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COMPARISON OF SIX WEEKS ECCENTRIC OVERLOAD TRAINING BETWEEN BILATERAL AND UNILATERAL SQUAT IN BASKETBALL PLAYERS

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ABSTRACT

Basketball is a team sport in which strength and power in the lower limb are key variables. The use of eccentric overload devices has augmented in the past years, and several studies have shown the benefits of this methodology to improve physical parameters. The aim of the present study is to compare the effects of bilateral and unilateral squat during eccentric overload training. Ten players from a same team participated in a six weeks of two session per week eccentric overload training. Participants were divided in two groups according to their performance in pretest. Test measured in pre and postest situation were a power test in flywheel, CMJ, triple hop test and T-Test. Training consisted in 4 sets of 8 repetitions of bilateral or unilateral squat. After treatment both groups improve their performance in T-Test and power test in flywheel device. Trends of improve were observed for triple hop test, with a greater ES for unilateral group. Results shown as eccentric overload training of bilateral or unilateral squat can be a good choice to improve physical performance, with different benefits according to the type of execution.

Key words: basketall, eccentric overload training, flywheel, unilateral squat

COMPARACIÓN DE LOS EFECTOS DE SEIS SEMANAS DE ENTRENAMIENTO CON SOBRECARGA EXCÉNTRICA BILATERAL Y UNILATERAL EN JUGADORES DE BALONCESTO

RESUMEN

El baloncesto es un deporte de equipo en el que la fuerza y la potencia del tren inferior son aspectos claves. El uso de dispositivos de sobrecarga excéntrica se ha incrementado en los últimos años, y varios estudios han mostrado los beneficios de esta metedología para desarrollar parámetros físicos. El objetivo del presente estudio es comparar los efectos del entrenamiento con sobrecarga excéntrica en acciones de sentadilla bipodal y monopodal. Diez jugadores de un mismo equipo participaron en un programa de entrenamiento de sobrearga excéntrica durante seis semanas, realizando dos sesiones semanales. Los participantes fueron divididos en dos grupos en función de su rendimiento durante las test previos al entrenamiento. Los test pre y post tratamienot fueron un test de potencia en el dispositivo de sobrecarga excéntrica, CMJ, test de triple salto y test de agilidad T-Test. Las sesiones de entrenamiento consistieron en 4 series de 8 repeticiones de squat bipodal o monopodal en función del grupo de entrenamiento. Tras la intervención, ambos grupos mejoraron su rendimiento en T-test y en el test de potencia con sobrecarga excéntrica. Se observó una tendencia de mejora en los valores para el triple salto, con tamaños del efecto mayores para el grupo que entrenó de manera monopodal. Los resultados muestran como el entrenamiento con sobrecarga excéntrica ejecutado de manera bipodal o monopodal puede ser una buena opción para mejorar el rendimiento físico en jugadores de baloncesto, con diferentes beneficios acorde al tipo de ejecución.

Palabras clave: baloncesto, entrenamiento con sobrecarga excéntrica, dispositivo rotatorio, sentadilla monopodal

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INTRODUCTION

Basketball is a team sport in which aerobic and anaerobic performance are important (Sallet, Perrier, Ferret, Vitelli, y Baverel, 2005; Ostojic, Mazic, y Dikic, 2006; Delextrat, y Cohen, 2009; Abdelkrim, Castagna, Jabri, Battikh, El Fazaa, y El Ati, 2010; Köklü, Alemdaroğlu, Koçak, Erol, y Fındıkoğlu, 2011; Ziv, y Lidor, 2009), but the last one is the most relevant for offensive and defensive actions (Boone y Bourgois, 2013). Some key anaerobic variables associated to performance in basketball are jump ability (Hoare, 2000; Ziv y Lidor, 2009), change of direction (COD) ability and high intensity lateral displacement (McInnes, Carlson, Jones and McKenna, 1995).

The mentioned actions show a strong relationship with strength and power in the lower limb. Therefore, it is usual to find many coaches who spend an important time trying to improve strength conditioning using different methods and exercises, as Olympic weightlifting, plyometrics or traditional resistance exercises. In the last years, new procedures to improve strength have been developed under the concept of eccentric overload. Several studies have observed the efficiency of the use of apparatus such as flywheel devices or versa pulleysin the improvement of sport performance (Tous-Fajardo et al, 2016; Sabido et al, 2017) and in injury prevention (De Hoyo et al, 2015; Gual et al, 2016). These procedures are designed to produce high forces during both concentric and eccentric phases of movement, but with a special emphasis on the eccentric phase.

To the authors' knowledge, only one study has employed the use of eccentric overload training (EOT) in basketball players to improve their performance. In that study, Gonzalo-Skok et al (2017) tried to show the benefits of a bilateral and unilateral EOT using a versa pulley. Authors found bilateral EOT (executed with a bilateral squat exercise) obtained greater enhancements in tests in which the vertical component is a key factor (bilateral and unilateral CMJ). On the other hand, in the group that trained unilateral EOT the authors found better results in the horizontal jump test and the COD test (in which the displacements and movements with two legs are executed asymmetrically). However, the training procedures proposed by those authors could not be considered unilateral and bilateral, because in the movements employed by Gonzalo-Skok et al (2016) both legs were used during the execution of exercises.

Therefore, the aim of the present study is to know the effects of bilateral and unilateral squat exercises after a period of EOT. We hypothesised that unilateral squat can be a more useful tool than bilateral execution to improve several performance tests important for basketball actions.

METHOD

Participants

Thirteen amateur participants, from a same basketball team, were recruited for the study. Three of them failed to more than two training sessions and they were excluded from the study. So, ten participants (age: 21.6 ± 2.41 years, height: 1.80 ± 0.09 m, weight: 83.6 ± 21.4 kg) took part in the study. Participants were divided into two groups according to their values in pretest. The first group executed the squat exercise in a flywheel with bilateral support (BG, n=5). On the other hand, the second group realized the training with a single leg support (UG, n=5). All participants were informed about the possible risk of the study and signed a written informed consent approved by the Ethics Committee of the University according to the declaration of Helsinki.

Procedure

One week before the training intervention, both groups performed a familiarization sessionwith the flywheel device consisting of two sets of eight repetitions of half-squat exercise with two legs and four sets with one leg (two sets with each leg). The inertial load used for this session and for training was 0.025 $kg·m^2$, because previous studies have showed that with low loads power values are higher (Sabido et al, 2017).

During the training intervention (6 weeks), two sessions per week of eccentric overload training (EOT) were added to their usual on court training. In EOT sessions participants performed 4 × 8 bilateral (BG) or unilateral (UG) half squats, with a rest interval between sets of 2 minutes. During each repetition, participants were instructed to perform the concentric phase as fast as possible, delaying the braking action until the last third of the eccentric phase. Participants were encouraged by experimenters during all the training sessions.

The EOT training was added to their usual on court training which consisted in three sessions of 90 min per week to improve technical and tactical variables. Total time trained and time played were recorded by researchers, aimed at quantifying both training and competition volume in each group. In addition, all injuries were registered during the entire study period.

Before and after treatment several performance tests were done in two separate days. The first one participants executed T-Test, CMJ and single leg CMJ. The second day a triple hop test and a power test in flywheel were realized.

Power test in flywheel

Three sets of two legs squat and six sets of one leg squat (three sets with each leg) were realized. Peak power output were recorded using an encoder (Smart-Coach Power Encoder, Smart Coach Europe AB, Stockholm, Sweden) with the associated software (v 3.1.3.0). Peak power was measured in both concentric and eccentric phases of the movements (two and one legs) with reliability scores ranging from 0.79 to 0.93 (intraclass coefficient correlation; ICC) and from 7.5% to13.2% (coefficient of variation; CV).

Vertical jump test

Height jump during CMJ test was calculated by measuring flight time with a contact platform (Tapeswitch Signal Mat, Tapes witch Corporation America, New York, USA). Height was calculated from the formula $h = g \cdot ft2/8$ (where h is the jump height in m; g is the gravity acceleration (9.81 m s−2); ft is the flight time in s). Jumps were performed with a self-selected depth, with the hands on the hips and with the instruction to jump as high as possible. Each participant performed three attempts separated by 2 minutes of rest, using the best trial for statistical analysis. The test was executed bilateral (CMJ bi) and unilaterally, with dominant (CMJ D) and non-dominant leg (CMJ ND).

T-Test

As a measure of agility in changes of direction a T-Test was done. Pauole et al (2000) shown validity and reliability of this test to assess change of direction performance. So, four cones were arranged in T shape, and participants were instructed to run as fast as possible between cones. Participants were able to start the test without a starting signal and time was recorded by using photoelectric cells (Datalogic S6 Series, Bologna, Italy). Three trials were assessment for each direction, and the two best trials (one for each direction) were used for the analysis. The rest between trials was 3 min.

Triple hop test

The participants stood on one leg and then they jumped as far as possible three times along a straight line with the same leg. The distance was measured in m from the toes at the push-off to the heel where the subject landed. The landing position was measured by testers. Free leg swing was allowed. Participants have to maintain their hands on hip during the test. Test were executed with dominant (TRIPLEd) and non-dominant leg (TRIPLEnd), and the best attempt was used for the analysis.

Statistical analysis

Results from pretest and postest are summarized as means ± SD. *T*-tests were performed to detect possible between-group differences both pre- and post-training intervention. Statistical significance was accepted where $p < 0.05$. Cohen's d and the standardised mean difference was used to calculate effect size (ES), represented by 'd' and interpreted for a recreationally trained sample according to Rhea (2004) as < 0.35 (trivial), 0.35–0.80 (small), 0.80–1.50 (moderate) and >1.5 (large).

RESULTS

Concentric and eccentric power output as well as the eccentric/concentric ratio pre and post training intervention for each group is shown in Table 1. For the BG group, significant improvements were found in concentric and eccentric peak power in the bilateral squat exercises. In spite of moderate effect size values, no significant increases were found in the peak power output during the bilateral for the UG group. Regarding the unilateral squat with the dominant leg, both BG and UG groups showed significant increases in the eccentric peak power. In addition, the BG group increased the concentric peak power in the unilateral squat performed with the non-dominant leg.

TABLE 1
Peak power (W) in the flywheel squat exercise pre and post training intervention for the bilateral and unilateral training group.

	Bilateral Training Group (BG)				Unilateral Training Group (UG)			
	Pre	Post	ES	%	Pre	Post	ES	%
Con Bi	1219 ± 377	1467 ± 382*	0.66	20.4	1104 ± 391	1261 ± 166	0.52	14.3
Ecc Bi	1267 ± 387	1594 ± 268*	0.98	25.8	1121 ± 437	1309 ± 310	0.50	16.7
Ratio Bi	1.05 ± 0.12	1.12 ± 0.22	0.41	6.9	1.00 ± 0.09	1.03 ± 0.16	0.25	3.2
Con D	566 ± 271	712 ± 244	0.57	25.7	574 ± 163	663 ± 133	0.84	23.3
Ecc D	547 ± 231	702 ± 192*	0.73	28.5	570 ± 192	709 ± 77*	0.95	24.4
Ratio D	0.99 ± 0.19	1.01 ± 0.14	0.12	2.0	1.06 ± 0.12	1.09 ± 0.17	0.19	2.6
Con ND	545 ± 145	697 ± 202*	0.87	27.9	536 ± 138	577 ± 60	0.38	7.6
Ecc ND	514 ± 114	664 ± 169	1.04	29.2	559 ± 151	670 ± 160	0.71	19.8
Ratio ND	0.96 ± 0.12	0.96 ± 0.11	0.07	0.8	1.05 ± 0.10	1.15 ± 0.21	0.66	10.1

Con = concentric, Ecc = eccentric, Bi = bilateral, D = dominant; ND = non-dominant.

Figure 1 shows the changes in the countermovement jump ability. The BG group showed non-significant increases in the bilateral CMJ (from 0.37 ± 0.08 to 0.39 ± 0.08; ES = 0.21), dominant CMJ (from 0.19 ± 0.08 to 0.21 ± 0.08;ES = 0.40) and non-dominant CMJ (from 0.18 ± 0.05 to 0.20 ± 0.04; ES = 0.40). Similarly, the UG group showed also a non-significant increase in all the CMJ modalities (from 0.36 ± 0.10 to 0.38 ± 0.07; ES = 0.32, from 0.20 ± 0.10 to 0.22 ± 0.07; ES = 0.47, and from 0.19 ± 0.06 to 0.20 ± 0.03; ES = 0.45 for the bilateral, dominant, and non-dominant CMJ respectively).

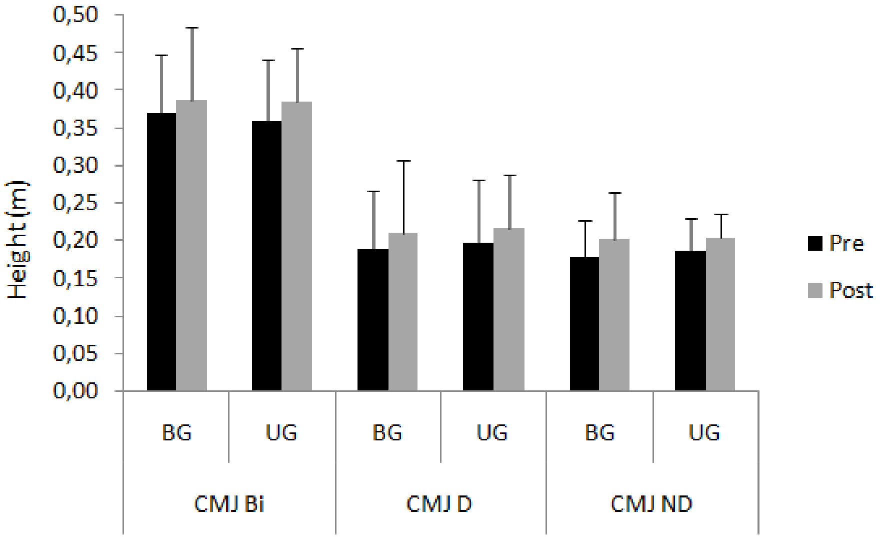

FIGURE 1: *Changes in vertical jumping ability after the training intervention for both bilateral training group (BG) and unilateral training group (UG).*

In Figure 2 are shown the results of the triple hop test pre and post training intervention for the BG and UG group. For the dominant triple hop, the BG group showed trivial effects (from 6.01 ± 0.81 to 6.15 ± 0.64; ES = 0.14) while the UG group showed a moderate (from 5.91 ± 1.17 to 6.33 ± 0.64; ES = 0.66) although non-statistically significant increase. In the same way, the increases in the non-dominant triple hop were trivial for the BG group (from 5.88 ± 1.17 to 6.08 ± 0.64; ES = 0.21) and moderate (from 5.57 ± 0.90 to 5.98 ± 0.65; ES = 0.69) in the UG group.

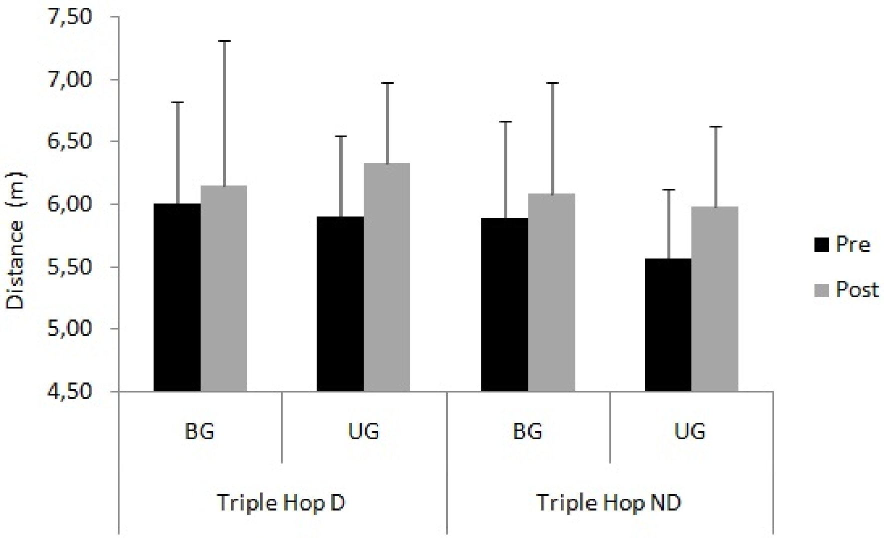

FIGURE 2: *Performance in the triple hop test pre and post training intervention for both bilateral training group (BG) and unilateral training group (UG).*

In the T-Test performing the change of direction with the dominant leg, both BG and UG groups reduced significantly the time (from 13.23 ± 0.52 to 12.45 ± 0.47, and from 13.24 ± 0.76 to 12.64 ± 0.59 respectively), being this improvements larger for the BG group (ES = 1.41 and 0.87 for the BG and UG group). In the T-Test performing the change of direction with the non-dominant leg, only the BG group showed significant improvements (from 13.23 ± 0.38 to 12.60 ± 0.51; ES = 1.57). The UG showed a moderate (from 13.35 ± 0.96 to 12.86 ± 0.52; ES = 0.64) although non-significant improvement in this test.

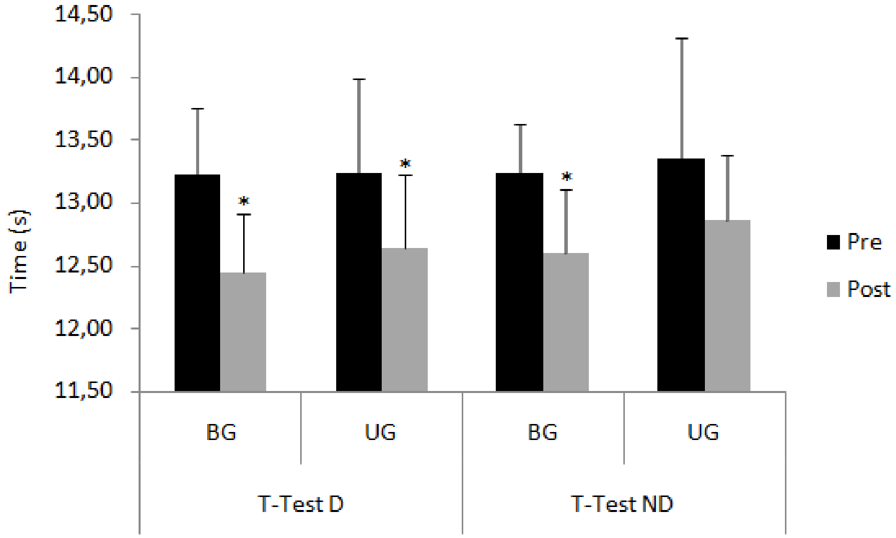

FIGURE 3: *Performance in the T-Test agility test pre and post training intervention for both bilateral training group (BG) and unilateral training group (UG). * = significantly different (p < 0.05) to pre test value.*

DISCUSSION

The current work evaluated the effect of two weekly EOT sessions of bilateral or unilateral squat during 6 weeks on different tests (Jump ability, COD and power in OE exercises). The main finding was that T-test obtained a significant improvement, especially in the BG. However, an important trend was observed in the UG in the triple hop test, supported by ES values. In addition, power output data in the half-squat exercise showed an important change in both groups, and primarily in BG.

Vertical jump ability measured by CMJ did not show statistical increases, but the magnitude of changes was similar to previous works. Therefore, the BG and the UG obtained increases of 5% and 7%, respectively. These values are similar to studies in which EOT was employed. For example, Gual et al (2016) showed gains of 3.22% after a season with a one-week EOT session in basketball and volleyball players. In soccer players, several studies (Tous Fajardo et al, 2016; De Hoyo et al, 2015; Raya-González et al, 2018) obtained increases between 4.4% and 7.6% for CMJ, similar values to our study. In addition, Sabido et al (2017), showed changes of 6% in team handball players after an OET implementation, values which are also similar to ours. Therefore, EOT may be a good option to improve vertical jump with two legs.

Values obtained in our study about one leg CMJ were slightly greater for the BG (12% and 12.5% for dominant and non-dominant leg respectively) than for the UG (9.15% and 9% for dominant and non-dominant leg respectively). Gonzalo-Skok et al (2017) found results similar to ours in a previous study with team sport players. They found greater increases for bilateral training (between 7.8% and 10.9%) than unilateral (between 5.4% and 5.7%). These authors measured CMJ in right and left leg, but there is no information about dominant or non-dominant leg. One must point out that Gonzalo-Skok et al employed versa pulley for their study with a lower inertial load than the present study. Greater values obtained by the BG may be due to the greater power values shown by this group compared with the UG. Participants from the UG had to do an important effort to execute the one-leg squat with a good balance and for this reason their values were lower compared with the BG.

Results of the triple hop test showed a greater improvement for the UG (7.18% and 7.4% for dominant and non-dominant leg respectively) than BG (2.4% and 3.3% for dominant and non-dominant leg respectively). Calculation of ES support these results with moderate changes for the UG and trivial in the BG. Sabido et al (2017) found similar improvements when bilateral exercises with overload eccentric devices were added during a 8 week handball team periodization. In addition, Gonzalo-Skok et al (2017) also observed an important gain in horizontal jump ability after a treatment with horizontal displacements versus a training based in vertical movements. In this way, one leg squat EOT seems a better choice to improve horizontal one leg jump ability.

A higher performance in COD actions was observed mainly in the BG (5.9% and 4.8% for each direction) regarding the UG (4.4% and 3.6% for each direction). This difference is especially important when ES is calculated, as the BG obtained important changes for each T-Test direction, while there were moderate changes in the UG. Similar results have been reported by Gonzalo-Skok et al (2017), Tous-Fajardo et al (2016) or Raya-González et al (2018) but with different tests. The BG training could be more similar in the way that the lower limb works during COD actions, and for this reason ES in our study showed an advantage for the BG compared to the UG.

Finally, data from the power test in flywheel showed a greater improvement for the BG. When power is analysed during a bilateral test in flywheel, improvements during concentric (BG=20.39%; UG=14.27%, respectively) and eccentric phases (BG=25.77%; UG=16.73%, respectively) were greater in the BG. However, different results were obtained when the test was performed with one leg: improvements were similar for the dominant leg, but very different for the non-dominant leg. While increases in the BG are similar to previous studies (Gual et al 2016; Raya-González et al, 2018), gains after treatment in the UG are lower for two-leg and non-dominant tests. As was previously noted, the difficulty to maintain balance during one leg training (especially with the non-dominant leg) resulted in a poor power production during training. This lower power produced by the UG during non-dominant leg training can be the reason for the differences observed between groups.

In conclusion, we have showed that EOT is an interesting tool to improve different physical variables important for basketball performance. Therefore, bilateral EOT seems a good choice if the aim is to improve COD tasks, while one leg EOT could be the best option to improve horizontal jump ability. However, more studies are necessary to know the influence of one-leg and two-leg squat in flywheel device to establish the difference between these two situations in depth and to study other important aspects as injury prevention.

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