.6	14	52.9±7.1	1.65±0.06	19.2±1.7
U15	15	65.5±6.9	1.78±0.08	20.7±0.8	13	56.2±6.2	1.70±0.07	19.5±1.7
U16	10	69.7±9.0	1.76±0.06	22.5±2.2	17	61.1±5.4	1.68±0.07	21.6±1.7

Data were analyzed by descriptive statistics. Differences between genders and tests performances were assessed by unpaired T-test assuming $P<0.05$ as significant.

RESULTS

Results are shown in table 2 and 3 for females and males respectively.

Table 2

Results for female tennis players (mean±SD).

Age	n	20 m sprint (s)	4 x 5 m open stance (s)	4 x 5 m neutral stance (s)	4 x 5 m forehand (s)	4 x 5 m backhand (s)	Difference between 4 x 5 m open and 20 m (s)	Difference between 4 x 5 m neutral and open (s)	Difference between 4 x 5 m forehand and backhand (s)
U11	48	3.95±0.24	6.92±0.36	7.44±0.49	7.09±0.45	7.01±0.37	2.97±0.26	0.53±0.35	0.09±0.39
U12	65	3.82±0.23	6.65±0.44	7.27±0.46	6.94±0.44	6.93±0.43	2.83±0.36	0.62±0.30	0.01±0.30
U13	20	3.35±0.09	6.23±0.20	7.12±0.16	6.35±0.24	6.34±0.25	2.89±0.21	0.88±0.19	0.01±0.14
U14	9	3.34±0.13	6.27±0.21	7.15±0.07	6.25±0.28	6.30±0.17	2.92±0.16	0.88±0.18	-0.05±0.18
U15	15	3.33±0.13	6.14±0.19	6.90±0.21	6.18±0.24	5.87±0.23	2.81±0.17	0.76±0.14	0.31±0.19
U16	10	3.40±0.20	6.29±0.33	6.97±0.27	6.08±0.42	6.12±0.47	2.89±0.32	0.68±0.31	-0.03±0.22

Table 3

Results for male tennis players (mean±SD).

Age	n	20 m sprint (s)	4 x 5 m open stance (s)	4 x 5 m neutral stance (s)	4 x 5 m forehand (s)	4 x 5 m backhand (s)	Difference between 4 x 5 m open and 20 m (s)	Difference between 4 x 5 m neutral and open (s)	Difference between 4 x 5 m forehand and backhand (s)
U11	45	3.95±0.24	6.81±0.43	7.19±0.38	6.88±0.39	6.89±0.45	2.86±0.32	0.38±0.35	-0.01±0.27
U12	72	3.85±0.19	6.54±0.33	7.00±0.38	6.67±0.36	6.64±0.38	2.69±0.26	0.46±0.30	0.03±0.29
U13	13	3.52±0.18	6.10±0.17	6.90±0.26	6.22±0.34	6.06±0.19	2.59±0.22	0.79±0.22	0.16±0.37
U14	14	3.41±0.19	5.87±0.29	6.89±0.34	6.09±0.25	6.04±0.26	2.46±0.35	1.02±0.44	0.05±0.21
U15	13	2.99±0.07	5.64±0.16	6.38±0.13	5.78±0.20	5.60±0.25	2.65±0.15	0.77±0.20	0.19±0.25
U16	17	2.90±0.07	5.55±0.07	6.28±0.49	5.58±0.16	5.55±0.17	2.65±0.25	0.73±0.30	0.03±0.15

Table 4

Differences between female and male youth tennis players.

Age	n	20 m sprint (s)	4 x 5 m open stance (s)	4 x 5 m neutral stance (s)	4 x 5 m forehand (s)	4 x 5 m backhand (s)	Difference between 4 x 5 m open and 20 m (s)	Difference between 4 x 5 m neutral and open (s)	Difference between 4 x 5 m forehand and backhand (s)
U11	NS	NS	P<0.05	P<0.01	NS	NS	P<0.025	NS	-0.01±0.27
U12	NS	NS	P<0.001	P<0.001	P<0.001	P<0.01	P<0.005	NS	0.03±0.29
U13	P<0.0025	P<0.05	P<0.01	NS	P<0.001	P<0.001	NS	NS	0.16±0.37
U14	NS	P<0.001	P<0.01	NS	P<0.005	P<0.001	NS	NS	0.05±0.21
U15	P<0.001	P<0.001	P<0.001	P<0.001	P<0.0025	P<0.01	NS	NS	0.19±0.25
U16	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.05	NS	NS	0.03±0.15

DISCUSSION

As expected, performances of youth female and male tennis players in the proposed test battery tend to improve with age according with growth and development, showing not always better results in males compared to females (table 4).

The difference between times in the 20 meters test and the 4 x 5 meters sprints with COD in open stance assess the decrease of speed passing from the linear running to COD in the tennis court. Considering these mean difference times as shown in tables 2 and 3, and adding one Standard Deviation from the mean, it can be assumed that differences greater than 3.13 and 2.91 seconds denote inadequate displacement capacity on the court of female and male youth tennis players respectively.

The difference between open and neutral sprints with COD assess the coordination capacities of lower limbs in the tennis court. The expected optimal result is below 0.43 and 0.39 seconds for female and male respectively, while differences higher than 1.00 seconds appear to highlight a lack of in-court neuromuscular control of the lower limbs.

The difference between forehand or the backhand sprints with COD assess the displacement capacities utilizing these two techniques. In the symmetric players it should tend towards 0.00 seconds indicating the capacity to move in all areas of the court with the same acceleration/deceleration capabilities regardless laterality.

This is a descriptive study not-exempt from limitations, such as the non-homogeneity of the groups in terms of number of players, biological maturity, physical and technical capacities. Furthermore, the cut-off times proposed to consider as sufficient or insufficient the performances in the tests should be more deeply analyzed in the future. Other limitation is that players performed the tests without hitting the ball with the racket.

Finally, another limitation is the only hardcourt utilized for the tests. It is well known that different surfaces affect the performances of the players (Martin & Proiux, 2015) thus, the same surface must be utilized for comparisons.

CONCLUSIONS

Unlike the general fitness tests, those proposed in this paper highlight the capabilities expressed on the court by youth tennis players with regard to footwork and some aspects of laterality. Analyzing the results of the tests the coach and trainer must focus on some coordination aspects necessary for tennis performances. These tests can be proposed at any age as they give an idea of the coordination capacities of lower limbs in relation to specific tennis movements. We propose, however, that earlier age assessment may serve to address any laterality deficits sooner versus later.

Further studies are needed to better analyze the effects of specific training based on the results of the proposed tests on the tennis performance and how to optimally develop tennis specific coordination of the lower limbs during growth. Other studies should be performed studying high level players and analyzing the different performances in the test carried out on different court surfaces.

CONFLICT OF INTEREST AND FUNDING

The authors declare that they do not have any conflict of interest and that they did not receive any funding to conduct the research.

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