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RESEARCH ON ISOKINETIC SHOULDER STRENGTH TESTING OF FEMALE ELITE SWIMMERS

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The purpose of this study was to investigate the shoulder muscle strength characteristics of the female elite swimmers in Sichuan province, find out specific weakness part of their shoulder joint strength . Using IsoMed 2000 isokinetic dynamometer measured the shoulder muscle strength for the subjects(n=15) of the shoulder flexors, extensors, adductor and abductor at the different angular velocities, then analyzed the problem in the subjects' shoulder strength training, the result showed that：there is a significant difference($P < 0.01$) about the muscle strength endurance ratio between two sides of the shoulder extensors and flexors, and the extensors strength rate of decline is less than flexors. The information has important significance for improving athletic performance and preventing subjects from shoulder injury.

KEY WORDS: swimming, shoulder joint, isokinetic testing, muscle strength.

INTRODUCTION: After 1970s, many countries in the world to start applied and researched isokinetic testing, and was considered as a major innovation on muscle strength testing and training(WuYi,2002). Isokinetic muscle testing could provide a series of muscle characteristics, and even could asses muscle characteristics at the model of concentric contraction and eccentric contraction.

The requirements of shoulder muscle strength is very important for swimmers, because of the involved muscles' complex on shoulder movement(XUE Gang,2005), to date, there remains a dearth of studies on the shoulder joints on swimming program, therefore, measured the 15 elite female swimmers muscle strength of the shoulder flexors(F), extensors(E), adductor(D) and abductor(B) at the different angular velocities, then analyzed the problem in the subjects' shoulder strength training.In this text，to find out the lack of athletes' strength training, through carried out test for their shoulder muscle strength, in case provide reference basis for shoulder joint strength training, the information will has important significance for improving athletic performance and preventing subjects from shoulder joint injury.

METHODS: Using IsoMed 2000 isokinetic dynamometer（Germany) measured the shoulder muscle strength for the 15 subjects. Before the test, subjects were asked to warm up their shoulder 10 min, preheated their shoulder fully. The whole test was divided into two sessions. The first session was to asses the strength and endurance of shoulder flexors and extensors. In the first session, the subjects performed five maximum contractions for shoulder (range of motion is 180°) flexors and extensors at the angular velocities of 60°/s. The highest peak torque (PT) was normalized by kilogram of body weight (relative peak torque, PT/BW) and used as the parameters for muscle strength evaluation. Interval 1min, the dynamic endurance of the knee extensors and flexors were assessed by measuring 25 repeated maximum isokinetic contractions with an angular velocity of 240°/s. The endurance ratio (ER) was defined as the ratio of the work during the last five contractions over the first five contractions. After a 15 min relaxation period, the strength of shoulder adduction and abduction was evaluated in the second session. According to aforementioned means, PT was determined as the highest torque generated from the five trials. In addition, the relative PT was analyzed. Agonist and antagonist muscle peak torque ratio (PTR),refer to the relevant literature and select a different side of the same name muscles ratio and endurance ratio (ER) were analyzed quantitatively. The test also selected the peak torque (PT), agonist and antagonist muscle peak torque ratio (PTR), as the parameters for muscle strength evaluation.

The limitation of the study was lack of the study of the contraction model of internal and external rotation. Because of the complexity of shoulder joint, we only selected aforementioned four kinds of contraction model（F,E,D,B).

Subjects

Table 1 gives a general description of the subjects. All the subjects are sports master. No difference was noted in age, height, weight and training experience across the 15 subjects. Participate testers had similar physical levels, their shoulder has no manifest damage.

Table1

Basic Information of Subjects

N	Age(years)	Height(cm)	Weight（kg）	Training（years）
15	16.43±0.90	170.14±4.88	60.14±8.06	5.86±2.29

Statistics

Data were expressed as mean and standard deviation (SD). And the differences between the fifteen subjects were compared through an independent t-test. The significant level was set at.05. *:P＜0.05,significant difference，**:P＜0.01，Very significant differences.

RESULTS

PT and PT/BW under the four contraction model (60˚/s)

To date, the study show that the Isokinetic test results of different populations on shoulder flexor and extensor PT, relative PT value magnitude has not been uniformed.

Table 2

Comparison of PT and PT / BW Value Differences at an Angular Velocity of 60 ° /S

	PT（Nm）		PT/BW(Nm/kg)	
	Left	Right	Left	Right
Flexors	41.71±7.38	33.29±7.00	0.69±0.04	0.55±0.05
Extensors	57.57±6.69*	67.71±7.55*	0.96±0.05*	1.13±0.08*
Adductors	47.43±8.63	53.29±6.25	0.79±0.12	0.90±0.14
Abduction	49.86±7.06*	51.14±13.99	0.83±0.05*	0.86±0.27

The PT and PT/BW agonist /antagonistic (60˚/s)

Table 3

Comparison of agonist / antagonist difference

	Agonist / Antagonist	
	flexors/ extensors	adduction/ abduction
left	0.72±0.06**	0.95±0.13
right	0.49±0.07	1.09±0.20

Noffal GJ found that if only the agonist and antagonist maintain balance, the shoulder joint can sustain stable. Shoulder joint will be injured easily when it break the balance. So far, Joint agonist and antagonist muscle group ratio is more common in the knee(Noffal GJ, Oberg B).No uniform standard for the reasonable range of the shoulder joint. Therefore, the results of this study is only as a reference for future research comparison.

The PT difference statistics of the opposite side same name muscle (60 ° / S)

Some studies have shown that the exclusive side of the same name muscle PT differences within the 10%, which is a reasonable range, more than 15% has clinical significance, strength training need to be concerned in peacetime. Isokinetic testing research literature on

both sides of the same name muscle strength ratio differences are mostly found in the knee, the few studies on shoulder in this aspect.

Table 4
The PT difference Statistics of the Opposite Side Same Name Under the Four Model

Difference	Flexors	Extensor	Adduction	Abduction
≤10%	0	2	4	4
＞10%	15	13	11	11
≥15%	12	10	8	4

Endurance ratio (240 ° / S)

Table 5
Comparison the Difference of ER in the Status of F and E

Left		Right	
Flexors	Extensor	Flexors	Extensors
0.82±0.12**	0.98±0.13	0.81±0.06**	0.96±0.11

DISCUSSION：Table 2 shows that extensors' PT and PT/BW value were greater than the flexors, and they has difference (P <0.05); abduction PT and PT/BW value were greater than the adductors on the left, and there is difference between(B/D) differences (P <0.05), but the right side has no significant difference (P> 0.05), it may because of right hand is dominant hand. Shoulders strength's imbalance may result in deviate from the straight line in the swimming process, waste energy, therefore, the subjects should balance the muscle strength on their double shoulder.

The difference of agonist / antagonist is shown in Table 3. In this test, subjects' left shoulder has a significant difference (P <0.01) when(F/E) compared with right shoulder and another group(D/B); D/B ratio has no significant difference (P> 0.05). Enhanced strength training for weaker muscle strength, to ensure the balance of F, E, D and B.

As can be seen from Table 4 in the test(60°/S) of the four kinds of contraction, the difference between left and right shoulder was no less than 15%, each model Views were 12, 10, 8 times. Therefore, the subjects should enhance strength exercises of weak side muscles, so that improve athletic performance and prevent sports injuries.

So far, shoulder flexor and extensor endurance ratio has no standard. Through measured these two kinds of contraction model（240 °/ S), the subjects' ER have a significant difference(P <0.01) between flexor and extensor both in left and right shoulder which is shown in table 5. And the strength of two sides of the extensor endurance about the rate of decline is less than flexors, the author analyzes that this result may be related to the feature of swimming action.

CONCLUSIION: From the discussion,we get the following conclusions.

(1)The subjects' abduction PT and PT/BW were greater than the adductors on the left, and has a difference (P <0.05), but the right side has no significant difference (P> 0.05).

(2)The muscle strength difference statistics between left and right shoulder was no less than 15% under the four kinds of contraction model among the majority subjects.

(3) The subjects' ER has a significant difference(P <0.01) between flexor and extensor both in left and right shoulder, and the rate of decline is less than flexors.

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