Research on the Sports Medicine of the Thigh in the Tennis Match

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Abstract
With competitive tennis skills improving and fitness popularization, tennis showed rapid development and expansion of the momentum today. The thigh muscle injury of athletes in the tennis game also showed a trend of high incidence at the same time. The 42 players who had suffered from a thigh injury or a knee injury and a history of chronic injury were the subjects in the tennis. The methods for BIODEX multi joint constant velocity measuring force and rehabilitation system were adopted to measure Knee flexor and extensor muscle strength in these indicators that $60(^{\circ})/s$ *centrifugal and centrifugal as well as* $240(^{\circ})/s$ *the maximum torque (PT) of the concentric contraction. The moment curve is analyzed, which can be used as the thigh and knee injury function diagnostic reference index. The muscle strength recovery method of thigh muscle including the movement therapy and the comprehensive treatment of Chinese medicine were proposed according to the result of the determination, which provided an attempt and innovation for the treatment of the injury of thigh in the tennis match.*

Keywords: tennis, BIODEX, thigh injury, muscle strength recovery.

Introduction

The rapid popularization of tennis promoted the competitive level of ascension in recent years. The competitive forms of tennis have presented the competition of a variety of elements in modern society. Technology and tactics of the modern tennis fuse power, speed and other technical elements so that obtain the formation of the overall quality of the competition, which is also a comprehensive level of confrontation. With the competitive level of ascension, it can also bring challenges to human muscle. The challenge of high strength has higher requirements to the flexible function and flexibility of the motion system.[1]

For example, the active function of the joint part of the requirements and the flexibility of the ligament were also put forward higher requirements, especially skeletal muscle. Skeletal muscle must be able to adapt to the rapid and sudden contraction in players hit the ball enable power reached maximum to develop an explosive force with the speed. How to improve the speed of the service is the focus of the tennis world in order to be able to take the initiative to deal with in the confrontation and enhance the tactics. Make the lower limb strength to achieve maximum utilization is one of the most important factors to decide to the serve quality when hit the ball.

Medicine A C O S believed that most of the injured cause results from knee extension pedal suddenly then put heel take-off quickly. For example, you must be do this action when the master sent the ball, which cause that the great power is applied to the muscles when the muscles are contracting. This part of the muscle is easy to be pulled or even broken. [2, 3] In addition, direct impact can also cause plantar tendon rupture. Especially it often results in broken muscle part of the fracture or complete fracture when the muscles with sharp contraction suffered a sudden impact from an external force. [4]

Brancaccio P believes that the disease is more common in knee extension when pedal suddenly and heel take-off (tennis serve and volley after Golf action) or in the extension of knee when ankle suddenly extreme dorsiflexion (such as forward step when the ball after the kick), which can make the plantaris muscle injured. The extent of the damage is different due to force. The plantar muscle is generally more than the total fracture. [5] Eichner ER believed that plantaris tendon rupture is caused by foot suddenly violently plantar flexion, which occurred more common in basketball, the sprinter and a ballet dancer. [6, 7]

P Schur et al. believed that patients have a history of indirect or direct injury in motion. They feel like a blow to the back of the thigh or shot like severe pain in most of the wounded immediately. It was forced to stop the movement at this time. They can't jump, run. Some of the injured can hear a sound.[8] They often complained of thigh pain. Pain is increased when limp, toes or kicking.

There is no change from the leg shape when injured. Swelling, deformation and subcutaneous hemorrhage occurred in later. The rear thigh is more obvious.[9] If you can touch the hard scar tissue in the late stage, this is the broken end of the contracture because of its adhesion to the surrounding tissue. Posterior of thigh obtained pain when ankle dorsiflexion conducted movement so that ankle dorsiflexion movement limitation, which forms the point of foot. The gastrocnemius muscle was also atrophy, and the thigh circumference was significantly smaller than that of the healthy side. Xue Lifang summarized ultrasound features of thigh muscle damage of ultrasound diagnosis with 19 cases and rupture of the plantar tendon in 4 cases. Longitudinal scan of the tendon and tendon continuity were

found suddenly, which had small amount of liquid aggregation around it. Although nuclear magnetic resonance and ultrasound can clearly is what muscles and the degree of injury and hematoma with associated, the specificity of MRI over the ultrasound can well show the muscles go and muscle between adjacent relationship. [10] P Edouard evaluated in the MRI of the injury of the plantar muscle, and it was considered that the MRI examination could provide the degree of injury of the plantar muscles. The performance is different according to the severity of the injure site. [11]

Experiment object and Methods

When the thigh muscle strength is insufficient, it is very easy to damage the ligament Due to the fast changing of the tennis movement, more and more power. The most common is the torn medial collateral ligament or fracture and the cruciate ligament injury. At the same time, suddenly starting caused easily injured meniscus when the knee in bending. Most of these structures are needed to be repaired by surgery.[12] If not surgery, long-term instability of the knee will increase the risk of re injury and lead to premature degeneration of the knee, which caused osteoarthritis. At the end, it may even progress to require joint replacement treatment, which affected the quality of life seriously.

The fracture of the flexor tendon in the course of movement is a more common disease in tennis, which is usually said of the "tennis legs". The plantar muscle is a degenerative muscle and its tendon is elongated. But its muscle belly is shorter. It is located outside the ankle of the gastrocnemius muscle. The femur is in the sole of the flounder and the gastrocnemius muscle. It stops at the edge attached to the Achilles tendon calcaneus. [13]

Tennis players are often in the squat state at the beginning with the high handball, which is in the buckling state. And then the knee joint in a sudden outbreak of action straight. The ankle joint is injured in the rapid movement of flexion and extension. The athletes are quick and sudden start in athletes based from knee squat state, which leads to the sudden injury in knee extensor moment. The triceps contraction was also at that moment because of the onset of the moment of the plantaris muscle contraction is very suddenly. When the plantar muscle is still in a state of contraction, it is caused by a large force acting on the plantar muscles, which is caused by the great force of the superficial gastrocnemius and the deep.[14]

Experiment object

42 subjects selected (Table L) in the Beijing Institute were studied including 28 male and 14 female. The subjects are engaged in tennis. All subjects had a history of injury. The nature of injury includes acute and chronic knee injury, hamstring strain and four muscle strains of the four types. That had a double lower extremity injury accounted for 6 people. Most of the injured have been fully or partially restored when testing.[15]

Fig. 1: Tennis player thigh injury

Table 1
Subjects BASIC

Gender	Number of people	Age	Height	Body weight
male	28	20.4 ± 3.6	179.0 ± 11.6	75.4 ± 20.8
female	14	20.9 ± 3.1	173.1 ± 7.2	72.2 ± 20.3

Experimental Method

All tests were carried out in the United States on the BIODEX multi joint force and rehabilitation system. Determine knee flexor and extensor seat. [16, 17] Test plan is as follows: concentric contraction is $60(^{\circ})/s\times 5$. Shrinkage and shrinkage are $240(^{\circ})/s\times 15$. Centrifugal contraction is $60(^{\circ})/s\times 5$. General subjects was detected only once in the system, and who has rehabilitation exercise for 2~3 times. Evaluate the results by the evaluation form. The significance of the difference was examined by the paired T test and the rank sum test with taking 0.05 levels.

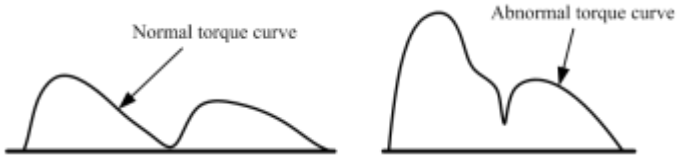

Fig. 2: Normal and abnormal torque curve

Thigh injury judgement

The most regular pattern is the $60(^{\circ})/s$ four - head - muscle force moment curve in the flexion and extension of the knee joint. We will find that the torque curve is very abnormal state of the existence of 9 cases when conducted analysis of this curve. It can be seen in Figure 5. Most of them are produced in the knee joints of long-term chronic injury or knee joints of short-term acute injury and thigh muscle injury.

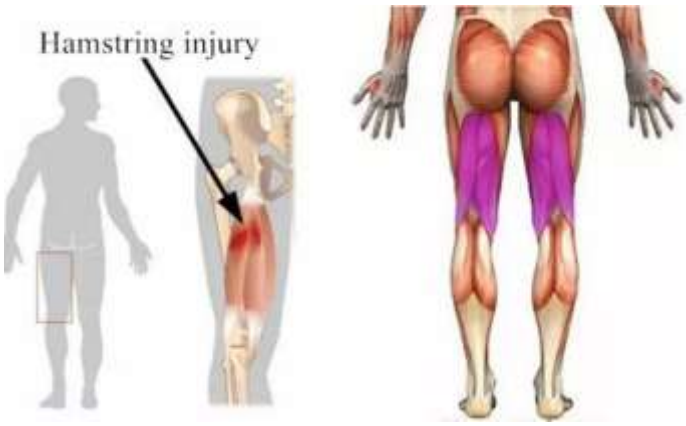

Fig. 3: The hamstring injury

Fig. 4: The plantaris muscle injury

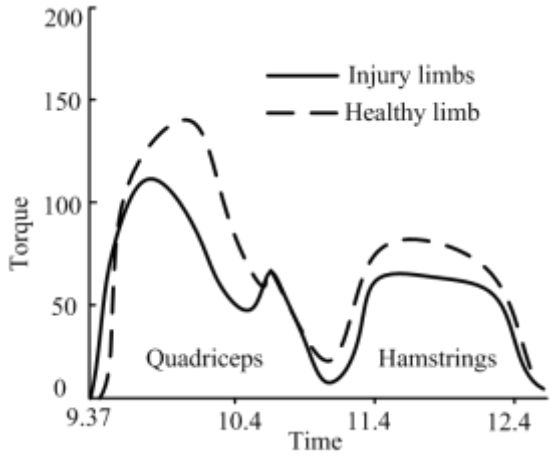

Fig. 5: The abnormal torque curve

Significance of H / Q in the diagnosis of post injury function: Generally believe that H/O is low, the incidence of thigh and knee injury is higher. The damage may lead to H/Q ratio does not adjust status. The results of this study are that all fast, slow, health limb H / Q are less than the injured limb in slow motion and the difference is obvious. Choose the evaluation to form assess the results of H/Q (Figure 6). Contralateral H/Q significantly is lower than the injured side. Conclusions are as follows: the injured side was high and this phenomenon is not accidental to H/Q mean. The reason why the H/Q is too high due to damage to the four head of the muscle function damage was caused by muscle decline in specific analysis of some similar cases. [18] H / Q is low because of mostly impaired function of bilateral hamstring and lead to muscle strength were due to lower, may be due to lack of daily training. H/Q high of function after injury diagnosis has significance in preliminary judgment.

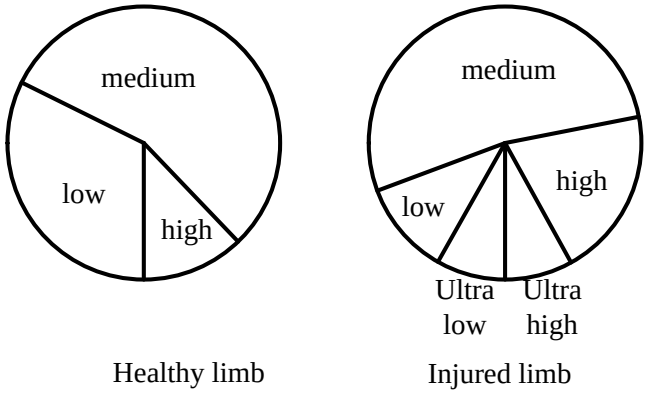

Fig. 6: The distribution of H/Q of healthy limb and injured limb

Significance of I / UN in the diagnosis of injury after injury: Muscle torque ratios on both sides of the same name are not low 90%, which is to maintain the normal value. The low side is abnormal. Qu Mianyu has the following judgment to achieve what degree of rehabilitation: normal training requires muscle strength recovery to 95% normally. The result of the test was analyzed by the evaluation table. The low ratio of I/UN in fast motion is less than the slow motion. Hamstring low I/UN ratio is less than the stock four muscles. Regardless of the speed and no matter what muscle groups, as long as it is low I/UN, which was caused by that contralateral is less strength than the injured side in specific analysis of similar cases. It can be found, it has the effect of diagnosis to the function of knee and thigh injuries when the I/UN index is not high. Most of the four muscles I/UN is not high in the case of the four muscle strain of the femoral head. No matter the knee is acute or chronic injury, it will affect the thigh muscles before and after I/UN.

Firstly, we should grasp the relationship between the torque curve, the knee, thigh and the injury and study whether the torque curve has a significant impact on the distribution of I/UN and H/Q. It can choose to use the rank sum test method to carry on the observation: l) when the muscle contraction is slow, the torque curve of the normal group is significantly lower than that of the abnormal group H/Q. There is no significant difference when conduct rapid contraction.2) The I/UN torque curve of the normal group was significantly higher than that of the abnormal group in the four head of

the femoral head at the time of slow contraction. [19] But the other 3 are not significantly affected. A preliminary conclusion can be obtained By virtue of the relationship between the non-normal and I/UN of the torque curve and the H/Q on the high side: abnormal torque curve can be used as the thigh and knee injury function diagnostic reference index.

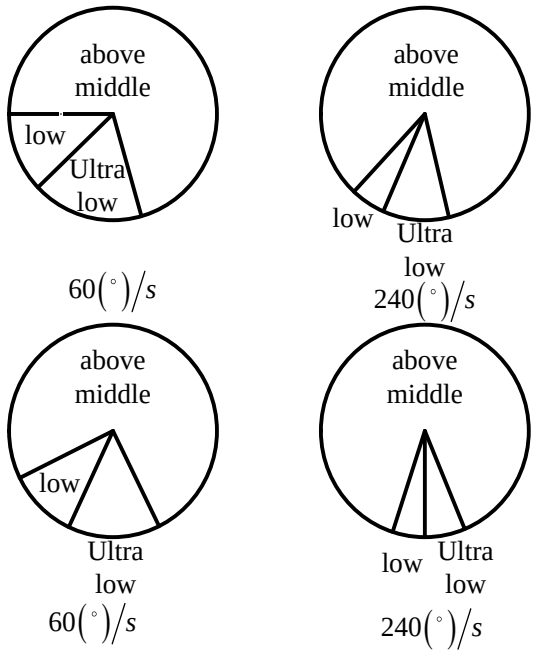

Fig. 7: The I/UN distribution

Therapeutic Method

Adopt PRICE principle: For the wounded immediately treatment after the injury, immediately brake and fix his injured thigh, stop the activities of the injured part with local ice compress. And the temperature of mixture of ice and water is controlled in 0~4^{0}C, and ensure its full contact with skin, 20min/ times. Pressure dressing and raise the injured limb. Since then ice it for 4~6 times in 6h. If the injury is serious, the number and time of ice should be prolonged. The principle of PRICE is Protection, Rest, Ice, Compression, and Elevation.

Exercise therapy method: Early treatment methods: This period is the restricted activity period, the main purpose of treatment is to stop bleeding and reduce inflammatory exudation. The "L" type wire plate of ultra- knee is used to fix the ankle in neutral position, and maintain the stable state of the static.

During the fixed period, the thigh muscle static contraction exercise should be strengthened, with assist of the contralateral upper and lower limbs, waist and abdominal muscle exercise.

Medium-term treatment method: This period is the abreaction period of hematoma and inflammation, and its aim is to promote the dissipation and absorption of blood stasis and inflammation. In this period, continuous observation of local hematoma is conducted by using color Doppler, with the symbol that local hematoma has no worsening signs in the fore walking 3~5d after the lifting plate fixed. Patients should gradually strengthen walking exercise, and still use wire splint to fix the foot and ankle dorsiflexion. Patients during the day to walk are required without the aid of crutches and other auxiliary, and walk 100~200m in the daily morning and evening in a gradual and orderly manner. The limb should choose the heel walking way with the maximum normal gait. After the pain relief, exercise should be gradually increased and accelerated. After the end of each exercise, immediately ice the injured area for 20min. After 2 weeks, the fixed wire splint at night is removed, during the day to increase walking or running exercise. Exercise should be done under the supervision of a doctor: 1) Lunge pull: The injured limb is required in the rear, and two feet parallel to the axis with each maintaining at more than 30s and 3~10 times; 2) Heel raise exercise: At the beginning, the patients use the hand on the wall for exercise, each request quickly put slow with10~20 times; 3) The passive traction is carried out by the doctor after the local massage to relax. Patients prone, with hand pressure the passive flexion and dorsiflexion of ankle joint position. In the maximum extent of the patient's tolerance, the behind thigh muscle is stretched for 30s and 3~6times and the rest interval is 2min. 4) Resistance to flexion and extension ankle joint exercise: Patients are lying on the back, the lower limb extension position, and the rubber auxiliary is used to do the auxiliary ankle injury side plantar flexion and dorsiflexion resistance exercise, each 10~20 times. At the end of the exercise timely, ice the affected area.

Post processing method: This period is the period of adhesions. The sign of the beginning of this period is the disappearance of wound hematoma showed by Ultrasonography (CDFI showed disappearance of liquid dark area), and patients returned to normal walking function. The jump training is increased, at the same time, we will focus on the recovery of adhesion and muscle strength training. Functional recovery should be active and passive stretch combination. 1) Brisk walking or jogging for 200~400m, sooner or later each 1 time; 2) Step lunge pull: Select the about 20cm steps, the healthy limb is used in the front of the injured limb. The heel is left hanging, stretching the muscles of the posterior group of the thigh, and in the maximum tolerance range to maintain 30~60s and 6~12 times, sooner or later each with 1 group; 3) Skipping and high leg exercise should be gradual. At the beginning of skipping exercise, jump 10~100, and after he can be able to complete 100 movements, turning to skipping high leg exercise, every time for 10~40. 4) Passive traction is done with the help of the doctor, and the traction range is strengthened based on the medium term with the traction time of 60s and 6 times. 5) After the rehabilitation training, ice the injured area and rest for 20min.

Fig. 8: Sports therapy-treatment of thigh muscle recovery

TCM Comprehensive Therapy: Traditional Chinese medicine treatment: The new wound detumescence powder can be used as early treatment (phellodendron, angelica and Xue Tong), grinded into powder, and be put on the injured area after taking a little honey with water, one time a day. The wounded with local skin allergy should stop taking the medicine in time. Seven kinds of San Qi oral liquid (San Qi, safflower, radix paeoniae rubra) is taken agent a day, oral 2~3 times, and be taken for 10~14 days in a row in the medium term. After the wound swelling subsided, the blood stasis medicine (safflower, Xue Tong, radix paeoniae rubra) is chosen to pan fried smoked wash, 2 times a day, using 7~14 days. The later term is suitable for selection the oral decoction which can promote blood circulation and relax tendons (notopterygium, schizonepeta, windproof, angelica, radix dipsaci, angelica, achyranthes, peel, safflower, fructus aurantii), one day 1 agent, oral 2~3 times, uninterrupted administration of 7~14 days.

Massage treatment should start in early swelling pain of loss and the stop of local bleeding, and the application of light massage tendon is used to promote blood reflux absorption. According to the situation around the injured blood stasis dissipation, massage force of the medium term is gradually increased. [20] First with the lesser surface touch, kneading manipulation, and to make rubbing, kneading, rolling, kneading and pushing with the heavier technique. In the later period, if the induration cleared is not obvious, it can be supplemented by poking, pressing, lifting and pulling to loosen the adhesion.

Acupuncture treatment: Electric acupuncture treatment is used in 7 days after the injury. The main point is the point of Ashi, with the Xiguan, Chengshan, Zhubin, Weizhong, Taixi, Kunlun, Chengjin, Shen Mai, Zhao Hai and other points. Continuous wave therapy produced by G6805-type II electric acupuncture therapy instrument is used. The electric acupuncture is arranged in a pair of longitudinal manner, continuous wave is used with the frequency of2Hz. The current intensity does not exceed with tolerance of patients for 15min, 1 times /d.

Solution to the key problem of tennis leg injury: Using PRICE principle is an effective approach according to the problem of local bleeding. The prescription of promoting blood circulation to remove blood stasis is determined according to the location of damage. This is the essence of traditional Chinese medicine syndrome differentiation. Activating blood circulation to dissipate blood stasis prescription can pass through its closed resistance, change its blood stasis and promote its new health. But it needs a stable environment to reduce static blood oozing at this time. Brake and fixed can avoid aggravating the injury and reduce local blood accumulation. Moderate muscle contraction can play a role in the pump suction without aggravating the damage and promote blood flow. The bleeding has been basically stopped bleeding limbs after5~7d. The injured limb movement can promote the absorption of blood stasis accumulation reflux. The movement is the important method in promoting the absorption of blood stasis.

Fig. 9: Electric acupuncture

The injury cases due to misdiagnosis and mistreatment to bed rest and immobilization form degree of adhesion heavier and need significantly prolonged recovery time, which was often accompanied by dysfunction according to clinical experience. The plantar muscle is a muscle of the flesh and the tendon of the human body or even there is no 7%~8% without it. So it is unnecessary to suture the plantar tendon. If the fracture position is in ankle plantar flexion scar repair, it will lead to inevitably that plantar extension is not enough resulting in ankle dorsiflexion dysfunction. Therefore, avoid the adhesion is the most important treatment problems in the process. Wire splint neutral position fixation can avoid flexion contracture of two fracture end position in plantar adhesion repair. This static fixation is conducive to the posterior thigh muscles to complete the function of ankle dorsiflexion. Early exercise after injury can strengthen local blood pumping and diffusion so that local inflammation can be reduced. It is inevitable that the local adhesion of the injured area will be reduced.

Walking, running and pulling thigh exercise can effectively increase the thigh muscles of the elastic energy and the extension in essence through stretch training. Zhang Shengnian and other research results are concluded as follows: as far as the tensile strength is concerned, there is a double effect in the stretch of the muscle during the acute strain, which can play a positive role in the repair period. It also has a positive effect on the recovery of the muscle injury and its ability to resist tension and strain. Moderate jogging can have a positive effect on muscles. But the intensity is not

suitable for running a larger. Otherwise the recovery of muscle function is difficult, which increased likelihood of repetitive injury. Therefore, the movement of the exercise therapy and the appropriate load of the sports play a role in the promotion of tennis leg injury. 92% of the patients achieved clinical recovery after 3~6 weeks of injury in the study. Which is faster compared with injury patients without walking pain after 4~12 weeks

Early movement can not only avoid the partial contraction of the injured and the atrophy of the waste, but also can make the overall functional status have been improved. Exercise therapy can accelerate the absorption of blood stasis and can accelerate the injured limb vein and lymph backflow, which not only conduct preventive effect on the site of injury tissue adhesion, reduce the scar, make the gastrocnemius flexibility function be improved and help to restore muscle strength. Blood stasis exudative stage is in the post injury 5~7d. Functional exercise is mainly based on static. On one hand, it can avoid local congestion and exudation. On the other hand, it can prevent muscle atrophy due to decreased muscle strength. The functional exercise can promote repair of wounds of the muscle fascia to conform to the requirements of the motor function of the thigh and avoid local adhesion in the latter part. It is also beneficial for recovery and maintenance of muscle strength. Therefore, the movement method is an important method in damage repair and functional recovery. The results are shown in Table 2 and table 3.

Table 2
Comparison of the results before and after the tennis team strength test

Group	N	Forearm muscle ratio		Thigh muscle ratio	
		Before the experiment	After the experiment	Before the experiment	After the experiment
Control Group	12	2.12±0.27	3.07±0.15	6.14±0.82	7.56±0.96
Recovery Group	12	2.17±0.31	3.94±0.17	6.09±0.97	8.28±0.90

Conclusion

Sports medicine has made great progress in recent years. Therefore, study the injury and recovery of thigh muscles of athletes in tennis competition combined with the theory of Sports Medicine. Conclusions are as follows: Knee flexion and extension with isokinetic concentric $60^{\circ}/s$. If H/Q is on the high side, they are mostly caused by the decline in the strength of the four head of the stock. There is diagnostic significance for the four head of the femoral muscle strain, knee acute, chronic injury after the function. If the knee flexor and extensor muscle group I/UN is low, the number of injuries caused by muscle weakness. The function also has the diagnostic significance to the above injury. The four muscle torque curve of the concentric slow contraction unit is abnormal more with H/Q, I/UN ratio imbalance, which can be used for the selection of athletes and the evaluation of the rehabilitation of injured organs. BIODEX constant velocity measurement system played an important role to the function of the motor function evaluation, check the effect of exercise, determine the recovery of training standards and so. Adopt the combination of sports therapy and traditional Chinese medicine treatment through the analysis of the thigh injury can effectively ease and treatment of injury in tennis and solve the main problems of the leg muscle injury and recovery, which can better avoid the two injury.

Table 3
Tennis players than muscle strength before and after the experiment results

Group	Grip(kg)		Back strength(kg)		Thigh force(kg)	
	Before the experiment	After the experiment	Before the experiment	After the experiment	Before the experiment	After the experiment
Control Group	47.64±4.14	57.77±3.22	76.03±4.15	77.45±3.70	264.64±10.04	327.45±11.40
Recovery Group	48.46±4.90	66.58±4.06	75.21±4.57	79.00±4.46	266.08±11.61	360.67±12.36

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