EFFECTS OF IN-SEASON PLYOMETRIC TRAINING ON SPRINT AND BALANCE PERFORMANCE IN BASKETBALL PLAYERS

Abbas Asadi
Roudbar Branch, Islamic Azad University, Roudbar, Iran

Abstract
The purpose of this study was to examine the effects of in-season plyometric training program on balance and sprint performance in basketball players. Twenty intermediate basketball players participated in this study and were divided into two groups; plyometric training (PL; n = 10) and control group (CG; n = 10). Plyometric training took place 2 days a week for 6 weeks including depth jump, vertical jump, and standing long jump. Star Excursion Balance Test (SEBT) and 20-m sprint were measured at pre- and post-training. The PL demonstrated significant improvement (P < 0.05) in 20-m sprint (~7%) after a 6-week of training and compared to CG. There were not significant changes (P > 0.05) in SEBT, but PL showed ~5% improvement. In conclusions, it could be concluded that a 6-week in-season plyometric program can improve sprint and balance in male basketball players. Also, this study provides support for coaches and basketball players who use this training method at during competitive phase.

Key words: basketball, quickness, postural control

Introduction
In basketball, muscular power has been considered as essential to obtain high sport performance levels (Klinzing, 1991). Moreover, balance and sprint are vital components for the success in basketball players. Two methods, plyometric and resistance training, are usually referred to in the literature as improving the most powerful strength characteristics (explosive strength) in basketball players. Several studies have demonstrated the positive effects of plyometric and resistance training for higher increases in the explosive strength indicators (Brown et al., 1986; Fulton, 1992; Matavulj et al., 2001; Wagner & Kocak, 1997). Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness (Chu, 1998). Plyometrics consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue (Chu, 1998). The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone (Asmussen & Bonde-Peterson, 1974). Several investigations reported that, plyometric training can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness, and overall proprioception (Harrison & Gaffney, 2001; Hewett et al., 1996; Holcomb et al., 1996). This type of exercise causes higher muscle tension compared to conventional resistance training (Asmussen & Bonde-Peterson, 1974). For this reason, plyometric exercises are widely recommended for power enhancement in jumping (Verkhoshanski, 1973). Furthermore, the bulk of research investigated plyometric training efficacy (Adams et al., 1992; Brown et al., 1986; Holcomb et al., 1996; Saez-Saez de Villarreal et al., 2008), but there were a little study that examined the effects of plyometric training in basketball players at in-season. This is especially the case in young male basketball players, for whom there are, to our knowledge, related studies available in literature. But, in young male basketball players, the effects of in-season plyometric training especially on balance and speed performance are unknown. Therefore, the aim of the present study was to determine how balance and speed are affected by a 6-week in-season plyometric training program in young male basketball players.

Methods
Subjects
Twenty male basketball players volunteered to participate in this study and were randomly assigned to two treatment groups that performed 2 times per week plyometric training (PL; n=10; age 20.2±1 y; height 182.1±9.2 cm; and weight 78.5±5.5 kg). A control group of 10 subjects (CG; age 20.1±1.5 y; height 180.1±7.2 cm; and weight 79.5±4.5 kg) did not train plyometric training and were tested before and after a 6-week period. The subjects performed technical and tactical training 3 times a week for 90 min. The subjects were healthy, free of lower body injuries and they had no medical or orthopedic problems. Subjects were carefully informed about the experiment procedures and possible risk and benefits associated with participation in the study and signed an informed consent document before the investigation. The Institutional Review Board of the University approved the research protocol.

Plyometric training
Plyometric training was taken twice weekly for 6 weeks (on Sunday and Tuesday). Participants in the PL group performed depth jump, vertical jump, and standing long jump, respectively.
Participants in the PL group performed exercises that always began with a drop from a height (45 cm). The training protocol required 3 sets of 15 jumps separated by 2-minute rests for each exercise. Training sessions in PL group lasted 55 min; and began with a standard 10 min warm-up, 5 min of jogging, 5 min ballistic exercises and stretching; 40 min training, and 5 min cool-down. Subjects in PL group were instructed to perform exercises in each training session with maximal effort. During the training, all subjects were under direct supervision and were instructed on how to perform each exercise. During the intervention of 6 weeks, PL and CG continued their basketball training, and were not allowed to perform any other training (such as: resistance training and or plyometric training) that would impact the results.

**Measurements**

*Star Excursion Balance Test (SEBT)* is a test that incorporates a single-leg stance on one leg with maximum reach of the opposite leg. The test is consisted of 8 lines that make a 45° angle to one another. The 45° increments are from the center of the grid. The 8 lines positioned on the grid are labeled according to the direction of excursion relative to the stance leg (anterior, anterolateral, anteromedial, medial, lateral, posterior, posterolateral, posteromedial) (Kinzey & Armstrong, 1998). The diameter of the circle is 182/9 cm and it is placed on a firm surface. The width of each line is 7/62 cm. In order to reduce the learning effect each subject chooses 6 directions out of the 8 to practice (Blackburn, et al., 2000). The subject stood in the middle of the circle with the dominant leg; then with the opposite leg he reached for the furthest marked distance. Each subject was asked to touch the furthest part of the line with the most distal part of his reach foot. This was done with control and in a slow manner to ensure adequate neuromuscular control of the stance leg. The subject then returned to the original stance and the touch points that were marked during examination were recorded. Three second rest was allocated between each reach. The direction of the revolution based on the right or left reach legs was clock wise and counter clock wise, respectively (Blackburn, et al., 2000). The reach was not accepted if the leg could not touch the target line, if the subject’s weight was shifted to the reach leg, if the support leg was lifted from the center, or if balance was disturbed during the reach (Blackburn, et al., 2000). Participant’s legs were measured from the anterior superior iliac spine to the distal tip of the medial malleolus using a standard tape measure while participants lay supine. Leg length was used to normalise excursion distances by dividing the distance reached by leg length then multiplying by 100 (Gribble & Hertel, 2003).

20-m sprint: The sprint running tests were performed on an outdoor track. The sprint running test consisted of 3 maximal sprints of 20-m, with a 2 min resting period between each sprint. Sprint time was recorded using hand-held stopwatch (Joerex, ST4610-2).

The subjects started the sprint when ready from a standing position start, behind the start line. On command, subjects were instructed to sprint as fast as possible through the distance. The timer stood at the finish line (Marković, et al., 2007). Statistical analyses: All data are presented as mean ± SD. A 2 × 2 analysis of variance (ANOVA) was used to determine significant differences between groups. In the event of a significant F ratio, Tukey post hoc tests were used for pairwise comparisons. A criterion α level of P ≤ 0.05 was used to determine statistical significance. All statistical analyses were performed through the use of a statistical software package (SPSS®, Version 16.0, SPSS., Chicago, IL).

**Results**

No injuries occurred throughout the study period, and the testing and training procedures were well tolerated by the subjects. After 6 weeks of training, the PL group made significantly (P < 0.05) greater improvements than CG and pre-training values in sprint performance (Figure 1). The PL group improved their dynamic balance ~5%, but this change was not statistically significant (P > 0.05) (Table 1).

![Figure 1](image)

**Discussion and conclusion**

A novel approach in this investigation was to examine the effects of in-season plyometric training on dynamic balance, and sprint in young male basketball players. Information regarding the effects of plyometric training on dynamic balance is generally lacking. The results of the present study are in line with Myer et al. (2006) and Twist et al. (2008) who reported plyometric training can improve balance performance in adults and female. Paterno et al. (2004) who used a combine dynamic balance and plyometric protocol and found that improvements in body sway measures occurred in the anterior/posterior plane. Recently, Arazi and Asadi (2011) reported changes in dynamic balance following 8 weeks plyometric training, but these changes were not statistically significant. In this study we found that PL group improved their dynamic balance ~4% (not significant).
Subjects were tested at 8 plans, and the highest improvement was observed in the anteromedial plan. These suggest that peripheral and central neural adaptations and enhancement of neuromuscular factors were induced by plyometric training, resulting in improved joint position sense and detection of joint motion. Peripheral adaptations that may have occurred because of plyometric training likely resulted from the repetitive stimulation of the articular mechanoreceptors near the end range of motion (Grigg, 1994). Central adaptation resulting from plyometric training may also improve proprioception. The novelty of this task required preparatory muscle activation (Chimera, et al., 2004). The results of this study show that in-season plyometric training can positively affect sprint performance (~7%). These findings support studies showing improvements in sprint speed after a plyometric program (Rimmer & Sleivert, 2000; Markovic et al., 2007; Saez-Saez de Villarreal et al., 2008). The factor that probably affected the obtained results for the 20-m distance was the quality of the applied training program (intensity and volume). In relation to the transfer of plyometrics training to sprinting, it is likely that the greatest improvements in sprinting will occur at the velocity of muscle action that most closely approximates the velocity of muscle action of the plyometric exercises employed in training (Rimmer & Sleivert, 2000). It is also possible that a training program that incorporates greater horizontal acceleration would result in the most beneficial effects (Saez-Saez de Villarreal et al., 2008). In conclusion, the results of this study highlights the potential of using plyometric training at in-season of competitive phase to improve sprint and dynamic balance, especially in young male basketball players (19-20 years old). It is recommended that, coaches sometimes design plyometrics for young athletes, because this type of training can be effective for improving performance. Also, basketball players who use plyometrics to train dynamic balance should create programs that progress train intensity of the exercises based on the results of this study. Since coaches and athletes are often restricted to a short preseason, this is beneficial for coaches or athletes during competitive phase such as collegiate or logical competitions.

Table 1. Mean ± standard deviations for normalised maximum excursion distance (excursion distance/leg length × 100).

<table>
<thead>
<tr>
<th></th>
<th>PL (n=10)</th>
<th></th>
<th>CG (n=10)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>Anterior</td>
<td>98.19 ± 5.05</td>
<td>103.02 ± 3.63</td>
<td>96.86 ± 5.65</td>
<td>97.54 ± 4.97</td>
</tr>
<tr>
<td>Anteromedial</td>
<td>83.29 ± 8.07</td>
<td>87.32 ± 7.19</td>
<td>88.57 ± 9.42</td>
<td>88.54 ± 8.61</td>
</tr>
<tr>
<td>Anterolateral</td>
<td>99.68 ± 7.15</td>
<td>104.04 ± 6.38</td>
<td>97.57 ± 4.37</td>
<td>97.71 ± 5.61</td>
</tr>
<tr>
<td>Medial</td>
<td>71.41 ± 7.48</td>
<td>74.12 ± 6.67</td>
<td>79.61 ± 11.32</td>
<td>79.43 ± 11.45</td>
</tr>
<tr>
<td>Lateral</td>
<td>93.2 ± 7.92</td>
<td>97.08 ± 5.85</td>
<td>91.14 ± 6.88</td>
<td>90.71 ± 6.5</td>
</tr>
<tr>
<td>Posterolateral</td>
<td>87.6 ± 11.62</td>
<td>90.82 ± 10.64</td>
<td>86.63 ± 10.66</td>
<td>86.62 ± 9.72</td>
</tr>
<tr>
<td>Posteromedial</td>
<td>80.81 ± 12.29</td>
<td>83.93 ± 10.73</td>
<td>82.69 ± 9.4</td>
<td>83.27 ± 10.73</td>
</tr>
<tr>
<td>Posteromedial</td>
<td>91.64 ± 10.41</td>
<td>94.17 ± 10.61</td>
<td>92.43 ± 7.29</td>
<td>91.95 ± 7.87</td>
</tr>
</tbody>
</table>

PL = plyometric group; CG = control group; ~% = percent change in PL.

References


**UČINCI PLOMETRIJSKOG TRENINGA ZA VRIJEME SEZONE NA SPRINT I BALANS IZVEDBU KOŠARKAŠA**

**Sažetak**

Cilj ovog istraživanja bio je ispitati učinke pliometrijskog programa obuke na ravnotežu i izvođenje sprinta košarkaša za vrijeme trajanja sezone natjecanja. Dvadeset košarkaša srednje razine kvalitete sudjelovalo je u ovom istraživanju, a bili su podijeljeni u dvije skupine: pliometrijski trening (PL, n = 10) i kontrolnu skupinu (CG, n = 10). Pliometrijski trening je provođen dva dana tjedno kroz 6 tjedana, uključujući dubinski skok, skok u visinu i skok u daljinu. Uz pomoć uredaja „Star Excursion Balance Test“ (SEBT) i 20 m sprinta ispitanici su izmjereni u pre-i post fazi rada. Grupa PL pokazala je značajno poboljšanje (P < 0,05) u 20 - m sprintu (~7 %) nakon 6 tjedana treninga, a u odnosu na grupu CG. Nije bilo značajnijih promjena (P > 0,05) u SEBT, ali je grupa PL pokazala ~ 5 % poboljšanja. U zaključcima, moglo bi se reći da 6 - tjedna pliometrijski trening u sezone može poboljšati sprint i balans kod muških košarkaša. Također, ova studija pruža podršku za trenere i košarkaše koji koriste ovu metodologiju treninga u vrijeme konkurentne natjecateljske faze.

**Ključne riječi:** košarka, sprint, posturalna kontrola

Received: March 19, 2013
Accepted: June 10, 2013
Correspondence to:
Abbas Asadi, Ph.D.
Roudbar Branch
Islamic Azad University
Roudbar, Iran
Phone: +98 91 1321 3041
E-mail: Abbas_asad1175@yahoo.com