ISSN : 0974 - 7435 Volume 10 Issue 15

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(15), 2014 [8929-8933]

A study on constant velocity centripetal test of high jumpers swinging leg three joint flexor and extensor muscle group

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ABSTRACT

Constant velocity test is to use pre-set kinematic velocity, ensure constant velocity in actual test and make tests on maximum torque output of various muscle groups within the scope of the whole joint movement. Starting from the present development status and advantages of constant testing technology, this paper introduces the actual situation of constant centripetal test of high jumpers' swinging leg three joint flexor and extensor muscle groups.

KEYWORDS

High jumper; Three joint flexion muscle groups; Constant centripetal test.

INTRODUCTION

The operation of constant velocity centripetal test technology is relatively simple. It would automatically record instantaneous torque changes and multiphase reaction muscle function parameters in actual tests, so it has higher reliability. The strength of athlete's each muscle contraction equals the resilience resistance formed by constant velocity instrument, so it has higher safety performance. Therefore, constant test is widely applied in the muscle strength evaluation. Computer processing system can record participants' peak torque curve chart, peak torque angle, acceleration energy, average power and other related information of joint flexion muscle group. Meanwhile, the computer processing system is equipped with the performance of saving data automatically. Because it can provide safe and accurate data to participants, it is commonly applied to training, evaluation and other aspects of muscle strength. This paper takes constant centripetal test of high jumpers' swinging leg three joint flexion muscle groups as research gist, briefly describes advantages of the system and summarizes the actual situation of constant velocity centripetal test application.

DEVELOPMENT OF CONSTANT VELOCITY TEST TECHNOLOGY

Development status of constant velocity test technology

In 1970, the world's first constant velocity muscle strength test instrument was developed and produced by American Cybex Company. The use of the test instrument brought a breakthrough for muscle strength test. At present, the widely used constant velocity dynamic muscle strength test instruments in the world include Cybex6000, Mcral, Lido Active, etc. Among them, Cybex related dynamic muscle strength test system has the widest application scope. This paper considers Cybex as the measuring technique. This system consists of two parts, operating system and computer processing system. The operating system can set the sphere of activities, the number of repeats and kinematic velocity of test joints in advance for testers and record participants' age, weight, height and other general data. The operating system can be divided into two parts, mainframe and module of flexion and extension. The mainframe is connected with the computer and all set parameters and the concrete test instructions are controlled by the computer. The computer mainframe controls different patterns of joint movement to ensure that the actual requirements of the test can be satisfied.

Advantages of constant velocity test system

(1) Security: The resistance set by the constant velocity test system is changed with athletes' different strength. That is, if the athlete has greater strength for the first time, the resistance will be increase. With the increasing frequency, the athlete has smaller and smaller strength, the resistance will decrease accordingly. So athletes can conduct maximum intensity exercise safely and continuously and ensure that their muscle strength has been in a state of ascension.

(2) Selectivity: The required velocity and angle in the test can be set in accordance with each muscle group of the body to ensure that different muscle groups can obtain different modes of training and have stronger pertinence.

CONSTANT VELOCITY CENTRIPEAL TEST OF HIGH JUMPERS' SWINGING LEG THREE JOINT FLEXION MUSCLE GROUPS

Select research objects

This paper considers 28 high jumpers selected from Track and Field Team of Liaoning and Dalian Sports School, including 8 female first-class athletes which form Female Group A, 7 female second-class athletes which form Female Group B, 7 male first-class athletes which form Male Group A and 7 male second-class athletes which form Male Group B. Details are shown in TABLE 1.

TABLE 1 : Basic information of research objects

Group Number（n）	Height (m)	Age (Year)	Weight（Kg）
Female Group A	7	177.5±4.5	18.2±3.3	56.3±4.2
Female Group B	7	171.7±5.3	18.0±2.5	58.7±3.7
Male Group A	7	187.2±3.8	20.2±2.0	72.4±5.0
Male Group B	7	183.3±6.2	19.0±1.8	68.3±3.5

Test approach

Test steps

This test is mainly to evaluate high jumpers' swinging leg three joint muscle strength and is conducted according to the above mentioned groups of subjects.

First, subjects stay in the early period of matches and their physical and mental state is good. All patients clearly understand the test purpose and they have stable emotions and peaceful mind. All subjects master the test feeling though examinations. Plenty of warming-up activities are made before the test. After 10 minutes of jogging, 5 minutes of muscle

stretching exercises are needed and slight perspiration is sufficient. Second, before the test, motion scope, range and velocity that will be tested should be checked to prevent athletes from getting hurt. In terms of the test of athletes' three joint flexion muscle groups, subjects are in a sitting position and implementation should be strictly made following the instructions of the monitoring instrument. Subjects are first fixed on the instrument and rotation axis and three joint motion axis of the instrument power arm should be ensured to be parallel and two hands complete the test of swigging leg three joints based on two sides of the test chair.

TABLE 2 : Test results of knee flexors and extensors relative peak torque of volleyball and high jumpers (x ± s)

Projects	Angular velocity $(^0)\cdot s^{-1}$	Quadriceps		hamstring	
		Advantage leg	non-dominant leg	Advantage leg	non-dominant leg
Volleyball	360	2.9 ±0.6 (1)	2.3 ±0.7(1)	2.2 ±0.2(2)	2.1 ±0.7(2)
	90	3.2 ±0.5(1)	2.9 ±0.3(1)	2.5 ±0.4(2)	2.2 ±0.5(2)
High Jump	360	3.4 ±0.3	2.8 ±0.7	2.1 ±0.4	2.3 ±0.2
	90	3.6 ±0.2	3.3 ±0.3	2.4 ±0.3	2.4 ±0.6

(1)P<0.05, (2)P>0.05

Third, when the test is being made, joints are required to implement 2 or 3 times sub-maximal graded constant velocity exercises which are used to ensure that three joints can adapt to the test equipment when they are texted in the actual flexion and extension pattern. Giving them verbal suggestion and cheering for subjects can motivate them to complete the regulated test items with greatest strength. Fourth, after the test, subjects' three joint flexion muscle groups should be relaxed. The measured data should be kept timely and the researcher should check if there is any missing data. If some data is missing, strength test should be remade to avoid bringing troubles to the subsequent data analysis and statistics.

Test items

This experiment is mainly to test high jumpers' swinging leg three joint flexion muscle groups. Constant velocity centripetal contraction tests are made on athletes' flexion muscle groups of knee, ankle and hip in four groups, Female Group A, Female Group B, Male Group A and Male Group B. Then the measured data will be arranged. Analysis and statistics will be conducted on the four groups of athletes' test data to obtain the final result. Each athlete is tested with three groups, ankle test slow speed 30^o/s, 60^o/s and intermediate speed 90^o/s; knee test slow speed 30^o/s, intermediate speed 120^o/s and high speed 150^o/s; hip test slow speed 60^o/s, intermediate speed 90^o/s and high speed 150^o/s. Each group has five repeated tests and 60s time interval. In actual tests, the operation of various angles should be paid attention to and the researcher needs to timely communication with the participants, well record and save the test data.

ANALYSIS OF TEST RESULTS

Analysis of the total work of flexor and extensor of athletes' swinging leg knee joint constant velocity centripetal test

TABLE 3 shows the total work of athletes' knee joint extensor in different test velocity, it can be seen that when the test speed increases from 60^o/s to 150^o/s, in this research, the total work of four groups of high jumpers' swinging leg knee joint flexor group constant velocity centripetal test is in a reduced state. The total work of life mechanical characteristics of athletes' swinging leg hip joint flexor in the speed of 60^o/s is obviously bigger than that of in other two kinds of speed. When the test is done in the speed of 60^o/s and 120^o/s, the total work of high jump athletes' swinging leg hip joint flexor group in Female Group A is bigger than that in Female Group B. There is significant difference between two groups (P<0.05). When the test speed is 120^o/s, the total work of two groups of female athletes' swinging leg hip joint flexors is not significantly different. The total work of high jump athletes' swinging leg hip joint flexor in Male Group A is obviously bigger than that in Male Group B and there are significant differences (P<0.05).

TABLE 3 : Total work of athletes' knee joint extensor in different test velocity (J)

Swinging Leg Knee Joint Total Work of Flexor		
Test Speed（^{0}/s）	60	90 120
Test Times（Times）	5	5 5
Female Group A	514.33±64.34▲	451.36±69.83▲ 311.16±28.64▲
Female Group B	426.91±77.54	354.14±69.25 294.59±34.33
Male Group A	695.91±122.10▲	627.62±124.73▲ 556.21±85.23▲
Male Group B	614.11±112.43	555.74±104.70 474.52±91.51

Analysis of the total work of flexor and extensor of athletes' swinging leg hip joint constant velocity centripetal test

TABLE 4 shows the total work of hip joint flexor in different test velocity, it can be seen that when the test speed increases from 60°/s to 150°/s, the total work of four groups of high jumpers' swinging leg hip joint flexor group constant velocity centripetal test is in a reduced state. The total work of life mechanical characteristics of athletes' swinging leg hip joint flexor group in the speed of 60°/s is higher than that of in other two kinds of speed. This result is consistent with the conclusion that the peak torque of four groups of athletes' swinging leg hip joint flexor in the speed of 60°/s is significantly bigger than that in other two kinds of speed. Meanwhile, in this speed, the total work of high jump athletes' swinging leg hip joint flexor in Female Group A is significantly bigger than that in Female Group B with significant differences ($P<0.05$). The total work of high jump athletes' swinging leg hip joint flexor in Male Group A is bigger than that in Male Group B and there are significant differences two groups ($P<0.05$).

TABLE 4 : Total work of hip joint flexor in different test velocity (J)

Swinging Leg Knee Joint Total Work of Flexor		
Test Speed（°/s）	60	90	150
Test Times（Times）	5	5	5
Female Group A	655.33±85.74▲	589.24±86.73▲	559.75±57.26▲
Female Group B	587.15±94.75	530.74±75.58	472.12±64.33
Male Group A	836.75±100.73▲	752.33±93.48▲	674.33±94.42▲
Male Group B	767.58±98.31	684.10±82.25	602.86±75.63

Compare the Total Work of Four Groups of Athletes' Hip Joint Extensor in Different Test Velocity (shown as TABLE 5), it can be seen that when the test speed increases from 60°/s to 150°/s, the total work of four groups of high jumpers' swinging leg hip joint flexor group constant velocity centripetal test is in a reduced state and the total work of extensor in each speed is obviously bigger that that of flexor. The total work of high jump athletes' swinging leg hip joint flexor in Female Group A is significantly bigger than that in Female Group B with significant differences ($P<0.05$). The total work of high jump athletes' swinging leg hip joint flexor in Male Group A is bigger than that in Male Group B with significant differences two groups ($P<0.05$).

TABLE 5 : Compare the total work of four groups of athletes' hip joint extensor in different test velocity (J)

Swinging Leg Hip Joint Total Work of Extensor		
Test Speed（°/s）	60	90	150
Test Times（Times）	5	5	5
Female Group A	864.56±114.73▲	735.22±119.65▲	559.73±92.56▲
Female Group B	779.22±124.73	624.31±129.36	486.53±84.65
Male Group A	1120.54±252.54◆	984.67±204.74◆	825.51±210.54◆
Male Group B	997.34±195.33	825.51±197.30	674.43±168.74

CONCLUSION

Peak torque means the maximum output torque of muscle contraction, i.e. the torque values at the highest point of the torque curve. Because of the differences between conventional limbs and individuals themselves, bilateral knee flexion and extension of normal individuals have differences between the muscles; this difference in addition affected by the advantages of the side of the body, but for the rest of the population, both sides of the limb muscles power difference is very small. Foreign studies show that this difference is within 10%. Studies suggest that the difference between the left and right side of the country for more than 20% results have indicated that the clinical significance. Guangbo Xie etc: this difference with less than 15% is more reasonable. The results of this study indicate that volleyball players bilateral hamstring peak torque (90º) / s) was significantly less than high jumpers ($P <0.05$). This may because of the different characteristics of the two sports technology, volleyball players use both feet and step off, while the high jumper jump on one foot. Although isokinetic has better accuracy and repeatability, but there are many factors inevitably affect the test results in testing. In the constant movement of the knee, the impact of angle and time is a significant moment, especially the position of the joint angle is more important, so we should pay particular attention to starting angle, angle and joints range when measured to obtain the objective results. The isokinetic testing technology operation is relatively simple. The operation of constant velocity centripetal test technology is relatively simple. It would automatically record instantaneous torque changes and multiphase reaction muscle function parameters in actual tests, so it has higher reliability. This paper has considered constant centripetal test of high jumpers' swinging leg three joint flexor and extensor muscle groups as the research gist, briefly described development and advantages of the system and introduced the actual situation of high jumpers' swigging leg three joint flexor and extensor constant velocity centripetal test.

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