Evaluation of the Effects of Core-Quick Strength and Core-Plyometric Studies on Balance, Agility and Strength Traits of Volleyball Players

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Abstract

The aim of this study is to investigate the effects and differences of two different strength training models on balance, agility and strength traits of volleyball players. 45 female athletes aged 12.08 ± 0.82 who played volleyball in a private club participated in the study. The athletes who participated in the study were divided into three groups as core-plyometric (KRP) (n=15), core-quick strength (KRC) (n=15) and control (KNL) (n=15) groups. Within the scope of the study, KRP group performed plyometric training after core training and KRC group performed quick strength training after core training. The KNL group continued their volleyball training The trainings were conducted 2 days a week for 8 weeks. Height, weight, BMI, t-test, standing long jump test, flamingo balance test and throw-in test were applied to all three groups before and after the study. The data obtained in the pre and post test were evaluated with a statistics package program and the significance level was determined as p<0.05. The One-Way ANOVA test and Paired-Samples t-test were used for statistical analysis. As a result, a significant difference was found in the standing long jump test in all three groups (p<0.05). Throw-in and flamingo balance tests showed a significant difference in the KRP and KRC groups (p<0.01), but not in the KNL group (p>0.05). T-test showed significant difference in KRP and KRC groups (p<0.05), but no significant difference was found in KNL group (p>0.05). When the differences between the groups were examined, no significant differences were found between the averages as a result of height, standing long jump, throw-in and flamingo balance tests (p>0.05), and the KRC group showed significantly more improvement than the KNL group in the t-test.

Keywords: Plyometric, Balance, Agility, Core, Strength, Volleyball.

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1. Introduction

Volleyball involves movements consisted of technical and tactical skills of different intensity performed in an aerobic environment in terms of playing time (Gabbett et al., 2007; Busko et al., 2013). Biomechanics traits such as high aerobic and anaerobic endurance, strength, flexibility, speed, agility, balance, reaction are also effective in game performance (González et al., 2011; Bazyler et al., 2018; Sopa and Pomohaci, 2018).

Sudden changes in direction, jumping in different positions and agility trait involving speed changes affect performance in volleyball (Sheppard et al., 2008). Agility is body control and the ability to change direction suddenly (Barnes et al., 2007). In another definition, it is described as a locomotor skill that enables the body to change its direction as fast, smooth, easy and controlled as possible while moving between two points (Turner, 2011). The static and dynamic balance adequacy of core area muscle groups which provide connection between body, legs and arms also affects agility (Makhbout et al., 2018). In addition, the strength development of the core area has a positive effect on the balance system of the body and provides support to the movement economy and positively affects the power output (Herrington and Davies, 2005; Carpes et al., 2008; McGill, 2010).

The balance feature, which is one of the important parameters of physical movements (Hrysomallis, 2011) is known to play an important role in successful exhibition of many sports skills, in changing direction, stopping, moving an object, maintaining certain position of the body and preventing injury (Oliver and Di Brezzo, 2009; Shubert et al., 2010). In almost all sports branches, the most successful athletes have superior control over the center of gravity and therefore their balance traits are at the highest level (Roetert, 2001).

In order to develop the explosive force which is another effective physical feature in volleyball, the force and speed relationship should be at the highest level. In this context, plyometric training is one of the most used methods (Haghighi et al., 2012). Plyometric study is a kind of neuromuscular study that leads to the development of explosive force to use maximum force at minimum time (Nikoseresh et al., 2014). In-game jumping skills should be developed sufficiently for players to practice spike and block techniques well. In a study they conducted, Reeser and Bahr (2017) reported that volleyball players jump between 30,000 and 40,000 times in a year. Therefore, it is necessary to pay attention to the parameters that affect the ability to jump in all kinds of training practices aimed at increasing the sporting performance of volleyball players.

Another training method which can be implemented on the ability to jump in volleyball is the quick strength training. The quick strength training is an important type of training used in the development of agility, strength and jump (Rodriguez et al., 2017). The movements used in volleyball should be quick and the techniques should be proper. Therefore, the training practices that combine strength trainings with speed should be consistent with the volleyball technique (Bompa and Carrera, 2003). Within the framework of this approach, the aim of this study is to investigate the effects and differences of two different strength training models on balance, agility and strength traits of volleyball players.

2. Materials and Methods

45 licensed female athletes playing volleyball were included in this study. At the beginning of the training sessions, the athletes were homogeneously distributed to 3 groups according to the pre-test results by using the pairing method. There was no significant difference between the averages of the groups and the One-Way Anova test results. The athletes were divided into 3 groups as core-plyometric (KRP) (n=15, age: 12,0±0,83 years, weight: 55,6±6,62 kg, height: 168,7±4,83 cm) and control group (KRC) (n=15, age: 12,3±0,79 years, weight: 50,7±3,74 kg, height: 165,7±4,39 cm) and control group (KNL) (n=15, age: 12,2±0,86 years, weight: 56,5±6,85 kg, height: 167,9±7,63 cm). The KRP group participated in plyometric training after core training and the KRC group participated in quick strength training. The KNL group continued traditional volleyball training. A total of 16 sessions were conducted for 8 weeks, 2 days a week. In the training days, the sessions consisted of 4 phases. These were: the warm-up phase, core-plyometric and core-quick force training practices, volleyball-specific technical-tactical training of the coach and finishing phase. In order to avoid differences in the study, predefined standard warm-up drills were implemented in all three groups.

Preliminary and final tests were performed in the study. Height and weight measurements were taken as the anthropometric measurements, throw-ins and standing long jumps were used as the strength test the flamingo balance test and t-test were also implemented. Care was taken to ensure that the coaches performing the tests were the same during both test periods. The participants were asked to rest completely before testing.

Height and Body Weight: Height and weight measurements were taken as the digital display scale with a sensitivity of 0.01 kg. During the measurements, the heavy equipment of the subjects other than the shorts and t-shirts were removed (Weiner and Lourie, 1969). Body mass index (BMI): The ratio of body weight to height was calculated by using this formula: weight (kg)/height (m)2.

Agility measures: T-test was used (Semenick, 1990). 4 cones, tape measure and photocell were used. The athletes were asked to run a total distance of 36.57 meters in as short a time as possible. The time was recorded in seconds.

Balance measurements: The flamingo static balance test was applied (Sipal, 1989). The aim is to determine how many seconds the static balance of the subject is within one minute. The shortest execution time was discarded and the best of the two execution times was taken and recorded as the test score.

Strength tests: Throw-in and standing long jump tests were implemented.
Throw-in test: Measures the circumference of the shoulder-chest muscles and the strength of the flexor muscles. The subjects threw the medicine ball forward with both hands, from a fixed distance with both arms above their head and their feet lined up. The shot was repeated 3 times and the best result was recorded in cm (Kamar, 2008).

Standing long jump test: Subjects jumped forward with both legs without stepping on the start line and the measurements were taken at the heel of each athlete's leg behind. Each subject repeated the jump 3 times and the best value was recorded as the measurement (Ratamess, 2012).

Data analysis: At the beginning of the study, the level of significance for the whole procedure was determined as $p<0.05$ and the statistical procedures were performed using the program SPSS 23.0 for Windows. The data obtained in the pre and post tests were evaluated with the statistical package program and the significance level was determined as $p<0.05$. The Shapiro-Wilk test was used to determine the distribution of the parameters used in the study. The One-Way Anova test was used to analyze the differences between the groups, and The Paired-Samples t-test was used for statistical analysis of the differences within the groups.

### 3. Findings

<table>
<thead>
<tr>
<th>Parameters</th>
<th>KRP Avg±Sd</th>
<th>KRC Avg±Sd</th>
<th>KNL Avg±Sd</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>12,06±0,83</td>
<td>12,14±0,79</td>
<td>12,25±0,86</td>
<td>0,80</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168,7±4,33</td>
<td>165,7±4,39</td>
<td>167,9±7,63</td>
<td>0,61</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>55,0±6,2</td>
<td>60,1±5,7</td>
<td>56,5±5,03</td>
<td>0,32</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19,3±1,85</td>
<td>18,2±1,15</td>
<td>19,2±1,72</td>
<td>0,01</td>
</tr>
</tbody>
</table>

$p<0,05$, BMI: Body mass index.

In Table 1, as a result of the statistical analysis, it was concluded that there was a significant difference only in the BMI values of the participants in terms of demographic data and there was no significant difference between the other traits ($p>0.05$).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>KRP Avg±Sd</th>
<th>KRC Avg±Sd</th>
<th>KNL Avg±Sd</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test (sec)</td>
<td>10,52±0,39</td>
<td>10,32±0,32</td>
<td>10,02±0,45</td>
<td>0,06</td>
</tr>
<tr>
<td>Throw-in (cm)</td>
<td>665,5±29,7</td>
<td>647±23,6</td>
<td>725,6±104,2</td>
<td>0,18</td>
</tr>
<tr>
<td>Flamingo (sec)</td>
<td>6,7±1,1</td>
<td>6,2±0,8</td>
<td>6,2±0,9</td>
<td>0,29</td>
</tr>
<tr>
<td>Horizontal jump (cm)</td>
<td>164,0±17,1</td>
<td>170,0±14,3</td>
<td>172,2±12,8</td>
<td>0,12</td>
</tr>
</tbody>
</table>

In Table 2, there was no statistically significant difference between the KRP, KRC and KNL groups in any of the pretest values ($p>0.05$).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>N</th>
<th>Avg±Sd</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test (sec)</td>
<td>15</td>
<td>0,13±0,24</td>
<td>0,04</td>
</tr>
<tr>
<td>Throw-in (cm)</td>
<td>15</td>
<td>25,3±20,9</td>
<td>0,03</td>
</tr>
<tr>
<td>Flamingo (sec)</td>
<td>15</td>
<td>1,83±1,3</td>
<td>0,00</td>
</tr>
<tr>
<td>Horizontal jump (cm)</td>
<td>15</td>
<td>4,0±5,75</td>
<td>0,01</td>
</tr>
</tbody>
</table>

$p<0,01$, $p<0,05$: T-test, throw-in, flamingo, horizontal jump.

In Table 3, according to the paired t-test results, there was a statistically significant difference in the pre- and post-test values of the t-test, throw-in and horizontal jump tests of the KRP group ($p<0.05$). There was a statistically significant difference in pre- and post-test values of the Flamingo test ($p<0,01$).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>N</th>
<th>Avg±Sd</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test (sec)</td>
<td>15</td>
<td>0,15±0,24</td>
<td>0,04</td>
</tr>
<tr>
<td>Throw-in (cm)</td>
<td>15</td>
<td>56,2±60,3</td>
<td>0,003</td>
</tr>
<tr>
<td>Flamingo (sec)</td>
<td>15</td>
<td>1,6±1,6</td>
<td>0,002</td>
</tr>
<tr>
<td>Horizontal jump (cm)</td>
<td>15</td>
<td>6,7±10,4</td>
<td>0,02</td>
</tr>
</tbody>
</table>

$p<0,01$, $p<0,05$: T-test, throw-in, flamingo, horizontal jump.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>N</th>
<th>Avg±Sd</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test (sec)</td>
<td>15</td>
<td>0,02±0,39</td>
<td>0,2</td>
</tr>
<tr>
<td>Throw-in (cm)</td>
<td>15</td>
<td>8,5±12,6</td>
<td>0,02</td>
</tr>
<tr>
<td>Flamingo (sec)</td>
<td>15</td>
<td>0,03±1,3</td>
<td>0,08</td>
</tr>
<tr>
<td>Horizontal jump (cm)</td>
<td>15</td>
<td>1,5±3,04</td>
<td>0,07</td>
</tr>
</tbody>
</table>

$p<0,05$: Throw-in.
Table 6: The biomotor traits between the KRP, KRC and KNL groups and the last one-way ANOVA test results.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>KRP Avg±SD</th>
<th>KRC Avg±SD</th>
<th>KNL Avg±SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-test (sec)</td>
<td>10,9±0,51</td>
<td>10,1±0,32</td>
<td>10,6±0,87</td>
<td>0,01</td>
</tr>
<tr>
<td>Throw-in (cm)</td>
<td>69,0±8,61</td>
<td>70,3±2,106,7</td>
<td>73,4±1,062</td>
<td>0,55</td>
</tr>
<tr>
<td>Flamingo (sec)</td>
<td>4,9±1,7</td>
<td>4,6±1,6</td>
<td>5,5±1,6</td>
<td>0,27</td>
</tr>
<tr>
<td>Horizontal jump (cm)</td>
<td>168,8±17,4</td>
<td>182,8±17,2</td>
<td>173,7±12,3</td>
<td>0,06</td>
</tr>
</tbody>
</table>

*p<0,05; T-test.

Table 7: Correlation table of the development rates between parameters.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Throw-in</th>
<th>Flamingo</th>
<th>T-test</th>
<th>Horizontal jump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throw-in</td>
<td>1</td>
<td>-0,171</td>
<td>0,051</td>
<td>-0,011</td>
</tr>
<tr>
<td>Flamingo</td>
<td>1</td>
<td>0,101</td>
<td>0,182</td>
<td>0,093</td>
</tr>
<tr>
<td>T-test</td>
<td>1</td>
<td>0,101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal jump</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n=45, *p<0,05.

4. Results

The aim of this study was to investigate the effects of two different strength training models on balance, agility and strength traits as well as the differences of volleyball players. In volleyball, motoric traits such as strength, quickness, agility, balance directly affect performance. In order to have an effective performance during the game, it is necessary to make proper training programming in accordance with the development of these traits which are the requirements of volleyball.

Volleyball is a sport where high jumps, falls and movements involving sudden changes of direction are quite present. Having the body at the most balanced position during the execution of these movements is very important for the achievement of these skills. In this context, it is known that balance skill, which forms the basis of performance. In a similar study, it is known that balance skill, which forms the basis of performance. In a study conducted with volleyball players, it was reported that plyometric training is effective in jumping and agility skills (Harmandeep et al., 2013).

Research shows that plyometric and strength training programs are linked to agility development (Bozdoğan and Kızılet, 2017; Can et al., 2017; Furqoni and Sudjandoko, 2019). In another study, Pamuk and Ozkaya (2017) concluded that resistant plyometric training was effective in the development of agility. Schultz et al. (2015) concluded that there is an important relationship between strength and agility. There are studies with different opinions that are not similar to the studies that show parallelism in the correlations with the literature results related to the presented study. Bozdoğan and Kızılet (2017) examined the effect of coordination and plyometric studies on agility, jump and endurance traits and found no significant difference in agility traits in the plyometric training group.

Volleyball is a sport in which the vertical and horizontal jumps are very frequent. Volleyball player's ability to jump is an important factor in the success of the team in terms of performance (Bompa and Carrera, 2003). It is necessary to have the necessary muscle strength in order to perform explosive skills or defensive movement correctly. Muscle strength required in sports branches can be achieved by plyometric and strength training (Neagu et al., 2018). Therefore, strength and plyometric trainings are used to increase the jumping skills (Harmandeep et al., 2013). Research on the subject has shown that plyometric training is effective in jumping and agility skills (Fathi et al., 2018; Voisin and Schoier, 2019). In a study conducted with volleyball players, it was reported that plyometric training significantly improved leap and agility values (Hale et al., 2019). In another study, Abade et al. (2019) concluded that horizontal and vertical strength training they implemented had a positive effect on the jump performance. In a similar study, Fathi et al. (2018) applied plyometric training to adolescent volleyball players. As a
result of the study, it was concluded that strength development was changed positively with plyometric training. In another study examining upper and lower extremity strength, Ateş and Ateşoğlu (2007) concluded that plyometric training had a positive effect on both upper and lower extremity strength. In the presented study, the practice groups, similar to the literature, showed improvement in the horizontal jump and throw-in values. In this respect, it can be said that core, strength and plyometric trainings have positive effects on jump, on strength and balance.

In the presented study, the effects of plyometric and quick strength training, when combined with the core training, on agility, strength and balance traits were investigated. Plyometric and quick strength training combined with core training improves balance, agility and strength. When applied to the adolescent athletes, the plyometric and quick strength trainings used to increase volleyball-specific performance yields higher development compared to the adult athletes. The biomotor traits of strength, agility and balance, which are important parameters of performance in volleyball, should be implemented in a planned way by taking into consideration the requirements of the game.

References


