IZOMETRIC MUSCLE POTENTIOAL IN YOUNG BASKETBALL ATHLETES

UDC: 796-323.2.012.11
(Original scientific paper)

Aleksandar Ignjatović[1], Ratko Stanković[2] and Živorad Marković[1]

[1]University of Kragujevac, Faculty of Pedagogy, Jagodina, Serbia
[2]University of Niš, Faculty of Sports and Physical Education, Niš, Serbia

Abstratct:

Isometric test are generally performed to quantify the maximal force (or torque) and/or the maximal rate of force development (RFD). The RFD presents the rate of rise in contractile force at the onset of contraction within the early phase of rising muscle force, and it has been one of the most often applied test for explosive force production. Subjects of this study were 48 young male basketball players. The testing of isometric muscle force provided the values of maximum voluntary force (Fmax), and other indices of explosive force production by muscle being tested (T25-75, Force gradient). Subjects were tested in the isometric machine in two different positions. The results of the isometric tests test have presented findings that demonstrate different relationship to dynamic testing. The largest correlation was between the Fmax in isometric testing and the 1 RM in our study was r=0.705.

Key words: *isometric force, correlation, explosive power, dynamometry*

INTRODUCTION

Isometric strength is the maximum force that a muscle group can exert without movement. Tests of isometric strength are easy to perform as they require only a single maximal contraction. Isometric tests are very popular tests for of muscle function and have been among the most widely used methods of strength assessment over the last 50 years. There are several reasons:

They are easily standardized and hence reproducible. Indeed, a number of studies have reported high levels of reliability with the use of isometric procedures (Bemben, Massey, Boileau, & Misner, 1992; Hortobagyi & Lambert 1992)

They are simple tests that require very little technique or skill and hence can be used with untrained and trained subjects.

They are straightforward to administer and safe for subject to perform.

They use relatively inexpensive equipment.

Isometric test are generally performed to quantify the maximal force (or torque) and/or the maximal rate of force development (RFD). The RFD presents the rate of rise in contractile force at the onset of contraction within the early phase of rising muscle force (Hakkinen & Komi, 1986), and it has been one of the most often applied test for Explosive Force Production (Mirkov, Nedeljković, Milanović, & Jarić, 2004). In isolated muscle preparations, contractile RFD is obtained from the slope of the force time curve (force/time), whereas, for intact joint actions, RFD is calculated as the slope of the joint moment-time curve (moment/time). The maximal RFD is typically quantified as the greatest slope of the force time curve over some time interval (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002). Other methods include determining the time to reach a certain level of absolute force, or the time to achieve relative force level such as 30% (Hakkinen, Alen, & Komi, 1985). Another important strength parameter is the total contractile impulse that can be produced within a given contraction time (Baker, Wilson, & Carlyon, 1994).

Alternatively the time interval between two relative force levels (Gorostiaga, Izquierdo, Iturralde, Ruesta, & Ibanez, 1999; Mirkov, Nedeljković, Milanović, & Jarić, 2004).

The main aims of the study were to examine the relationship between the muscle strength tests of muscles involved in bench and leg press action in isometric conditions. Also we tried to determined relationship between the different explosive force production tests in young athletes.

METHODS

The study participants (N= 48) were young basketball players (15.8±0.8 yrs) without previous experience in organized resistance training. Participants were enrolled only if they were involved in a basketball training process for more than 3 years. Before pre-testing, the participants, their coaches and parents were provided with both a complete written and oral explanation of the study, and each of them signed an informed consent. Subjects were also asked to complete themselves their medical history and physical activity readiness questionnaires to ensure that all the subjects were free of cardiovascular, musculoskeletal, or metabolic diseases that could preclude them from participating in the study.

The testing procedure took part in the laboratory of biomechanics and sport diagnostics in Faculty of Sport and Physical Education in Nis. Measurement of maximal muscle strength and RFD was carried out under isometric conditions on specially designed isometric equipment in laboratory of biomechanics.

Subjects were tested in the specially designed press machine while the bar with dynamometer was placed in to two different positions. In the first position the bar was fixed in 30-50 cm distance from the chest depending on the position where the elbow joint angle was 135º (180 full extensions) and in the second position the bar was fixed in 40-60 cm distance from the hips depending on the position where the knee joint angle was 135º (180 full extensions).

The testing was carried out by the software system ` Digidy` Co TCR, Novi Sad, Serbia. The signal was recorded and stored on the computer disk. The curve provided the maximum voluntary force (F_{max}), and other indices of explosive force production by muscle being tested (Graph 1). The F_{max} was assessed as the highest force level recorded during each contraction. The index of explosive force development included the time interval elapsed between the achieving the 25% and 75% of F_{max}. (T_{25-75}). For estimation of RFD we used the ratio $F_{0,5max}/T_{0,5max}$, where $T_{0,5max}$ is the time to achieve half of the maximum force and its usually called force gradient or s – gradient (Zatsiorsky & Kraemer, 2006).

RESULTS

Table 3. Shows the correlation coefficients among different muscle strength test obtained in both position. All three tests on specially designed isometric equipment shows different aspects of force production and don't correlate significantly one with another, while the F_{max} correlate significantly with the 1RM bench press test (.705 at the 0.01 level).

DISCUSSION AND CONCLUSION

Even thou it is much easier and safer to measure isometric strength then dynamic strength, and the correlation between the isometric and isotonic test in some studies were very high (Laughlin, 1998), the majority of studies that have directly compared isometric tests and dynamic test performance have presented findings that demonstrate poor relationship to dynamic performance and dynamic testing.

The result of our study confirmed the results of the previous mentioned studies that failed to demonstrate high correlation between the different explosive force production tests in isometric conditions and the dynamic test. Only the correlation between the F_{max} in isometric testing and the 1 RM in our study in bench press position was r=0.705.

In the study (Murphy, Wilson, & Pryor, 1994) on trained athletes, isometric and isoinertial strength testing in a bench press were compared

Graph 1. *Force – time curve and explosive force production parameters*

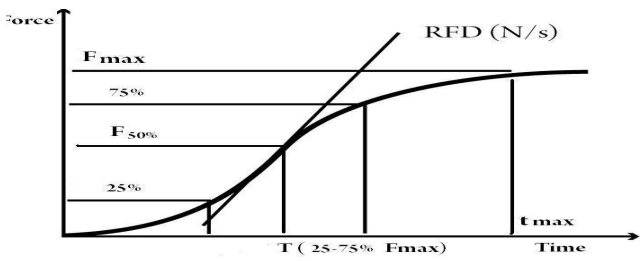

Table 1. Descriptive statistics for the first position (bench press)

Bench press	N	Minimum	Maximum	Mean		Std. Deviation
Variable	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Fmax (Newton)	48	44,52	102,20	72,6157	1,89031	13,23217
Time 25-75 (sec)	48	,02	,25	,0705	,00549	,03840
Force gradient (N/s)	48	240,16	1209,41	602,1562	33,42238	231,55705
1RM (kg)	48	42,00	93,00	60,2491	1,69946	11,89625

Table 2. Descriptive statistics for the second position (leg press)

Leg press	N	Minimum	Maximum	Mean		Std. Deviation
Variable	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Fmax (Newton)	48	88,78	299,63	157,6802	8,73428	60,51283
Time 25-75 (sec)	48	,03	,37	,1124	,01179	,08170
Force gradient (N/s)	48	221,97	2755,09	1113,4488	91,59238	634,57062
1RM (kg)	48	54,00	150,00	102,3061	3,13123	21,91860

Table 3. Correlation coefficients among different muscle strength test obtained in both position.

Correlation		Fmax	Time 25-75	Force gradient	1RM
Fmax	Pearson Correlation	1			
	Sig. (2-tailed)				
Time 25-75	Pearson Correlation	,237	1		
	Sig. (2-tailed)	,101			
Force gradient	Pearson Correlation	,122	-,451**	1	
	Sig. (2-tailed)	,411	,001		
1RM	Pearson Correlation	,705**	,055	,138	1
	Sig. (2-tailed)	,000	,706	,349	
**. Correlation is significant at the 0.01 level (2 -tailed).					

against a variety of dynamic upper body performances and a maximal bench press lift. They found correlation between the F_{max} and RFD in a bench press and the 1RM bench press was r=0.47-0.78. In similar study (Pryor, Wilson, & Murphy, 1994) on strength trained males RFD was compared with the same performance test. The correlation was r=0.42.

Many studies have examined the relationship between the isometric muscle strength of lower body and the vertical jump performance, and most

of them have found small or moderate correlation. The study (Jaric, Ristanovic, & Coroc, 1989) that compared F_{max} and RFD in a variety of lower body action and vertical jump performance on active male physical education students found correlation for F_{max} r=0.22-0.42, and for RFD R= 0.35-0.46. Similar studies (Viitasalo, Hakkinen, & Komi, 1981; Hakkinen, Komi, & Kauhanen, 1986) that examined the relationship between RFD in a leg pres and vertical jump performance found correlation around 0.5.

The insignificant correlation between F_{max} and the T_{25-75} and Force gradient in bout positions could explain with general consideration that these tests reflect two independent functional abilities of the tested muscles, and different relationship with various functional movements (Paasuke, Ereline, Gapeyeva, Sirkel, & Sander, 2000; Wilson & Murphy 1996).

Therefore, it would appear that for quality and valid athletic assessment of muscular function more different muscle tests should be used (in static and in dynamic conditions), because they can provide more valid assessment of the functional capacity of the musculature then just some values of isometric tests.

REFERENCES

Aagaard, P., Simonsen, E., Andersen, J., Magnusson, P., & Dyhre-Poulsen, P. (2002). Increased rate of force development and neural drive of human skeletal muscle following resistance training. *Journal of Applied Physiology,* 93, 1318-1326.

Baker, D., Wilson, G., & Carlyon, B. (1994). Generality versus specificity: a comparison of dynamic and isometric measures of strength and speed-strength. *European Journal of Applied Physiology*, 68, 350–355.

Bemben, M. G., Massey, B. H., Boileau, R. A., & Misner, J. A. (1992). Reliability of isometric force-time curve parameters for men aged 20 to 79 years. *Journal of applied Sport Science Research, 6*(3), 158-164.

Gorostiaga, E., Izquierdo, M., Iturralde, P., Ruesta, M., & Ibáñez, J. (1999). Effects of heavy resistance training on maximal and explosive force production, endurance and serum hormones in adolescent handball players. *European Journal of Applied Physiology and Occupational Physiology*, *80*(5), 485-493.

Hakkinen, K., & Komi, P. V. (1986). Training induced changes in neuromuscular performance under voluntary and reflex conditions. *European Journal of Applied Physiology*, 55, 147–155.

Hakkinen, K., Alen, M., & Komi, P. V. (1985). Changes in isometric force and relaxation time, EMG and muscle fibre characteristics of human skeletal muscle during training and detraining. *Acta Physiologica Scandinavica*, 125, 573–585.

Hakkinen, K., Komi, P.V., & Kauhanen, H. (1986). Electromiographic and force production characteristics of leg extensor muscles of elite weigthlifters during isometric, concentric and various strech-shortening cycle exercises. *International Journal of Sports Medicine*, 7, 144-151.

Hortobagyi, T. & Lambert, N. J. (1992). Influence of electrical stimulation on dynamic forces of the arm flexors in strength-trained and untrained man. *Scandinavian Journal of Medicine and Science in Sport*, 2, 70-75.

Jaric, S., Ristanovic, D., & Coroc, D. M. (1989). The relationship between muscle kinematic parameters and kinematic variables in a complex movement. *European Journal of Applied Physiology,* 59, 370-376.

Laughlin, M. S. (1998). *The Relationship between Isometric and Isotonic Closed Kinetic Chain Leg Strength*. Unpublished M. S., Houston: University of Houston.

Mirkov, D., Nedeljković, A., Milanović, S.D. & Jarić, S.M. (2004). Muscle strength testing: Evaluation of tests of explosive force production. *European Journal of Applied Physiology, 91* (1-2), 147-154.

Murphy, A. J. Wilson, G. J., & Pryor, J. F. (1994). The use of the isoinertial force mass relationship in the prediction of dynamic human performance. *European Journal of applied Physiology, 69* (3), 250-257.

Paasuke, M., Ereline, J., Gapeyeva, H., Sirkel, S., & Sander, P. (2000). Age-related differences in twitch contractile properties of plantarflexor muscles in women, *Acta Physiologica Scandinavica*, *170* (1), 51-57.

Pryor, J., Wilson, G. J., & Murphy, A. J. (1994). The effectiveness of eccentric, concentric and isometric rate of force development tests,

Journal of Human Movement Studies, 27, 153-172.

Viitasalo, J. T., Hakkinen, K., & Komi, P. V. (1981). Isometric and dynamic force production and muscle fibre composition in man . *Journal of Human Movement Studies*, 7, 199–209.

Wilson, G., & Murphy, A. (1996). The use of isometric tests of muscular function in athletic assessment. *Sports Medicine*, *22* (1), 19-37.

Zatsiorsky, V. & Kreamer, W. (2006). *Science and practice of strength training*. Champaign, IL:Human Kinetics.

ИЗОМЕТРИСКИОТ МУСКУЛЕН ПОТЕНЦИЈАЛ КАЈ МЛАДИТЕ КОШАРКАРИ

УДК: 796-323.2.012.11
(Оригинален научен труд)

Александар Игњатовиќ[1] Ратко Станковиќ[2] и Живорад Марковиќ[1]

[1]Универзитет во Крагуевац, Педагошки факултет, Јагодина, Србија
[2]Универзитет во Ниш, Факултет за спорт и физичко воспитување, Ниш, Србија

Апстракт:
Со изометриските тестови обично се испитуваа максималната сила (или обртниот момент) и /или максималниот степен на развојот на снагата (РФД). РФД претставува степен на растот во почетната фаза на растот на мускулната сила. Тој е еден од начесто применуваните тестови за проценување на експлозивната снага. Примерокот на испитаниците го сочинуваа 48 млади кошаркари. Испитувана е поврзаноста на изометриската сила, односно вредностите на максималната сила (Фмац), и други параметри на на експлозивната снага на мускулите (Т25-75, снага на градиентот). Испитаниците се тестирани во две изометриски машини во две различни позиции.Сите испитаници се тестирани во класична акција на потиснување од градите и потиснување со нозете. Најголема корелација е утврдена меѓу показателите Фмац и 1 РМ (p=0,705).

Клучни зборови: *изометриска сила, корелација, тестирање, експлозивна снага, динамометрија*