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Study on the influence of fixed apparatus and variable resistance training on the special sensitivity of college male basketball players

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Abstract: To explore the effects of fixed apparatus strength training and variable resistance strength training on the special sensitivity of college men's basketball players. A college men's basketball players in Chongqing area were selected and randomly divided into fixed apparatus group and variable resistance group. The two groups were supplemented with lower limb strength training on the basis of routine basketball training, the fixed apparatus group was trained with barbell and dumbbell, and the variable resistance group was trained with elastic band. The test data of T-shaped agile run, trapezoidal slide and four-line round trip run before and after 8 weeks of training were analyzed by SPSS statistical analysis of intra-group and inter-group differences. The results showed that the two training methods could significantly improve the special sensitivity of basketball players, and the scores of each agility test had significant differences before and after training (P<0.01); Compared with the fixed apparatus group, the variable resistance group had a greater improvement in the scores of all tests, and

the differences in some indexes between the two groups after training were statistically significant (P<0.05). The research shows that variable resistance training can effectively enhance the explosive power of lower limbs and the ability to change direction, and has a better effect than fixed apparatus training in improving the sensitivity of basketball players. It is suggested to combine the elastic band and other variable resistance equipment with the traditional strength training in college basketball training, so as to optimize the effect of agility quality training.

Key words: Fixed apparatus training; Variable resistance training; Basketball special sensitivity; College men's basketball player

Introduction

Agility refers to the ability of players to quickly change the direction of body movement, which is one of the indispensable physical qualities in basketball. The basketball game is changing rapidly, the players need to stop, change direction and turn in the high-speed running. Good sensitivity can make the players take advantage[1] in the transition of attack and defense. Studies have shown that basketball requires agility as much as speed and strength, and high-level players often have excellent responsiveness[2]. However, in the past, the research and practice of basketball physical training in China paid more attention to the strength and speed quality, and the special research on the sensitivity quality was relatively less. The traditional means of sensitivity training mainly include special exercises such as sensitive running and changing direction running, or combine speed and strength training to improve the ability of changing direction. Fixed equipment strength training (such as barbell squats, half squats) can improve the maximum strength and muscle strength endurance of lower limbs, and lay the strength foundation for sensitivity, but its constant load and relatively slow movement speed may have certain limitations[3] in improving explosive power and rapid direction changing ability. Variable resistance training is the rise of physical training methods in recent years, the typical form is the use of elastic bands and other resistance with the length

of the equipment for training. When the muscles contract to promote the movement of the limbs, the resistance of the elastic band will increase with the stretching, showing nonlinear load characteristics. This feature allows the athlete to maintain muscle force throughout the whole process of movement, which helps to improve the force ability and joint stability after acceleration. Some studies have pointed out that the application of variable resistance such as elastic band to strength training can improve the strength-speed adaptability of muscles and enhance the explosive power[4] of athletes. Therefore, it is of potential value to introduce elastic band training into basketball agility training. However, at present, the comparative study on the influence of fixed apparatus and variable resistance training on the sensitivity of basketball is lacking.

In view of this, this study adopts the experimental method to observe the influence of two different lower limb strength training methods (fixed equipment vs elastic band) on the special sensitivity of college men's basketball players, in order to provide scientific basis and new training ideas for basketball agility training.

1. Object and method of study

1.1 Research objects

In this study, male basketball players from a university in Chongqing were selected as subjects, and 20 male basketball players from a university team were selected, aged 20±1.24 years old, with a training period of 2-4 years. All subjects were in good health and had no recent lower limb injuries. The subjects were randomly divided into two groups: fixed apparatus training group (n=10) and variable resistance training group (n=10). Before the experiment, there were no significant differences in age, training years, physical fitness and basketball sensitivity test scores between the two groups (P>0.05), which showed that the two groups were comparable.

1.2 Research Methods

During the 8-week experiment, subjects in both groups maintained 5 times a week of routine basketball skills and tactics training, and added 2 times a week of lower limb strength training (interval ≥48 hours). The fixed apparatus group mainly used free weight strength training, that is, the use of barbells, dumbbells for lower extremity strength training, the main exercise content is squat and half squat. The load during training is determined according to the maximum strength level of each player (1RM), the initial load is about 60% to 70% of 1RM, 8 to 10 times per group, 4 groups/times, and gradually increase the load weight or

number of training weeks to ensure strength stimulation. The variable resistance group mainly adopts elastic band resistance training, and the practice content is also squat and half squat lower extremity action. According to the strength level of the players, the appropriate resistance level of the elastic band was selected (medium resistance, providing resistance equivalent to about 60% of 1RM in the initial position tensioning state). During the movement, the tension of the elastic band increased with the increase of squatting amplitude. In the variable resistance group, each group performed 8 to 12 movements, 4 sets/times, and gradually increased the resistance of the elastic band (by using the elastic band of higher resistance level) to increase the training intensity. Both groups were required to have standardized movements in the training process, and were guided by the coach on the spot to ensure that the training load and amount reached the expectation.

1.3 Test Indicators

In order to evaluate the sensitivity of the special task, the study selected three indexes, such as T-shaped run test, trapezoidal slide test and four-line round trip run test, as the evaluation means. Specifically, T-shaped running test: subjects run at high speed along the "T" shaped path, including front sprint, side slide and backward running, and record the total time to complete the T-shaped line. Trapezoidal slide test: Draw a trapezoidal area under the basket (simulate the shape of a basketball three-second zone), and the subject moves along the four sides of the trapezoidal step at a fast speed, bypassing each vertex in turn, and recording the time spent to complete the whole course. Four-line round trip test: the subjects start from the end line and sprint to the four marking lines (free throw line, middle line, opposite free throw line, opposite end line) at different distances from the end line on the basketball court. Each line touches the line to return, and then run the next line until returning to the starting point, and record the total time of completing the whole round trip.

The above tests were carried out in the standard indoor basketball court. The subjects fully warmed up before the test. Each test was tested twice in a row to get the best result.

2. Data processing

The test results of the two groups of subjects before and after training were statistically analyzed. All data were expressed as mean ± standard deviation. SPSS 25.0 software was used for statistical processing of the data: before and after intra-group training, paired sample t test was conducted, and independent sample t test was conducted between groups. The

significance test level was set as α=0.05, that is, P<0.05 meant that the difference was statistically significant.

3 Results

3.1 T-Run test

3.1.1 Intra-group comparison of T-run test scores between the two groups

The T-form running score of the fixed apparatus group was 18.0±0.5s before training, and increased to 17.2±0.4s after training, and the score was reduced by about 0.8s, and the difference between the two groups was statistically significant (P<0.05). The performance of the variable resistance group was 17.9±0.6s before training, and increased to 16.8±0.5s after training, and the time was reduced by about 1.1s, which was higher than that of the fixed apparatus group, and the difference within the groups was extremely significant (P<0.01). This indicates that both the traditional strength training with fixed apparatus and the elastic band training can significantly shorten the time of T-shaped agile running and improve the agility of athletes moving in multiple directions.

Table 3.1.1 Comparison of intra-group differences in T-shaped running test results between the two groups before and after the experiment ($\bar{X}\pm S$)

Groups	T-line run times (s) before experiment	T-row running performance (s) after experiment	T	P
Stationary device set	18.0±0.5	17.2±0.4	2.147	0.037 *
Variable resistance group	17.9±0.6	16.8±0.5	4.319	0.000 * *

Note: * means P<0.05, ** means P<0.01.

3.1.2 Comparison of T-run test scores between the two groups

There was no significant difference in T-form performance between the two groups before training (P>0.05). After training, the average performance of T-form running in both groups was significantly improved, but the variable resistance group (16.8±0.5s) was slightly better than the fixed apparatus group (17.2±0.4s). The results of the two groups after training were compared, and the difference reached a significant level (P<0.05), indicating that the improvement effect of elastic band training group on T-shape sensitive running was better than that of the traditional equipment group.

Table 3.1.2 Comparison of T-shaped running test scores between the two groups before and after the experiment (X±S) ¯

Groups	Post-experiment T-run performance (s)	T	P
Stationary device set	17.2±0.4	2.162	0.041 *
Variable resistance group	16.8±0.5		

Note: * means P<0.05, ** means P<0.01.

3.2 Trapezoidal slide test

3.2.1 Comparison of trapezoidal slide test results between the two groups

The trapezoidal slide test score of the fixed apparatus group was 12.5±0.4s before training, and improved to 11.7±0.4s after training, decreased by 0.8s, and the difference was significant (P<0.05). The score of the variable resistance group was 12.4±0.3s before training, and increased to 11.2±0.5s after training, which was reduced by 1.2s, and the difference also reached a significant level (P<0.01). The results show that the two training methods can effectively improve the speed and flexibility of lateral sliding movement of basketball players.

Table 3.2.1 Comparison of differences in trapezoidal step test results between the two groups before and after the experiment (X±S) ¯

Groups	Trapezoidal slide score before experiment (s)	Trapezoidal step score after experiment (s)	T	P
Stationary device set	12.5±0.4	11.7±0.4	2.262	0.027 *
Variable resistance group	12.4±0.3	11.2±0.5	4.471	0.000 * *

Note: * means P<0.05, ** means P<0.01.

3.2.2 Comparison of trapezoidal slide test results between the two groups

After training, the average trapezoidal slide time of the variable resistance group was shorter (11.2±0.5s) than that of the fixed apparatus group (11.7±0.4s), indicating that the elastic band group had a greater improvement in lateral slide sensitivity. The difference between the test groups was significant (P<0.05). This means that variable resistance training with elastic band may have more advantages than traditional machine training in improving lateral movement ability.

Table 3.2.2 Comparison of the difference between the two groups' trapezoidal slide test results before and after the experiment (X±S) $\bar{}$

Groups	Post experiment Trapezoidal slide score (s)	T	P
Stationary device set	11.7±0.4	2.036	0.039 *
Variable resistance group	11.2±0.5		

Note: * means P<0.05, ** means P<0.01.

3.3 Four-way round trip test

3.3.1 Intra-group comparison of the two groups of subjects in the four-line round-trip running test

The four-track round-trip running performance of the fixed apparatus group decreased from 30.0±1.0s before training to 28.0±0.9s after training, with an average shortening of 2.0s, and the improvement was significant (P<0.05). The variable resistance group improved from 29.8±1.2s before training to 26.8±1.0s after training, with an average shortening of 3.0s, and the improvement was more obvious, and the difference was extremely significant (P<0.01). This indicates that after systematic lower extremity strength training, the players in both groups have significantly improved their ability of running back and forth, and can complete multi-stage round-trip sprint faster.

Table 3.3.1 Comparison of intra-group differences in four-track round trip test scores of the two groups before and after the experiment (X±S) $\bar{}$

Groups	Round trip results (s) for the first four lines of the experiment	Round trip performance of the first four lines after experiment (s)	T	P
Stationary device set	30.0±1.1	28.0±0.9	2.261	0.043 *
Variable resistance group	29.8±1.2	26.8±0.8	3.357	0.000 **

Note: * means P<0.05, ** means P<0.01.

3.3.2 Comparison between the two groups of subjects in the four-track round-trip test

After training, the average performance of the variable resistance group (26.8±1.0s) was significantly better than that of the fixed apparatus group (28.0±0.9s), and the difference

between the two groups was statistically significant (P<0.05). It can be seen that in the sensitivity of repeated sprint and return in simulated competition, the improvement effect of elastic band training group is also stronger than that of traditional fixed equipment training group.

Table 3.3.2 Comparison of the difference between the two groups of four-track round trip test results before and after the experiment (X±S) $\bar{}$

Groups	Post experiment Trapezoidal slide score (s)	T	P
Stationary device set	28.0±0.9	2.581	0.017 *
Variable resistance group	26.8±0.8		

Note: * means P<0.05, ** means P<0.01.

4 Discuss

The results of this study prove that both fixed apparatus strength training and variable resistance strength training can significantly improve the specific agility of college men's basketball players in a relatively short period (8 weeks). This is basically consistent with the results of relevant researches at home and abroad in recent years, that is, the enhancement of lower limb strength can significantly promote the acceleration and deceleration ability of athletes in variable direction running, so as to effectively improve the agility performance[5].

As a key special physical element of basketball, agility is directly related to the speed of offensive and defensive transition, breakthrough ability and defensive coverage. Therefore, it is of great training value and practical significance[6] to optimize the strength training mode and enhance its transfer effect on agility. Studies have fully confirmed that there is a significant correlation between lower extremity strength and sensitivity performance, especially the maximum strength and explosive force of lower extremity have a particularly prominent[7] contribution to changing direction speed. Lin Hai et[8] al. 's research shows that through lower limb strength training such as squat, the T-run performance of young basketball players is significantly improved, reflecting that the improvement of lower limb strength effectively enhances the athletes' sensitivity in changing directions. Strength training not only improves the absolute strength, but also shortens the time for muscle contraction to produce the necessary torque, so that athletes have stronger explosive power and control when stopping, starting and turning quickly, laying a physiological foundation[9] for the

improvement of sensitive performance. However, the improvement of sensitivity is not solely dependent on the increase of absolute strength, but more depends on the ability of power to output in the form of speed, that is, power-speed ability or power output ability[10]. In this regard, variable resistance training, which has received much attention in recent years, may have a unique application advantage[11]. Compared with fixed-machine training, variable resistance training can better simulate the dynamic load characteristics in motion. In elastic band squats and half squats training, the resistance gradually increases with the increase of the movement range, so that the athlete still needs to continue to exert[12] in the late acceleration period. This loading mode not only effectively enhances the full force ability, especially the rapid explosive power at the end of the movement, but also is closer to the real stress situation in the game. For example, the acceleration of the push off during the change direction breakthrough often occurs when the large joint is close to the full extension stage, and the intensity peak of the variable resistance training just appears in this movement interval, thus strengthening the specific key movement mode[13]. In addition, when the load of variable resistance training is relatively light, the athletes are allowed to complete the resistance training at higher speeds. This strengt-speed synchronous development mode has a significant effect[14] on the high-frequency coordination of neuromuscular adaptation during the rapid direction change process.

In fixed equipment training, barbell squat due to the constant and usually large load, resulting in the acceleration ability of the movement after the movement is inhibited, it is difficult to achieve resistance training under high speed conditions. This training mode contributes a lot to raising the maximum strength, but it is relatively insufficient to train the high-speed power output capacity required for sensitivity. The advantage of elastic band training is that the load increases with the range of motion, and when combined with low load and high speed training, the strength and speed synergistic training effect is closer to the actual competition demand. Especially in the movements such as stop-start and lateral sliding in basketball, good high-speed power output ability directly determines the athletic performance, and this specific physical characteristic has been more effectively developed[12] through variable resistance training. From a biomechanical perspective, agility requires a high level of centrifugal force for rapid deceleration and a strong amount of centripetal force for rapid reacceleration. Variable resistance training provides the ability to enhance centrifugal-to-centripetal conversion through its unique resistance curve. In elastic-band assisted squats, athletes need to control the process of squatting under the pull of the elastic band (centrifugal

contraction), and then quickly overcome the resistance to complete the standing (centripetal contraction). This cycle enhances the energy storage and release efficiency of the muscle-tendon complex, forming a certain degree of plyomic training effect. At the same time, the continuous tension stimulation in the elastic band training also has a positive impact on joint stability and the coordination ability of small muscle groups. This improvement of overall stability and local control ability is especially beneficial to the sensitivity test performance of lateral stability control, such as trapezoidal slide.

It should be pointed out that sensitivity is a comprehensive ability composed of multiple factors. Zhao Jiawei et[15] al. pointed out that sensitivity includes two major factors: speed of changing direction and reaction ability. The T-shaped run, trapezoidal slide and round-trip run used in this study belong to the sensitivity test in the pre-set mode, which mainly reflects the athletes' ability to change direction speed, but does not involve the reaction and decision-making ability under the scene stimulus. Therefore, when designing agility training in the future, in addition to strength and speed training, situational response training should also be combined to comprehensively develop agility ability. In basketball, a highly confrontational collective ball game, players often need to quickly identify, make decisions and execute directional changes under uncertain stimuli. The integrity of this "perception - decision - execution" chain is the key factor to determine the agility of actual combat. In addition, the sample size of this study is relatively limited, the experiment period is short, and only two training modes of elastic band and fixed apparatus are compared. Future studies can further expand the sample size, extend the training period, and introduce more training methods (such as plyometric training, speed sensitive ladder, dynamic coordination training, etc.) to systematically evaluate the long-term effects of different training combination modes on the sensitivity of basketball. At the same time, combined with sports physiology and biomechanical monitoring technologies, such as surface electromyography, motion capture and ground reaction force analysis, to explore the specific influence mechanism of different strength training modes on the technical details of sensitive movements and biomechanical parameters.

5 Conclusions

Both strength training with fixed apparatus and variable resistance training can significantly improve the special agility of college male basketball players within 8 weeks. Compared with fixed apparatus training, variable resistance training shows a better effect in

improving the special agility of basketball players. It is suggested to combine the variable resistance training with the traditional strength training in college basketball training practice, so as to comprehensively improve the athletes' agility. In addition, the load and frequency should be reasonably arranged according to the training stage and individual differences, and supplemented by special sensitivity exercises and reaction training to achieve the best training results.

Reference：

[1] Zhou Junhui, Zhou Baolong. Correlation Analysis of Body Shape and attacking technique under basket of Cangzhou High School Basketball Center. Abstracts of the 11th National Sports Science Conference, 2019.

[2] Du Pengfei. An experimental study on the Influence of agility Training on foot movement ability of high school male basketball players. Shaanxi Normal University, 2020.

[3] Li Gaofeng, Wang Jun. A meta-analysis of the effects of simultaneous aerobic and strength training on sports performance. Journal of Tissue Engineering Research, 2019,26(26): 7.

[4] Shi Lin, Han Dong, CAI Zhidong, et al. A systematic review and meta-analysis of the effect of variable resistance training on strength performance. Journal of Shanghai University of Physical Education, 2002,46(9): 90-104.

[5] SUCHOMEL T J, COMFORT P, STONE M H. Weightlifting Pulling Derivatives: Rationale for Implementation and Application. Sports Medicine, 2015,45(6): 823-839. (in Chinese)

[6] CHAABENE H, PRIESKE O, NEGRA Y, et al. Change of Direction Speed: Toward a Strength Training Approach with Accentuated Eccentric Muscle Actions. Sports Medicine, 2018.

[7] SPITERI T, NIMPHIUS S, HART N H, et al. Contribution of Strength Characteristics to Change of Direction and Agility Performance in Female Basketball Athletes. Journal of Strength & Conditioning Research, 2014,28(9): 2415-2423.

[8] Lin H. Experimental study on the influence of lower extremity strength training on the agility and quality of adolescents. Guangzhou University.

[9] CORMIE, PRUE, MCGUIGAN, et al. Developing Maximal Neuromuscular Power: Part 2 - Training Considerations for Improving Maximal Power Production. Sports Medicine, 2011.

[10] HAFF G G, NIMPHIUS S. Training Principles for Power. Strength & Conditioning Journal ストレングス & コンディショニング, 2013,20(6): 2-12.

[11] GILA M A S, RIOS I C, GONZALEZ I J B, et al. Effects of Variable Resistance Training on Maximal Strength: A Meta-Analysis. Journal of Strength & Conditioning Research, 2015,29(11): 3260.

[12] PETRE H, WERNSTAL F, MATTSSON C M. Effects of Flywheel Training on Strength-Related Variables: a Meta-analysis. Sports Medicine-Open, 2018,4(1).

[13] SUCHOMEL T J, NIMPHIUS S, STONE M H. The Importance of Muscular Strength in Athletic Performance. Sports Medicine, 2016,46(10): 1-31.

[14] BEATO M, MCERLAIN-NAYLOR S A, HALPERIN I, et al. Current Evidence and Practical Applications of Flywheel Eccentric Overload Exercises as Postactivation Potentiation Protocols: A Brief Review. International Journal of Sports Physiology and Performance, 2019.

[15] Zhao Jiawei. A study on the correlation between agility and speed of changing direction in amateur football players . Sports Fashion, 2019(12): 2.