The effect of a coordination training program on the development of tennis service technique

The present study aimed to: i) define which coordination abilities are most important in tennis and ii) evaluate whether a coordination training program could improve the service technique. The study involved 48 children (age 11 ± 2 years) divided into a control group (C) and an intervention group (A) that performed a specific coordination program 3 times/wk. Additionally, both groups followed a tennis training program 3 times/wk. The service technique was assessed in all subjects at the start (T₀), after the 5-week specific coordination program (T₅), and one week after the intervention program was completed (T₆). Two-way repeated measurements ANOVA indicated a significant increase in the service technique between groups (C and A) and among the different phases (T₀, T₅, and T₆). Key Words: Coordination abilities, kinaesthetic differentiation, reaction, young tennis players.
INTRODUCTION

Tennis is a sport which demands high level of coordination (2). The term "coordination" has been defined as the ability to perform complex motor exercises. Hirtz, (7) proposed a list of 5 basic coordination abilities: reaction, rhythm, balance, kinaesthetic differentiation and space-time orientation. It has been suggested (1) that coordination abilities should be practiced during childhood and adolescence with an "additional technique training". This term includes additional exercises that will improve virtuosity, stability and the coordination of special athletic techniques. In most sports the technique training alone is not enough for learning and stabilizing a new skill, thus, there is a need of specific exercises which will facilitate the development of the technique. Previous studies (13, 16) developed a theory with regard the coordination requirements for each sport. A coordination profile specific for each sport will facilitate athletes to maximize the performance (5, 16 - 18). Starosta, Rostkowska & Kokoszka (21) studied the water feeling at water sports with the use of questionnaires based on the 5 basic coordination abilities: reaction, rhythm, balance, kinaesthetic differentiation and orientation. The questionnaires were given to athletes from different water sports (swimming, synchronized swimming and diving) and to their coaches. The study showed that different swim phases depended differently on the coordination abilities. Furthermore, Derri, Mertznidou & Tzetzis (5) evaluated dynamic balance and body coordination between athletes (rhythm and gymnastics) and non athletes and showed that athletes had significant better dynamic balance and body coordination.

In addition, Mantis, Zachopoulou & Mavridis (11) in a study with young tennis players proposed that the abilities which contribute mostly on proper service motion were: body coordination, reaction time and the ability of throwing at a target.

Coordination abilities are essential in order to perform well a tennis stroke (2). In tennis there is a lack of studies with regard to specific coordination exercises and the effect on the development of basic tennis skills technique.

The aims of the present study were: i) to define which coordination abilities are the most important for tennis players and ii) to explore if an additional coordination training program will facilitate the development of service technique.

METHOD

Participants: In the present study participated 48 male and female athletes aged between 9 - 13 years old (11 ± 2 years). They were randomly separated
into 2 groups, the intervention group (group A, n = 24) and the control group (group C, n = 24). The participants practiced tennis 2 - 5 years.

Procedures: Before the beginning of the protocol all participants from both groups underwent service technique evaluation (T₀). The participants, after five minutes tennis warm-up, performed 10 service which were recorded by a video-camera (Sony NP-98). An experienced, certified, tennis coach evaluated the service technique at 5 basic elements: i) the grip, ii) the side-way stance, iii) the elbow position before the touch, iv) the touch and v) the follow through. A score was given to each participant by the coach. A technique evaluation for both groups took place in the same way as the initial 5 weeks (T₅) later, when the intervention program was completed, and one week later (T₆), in order to examine if there were still changes on the technique of the participants.

In order to identify which coordination abilities are the most important in tennis players, a questionnaire distributed to 15 expert tennis coaches. They were asked to evaluate the coordination abilities from the most important to the less ones for tennis players. The coordination abilities that were valued: 1) kinaesthetic differentiation, 2) space and time orientation, 3) rhythm, 4) reaction and 5) balance. The two most significant abilities were selected as tennis specific coordination abilities and an intervention programme was made, based on them. Kinaesthetic differentiation, with regard to the movement perception, was defined as the ability that allows a player to control internal and external information, adapt it and use it correctly. Space and time orientation is the ability to determine and modify the position and movements of the body in space and time according to tennis court and/or an object in motion (tennis ball and opponent). Rhythm was defined as the ability to capture an acquire rhythm from an external source and to reproduce it in movement. Reaction is the ability to identify simple or complex situation rapidly and find the appropriate motor solutions. Finally, balance was defined as the ability to maintain perfect body position during stroke performance and recover the initial position. The analysis of the questionnaires showed that kinaesthetic differentiation and reaction ability are the two most important coordination abilities for tennis players. The intervention programme was a specific coordination program for those two abilities and performed before the tennis training session for 5 weeks, three times per week. (3 times/week × 5 weeks) (Table 1). In each session the participants practiced 4 exercises for five minutes each. Special attention was given to the exercises to be fun and in proportion to their training experience and level (Table 1).
Table 1. Intervention program for the tennis specific coordination abilities

<table>
<thead>
<tr>
<th>Ability being practiced</th>
<th>Exercise</th>
<th>Repetition/week</th>
<th>Duration</th>
</tr>
</thead>
</table>
| Reaction 1              | Equipment: tennis balls  
Description: coach stands 4-5 metres in front of the kids. He/she holds 2 balls, one at each hand. Coach must let one of the two balls unexpectedly and the kid must catch it before it bounces twice. | 3/week | 5 min. |
| Reaction 2              | Equipment: tennis balls  
Description: kids must shape a circle. Each one of them has to throw the ball to the next kid of the circle. Gradually coach gives the kids another one ball and then another one and goes on. Players must rotate all the balls at the same time without falling these down. | 3/week | 5 min. |
| Kinaesthetic differentiation 1 | Equipment: tennis balls, different size targets  
Description: each player has one ball and tries to mark the different types of targets in many different ways (overhead throw, underarm throw, behind the back, between feet e.t.c). | 3/week | 5 min. |
| Kinaesthetic differentiation 2 | Equipment: tennis balls (foam, red, orange, green, normal), 3 different sizes junior tennis rackets, 1 badminton racket, 1 table tennis racket.  
Description: all the rackets are put at the service line, one next to the other. The coach stands at the opposite side of the court and feeds the players with different ball each time. Each kid hits one ball, then changes the racket with another one and hits the next ball. | 3/week | 5 min. |

Analysis: In order to evaluate the observers’ internal reliability, the Pearson (r) correlation coefficient was performed between the scores from one day to the next day by the same person for the same video, (22). There was high correlation (r = 0.968, p = 0.000). To verify the reliability of the service technique test the scores were measured twice on two consecutive days at the same time of the day. The intraclass correlation coefficient between the repeated measures was high .91.

The Levene’s test was used to test the normality of the data distribution. Two-way repeated measures ANOVA (2 × 3) was used to test the difference in the service technique among the three different phases (T₀, T₅ and T₆) and between the two groups (C and A). The Bonferroni test was used for the post hoc analysis when differences were noted. The level of statistical significance
was set at $p < 0.05$. Data were analyzed using the SPSS PC (Version 12) program for windows.

**RESULTS**

The data were normally distributed. No significant differences were found between the groups C and A at $T_0$ ($p > 0.05$), means and standard deviations are showed in Table 2. Two-way repeated ANOVA revealed significant increase in the service technique over the different phases for both groups (C and A) ($F_{1,46} = 11.57$, $p < 0.001$). Also, these data analysis revealed differences among the three phases ($F_{2,92} = 100.55$, $p < 0.000$). More specific the Bonferroni analysis revealed significant difference in service technique between groups A and C at $T_5$ ($p < 0.05$). A week after the completion of the intervention program (T6), there was still a significant difference between group A and C ($p < 0.05$). Mean and standard deviation for each group are presented in Table 2.

**Table 2.** Service evaluation scores at $T_0$, $T_5$, and $T_6$ for control group (group C) and the intervention group (group A). Mean and standard deviation, $N_{group \, C} = 24$ and $N_{group \, A} = 24$

<table>
<thead>
<tr>
<th>Service</th>
<th>Group C</th>
<th>Group A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ± SD</td>
<td>M ± SD</td>
</tr>
<tr>
<td>$T_0$</td>
<td>27.79 ± 4.8</td>
<td>27.50 ± 3.7</td>
</tr>
<tr>
<td>$T_5$</td>
<td>31.17 ± 4.4</td>
<td>39.42 ± 5.6*</td>
</tr>
<tr>
<td>$T_6$</td>
<td>34.63 ± 6.7</td>
<td>40.17 ± 6.6*</td>
</tr>
</tbody>
</table>

* Significant difference between group A and group C, $p < 0.05$.

**DISCUSSION**

Tennis skills are composed by complex movements. The conventional method of teaching tennis focuses on the stroke movement technique. The player has to master the movement technique before developing the tactics of the game. In contemporary tennis, technique is considered as a function of the correct biomechanical principles as well as a mean to implement tactics more efficiently (4). Coordination abilities are essential in order to develop and perform optimal movement techniques (6, 2). Practicing those abilities with specific exercises would improve the technique of those skills (6).
The questionnaires' analysis from the present study suggested that kinaesthetic differentiation and reaction are the most important abilities for tennis. An important finding of the current study was that exercising kinaesthesia and reaction abilities with supplementary coordination program, in addition to tennis training, improved significantly the service technique in tennis athletes' 9-13 years old compared to the control group. Previous studies also suggested that training coordination abilities in childhood improved skill development (8) and performance in racquet sports (6) (1).

Differentiation and reaction abilities seem to be valuable in tennis as in other sports. For basketball players Zwierko, Lesiakowski and Florkiewick (23) showed that coordination abilities such as orientation, differentiation, reaction, balance and the technical skills are necessary parts of the basketball players' practice. Martin (12) claimed that kinaesthesia is very important for movement perception and motor skills learning. It has been suggested that kinaesthetic ability is developing rapidly until the age of ten and the well-trained athletes are quite superb at this ability (5). Roloff (20) suggested that a more developed kinaesthesia facilitates the learning process of a new motor skill. A study with volleyball players (10) revealed that rhythmic ability is important, while kinesthetic differentiation ability is limited to this sport. In addition, a study in rhythmic gymnastics (9) supported the importance of kinaesthesia to high performance.

Furthermore, a relationship has been reported between reaction ability and performance for basketball players (3) (19), soccer players (14) and karate athletes (15).

The ability to react in tennis is of utmost important at the net, on the return of serve or when the player has to volley a high-speed passing shot (2). The present study showed that exercising the ability to react with an additional coordination program can also improve the service technique.

In conclusion, the findings of the present study could be directly applied to tennis training in order to improve service technique. Coordination abilities are important during tennis play, and their development from the early age is essential. Coaches who work with young players could incorporate tennis specific coordination exercises into their training program. In addition, these exercises make training more joyful, fulfilling the need of young players for fun.

REFERENCES


Address for correspondence:
Vasiliki Malliou
Ethnikis Antistaseos 41
17237, Dafne
Athens, Greece
E-mail: bmalliou@phed.uoa.gr