Research Paper

Volume : 2 | Issue : 8 | August 2013 • ISSN No 2277 - 8179

Electromyographic Activity of Lower Limbs Muscle During Vertical Jump and Concentric Contruction Test in three Angle Isokinetic Dynamometer

Physical Education

KEYWORDS : Maximal force, Isokinetic, Concentric contraction, Squat jump (SJ), electromyographic activity

Xanthopoulos Nikolaos	Sport Biomechanics Laboratory Department of Physical Education and Sport Sciences Serres AUTH, GREECE Serres, P.C. 62110 Serres, Greece
Gissis Ioannis	Sport Biomechanics Laboratory Department of Physical Education and Sport Sciences Serres AUTH, GREECE Serres, P.C. 62110 Serres, Greece
Komsis Stergios	Sport Biomechanics Laboratory Department of Physical Education and Sport Sciences Serres AUTH, GREECE Aigaiou str 08, Evosmos Thessaloniki Greece
Papadopoulos Christos	Sport Biomechanics Laboratory Department of Physical Education and Sport Sciences Serres AUTH, GREECE Serres, P.C. 62110 Serres, Greece
Komsis Georgios	Sport Biomechanics Laboratory Department of Physical Education and Sport Sciences Serres AUTH, GREECE Serres, P.C. 62110 Serres
Bekris Evaggelos	National and Kapodistrian University of Athens Athletics Department, GREECE

ABSTRACT

*Several researchers studied the reliability and validity of measurements in isokinetic dynamometers of self-made constructions The purpose of this study was to evaluate the relationship of myoelectrical properties of lower limbs muscles between vertical squat jump (SJ) and the concentric isokinetic test ISC (Isokinetic Shortening Cycle) in three angle isokinetic dynamometer,. The sample was 18 students of Department of Physical Education & Sport Sciences (TEFAA, Serres), (age M=19,78years, sd=1,63, height M=178,06cm, sd=5,99 and weight M=74,42Kg, sd=8,54) without problems of wounds. The research took place in the Laboratory of Sport Biomechanics of TEFAA Serres of AUTH. For the methodology of measurement was used: Surface electrodes (motion Control co.) with preamplifier (myoelectrical activity was recorded from the rectus femoris, biceps femoris and gastrocnemius, with sampling frequency 1000Hz). For the evaluation of emg data used the APAS system (Ariel Performance Analysis System).The average pre-activation and activation of BF (SJ) showed a statistically significant correlation with the index of RFD of ISSC (r = 0,694, p = 0,001 ** and r = 0,530, p = 0,024 * respectively) and average GAS phase support (SJ) showed a statistically significant relationship with time the maximal curvature of ISSC (r = 0,550, p = 0,018 *).In order the results of correlation the test of ISSC could be considered as an appreciable test for the measurement of dynamic and power variables. Another one important application could appear to present in the process of training.*

INTRODUCTION

Isokinetic contractions can be performed with standard machines of various companies or isokinetic dynamometers of self made-constructions. Several researchers considered the reliability of these devices through various parts of the body, such as i.e. upper & lower limbs, trunk, or several individual muscles and joints (Caiozzo et al. 1981; Martin et al. 1993; Lands et al. 1994; Wilson et al. 1997; Dowson et al. 1998; Blazevich and Jenkins 1998; Walshe et al. 1998; Kubo et al. 1999; Li et al. 1999 ; Paasuke et al. 2001; Gissis, 2003)

Vertical jump ability is an important and specialized type of training in many disciplines. Many researchers have tackled the plyometrics (Drop Jumps) and their research results offered a lot to the development of the coaching process (Bosco and Komi 1979). It has been shown the relationship of vertical jump capacity with high explosive ability. Jumps are compound movements, where achieved high reaction forces in conditions of high coordination of movement. The power is developed based on energy storage mechanism in elastic items, during the eccentric contraction and release during concetric (Bosco and Pittera, 1982; Clutch et al. 1983).

According to Müller (1985) from the curve of normalized EMG (EMG) collected the following values for the description of the behavior of neuromuscular activation, as size of activation: height of the normalized signal (Hmax), as the size of the speed actuating means maximum slope (uphill) showing the curve of the EMG signal correlate it with the maximum EMG. The comparison however EMG parameters require their normalization. The process of relativization achieved through mathematical algorithms. For correlation with time we use the parameter, Average EMG), (Aremg). ARemg=1/(t2-t1) t2∫t1/e(t)•dt).

Literature suggests a precise set of performance testers' vertical jump, which is the indicator of the jumping ability (Garcia-lopez et al., 2005). This test package consists of the vertical jump from a standing position without swinging arms and the knees flexed 90° [Squat Jump (SJ)], the vertical jump with counter movement without swinging arms and upright [Counter Movement Jump (CMJ)] and the vertical jump performed after the body drop from a specific height [Drop Jump (DJ)], (Bosco et al., 1982; Liu et al., 2009; Pereira et al., 2009; Korff et al., 2009; Lazaridis et al., 2010). A stretch-shortening cycle (SSC) can be defined as an active stretch (eccentric contraction) of a muscle followed by a direct shortening (concentric contraction) of that same muscle. In human skeletal muscle SSC gives unique possibilities to study normal and fatigued muscle function and it's found in most sports. Although explosive power has been widely studied in lower body activities such as vertical jumps (Bosco et al., 1982; Tsatalas et al., 2010).

The purpose of this study was to evaluate the relationship of myoelectrical properties of lower limbs muscle between vertical squat jump (SJ) and the concentric isokinetic test (Isokinetic Shortening Cycle) in three angle isokinetic dynamometer, where involved the total of kinematic chain of lower extremities (H-K-A), to check the possibility of using deliberate training loads.

METHODS

Participants

The sample consisted of 18 students of physical education and sport sciences department of Serres, from different years of study, with no history of neurological injuries or diseases, gave written consent to participate in this study. Approval for the project was obtained from the committee on human research at the Aristotle University of Thessaloniki. All procedures used in this study were in conformity with the Declaration of Helsinki.

n=18	Age	Height	Weight
	(M±sd)	(M±sd)	(M±sd)
	19,78±1,63	178±6	74,4±8,5

Table 1:. Characteristics of the sample

Isokinetic machine of lower limbs
For the realization of the Isokinetic – SSC (ISSC), the concentric contraction, used an isokinetic construction, which is located in the Sports biomechanics Lab. Its function is based on the hydraulic pressure. It uses an electric motor 15PS, an oil tank 200lit and a piston which is linked to the platform. The force plate fixated on this platform via two sliders, i.e. pressure regulator, which refers to the range of resistance that will reach and supply regulator, which regulates the speed of the platform (the piston speed) are the basic functions of ISSC. The complete hydraulic system is shown in figure 1.

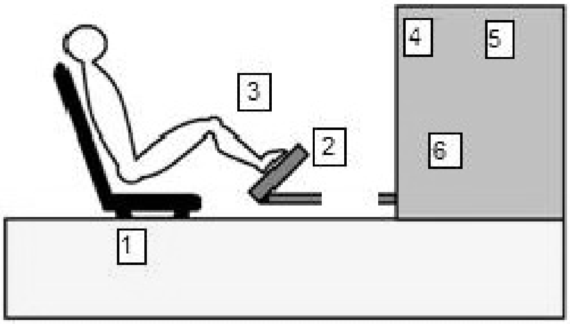

Fig 1 : Multyjoint Isokinetic Dynamometer 1.Seat, 2. Bolt 3. Force plate, 4. Velocity control, 5. Resistance control, 6. Electric engine

EMG Analysis
To capture the difference in electric potential of muscle of the lower limbs was used electromyograph APAS (motion control co.), through three active surface electrodes with preamplifier. The assets of each electrode was connected directly to the A / D converter card analog to digital (Kistler Analog / Digital input - 16 A / D Channels), which was common to the force plate and electromyograph. Then the digitized myoelectrical signal stored in the computer evaluation system (APAS). The average value of electromyographic activity was calculated as follows:: **ARemg=1/(t2-t1) t2∫t1/e(t)•dt) The average electromyogram (ARemg) is the quotient of the integral for the integration time and under Basmajian & de Luca (1985), is a valid parameter for assessing the myoelectric activity.**

Myoelectrical characteristics
From the data analysis evaluated the average muscle preactivation (MIMG-PRE) before supporting phase, or the measurement process ISSC, and the average muscle activation (MIMG-FS) during the support phase or measurement procedure ISSC to three (3) individual muscles, the rectus femoris (RF), the biceps femoris (long head), (BF) and gastrocnemius (medial head), (GAS). These muscles were selected because it has been found to be largely responsible for the performance of the vertical jump and thus pushing the foot (Bobbert et al.1988 ; Van Soest et al.1993).

Test protocol
Participants performed the following tests (Papadopoulos 2005) in forceplate (9281CA Kistler) with the use of EMG (motion control co.): a) maximum vertical jumping (SJ) and b) three attempts in ISSC (speed of the platform: 0.74 m/sec). The duration of the concentric contraction is shown in table 2.

Concentric phase	Velocity	time
ISC	0,74 m/sec	189 msec
SJ	2,21 m/sec	289 msec

Table 2: Linear velocity and duration of concentric contraction in SJ and ISSC

Procedure
During the vertical jump (SJ) hands of the participants was motionless. This position of the hands was chosen in order to avoid the involvement of arms during jump (Bobbert & Van Ingen Schenau 1988; Van Soest et al., 1985) and to exclude the possibility of transferring momentum from swinging of the arms. During the course of conducting measurements each participant wore athletic pants (shorts) and track sneakers. To have a heightened neuromuscular preparation as well as a minimizing of the probability of injury, was warming up (10 min) and stretching exercises of the lower limbs (5 min). The tests executed in the following order: d) Maximum (3) vertical jumps (SJ), and b) Maximum (3) efforts in IKB.

3.8 Variables

Variable	Muscle	Phase	
Rfpre(Aremg)	Rectus Femoris	Preactiv	μV
BFpre(Aremg)	Biceps Femoris		μV
GASpre(Aremg)	Gastroknemius		μV
RFact(Aremg)	Rectus Femoris	Activ	μV
BFact(Aremg)	Biceps Femoris		μV
GASact(Aremg)	Gastroknemius		μV

Table 3: EMG variables

Statistical analysis
The statistical analysis of the data was divided into two sections. To investigate the quantitative characteristics of the tests used the method of descriptive statistics, which calculated the average, standard deviation and standard error of average and follows the method of inductive statistical for calculating correlations between variables of individual tests. The correlations were made by using the Pearson correlation coefficient (r). The correlations between the variables were calculated at significance level $p \leq 0.05$.

RESULTS
The results showed statistically important correlations between the ISSC and the vertical squat jump (DJ) in EMG characteristics of the two movements ($p \leq .05$).

EMG characteristics

	(ISSC) RFD
(SJ) BF pre-activation	r=0.694
	p=0.001**
(SJ) BF activation	r-0.530
	p=0.024*

Table 4: The average pre-activation and activation of BF (SJ) showed a statistically significant correlation with the index of RFD of ISSC (r = 0,694, p = 0,001 and r = 0,530, p = 0,024 * respectively)**

	(ISSC) Fmax
(SJ) GAS touch time	r=0.550
	p=0.018*

Table 5: The average activation GAS touch time (SJ) showed a statistically significant relationship with the time of the maximal force in ISSC (r = 0,550, p = 0,018 *).

DISCUSSION
Our results show that ISSC and the vertical jump (SJ) from squat appeared two statistically significant correlations in EMG level. The reasons could be attributed to: a) the different visual control, b) at a potential different kinetic program, and c) the different preparation at the start of the test (Schmidtbleicher and Gollhofer, 1997).

The relationship of EMG characteristics varies due to variations in the length of the muscle, in the manner and to the speed of contraction during the ISSC and dynamic activities (SJ), (Ballard et al., 1988). The different position (ISSC & SJ) on the corner of the hip. The different skin impedance change as the angle of the joints, and the ability to differentiate between activation to be tested appear to play an important role in muscle activation of the muscles of the lower limbs (Wank et al. 2000). Based on the results of the degree of correlation could test the ISSC be considered a valuable test (test) for measuring dynamic and variable speed dynamic. An important application could seem to reveal in the training process.

The need for improving performance in SSC leads in finding the ideal height of fall and the ideal support time (touch time) to achieve maximum vertical jumps (DJ). So to determine the "ideal" height of fall, the sample performs vertical jumps, where the drop height ranges between 20-100 cm. The "ideal" drop height is this, which the sample will achieve the maximum vertical displacement of the CC (Katschajov et al. 1975).

CONCLUSION

Muscle EMG activity during the maximum eccentric is lower than the maximum concentric, as a consequence, followed by a single motor unit activity and synchronization strategies, as well as a higher potential for neural adaptations (Komi 1984; Enoka 1996). Increased eccentric muscle activity and neurological features are responsible for the favorable adjustments during training (Komi et al. 1978; Hortobagyi et al. 1996;).

Based on the results of correlation degree could the ordeal of ISSC be considered a worthwhile test (test) for measuring dynamic and courier-dynamic variables, an important application of seems to be present in the process of training.

REFERENCE

[1] Basmajian J.V, DeLuca C.J. (1985). Muscles Alive- Their Functions Revealed by Electromyography. Williams & Wilkins. Baltimore | [2] Blazevich A.J, Jenkins D.J. (1998). Predicting sprint running times from isokinetic and squat lift tests: A Regression Analysis J Strength Cond. Research, 12:2, 101–103. | [3] Bobbert, M.F. & Van Ingen Schenau (1988). Coordination in vertical jumping. J of Biomechanics, 21:3, 249-262. | [4] Bosco, C., Komi, P.V. (1979). Potentnation of mechanical behavior of the human skeletal muskel prestretchnig. Acta Physiol. Scand. 106: 467-472. | [5] Bosco, C., Komi, P.V., Locatelli, E. (1979). Physiologische Betrachtungen zum Tiefsprungtraining. Leistungssport, 6: 434-438. | [6] Bosco, C., Pittera, C. (1982). Zur Trainingswirkung neuentwickelten Sprungübungen auf die Explosivkraft. Leistungssport, 12: 36-39. | [7] Bosco, C., Viitasalo J.T., Komi, P.V., & Luthanen, P. (1982). Combine effect of elastic energy and myoelectrical potentiation during stretch-shortening cycle exercise. Acta Physiologica Scandinavica, 114, 557–565. | [8] Caiozzo V.J., Perrine J. J., Edgerton V.R. (1981) Training-induced alterations of the in vivo force-velocity relationship of human muscle. J Appl Physiol 51: 750-754. | [9] Clutch, D., Wilton, M., McGown, C., Bryce, G. (1983). The effect of depth jumps and eight training on leg strength and vertical jump. Res Q exerc Sport. 54: 5-10. | [10] Dowson M.N, Nevill M.E, Lakomy H.K, Nevill A.M, Hazeldine R.J. (1998). Modeling the relationship between isokinetic muscle strength and sprint running performance. J Sports Sci 16:3, 257-65. | [11] Enoka, R.M. (1996).Eccentric contractions require unique activation strategies by the nervous system. J. Appl. Physiol, 81, 2339-2346. | [12] García-López, J., Peleteiro, J., Rodgríguez-Marroyo, J.A., Morante, J.C., Herrero, J.A., & Villa, J.G. (2005). The validation of a newmethod that measures contact and flight times during vertical jump. International Journal of Sports Medicine, 26 (4), 294-302. | [13] Gissis I. (2003). Exzentrisch erzwungene maximal Kraftwerterhöhungen als reaktiver Impulsgewinn interpretiert. Sportwissenschaft, 1:62-75. | [14] Hortobagyi, T., Hill, J.P., Houmard, J.A., Fraser, D.D., Lampert, J., & Israel, R.G. (1996). Adaptive responses to muscle lengthening and shortening in humans. Journal of Applied Physiology, 80(3), 765-772. | [15] Katschajov, S.V, Gomberadse, K.G, Revson, A.S. (1975). Determinazione dell intensita di carico ottimale nella costruzione della capecita di sprinta degli atleti (juniores). Atletica leggera, traduzione da. Die Lehre der Leichtathletik, 44. | [16] Komi PV. (1984) Biomechanics and neuromuscular performance. Med Sci Sports Exerc.;16(1):26-8. | [17] Komi, P.V., & Bosco, C. (1978). Utilization of stored elastic energy in leg extensor muscles by men and women. Medicine and Science in Sports and Exercise, 10, 262-265. | [18] Korff, T., Horne, S.L., Cullen, S.J., & Blazevich, A.J. (2009). Development of lower limb stiffness and its contribution to maximum vertical jumping power during adolescence. Journal of Experimental Biology, 212(22), 3737-42. | [19] Kubo K., Kawakami Y., Fukunaga T. (1999) Influence of elastic properties of tendon structures on jump performance in humans J Appl Physiol, 87:2090-2096.. | [20] Lands L.C, Hornby L., Desrochers G., Iler T., Heigenhauser G.J. (1994) A simple isokinetic cycle for measurement of leg muscle function. J of Appl. Physiology, 77:5, 2506-2510. | [21] Lazaridis, S., Bassa, E., Patikas, D., Giakas, G., Gollhofer, A., & Kotzamanidis, C. (2010). Neuromuscular differences between prepubescents boys and adult men during drop jump. European Journal Applied Physiology, 110(1), 67-74. | [22] Li R.C., Wu Y., Maffulli N., Chan J.L. (1999). Eccentric and concentric isokinetic knee flexion and extension: a reliability study using the Cybex 6000 dynamometer Br. J of Sports Med., 33:2, 113-116. | [23] Liu, Y., Shih, S.M., Tian, S.L., Zhong, Y.J., & Li, L. (2009). Lower extremity joint torque predicted by using artificial neural network during vertical jump. Journal of Biomechanics, 42(7), 906-11. | [24] Martin, D., Carl, K., Lehnertz, K. (1993). Handbuch Trainingslehre. Hofmann. Schorndorf. Ελληνική μετάφραση. Εγχειρίδιο Προπονητικής. Εκδ. Σάλτος (1995) s. 158-159, 123-124. | [25] Müller K-J. (1985). Explosivkraft-eine generelle oder spezifische Eigenschaft. In: Grundlangen des Maximal- und Schnellkrafttrainings. M. Bührle (Ed.) Hofmann Verlag. Köln, s. 149. | [26] Paasuke, M., Ereline, J., Gapeyeva H. (2001). Knee extension strength and vertical jumping performance in nordic combined athletes. J Sports Med Phys Fitness. 41:3, 354-61. | [27] Pereira, G., de Freitas P.B., Rodacki, A., Ugrinowitsch, C., Fowler, N., & Kokubun, E. (2009). Evaluation of an innovative critical power model in intermittent vertical jump. International Journal of Sports Medicine, 30(11), 802-7. | [28] Schmidtbleicher, D., & Gollhofer, A. (1982). Neuromuskulare Untersuchungen zur Bestimmung individueller Belastungsgroessen fuer ein Tiefsprungtraining. Leistungssport, 12, 298-307. | [29] Tsatalas, T., Lazaridis, S., Zaggelidis, G., & Kotzamanidis, C. (2010). The effects of a stretch-shortening cycle fatigue protocol on knee kinematics during running in untrained children. Journal of Physical Education and Sport (JPES), 27(2), 39-43. | [30] Van Soest AJ., Schwab, AL., Bobbert, M.F., van Ingen Schenau G.J. (1993). The influence of the bi-articularity of the gastronomies muscle on vertical jumping achievement. J of Biomechanic, 26:1-8. | [31] Wank, V., Wagner, H., Blickman, R. (2000). Muskelkraft und Gelenkmoment- ein Vergleich ausgewählter Modelle zur Berechnung der Muskelmomenthebel für Kniestrecker. Sportwissenschaft, 30:1, 82-95. | [32] Walshe, A.D, Wilson, G.J, Ettema, J.C. (1998). Stretch-shorten cycle compared with isometric preload: contributions to enhanced muscular performance. J. Appl. Physiol. 84:1, 97-106. | [33] Wilson, G.J, Walshe, A.D, Fisher M.R. (1997). The development of an isokinetic squat device: reliability and relationship to functional performance Euro J of Applied Phys. & Occup Physiology, 75:5, 455-461.