

THE RESEARCH ON ISOKINETIC STRENGTH TESTING OF KNEE JOINT MUSCLE OF SHI DONGPENG, THE INTERNATIONALLY MASTER OF SPORTS

Caimian Liu¹, Huanbin Zhao¹ and Xiaoyang Jin²

¹College of Physical Education, Hebei Normal University, Shijiazhuang, China

²Nanjing Institute of Technology, Nanjing, China

Since over 10 years ago, there have been many reports concerning tests of muscle strength and evaluation of muscle function, both of which adopted isokinetic test system. Yet, in contrast, there have been fewer reports devoted to analysis and research on individual athletes. With Kinitech system, this paper will test and evaluate the knee joint muscle of Shi Dongpeng, the internationally top-notch 110m hurdle athlete, using the following 3 indexes: Relative Peak Torque (PT/BW), Time to Peak Torque (TPT) and Flexors/Extensors Values (F/E). And all the 3 indexes will be correspondingly contrasted with those of common young men's knee joint muscle. And the purpose of this paper is to provide scientific referent basis for the athlete to choose suitable training ways, to have specific strength training and to have great achievement.

KEY WORDS: knee joint, isokinetic test

INTRUDUCTION: China's 110 m hurdles is a traditional strong event within Asia, and once nearly reached the advanced international in the 1950s and 1960s, when many excellent athletes appeared. So it is urgently necessary for the Chinese hurdlers to find a theoretical and practical way to ensure a further achievement in this event in recent years. This paper is to take the excellent Chinese Hurdler Shi Dongpeng as the research object, to have an isokinetic test on the muscle strength of both his knee joints, in order to analyze the strength characteristics and the musculature skill of Shi's Knee joints, which is expected to be provided as a biomechanics basis for DE educators, coaches and athletes to reasonably arrange training and which is expected to help promote the development of the hurdle event and the hurdler's achievements.

METHODS:

Research object: Shi Dongpeng, the internationally top-notch hurdler from Hebei sports Team, who attacks hurdle with the left leg and who wasn't found to have knee joint injury. His basic situation is the following: (Table 1)

Table 1 Basic situation of Shi Dongpeng.

Event	Age	Height (cm)	Weight (kg)	Training year(year)	Best record
110m hurdles	20	193	82.30	5	13"43

Research methods: The machine using in the test is isokinetic strength test system named Kinitech made by Keylink Company in Australia. A regular demarcation is made to the testing system before being tested; the object has 10-15 minutes to fully do warming-up exercises. During the testing, the subject should sit with his upper part of body and thigh forming a right angle, his chest, waist and thigh fixed with a tie and his hands tightly holding the handles on both sides of the chair. The resistance pad attached to the motive apparatus is fixed to the inner side of the subject's ankle, and the pivot axis center of the arm of force is kept in line with that of the knee joint. Each set of testing has 3 times of exercises prior to 6 times of formal tests, and there is an interval of 1 minute between different sets of testing. Both joints are tested at the same time. The testing time is arranged in the morning. The computer automatically takes down various index data.

Setting of the velocity: The low angle velocity is 60°/s and 120°/s, and the high one is 240°/s, 300°/s and 360°/s.

Test index: Relative Peak Torque (PT/BW): an index used to evaluate strength. In view of the individual difference possibly caused by the close relevance between Peak Torque and

body weight. This experiment adopts Relative Peak Torque to better contrast it with common groups.

Time to Peak Torque (TPT): an index used to evaluate time, which refers to the time needed by the muscular group to contract from its relaxing state to the degree as to get maximum strength. It can reflect muscle's explosive force.

Flexors/Extensors Value (F/E): an index used to evaluate the strength balance of flexors and extensors of knee joints. It's of great significance for the maintenance of knee joint stability and the precaution of knee joint injury.

RESULTS AND DISCUSSION: The analysis of relative Peak Torque of the flexors and extensors of Shi Dongpeng's knee joints.

Table 2 The relative Peak Torque of Shi Dongpeng (% Nm/Kg).

	60°/s	120°/s	240°/s	300°/s	360°/s
Left flexion	247.87	349.94	349.94	204.13	260.02
Left extension	335.36	325.64	272.17	126.37	157.96
Right flexion	320.78	301.34	286.76	260.02	260.02
Right extension	320.78	349.94	335.36	260.02	252.73

The data in Table 2 has reflected the inconsistency between the muscle strength performance of the extensors and flexors of Shi Dongpeng's knee joints and that of the former reported common young men. The former researches held that the PT/BW value tended to go down as the testing velocity went up, while the PT/BW testing result of Shi Dongpeng's knee joints shows that with the testing velocity going up, the left flexors have an up-down inclination and the right extensors have a down-up inclination, both of which incline to go up at the angular velocity of 120°/s and 240°/s. (The increasing scale is the biggest at the velocity of 120°/s, the increasing rate for the left flexors is 40.96% and that of the right extensors is 9.09%.)

Shi Dongpeng's maximum muscle strength performance is related to the testing velocity and his left knee flexors and right knee extensors reach maximum strength at the testing velocity of 120°/s and 240°/s. Rynshi (1986) pointed out that at different velocities of muscle movement, the isokinetic muscle strength is related to the percentage of different fibers. According to his research, different intensity of muscle contraction makes different fiber types take part in the contraction: Only slow twitch fiber takes part in muscle contraction of low intensity and produce little strength, while both slow and fast twitch fibers all take part in contraction of high intensity and produce relatively much strength. The higher the velocity of isokinetic muscle strength is, the lower the intensity of muscle contraction. So in theory Shi Dongpeng's left knee flexors and right knee extensors should be expected to produce maximum strength at the velocity of 60/s, but in fact this is not what the testing result shows. It's presumed that such inconsistency is caused by the influence of nerve regulation on muscle strength. Hurdle event demands athletes with high speed and strong explosive force, so the hurdlers should take a long-run specific training to adapt their nerve system to the quick muscle contraction, so that more fiber types can take part in mid-intensity contraction to produce maximum strength. So more attention should be attached to the purpose of specific training.

Former research believed that the relative Peak Torque value of common young men's knee joint extensors is higher than that of their knee joint flexors, and so it is with Shi Dongpeng's right knee joint. But things about his left knee joint are different: its extensors' relative Peak Torque value is higher than of its flexors at nearly all angular velocities except 60/s. Such difference reflects the characters of Shi Dongpeng's specific strength training: Hurdle clearance includes the quick push of right leg accompanied by left leg's upward attacking the hurdle, and left leg's landing to buffer, of which the quick push demands concentric contraction of right knee joint's extensors and left leg's landing action demands concentric contraction of left knee joint's flexors to complete buffer action with extensors in order to

reduce the reaction force of ground. Shi Dongpeng's characters of knee joints muscle strength are mainly resulted from his long specific strength training.

Table3 is that the result of time to Peak Torque (TPT) of Shi Dongpeng's knee joint's isokinetic concentric contraction.

Table 3 Time to Peak Torque (Sec).

	60°/s	120°/s	240°/s	300°/s	360°/s
Left flexion	0.24	0.16	0.24	0.24	0.16
Left extension	1.07	0.70	0.05	0.40	0.12
Right flexion	0.25	0.15	0.21	0.00	0.00
Right extension	0.85	0.16	0.14	0.62	0.62

TPT refers to time needed by muscle when contracting to its Peak Torque, and can be an testing value for explosive force. Former research showed that TPT is shortened as the velocity increases, which is basically consistent with Shi Dongpeng's left knee extensors (300°/s as an exception) and right knee flexors (240°/s as an exception). But as the velocity increases, there is a down-up-down inclination for TPT value of left knee flexors and a down-up inclination for that of right knee extensors, which isn't consistent with the above-mentioned research. In views of the fact that different fiber types are needed for different intensities, and the analysis for relative Peak Torque of the flexors and extensors of Shi Dongpeng's knee joints, it's known that Shi Dongpeng's left knee flexors and right knee extensors can make more fibers take part in mid-intensive contraction and can produce more strength at the testing velocity of 120°/s and 240°/s. So at such velocity, his TPT is relatively short and his explosive force reaches its maximum value.

Table4 is that the result of flexors/extensors (F/E) value of Shi Dongpeng's isokinetic concentric contraction of knee joints at variant velocities.

The regular performance of knee joints is determined by the synergism and containment of variant muscular groups. The knee flexors and extensor's balance of strength is the main factor to ensure the knee joint stability, so testing the muscle strength is of great significance for the maintenance of knee joint stability, the improvement of sport ability and the precaution of injury of some weak muscular groups.

Table 4 Knee joint flexion and extension muscles PT ratio (%).

	60°/s	120°/s	240°/s	300°/s	360°/s
Left knee	73.91	107.46	128.57	161.54	164.62
Right knee	100.00	86.11	85.51	100.00	102.88

F/E value of knee joints' concentric contraction is an important index to evaluate knee joints' balance of strength. Research shows that the increase of F/E value will cause the increase of ratio value between flexors Peak Torque and extensors Peak Torque of knee joints, and the increases ranges from 50% to 80%, and if beyond the range, muscular group of the in dominant side and the ligament are liable for injury.

The ratio value between flexors Peak Torque and extensors Peak Torque of Shi Dongpeng's both knee joints is as Table5. And it shows that as the testing velocity increases, such ratio value of the left knee joint obviously increases. Yet the ratio values of the right knee joint pursue a down-up inclination.

The above results show that Shi Dongpeng's left knee flexors have more strength, especially when they quickly contract, and this has something to do with periodically quick sway of knee joints. His right knee flexors' strength increases and then decreases as the testing velocity increases. The tested ratio value between both F/E values is much higher than regular value, which reflects that the development of muscle strength of both his flexors and extensors are very unbalanced, which will deform his clearance, especially his quick clearance, cause the lack of muscle strength, even lead to sprain of flexors and extensors and injury of knee joints. So Shi Dongpeng should pay more attention to the improvement of his quick extensors strength of knee joints.

CONCLUSION: Shi Dongpeng's maximum muscle strength performance is related to the testing velocity, and his left knee flexors and right knee extensors reach maximum strength at the velocity of 120°/s and 240°/s. The possibly is resulted from Shi Dongpeng's long specific training. So more attention should be attached to the purpose of specific training.

His left knee extensors' relative Peak Torque value is higher than that of his flexors at nearly all angular velocities except 60°/s, such difference from former research result reflects the characters of Shi Dongpeng's specific strength training.

At the velocity of 120°/s and 240°/s, his TPT of left knee flexors and right knee extensors is relatively short and his explosive force reaches its maximum value, the reason of which possibly lies in his nerve regulation mechanism.

The tested ratio value between both F/E values is much higher than regular value (especially so is the case of his left knee), which reflects that the development of muscle strength of both his flexors and extensors are very unbalanced. So he should pay more attention to the improvement of his quick extensors strength of knee joints.

Hurdle event demands more about athlete's muscle strength of knee flexors and extensors than anything else, and especially demands the synergism ability of variant muscular groups. So it is important for hurdlers to improve their quick strength of knee extensors and flexors and the synergism ability.

REFERENCE:

- Knapik JJ. et al. (1980). Isokinetic and isometric torque relationship in the human body. *Arch Phy Med Rehabil*, 61-64.
- Hislop HJ. et al. (1967). The isokinetic concept of exercise. *Phys Ther*, 47-114.
- Kramer JF. (1990). Reliability of knee extensor and flexor torques during continuous concentric eccentric cycles. *Arch Phys Med Rehabil*, 71, 400-464.
- Kannus P. Maximal Peak Torque as a predictor of peak angular impulse and isometric and isokinetic study. *Sports Med*, 11, 146-149.

Acknowledgement

This work was supported by Scientific Fund of Hebei Normal University (L2003Q18) of PRC.