DETERMINING ASYMMETRY USING SPECIFIC UNILATERAL TESTS IN YOUNG BASKETBALL PLAYERS

UTVRĐIVANJE ASIMETRIJE PRIMJENOM SPECIFIČNIH UNILATERALNIH TESTOVA KOD MLADIH KOŠARKAŠA

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ORIGINAL SCIENTIFIC PAPER

doi: 10.5550/sgia.201601.en. drfck

UDC: 796.323.2.012.1

Received: 05.11.2020.

Approved: 13.11.2020.

Sportlogia 2020, 16 (1), 67-79.

E-ISSN 1986-6119

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ABSTRACT

Defining the differences between the dominant (D) and non-dominant (ND) leg is one of the ways to determine the asymmetry between the extremities and thus the risk of injury. The aim of this research is to determine the differences in specific unilateral tests in young male and female basketball players. The sample consisted of 17 female basketball players (average height 177.96 ± 6.38 cm; average weight 69.53 ± 8.00 kg and age 15.50 ± 0.96 yr.) and 34 male basketball players (average height 194.29 ± 7.52 cm; average weight 83.66 ± 9.66 kg and age 15.40 ± 1.28 yr.) of the cadet and junior national teams. Tests were used to assess the explosive power of the lower extremities: high jump with D and ND leg take-off with arm swing (S_vis_jedn_L; S_vis_jedn_D), basketball two-step with D and ND leg take-off (Dvokorak_L, Dvokorak_D) and Drift protocol consisting of 5 consecutive unilateral jumps in place (Drift_L, Drift_D). The tests S_vis_jedn ($p = 0.02$) and Dvokorak ($p = 0.03$) showed statistically significant differences with an error of $p<0.05$ in the group of male basketball players. Significant differences were found in female basketball players in the test S_vis_jedn ($p = 0.03$). In other tests, there are no significant differences between jumps with D and ND leg take-off. The presented results indicate differences between the extremities and represent the basis for the correction of the training plan and program. The methodology in this paper is simple to implement and analyse and is aimed at imitating situational conditions.

Keywords: ***basketball, unilateral jumps, dominant and non-dominant leg***

INTRODUCTION

Basketball is a sport dominated by different types of jumps and landings. These structures are performed with maximum intensity and exhibit large forces in the joint systems (Kozinc et al., 2020). Therefore, it is necessary to focus on the characteristics of these activities, i.e., defining motor skills and knowledge. Determining the difference between a dominant (D) and a non-dominant (ND) leg is one way of defining asymmetry and the risk of injury. Jumps are a simple activity to assess power of the extremities. Also, these differences can be observed through some landing parameters after horizontal and vertical jumps (Edwards et al., 2012). Basic basketball tests of explosive power, agility and speed are regularly used to determine the level of motor skills (Ostojic, Mazic & Dikic, 2006; Wen et al., 2018). For a better understanding and exploitation of athletes' potential, it is necessary to focus on tests that imitate specific situations in the game with their characteristics and structures. Specific elements can provide better insights into the level of ability and parameters that are implemented in less controlled conditions. In the basketball game, the structures of movement in which the take-off with one leg (unilateral jump) dominates play a significant role. Unilateral jumps are highly associated with the ability to quickly change direction and the development of one ability can affect another and vice versa (Thomas et al., 2018; Maloney at al., 2017; Maloney et al., 2019). Rodriguez-Rosell et al. (2017) found a large association between two-leg jump from place (Abalakov jump) and unilateral jumps with a run-up from one (corr. 0.80-0.96) and two steps (corr. 0.88-0.98). Also, Sugiyama et al. (2014) found significant differences between the D and ND leg in the maximum horizontal jump with a run-up in senior basketball players. By applying specific tests, the movement structure is much more similar to situational conditions and can provide better data on the athletes' abilities and knowledge. Reduced physical abilities and large differences in jump height are indicators of increased risk of injury in young athletes in team sports (Fort-Vanmeerhaeghe et al., 2020). Shiltz et al. (2009) state that basketball players who have previously had one of the knee injuries retain an asymmetry ratio greater than 10% for all measured isokinetic variables and more than 15% of the

difference variables to assess unilateral functionality. These findings indicate the great importance of diagnosing the condition and determining the asymmetry between the extremities in order to timely influence the correction of motor skills and knowledge. By observing several types of unilateral jumps, it is possible to get an exact understanding of the shortcomings in the level of power of the lower extremities. The aim of this study is to determine the differences in specific tests between dominant (D) and non-dominant (ND) leg jumps in young male and female basketball players.

METHODS

Subjects

The sample consisted of 17 female basketball players (average height 177.96 ± 6.38 cm; average weight 69.53 ± 8.00 kg and age 15.50 ± 0.96 yr.) and 34 male basketball players (average height 194.29 ± 7.52 cm; average weight 83.66 ± 9.66 kg and age 15.40 ± 1.28 yr.) of the cadet and junior national teams. All subjects were in good health status at the time of testing. The dominant, that is the take-off, leg of all subjects was the left one.

Procedure

Measurements were conducted in a basketball court during the preparation period of the national teams. Prior to the start of the measurement, the subjects were introduced to the measurement protocol and performed a standardized warm-up consisting of running, track-and-field drills, dynamic stretching, and imitating of the elements performed in the testing. Tests were used in the study to assess the explosive power of the lower extremities: high jump with left and right leg take-off with arm swing (S_vis_jedn_L; S_vis_jedn_D), basketball two-step with left and right leg take-off (Dvokorak_L, Dvokorak_D) and Drift protocol of 5

consecutive unilateral jumps in place (Drift_L, Drift_D). The subjects were instructed to perform the test with maximum intensity in order to achieve the highest possible jump height. The tests were repeated 3 times and the best result was used for further analysis. The jump height in the tests was measured with an optical measuring instrument Optojump, Microgate (Glatthorn et al., 2011). Test description: *S_vis_jedn* - The initial position of the subject when performing unilateral jumps from the steps is outside the measuring space. At the examiner's signal, the subject performs one step from the place and a vertical take-off with a stepping leg inside the measuring space. The other leg serves as a swing. During the jump, a swing of the arms and a two-legged landing are used.; *Two-step* - the subject performs two steps from the place and in the second step he turns horizontally into a vertical movement with the help of the movement of the swinging leg and the swing of the arms; *Drift protocol* - 5 consecutive unilateral jumps are performed using the swing of the arms and swinging leg in order to achieve the maximum height of the jump and maintain an equilibrium position.

Statistical analysis

The measured results were analysed by the statistical program STATISTICA v13.5. Basic descriptive indicators (Min, Max, Mean, St.dev) were determined for all measured variables. A t-test for independent samples was used to determine the differences between the jump height with the D and ND leg take-off. The results were considered statistically significant at $p < 0.05$.

RESULTS

Table 1. *Descriptive indicators of the observed variables in specific jumps*

Variables	G	Mean	Min	Max	SD
S_vis_jedn_L	Male	41.61	31.60	51.50	5.04
	Female	31.09	23.40	39.00	4.33
S_vis_jedn_D	Male	38.63	29.40	51.00	4.89
	Female	28.16	21.50	33.50	3.34
Dvokorak_L	Male	46.56	35.90	59.90	5.70
	Female	35.51	27.70	43.40	4.37
Dvokorak_D	Male	43.39	34.60	57.70	6.11
	Female	33.18	25.40	39.00	4.15
Drift_L	Male	21.69	16.00	30.70	3.43
	Female	16.01	11.60	21.70	2.74
Drift_D	Male	20.93	14.80	27.40	3.29
	Female	15.16	10.40	20.00	2.77

Legend: G - gender; Mean – arithmetic mean; SD - standard deviation; Min - minimum value; Max - maximum value; S_vis_jedn_L - jump from a step with the left leg take-off; S_vis_jedn_D - jump from a step with the right leg take-off; Dvokorak_D - jump with a horizontal run-up of two steps and the right leg take-off; Two-step_L - jump with a horizontal run-up of two steps and the left leg take-off, Drift_L - consecutive jumps in place with the left leg take-off with; Drift_D - consecutive jumps in place with the right leg take-off

Table 1 shows the basic descriptive indicators of unilateral jumps. Average, minimum, and maximum values are higher in the male basketball players. The highest value of the jump was achieved in the test Dvokorak_L (59.90 cm). The lowest result of a unilateral jump was achieved in the Drift_L test (10.40 cm). The average values of the jumps in all tests were higher when the test was performed with the D leg take-off. The results in the two-step tests show the highest values compared to other tests performed. Also, in this test, the largest deviations of the results (5.70 cm) were found. The parameters of male basketball players in all tests deviated

more in relation to the female basketball players. There is a noticeable difference in the average jump height between the male and female group.

Table 2. *T-test for independent samples – MALE BASKETBALL PLAYERS*

Variables	N	t	F-ratio	p	difference
S_vis_jedn_L/D	34	2.47	1.06	0.02*	2.98
Dvokorak_L/D	34	2.21	1.15	0.03*	3.17
Drift_L/D	34	0.93	1.08	0.36	0.76

* marked values are significant with an error $p<0.05$.

Table 2, by using the t-test for independent samples, shows the differences in the jump height with the D and ND leg between the observed tests of the male basketball players. The tests S_vis_jedn ($p = 0.02$) and Dvokorak ($p = 0.03$) showed statistically significant differences with an error of $p<0.05$. In the Drift test, there was no significant difference between the D and ND leg ($p = 0.36$).

Table 3. *T-test for independent samples – FEMALE BASKETBALL PLAYERS*

Variables	N	t	F-ratio	p-value	difference
S_vis_jedn_L/D	17	2.21	1.68	0.03*	2.93
Dvokorak_L/D	17	1.59	1.11	0.12	2.33
Drift_L/D	17	0.90	1.02	0.37	0.85

* marked values are significant with an error $p<0.05$.

Table 3 shows the differences in the unilateral jumps of the female basketball players. Significant differences were obtained in the test S_vis_jedn ($p = 0.03$). In the Dvokorak ($p = 0.12$) and Drift ($p = 0.37$) tests, there were no significant differences between the D and ND jumps.

DISCUSSION

Fast and explosive basketball elements require highly developed and balanced athletes' abilities. Large differences in the power of muscles and muscle groups can negatively affect performance and risk of injury. The observed sample shows the difference in tests for estimating explosive power by using specific unilateral jumps. A statistically significant difference between the D and ND leg was found in male basketball players in the tests S_vis one ($t = 2.47$, $p = 0.02$) and Dvokorak ($t = 2.21$, $p = 0.03$). Pehar et al. (2017) also pointed out the differences in the jump height with the D and ND leg in the two-step test considering the playing position and rank of the competition. Also, in the test S_vis_jedn in the group of female basketball players, significant differences were found ($t = 2.21$, $p = 0.03$). The results of all male basketball players tests show higher values of jumps compared to female basketball players. Although no statistically significant differences were found in the remaining tests, they are present. In the S_vis_jedn version, there is a small horizontal speed, and it is necessary to create a large vertical force from the steps. Therefore, a higher level of power is required to achieve high values. The ratio of the jump height in the S_vis_jedn test (2.98 cm and 2.93 cm) indicates asymmetry and a reduced level of take-off ability with the ND leg. The largest difference was observed in male basketball players in the Dvokorak test (3.17 cm). No significant differences were found in the Drift test ($p = 0.37$ and $p = 0.36$). This test requires athletes to perform consecutive jumps with an emphasis on minimizing mediolateral and anteroposterior movement.

The largest difference (%) in the jump height was measured in the test Skok_vis_jedn (M = 7.2%, F = 9.4%). Larger differences in lower extremities asymmetry in female basketball players were also measured when performing different types of landings (Pappas and Carpes, 2012). The authors (Vaisman et al., 2017) suggest that if the difference between the indicators of muscle strength of the lower extremities is less than 15%, it is considered that there is no significant asymmetry between the D and ND leg. Also, Bishop et al. (2018) indicate that differences greater than 10% between the extremities negatively affect ability and

performance. The results of two-step with the D leg take-off in female basketball players can be compared with the findings of Keerthi Kumar and Sundar Raj (2016) that observed changes in the jump height of senior female basketball players before and after the program. The values of the jump height are almost equal (35.5 cm vs 35.6 cm), which means that it can be concluded that the observed sample of female basketball players achieves results equal to the senior category of female subjects. Comparing the results with the research of Miura et al. (2010), the presented sample of male basketball players has significantly lower height values in the Dvokorak and S_vis_jedn tests.

Long-term training in team sports can develop certain asymmetries between the extremities. Consecutive repetitions of movements with the D leg (unilateral jumps) negatively affect the balance of muscle strength. Unilateral vertical jumps can cause greater asymmetries between the extremities relative to different horizontal jumps (Fort-Vanmeerhaeghe et al., 2015). Lower ND leg values can also be explained through a low level of coordination and a reduced frequency of repetitions of jumps through the training process. By developing the jump technique through a 6-week training program, it is possible to increase explosive properties and vertical jump (7.5% increase) (Attene et al. 2015). According to Stöckel and Weigelt (2012), the gradual inclusion of different coordination tasks and sport-specific drills for the development of the ND side of the body is crucial to begin in as young a category as possible. Proper use of arm and leg swings directly affects the result, and in addition to the emphasis on equalizing the power of the extremities, attention should be paid to the method of performing jumps and landings.

CONCLUSION

Basketball is a sport dominated by different types of jumps. Reducing the risk of injury is one of the main reasons for conducting diagnostics of the athletes' condition and identifying their weaknesses. Differences in the jump height with the D and ND leg indicate the existence of strength inequality between muscle groups. The aim of this paper was to define these asymmetries by using unilateral specific tests. Statistically significant differences in the S_vis_jedn and Dvokorak tests were found in male basketball players. Also, the results of the female basketball players differed significantly in the S_vis_jedn test. In all tests, a difference was obtained between jumps with the right and the left leg take-off. The presented results indicate the presence of asymmetry and represent the basis for the correction of the training plan and program. This paper presents a simple methodology for determining asymmetry in abilities by applying tests that mimic situational conditions. The conducted research is focused exclusively on differences in jump height. By observing several jump parameters (contact time, ground reaction force, joint angles), the differences and potential risks in performing the jumps would be more precisely determined. Further research should focus on defining asymmetries between different categories of athletes in order to start with the correction of technique and equalization of abilities as soon as possible.

REFERENCES

1. Attene, G., Iuliano, E., Di Cagno, A., Calcagno, G., Moalla, W., Aquino, G., & Padulo, J. (2015). Improving neuromuscular performance in young basketball players: plyometric vs. technique training. The Journal of sports medicine and physical fitness, 55(1-2), 1-8.

2. Bishop, C., Read, P., McCubbine, J., & Turner, A. (2018). Vertical and Horizontal Asymmetries are Related to Slower Sprinting and Jump Performance in Elite Youth Female Soccer Players. Journal of strength and conditioning research, Advance online publication.
https://doi.org/10.1519/JSC.0000000000002544
PMid:29489719

3. Edwards, S., Steele, J. R., Cook, J. L., Purdam, C. R., & McGhee, D. E. (2012). Lower limb movement symmetry cannot be assumed when investigating the stop-jump landing. Medicine and science in sports and exercise, 44(6), 1123-1130.
https://doi.org/10.1249/MSS.0b013e31824299c3
PMid:22595986

4. Fort-Vanmeerhaeghe, A., Montalvo, A. M., Sitjà-Rabert, M., Kiefer, A. W., & Myer, G. D. (2015). Neuromuscular asymmetries in the lower limbs of elite female youth basketball players and the application of the skillful limb model of comparison. Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine, 16(4), 317-323.
https://doi.org/10.1016/j.ptsp.2015.01.003
PMid:26093377

5. Fort-Vanmeerhaeghe, A., Milà-Villarroel, R., Pujol-Marzo, M., Arboix-Alió, J., & Bishop, C. (2020). Higher Vertical Jumping Asymmetries and Lower Physical Performance are Indicators of Increased Injury Incidence in Youth Team-Sport Athletes. Journal of strength and conditioning research. Advance online publication.
https://doi.org/10.1519/JSC.0000000000003828

6. Glatthorn, J. F., Gouge, S., Nussbaumer, S., Stauffacher, S., Impellizeri, F. M., Maffiuletti, N. A. (2011). Validity and reliability of optojump photoelectric cells for estimating vertical jump height. Journal of Strength Conditioning Research, 25 (2), 556-560.
https://doi.org/10.1519/JSC.0b013e3181ccb18d
PMid:20647944

7. Keerthi Kumar, M., Sundar Raj, U. R. S. (2016). Effect of plyometric and weight training programs on vertical jump in female basketball players. International Journal of Physical Education, Sports and Health; 3(3): 25-27.

8. Kozinc, Ž., Marković, G., Hadžić, V., & Šarabon, N. (2020). Relationship between force-velocity-power profiles and inter-limb asymmetries obtained during unilateral vertical jumping and singe-joint isokinetic tasks. Journal of sports sciences, 1-11. Advance online publication.
https://doi.org/10.1080/02640414.2020.1816271
PMid:32896221

9. Maloney, S. J., Richards, J., Nixon, D. G., Harvey, L. J., & Fletcher, I. M. (2017). Do stiffness and asymmetries predict change of direction performance?. Journal of sports sciences, 35(6), 547-556.

10. Maloney, S. J., Richards, J., Jelly, L., & Fletcher, I. M. (2019). Unilateral Stiffness Interventions Augment Vertical Stiffness and Change of Direction Speed. Journal of strength and conditioning research, 33(2), 372-379.
https://doi.org/10.1519/JSC.0000000000002006
PMid:30689617

11. Miura, K., Yamamoto, M., Tamaki, H., & Zushi, K. (2010). Determinants of the abilities to jump higher and shorten the contact time in a running 1-legged vertical jump in basketball. Journal of strength and conditioning research, 24(1), 201-206.
https://doi.org/10.1519/JSC.0b013e3181bd4c3e
PMid:19996782

12. Ostojic, S. M., Mazic, S., & Dikic, N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. Journal of strength and conditioning research, 20(4), 740-744.
https://doi.org/10.1519/R-15944.1
https://doi.org/10.1519/00124278-200611000-00003
PMid:17149984

13. Pappas, E., & Carpes, F. P. (2012). Lower extremity kinematic asymmetry in male and female athletes performing jump-landing tasks. Journal of science and medicine in sport, 15(1), 87-92.
https://doi.org/10.1016/j.jsams.2011.07.008
PMid:21925949

14. Pehar, M., Sekulic, D., Sisic, N., Spasic, M., Uljevic, O., Krolo, A., Milanovic, Z., & Sattler, T. (2017). Evaluation of different jumping tests in defining position-specific and performance-level differences in high level basketball players. Biology of sport, 34(3), 263-272.
https://doi.org/10.5114/biolsport.2017.67122
PMid:29158620 PMCid:PMC5676323

15. Rodríguez-Rosell, D., Mora-Custodio, R., Franco-Márquez, F., Yáñez-García, J. M., & González-Badillo, J. J. (2017). Traditional vs. Sport-Specific Vertical Jump Tests: Reliability, Validity, and Relationship With the Legs Strength and Sprint Performance in Adult and Teen Soccer and Basketball Players. Journal of strength and conditioning research, 31(1), 196-206.
https://doi.org/10.1519/JSC.0000000000001476
PMid:27172267

16. Schiltz, M., Lehance, C., Maquet, D., Bury, T., Crielaard, J. M., & Croisier, J. L. (2009). Explosive strength imbalances in professional basketball players. Journal of athletic training, 44(1), 39-47.
https://doi.org/10.4085/1062-6050-44.1.39
PMid:19180217 PMCid:PMC2629038

17. Stöckel, T., & Weigelt, M. (2012). Brain lateralisation and motor learning: Selective effects of dominant and non-dominant hand practice on the early acquisition of throwing skills. Laterality: Asymmetries of Body, Brain and Cognition, 17(1), 18-37.
https://doi.org/10.1080/1357650X.2010.524222
PMid:21500083

18. Sugiyama, T., Kameda, M., Kageyama, M., Kiba, K., Kanehisa, H., & Maeda, A. (2014). Asymmetry between the Dominant and Non-Dominant Legs in the Kinematics of the Lower Extremities during a Running Single Leg Jump in Collegiate Basketball Players. Journal of sports science & medicine, 13(4), 951-957.

19. Thomas, C., Dos'Santos, T., Comfort, P., & Jones, P. A. (2018). Relationships between Unilateral Muscle Strength Qualities and Change of Direction in Adolescent Team-Sport Athletes. Sports (Basel, Switzerland), 6(3), 83.
https://doi.org/10.3390/sports6030083
PMid:30127300 PMCid:PMC6162690

20. Vaisman, A., Guiloff, R., Rojas, J., Delgado, I., Figueroa, D., & Calvo, R. (2017). Lower Limb Symmetry: Comparison of Muscular Power Between Dominant and Nondominant Legs in Healthy Young Adults Associated With Single-Leg-Dominant Sports. Orthopaedic journal of sports medicine, 5(12).
https://doi.org/10.1177/2325967117744240
PMid:29318166 PMCid:PMC5753919

21. Wen, N., Dalbo, V. J., Burgos, B., Pyne, D. B., & Scanlan, A. T. (2018). Power Testing in Basketball: Current Practice and Future Recommendations. Journal of strength and conditioning research, 32(9), 2677-2691.
https://doi.org/10.1519/JSC.0000000000002459
PMid:29401204

DETERMINING ASYMMETRY USING SPECIFIC UNILATERAL TESTS IN YOUNG BASKETBALL PLAYERS

SAŽETAK

Definiranje razlika između dominantne (D) i nedominantne noge (ND) jedan je od načina utvrđivanja asimetrije između ekstremiteta a samim time i rizika od ozljeđivanja. Cilj ovog istraživanja usmjeren je na utvrđivanje razlika u specifičnim unilateralnim testovima kod mladih košarkaša i košarkašica. Uzorak ispitanika činilo je 17 košarkašica (prosječne visine 177,96 ± 6,38 cm; prosječne mase 69,53 ± 8,00 kg i dobi 15,50 ± 0,96 god) i 34 košarkaša (prosječne visine 194,29 ± 7,52 cm; prosječne mase 83,66 ± 9,66 kg i dobi 15,40 ± 1,28 god) kadetske i juniorske reprezentativne selekcije. Korišteni su testovi za procjenu eksplozivne snage donjih ekstremiteta: skok u vis iz koraka odrazom D i ND nogom sa zamahom ruku (S_vis_jedn_L; S_vis_jedn_D), košarkaški dvokorak odrazom D i ND nogom (Dvokorak_L, Dvokorak_D) i Drift protokol koji se sastoji od 5 uzastopnih jednonožnih skokova u mjestu (Drift_L, Drift_D). U testovima S_vis_jedn (p=0,02) i Dvokorak (p=0,03) prikazane su statistički značajne razlike uz pogrešku p<0,05 kod košarkaša. Kod košarkašica su utvrđene značajne razlike u testu S_vis_jedn (p=0,03). U ostalim testovima nema značajnih razlika između skokova odrazom D i ND nogom. Prikazani rezultati ukazuju na razlike između ekstremiteta te predstavljaju bazu za korekciju plana i programa treninga. Metodologija u ovom radu je jednostavna za provedbu i analizu te je usmjerena na imitaciju situacijskih uvjeta.

Ključne riječi: *košarka, jednonožni skokovi, dominantna i nedominantna noga*

Received: 05.11.2020.
Approved: 13.11.2020.

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