ANALYSIS OF MUSCLE STRENGTH CHARACTERISTICS FOR FLEXION AND EXTENSION OF THE KNEE JOINT IN FEMALE CYCLING ATHLETES

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The purpose of this study was to analyze the characteristics of muscle strength that is involved in extension and flexion of the knee joint in female cyclists. The flexion and extension exercise of the knee joint is the main source of the muscle power used by the bicycle athlete. It is also one of the subjects which attracts a great deal of attention from scientific researchers and instructors of physical culture both inside and outside of China. For the present study, an advanced CYBEX6000 dynamic testing equipment were used to carry out a considerable amount of research on athletes in various sports events. Based on the published studies from national and international, a specific theory, analysis and exploration were made to the working condition of muscle flexion and extension of the knee joint from the bicycle athlete. The following conclusion was gotten from the comparison between experienced athletes engaged in swimming and boat racing. It was found that athletes engaged in different sports, have different working characteristics of muscle strength from the knee joint. For the experienced bicycle athletes, with the acceleration of rotating speed of the knee joint, the descending degree of the maximum extension muscle torque is much greater than that of the flexion muscle.

KEY WORDS: cycling, knee joint, extension and flexion exercise

INTRODUCTION: It is well known that the main power of the bicycle sport originates from the extension and flexion of the joints of lower limbs. In the exercise of lower limbs joint, the most important aspect is the initiative pedaling with the knee joint to produce strength. The main factor that determines the speed of the bicycle depends on the amount of muscle strength generated by the knee joint, whether the pedaling speed is fast or slow or if the performed strength is in harmony. For the athlete, it is important to know what muscle working capability of knee joint is required. Whether there is any difference between other sports events has yet to be scientifically determined. Up to now, no such details have been reported, related to this research. Therefore, based upon the accumulation of numerous experiments, the writer has selected the experimental data from the 8 experienced female bicycle athletes and also the athletes from the sport of boat racing and swimming. A specific analysis has been carried out on the experimental data for the purpose of extending the theory to explore the problem. The analysis of muscle strength characteristics of extension and flexion of the knee joint from experienced female bicycle athletes will provide some useful reference for coaches and athletes in the sports training practice, and will enrich the theory of bicycle sports training. On the other hand, a constructive suggestion will also be provided for the selection of auxiliary training methods.
The subjects selected for the study included 8 experienced female bicycle athletes and the subjects selected for comparison are 5 experienced athletes from the boat racing team and 5 from swimming team.

METHODS: For the testing equipment, .the advanced CYBEX6000 dynamic testing system has been used. The testing is aimed at knee joint and the experiment code is 0101. The experimental method is extension and flexion. The anatomical zero position of knee joint is at zero degree. The testing speed is at 60°/sec., 120°/sec. and 240°/sec. Each group will be tested three times. The interval for taking a rest will be 30 seconds. Before the formal experiment is started, some detailed explanation about the whole experiment process will be given to the athletes and a pre-experiment will be carried out. The experimental process will be performed strictly according to the operating procedure. The measurement of the gravity force by the errors was corrected by the experimental procedure.
The various data indices from one athlete will be treated automatically by the experimental system and the same indices from the different athletes will be treated statistically. In the

tables are the data for the cycling athletes and are the average value of 8 athletes. The data for the athletes in racing boat team and swimming team are the average value of 5 athletes for each team.

RESULT AND ANALYSIS OF THE EXPERIMENT:

1. Under different experimental speed, the change of the peak torque for the knee joint and the angle of peak torque

Table 1 Part of Knee Joint Mechanics Indices from Excellent Bicycle Athletes

	speed (deg/sec)	60	120	240
Concentric Flexors	Peak torque(kgm)	104±5.1	94±4.3	76±2.4
	Angle of peak orque(deg)	17±2.1	14±1.5	34±2.3
	Peak torque/BW (%)	152±6.7	138±4.8	111±4.2
	Accel time(sec)	0.02±0.00	0.02±0.00	0.04±0.005
Concentric extensors	Peak torque	205±6.7	170±5.3	111±4.8
	Angle of peak torque(deg)	51±3.2	48±2.8	59±3.4
	Peak torque /BW (%)	310±8.9	279±6.7	177±6.7
	Accel time(sec)	0.01±0.00	0.01±0.00	0.02±0.00
Flexors /Extensors	Peak torque(%)	50±2.1	55±1.8	68±1.6
	Avg power (%)	56±2.3	64±2.7	79±1.9
Average ROM(deg)		102±4.1	104±1.8	106±2.9

From table 1, It can be seen that with the accelerating speed of the knee joint flexion and extension in the bicycle athletes, the peak torque for flexion and extension obviously has a tendency of descending. The descending extent of maximum peak torque for extension muscle is much bigger than that of flexion muscle. Among them, the flexion muscle at 240degree/second descended 27% than that at 60degree/second. The extension muscle has been lowered to 46%. The difference between the two is 19%.

Furthermore, from table 1, it also can be seen that under three experimental speeds, the angle of peak torque for the maximum muscle flexion and extension is different. Under the speed of 120degree/second, the angle that occurred in the peak value of torque is the smallest. That is: An irregular change will be take place between the angle that occurred in the peak value of torque and the rotating speed. This problem is under exploration for further study.

2. The Ratio Value for the Maximum Bending and Spreading Torque under Different Speed

Table 2 The Maximum Flexion and Extension Torque Ratio under Different Speed for the Athletes in the Sport of Swimming and Racing Boat

Speed	60	120	240
Bicycle(%)	50±2.1	55±1.8	68±1.6
Swimming(%)	49±1.8	56±2.0	25±1.0
Racing boat(%)	60±2.0	64±2.4	75±3.7

From table 2, it can be seen that under three different experimental speeds, the ratio value of the knee joint maximum flexion and extension torque for the female bicycle athletes will be 50%, 55%, 68% respectively. From this group of data it can be determined that with the acceleration, the ratio of peak torque for flexion and extension shows a tendency of increasing. From table 2, it also can be seen that for the athletes of bicycle and boat racing,

their ratio value of maximum flexion and extension torque will become the same with the change of the speed. But the value for the athletes of boat racing under various speeds will be bigger than the value for the bicycle athletes. But the data for swimming athletes reflect a different trend. It is obvious that the ratio value will be the maximum under the medium speed. It is judged from this that the capability of flexion and extension of the knee joint for the athletes will be effected differently in various sports events due to long term and different way of systematic training. On the other hand, it is illustrated that different sports event have different requirement for the working capability of the knee joint of the athletes. Therefore, when auxiliary training is chosen, the method of training should be chosen based upon different sports events with different characteristics.

3. The Raising Speed of Knee Joint Muscle for Different Item of Sports

Table 3 The Raising Speed of the Knee Muscle under Different Speed for the Athletes of Swimming and Racing Boat

Speed		60	120	240
Bicycle	Flexion	0.02	0.02	0.04±0.05
	Extension	0.01	0.01	0.02
Swimming	Flexion	0.03	0.03	0.14±0.02
	Extension	0.02	0.04	0.07±0.01
Racing boat	Flexion	0.03	0.03	0.06±0.01
	Extension	0.04±0.005	0.04±0.005	0.08±0.01

From table 3, it is apparent that in the flexion and extension exercise with three different rotating speed, the time required for the muscle to be reached to the set working speed will be increased with the acceleration of the rotating speed. But under the same experimental speed, the bicycle athletes are always the first to reach the set speed. When judged from the action frequency of the three items, the action frequency of the bicycle athletes is faster than that of the swimming and racing boat athletes. The characteristics of the event require that the bicycle athletes have fast pedaling capability of the knee joint. On the other hand, it is explained that through long term of systematical training, the main muscle working for different sports event has a different way of providing capability for working.

4. The Percentage of Maximum Bending and Spreading Torque and the Weight of Body

Table 4 The Percentage of Maximum Flexion and Extension Torque with the Body Weight under Different Speed for the Athletes of Bicycle and Swimming

Speed(deg/sec.)		60	120	240
Bicycle	Flexion	152±6.7	138±4.8	111±4.2
	Extension	310±8.9	279±6.7	177±6.7
Swimming	Flexion	117±4.3	110±3.5	27±1.7
	Extension	238±6.7	195±3.4	108±3.1
Racing boat	Flexion	180±3.9	152±4.1	120±1.4
	Extension	235±5.2	216±3.9	137±4.7

From table 4, it can be seen that under various experimental speeds, the flexion and extension strength of unit weight of body in the leg for the athletes in the bicycle sport is much greater than that of swimming athletes. Particularly under fast speed, the difference reached is more than 84%. The flexion muscle strength of unit body weight in the knee joint for the racing boat athletes is much greater than that of bicycle athletes and their extension muscle is smaller than that of bicycle athletes. It has been shown that through long term systematic training, the experienced bicycle athlete possesses very strong capability for fast flexion and extension of the knee joint.

CONCLUSION:

1. For the athletes in various events, through long term systematical training, there appears to be certain differences in the working ability of the knee joint flexion and extension muscle group and in the working characteristics.
2. The experienced bicycle athlete should maintain strong capability for fast flexion and extension in the knee joint. With the acceleration of the exercise speed, the descending extent of extension muscle torque is bigger than that of flexion muscle.
3. When choosing auxiliary training method, according to different event, coaches and athletes should choose respective of training in order to develop the muscle strength to be more suitable to meet the requirement of the event. Thus, the unrelated factors as a result of the training will be decreased and the level of training will be promoted.

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