Original Article

Effect of an intervention program that uses elastic bands on the improvement of the forehand topspin stroke in young table tennis athletes

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Abstract:

The purpose of the current study was to assess the effect of an intervention program with elastic bands on the improvement of the table tennis Forehand Topspin stroke accuracy and effectiveness at developmental ages. The sample of the study consisted of twenty four male and female table tennis players aged 13.75 ± 2.24 , with weight 48.33 ± 11.50 , height 1.58 ± 14.40 and time of experience 3.8 ± 1.31 years. Following an initial evaluation test which recorded the success and accuracy of the Forehand Topspin stroke the sample was divided into two equivalent groups (experimental and control). To ensure the accuracy and stability of the strokes, the participants used a specific training robot, which presented the same degree of difficulty for all. Next, the two groups followed the same training program, with the experimental group executing additional exercises with elastic bands after the end of the usual training, for 12 weeks. The measurements included two-way analyses of variance; a repeated (initial – final measurements) and an independent. The results showed that both groups presented a statistically significant improvement concerning Forehand Topspin strokes, while the experimental group increased successful strokes considerably and reduced unsuccessful ones ($p < 0.05$). What emerges from the study is that improved muscular coordination and physical control in both male and female athletes deriving from the use of elastic bands and contributed decisively to the amelioration of the Forehand Topspin stroke, concerning both accuracy and success. The results of the present study are similar to those of other scientific researches concerning other sports, where the use of elastic bands improved the performance of young athletes.

Key Words: strength training, successful strokes, performance, youth table tennis players

Introduction

Table tennis has become one of the most popular sports with over 300 million supporters worldwide. It is a very complex and varied game in terms of both technique and tactics (Bańkosz & Winiarski, 2017; Li, Li B., Wang, Fu, Dai, Nassis, & Ainsworth 2020; Munivrana, Furjan-Mandi, & Kondri, 2015). Table tennis athletes play one of the fastest ball games in the world which requires highly developed motor skills such as agility (Horníková, Doležalová, & Zemková, 2018) reaction speed, explosive power and strength, eye movement and coordination (Cao, Xiao, Lu, Ren, & Zhang, 2020; Zagatto, Kondric, Knechtle, Nikolaidis, Sperlich, 2018; Faber, Oosterveld, Nijhuis-van der Sanden, 2014). In its effort to make the game more attractive, the International Table Tennis Federation (ITTF) introduced a series of reforms such as allowing the co-existence of white and yellow balls, having different rubber surfaces on each side of the racket, introducing a 40-mm ball, increasing the ball spin and speed, using a shorter point system and banning the glues which contain harmful volatile compounds (Li, Zhao, & Zhang, 2007).

A tennis player's level depends on his technical skills, such as ball hitting, setting up and proper footwork, but also on his tactical and mental skills. In table tennis, the level of technical preparation is a crucial factor for high performances. This means that one should be able to use coordinated movements, with controlled power and manage to impart adequate speed and spin to the ball. A high level of technical preparation involves placing the ball correctly and being able to make the game almost unreadable to one's opponent. Table tennis is a complex activity that involves a repeated combination of acceleration, deceleration, changing of direction, and balance control in order to produce the optimal strokes (Li et al., 2020; Marsan, Rouch, Thoreux, Jacquet-Yquel, & Sauret, 2019). Naturally, all the above maneuvers require intense physical effort and specific techniques (Kondric, Mandic, Kondric L., & Gabaglio, 2010).

Winning a table tennis match not only requires outstanding technique, tactics and psychology, but also great physical strength (Djokić, 2007c). Concerning physical condition, it constitutes a complex and demanding activity where athletes use both the aerobic and the anaerobic system for energy production (Kasai, Akira, Eung, & Mori, 2010). Table tennis includes a wide variety of strokes, which requires frequent, quick and repetitive high intense efforts with short rest intervals (Katsikadelis, 2017), and does not demand the improvement of maximum strength but the development of the basic strength of the muscular groups which participate in the

execution of the various strokes. Strength and stamina are important elements for the correct execution of the different table tennis strokes (Molodtsov, 2008). The top athletes in all sport disciplines do some resistance training in order to boost or at least maintain their general strength.

Nowadays, training with resistances is very popular, especially at developmental ages. It is supported that training with resistances, under specialized supervision, is sufficient enough to increase strength in young athletes, improve their athletic performance and prevent injuries (Christou, 2006; Falk & Mor, 1996). Fernandez-Fernandez, Ellenbecker, Sanz-Rivas, Ulbricht and Ferrauti (2013), examined the effects of a 6-week strength-training program on serve velocity in youth tennis players. Thirty competitive healthy and nationally ranked male junior tennis players with a mean age of 13 years old, were randomly and equally divided into control and experiment groups. The experimental group performed 3 sessions (60-70 min) weekly for 6 weeks, comprising core strength, elastic resistance and medicine ball exercises. The results showed that a short-term training program for young tennis players can improve tennis performance and reduce the risk of overuse injury. Also, in the study by Treiber, Lott, Duncan, Slavens and Davis (2015), has been found that young tennis players who practiced in a 4-week exercise program with elastic bands and light weights increased their shoulder strength and subsequently the velocity of the ball when they served. Elastic bands are widely used to increase strength in several sporting activities. Similarly, it has been observed that after 8 weeks of hip-adduction strength training using elastic bands, soccer players increased their eccentric hip-adduction strength by 30% (Jensen, Holmich, Bandholm, Zebis, Lars, & Thorborg, 2012), while Taekwondo athletes who performed strength training with elastic bands for their lower limbs increased their kicking speed by 7% (Jakubiak & Saunders, 2008). Elastic bands were also used in rugby players. Two high level rugby groups applied two strength protocols for six weeks, the first using an elastic bands program, while the second following a traditional program with free weight lifting. The results showed that both groups had a statistically significant improvement. Nevertheless, the group that used elastic bands had greater improvement results, especially concerning the strength and velocity of the upper limbs.

Table tennis movements include footwork and stroke. Footwork involves different movement types (one step, short steps, and crossover) which are performed at varying frequencies and require great agility (Qian, Zhang, Baker, Gu, 2016; Yu, Shao, Awrejcewicz, Baker, & Gu, 2019). Stroke involves various sport specific techniques (drive, chop, and block) and is performed at varying frequencies with different types of ball spin (Munivrana et al., 2015).

One of the most important table tennis techniques is the forehand topspin since it is one of the primary attacking techniques and is vital for winning in a rally and that accounts for 36% of the total shots performed during a game (Malagoli Lanzoni, Di Michele, & Merni, 2014). Forehand topspin is considered as one of the most frequent and aggressive strokes in competitions, which is applied in order to hit the ball at a high velocity with a fast rotation (Qian, Zhang, Baker, & Gu., 2016). Most published studies on table tennis techniques refer to the forehand topspin, as the most frequent and effective stroke in the game (Fu, Zhang, Shao, Ren, Lake, & Gu, 2016). In other words, forehand topspin is considered the most important offensive stroke of the sport (Malagoli Lanzoni, Farina, Nardella, & Fantozzi, 2017). Athletes appear to use more forehand moves than backhand ones, while forehand topspin seems to be the most popular of all strokes (Djokic, Munivrana, & Dragomir 2015; Mulloy et al., 2014). Performing a perfect forehand topspin stroke is difficult, and is also indicative of a player's level (Iino & Kojima, 2016; 2011).

Methodologically, the consecutive casting of balls by the coach or a specific training robot is widely applied in research efforts, because it is the only way to achieve an accurate simulation of actual game parameters (Jospin & Fayt, 2004). The study of 35 table tennis games of top male level provided the authors with the opportunity to investigate the technical choices in the tactics of the players and simultaneously compare the differences between winners and losers. The results showed that athletes tend to strike the ball using forehand strokes (71.25%) rather than using backhand ones (28.75%). More specifically, concerning forehand strokes, it appears that the forehand topspin is the most usual stroke among athletes with a percentage of 19.09%. Most winning strokes were also forehand ones with a percentage of 61.45%, as opposed to backhand strokes with 38.55% (Djokic, 2000).

The results of the 2014 World Cup final team match between China and Germany were similar. There was an analysis of 806 strokes leading to 206 points. Among the statistically important technical differences of tactics between the two teams was the fact that the winning Chinese used forehand strokes more often than the defeated Germans who used backhand strokes. More specifically, concerning the initial strike which results at winning a point, the winners used forehand strokes more times than the losers (Djokic et al., 2015). In general, the improvement of physical condition both on a muscular and a cardio respiratory level, helps table tennis athletes to achieve more qualitative, accurate and successful stroke percentages (Willmore & Costill, 2004).

Although several studies have investigated the technical and tactical characteristics of table tennis, there are no surveys measuring the contribution of muscle strength and coordination to the accuracy and effectiveness of the various strokes. The present study aims to contribute to the acquisition of knowledge concerning the specialized reinforcement of the muscular groups used in table tennis, in order to improve neuromuscular coordination and strength in young athletes and, consequently, their strokes. The results of the study intend to show the degree to which a 12 week program with elastic bands can influence the effectiveness of the basic

strokes in table tennis i.e. their accuracy and success. More specifically, the present study aims to investigate the effect of an intervention program with elastic bands on the improvement of the forehand topspin stroke in young table tennis athletes.

Material & Method

Experimental approach to the Problem

The initial measurement concerned the success, failure and accuracy of the forehand topspin stroke, from the forehand position. The program included a total of 70 topspin strokes. Before the beginning of the intervention training program the participants' forehand topspin stroke accuracy and effectiveness were assessed, executing 70 forehand topspin hits. The first 20 hits were diagonal towards the left edge of the table; the following 20 hits were executed towards the right edge and the final 30 hits aimed alternately to the left and right edge. All strokes were performed after receiving the ball by a professional training robot, which cast 50-60 balls per minute, to ensure stability in the intensity, frequency and velocity of the strokes for all participants. Each participant aimed to strike the targets, which were A4 paper sheets. The targets were stuck on the right and left edge of the base line of the table, at a distance of 10 cm from the final line and 10 cm from the side line of the table. When the ball hit into the targets' area, the hit was considered "accurate" and it was awarded with two points. When the ball touched any other surface in the offensive area of the table, the hit was considered "successful" and was awarded with one point. When the ball was out of the table or touched the net, the hit was considered "unsuccessful" and no points were awarded. The final evaluation score of each participant was obtained by summing up his/her individual scores, which were recorded by one of the researchers. After their initial performance, the athletes were classified to two equivalent groups of 12 (1-3-5...23) who constituted the experimental group and (2-4-6...24) the control group. Then, the two groups followed the same competitive, training program on a daily basis for 12 weeks, while the experimental group executed an extra series of selected strengthening exercises, which are described analytically on Table 1a. After the end of the intervention program, the initial measurements were repeated for both groups.

Table 1. The above protocol was executed 3 times a week, with elastic bands of medium hardness.

Training with elastic bands	Set & repetitions	Interval/set (min)	Interval / /exercise
Chest pressures	4X12	1	4
Rowing from ground position	4X12	1	4
Biceps push-ups	3X10	1	4
Triceps stretching	3X10	1	4
Shoulder stretching	3X10	1	4

Participants

The sample of the research consisted of 24 young male and female table tennis players whose anthropomorphic characteristics are presented on Table 2. All the above players were listed in the official assessment tables of the Federation and took part in county's Championships.

Table 2. Anthropometric Characteristics of the sample

Age (years)	Height(cm)	Weight(kg)	Training of years experience
13.75 ± 2.24	1.58 ± 14.40	48.33 ± 11.50	4.8 ± 1.31

Statistical analysis

For the statistical analysis of the data the two-way repeated measures Anova analyses were used. One repeated ("time of measurement": pre vs. post the intervention period) and the other independent ("group": experimental vs. control). The Shapiro-Wilks test and the Mauchly's test were used to verify the normal distribution and Sphericity, respectively. The significance level was set as $p < 0.05$.

Results

Forehand Topspin

The two-way Repeated measures Anova analysis showed that there was a statistically significant interaction between the two factors [$F_{(1, 22)} = 15.728$; $p < 0.05$] concerning successful strokes (Figure 1). The analysis of this interaction and investigation of the differences between the two groups separately, in their initial and final measurements revealed that the statistically significant differences between the two groups concerned only the initial measurements [$F_{(1, 22)} = 14.916$; $p < 0.05$]. On the contrary, there were no differences between the two groups in the final measurements [$F_{1, 22} = 0.220$; sig = 0.643]. The analysis of the differences in the two measurements for each group separately revealed a significant improvement of the forehand topspin stroke only for the experimental group [$F_{(1, 22)} = 12.714$; $p < 0.05$]. In contrast, there were no statistically significant differences for the control group [$F_{(1, 22)} = 4.173$; sig = 0.053], which, in addition, presented a reduction of accurate strokes.

Figure 1. Initial and Final measurements for the successful Forehand Topspin strokes for both groups.

Forehand Topspin in Target

The analysis of variance of the two-way Repeated measures Anova revealed that there was not statistically significant interaction between the two factors in the forehand topspin in target [$F_{(1, 22)} = 0.961$; $p = 0.338$] (Figure 2). In addition, there were no statistically significant differences between the two groups [$F_{(1, 22)} = 0.562$; $p = 0.461$]. Nevertheless, there was a statistically significant improvement for both groups in the accuracy of the forehand topspin strokes [$F_{(1, 22)} = 18.437$; $p < 0.05$].

Figure 2. Initial and Final measurements for the accurate Forehand Topspin strokes for both groups.

Forehand Topspin OUT

The two-way Repeated measures Anova analysis showed that there was a statistically significant interaction between the two factors [$F_{(1, 22)} = 26.190$; $p < 0.05$]. The analysis of this interaction and investigation of the differences between the two groups separately, in their initial and final measurements revealed that there were statistically significant differences between the two groups for both the initial [$F_{(1, 22)} = 14.662$; $p < 0.05$] and the final measurements [$F_{(1, 22)} = 6.880$; $p < 0.05$] concerning unsuccessful strokes (Figure 3.). Nevertheless, the study of the differences between the two measurements for each group separately revealed a statistically reduction of unsuccessful strokes only for the experimental group [$F_{(1, 22)} = 48.947$; $p < 0.05$]. On the contrary, there were no differences for the control group [$F_{(1, 22)} = 0.058$; $sig = 0.812$].

Figure 3. Initial and Final measurements for the unsuccessful Forehand Topspin strokes for both groups.

Discussion

The findings of the current study revealed that the right strengthening program with elastic bands executed for young male and female table tennis players (Table 1) contributed significantly to the improvement of the forehand topspin stroke both in accuracy and success. Both groups were statistically improved in the accuracy of the forehand topspin stroke, while the experimental group greatly improved its successful strokes, reducing simultaneously the unsuccessful ones.

Investigating the results of the successful forehand topspin strokes (including the accurate ones) revealed statistically significant differences between the two groups only in the initial measurements (Figure 1). In the final measurements, the groups presented almost the same percentage of successful strokes. The above results indicate that the control group, which initially had lower successful stroke percentages, presented a higher improvement in the final measurements. In addition, investigating the accuracy of the forehand topspin strokes revealed neither a statistically significant interaction between the two groups nor a statistically significant difference. Nevertheless, there was a statistically significant improvement for both groups in the accuracy of the forehand topspin strokes in target (Figure 2). Recording unsuccessful strokes revealed a statistically significant interaction between the two groups in both initial and final measurements. Examining each group separately revealed that only the experimental group reduced the unsuccessful strokes (Figure 3). In opposition, the control group did not present any such reduction.

The findings of the present study are in agreement with corresponding results in other sports, such as football, tennis and taekwondo where the researchers used elastic bands for young athletes, improving their performance (Jensen, Holmich, Bandholm, Zebis, Andersen, & Thorborg, 2013; Treiber, Lott, Duncan, Slavens, & Davis, 2015; Jakubiak & Saunders, 2008). Furthermore, they agree with a research carried out during the 1991 World Table Tennis Championship in China, where 76.5% of the athletes asked believed in the effectiveness of resistance training in table tennis (I.T.T.F., 1992). Neuromuscular coordination seems to be directly connected to any technical application in sports. It has been observed that the better the neuromuscular control, the better the execution of a technical movement (Schmidt & Wrisbert, 2000).

What can be confirmed validly and clearly through various researches is that training with elastic bands contributes to a better development; it helps athletic performance and has a positive influence on the psychology of young athletes, reducing injuries (Falk & Mor, 1996). More specifically, a table tennis athlete's physical condition must be on an exceptional level, in order to execute all the required technical and tactical movements correctly, until the end of a game.

Table tennis training is often monotonous, especially at developmental ages, when a coach is mostly interested in the acquisition of the right technique of the strokes, which is probably due to the small number of researches on the sport, relating to scientific facts. The right combination of physical abilities and technique can induce improvement of performance in table tennis (Zhang, Wei, Hu, & Liu, 2014). A satisfactory neuromuscular coordination combined with good kinesthetic ability help to better control the ball and to execute effective movements (Messinis, 2000). Training with resistance increases muscular strength, as well as stability and coordination of movement techniques and it also improves agility and kinetic abilities of the upper and lower limbs in young athletes (Carroll, Barry, Riek, & Carson 2001).

The subject of the present study was to show the fact that strengthening training with elastic bands can contribute to the effectiveness of the basic forehand topspin stroke. They also confirm that the use of an unconventional training, including both technique movements and elastic bands can improve the accuracy and success of the basic forehand topspin stroke. Physical condition as well as percentages of failure or success in strokes is a basic element in the study of racket sports, since effectiveness strongly depends on them (Less, 2003).

Conclusion

In light of the above discussion, it's clear that well-designed strength training programs with elastic bands are vital to table tennis athlete's performance especially concerning the forehand topspin stroke. As a result, it can be recommended to the coaches and players in addition to the regular technical training. It is obvious that physical condition and technique are two aspects of the training process which must be developed simultaneously, as they help athletes to respond effectively and adapt more easily to the conditions of a competition. Consequently, training with elastic bands in order to develop the forehand topspin should be taken into account by tennis coaches when planning resistance-training programs for youth table tennis athletes. A future suggestion would be that the above protocol of exercises should be used for other ages and different athletic levels. A further suggestion would be that more table tennis strokes should be researched, as well as more measurements should be carried out, as in mid programs. Finally, there could be varied training protocols with different forms of resistances, such as free weights or exercises with body weight, in order to investigate more possibilities for the effectiveness of movements.

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