

RESEARCH ON THE BATTING MECHANISM OF BASEBALL

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The purpose of this study is to improve the batting technique of Chinese baseball athletes through the application of biomechanical analysis. In order to perform successfully, the batting technique of Chinese baseball players requires immediate improvement. The best approach is to improve the traditional batting technique, training methods, and to introduce a new batting mechanism. In practice, batters must emphasize contraction of the muscles around the last joints of arm. The accuracy of batting is of primary importance. The batter starts to swing when the distance between the coming ball and the front line of rubber is about 3.4m. The swinging and batting time should not exceed 0.1s, and the vertical displacement of the gravity of body is near zero during batting. In the instant of contact, the arm is bent and the wrist turns over. These results with the new batting mechanism have been used in practice for more than 3 years, and the feedback from China Baseball Team indicates that the research results have been effective and can be applied easily.

KEY WORDS: batting mechanism, baseball

INTRODUCTION: Many unreasonable ideas and errors in practice can be found in the tradition of baseball teaching and training. Therefore, we carried out a long-term research project on batting technique of China Baseball Team. Based on the results and training practice, an experimental batting mechanism was introduced and applied to practical teaching and training. The feedback from the team proved that the new batting mechanism was quite helpful in improving swinging and batting technique.

METHOD: A KODAK high-speed analyzer system recorded the swinging and batting movement of each batter, simultaneously, from right top view and right side view with the record frequency of 500/s. The recorded images of batters were analyzed and digitalized. One of the purposes of this study was to determine the batting techniques and problems that existed in swinging and batting techniques in the current situation. The other was to check the effects of the new batting mechanism in training. The research results collected from data on the performance of the baseball team were applied to teaching and training. Half a year later, the validity was tested and the new batting mechanism was developed and perfected. The main testing indexes include slugging average, flying distance after batting and accuracy of batting.

RESULTS AND DISCUSSION: Data and competition results indicated that when the batter knocks the coming ball, the speed of bat goes down. The average time span between the highest speed point and the batting point is 4.9 ± 1.8 ms. The batting point is far from the home plate and the average value is 45.76 ± 13.51 cm. The swinging time is too long and the average value is 0.16 ± 0.037 s. The data also showed that the straighter the extension of the arms, the lower is the speed of bat in batting, and the longer it takes from start of swing to actually batting. Also, the greater the distance of the batting point from home plate, the worse is the batting effect. In addition, batters couldn't determine accurately when to start swinging and experienced many failures while judging the pitch of the ball.

Based on the technical condition and experiences in teaching and training, a new batting mechanism was put forward, which is different from traditional baseball theories in terms of stressed parts, technical requirements and training methods. Its main ideals are, first, that accurate judgment is the most important factor and therefore must be stressed. Secondly, velocity of swinging should be controlled by accuracy, and accuracy is in turn coordinated by strength. The batter must actively contract the muscles around the last joints of arm and hand. The movement of the last joints should lead the movement of other joints of the body.

Turning waist is different from turning hip, which was considered to be the same in the past. In addition, the batter must apply the mechanism of stop action effectively. The details of the new mechanism are as follows:

a. The muscle groups of each joint must cooperate and coordinate with each other to finish swinging and batting, but the effect and form of each muscle group are different: some are active, some are passive. The effects of inferior limbs are to turn pelvis, to help the body maintain a good batting position, to pre-extend the length of muscles turning waist. The effects of inferior limbs are to stop suddenly in batting in order to form a firm inferior support, to prevent the body's over-movement in vertical and horizontal direction, and to adjust the body's position and control the range of hip-turning according to the on-coming ball. The major effect of muscle groups for turning waist and shoulder is to generate the greatest power to increase the batting speed. These muscles are the main power-resources, and the amount of power created by them directly influences the value of batting speed. The effect of extension muscles of superior limb was not emphasized in the past, because people did not regard them as a main power source that actually increases swinging speed greatly, but rather as a lever that passes on power. In fact, elbow joint and meta-carpal- joint, not only pass on power, but also create considerable power. It is especially true of the centrifugal contraction of bending elbow muscles and the centripetal contraction of internal-side muscles of meta-carpal joint. It is important to recognize that the initiative activity of muscle groups in meta-carapal joint has a decisive effect on the accuracy and timeliness of batting. This initiative activity leads the activity of muscle groups around other joints.

b. Movement of wrist joint is also a key factor in the new batting mechanism. Exercise anatomy shows that muscle contraction around the wrist joint makes the hand turn round easily, because the muscles across wrist joint are all oblique. In the light of anatomy and muscle mechanics, the anti-striking ability of grasping bat is the worst when the wrist joint is on the turning-over position. So the batter must strike the on-coming ball before the hand has started to turn round. At this moment, the elbow joint is in the absolutely bending position. Based on the test results, the greatest speed of the head of the bat can be obtained when the degree of the right elbow bend is within 100° - 110° . Therefore, the conclusion is reached that the batting condition and batting effect will be the best when the right elbow remains in this bent position.

c. The changed center of gravity in the body: The suitable change in center of gravity of body assures smooth and stable batting. The main reasons that the batter is unable to keep the center of gravity stable are that the batter starts to strike at the coming ball too early and too far from home plate.

d. The significance of ratio between judging time and swinging time: In order to judge correctly the speed, the path of rotation and other things of the coming ball, and to bat the coming ball at high speed, we concluded that the ratio was about 4:1 after precise calculating and testing. The ratio required that the batter should have good physical quality, high-leveled techniques, precise judgment ability and good mental quality.

e. The relationship between accuracy and batting speed: Improving overall accuracy is the primary solution for improved batting average, but developing judging skill and mastering proper starting time are the key to improve the accuracy of batting. Batters should prolong judging time and shorten swinging time. It was calculated that the batter starts to swing when the distance between the coming ball and the front line of rubber is about 3.4m. This has been established as the best time for starting to swing. Also, the swinging time span should not exceed 0.10 s. Accuracy is emphasized, but developing explosive force is also encouraged, because only at high speed can the on-coming ball be struck the maximum distance.

Application in practice: Only when the research results are applied in practice, can their advantages and disadvantages be tested, improved or corrected. The main methods used in training are as follows: (1) Renewing the concept of the game, understanding principles and technical features of new batting mechanism; (2) Completion of fixed exercises, which helps the batter understand and master initiative contracting technique of forearm, such as batting the ball with going down on a knee, swinging and batting by sitting on the pommel horse; (3)

Practice in braking exercises, which requires that the hip, shoulder and leading arm work coordinately; (4) Practice with the start of swinging, such as placing a sign at a point which is about 3.40m to 4.00m away from the front line of rubber; (5) Improvement in swinging speed. It requires that swinging time of the batter not exceed 0.1 s and the batting point should be at the front line of rubber; (6) Strengthening special power exercises, especially in speed-power; (7) Practice in ability to judge the pitch of the ball. After a year's training, the advantages and efficiency of the new batting mechanism can be seen. These improvements lie mainly in such aspects as the improvement of contact average, the accuracy of batting and increase in the batting distance.

CONCLUSION: Through this study, it has been demonstrated that it is feasible to improve the batter's swinging and batting techniques by improving traditional batting concept, using new batting mechanism and training methods. The new mechanism requires that emphasis should be placed on the accuracy of judging and explosive swinging. In addition, changes are required in the traditional training methods that stress training strength only. It is important that the swinging velocity is controlled by accuracy. In practical terms, the batter should pay attention to initiative and leading contraction of muscles around the last joints of arm and hand. During swinging, the muscles' activity of inferior limb and superior body should be coordinated and cooperate with the leading movement of forearm. Braking technique should be applied effectively and at the precise time. In technical index, the swinging time should be short (not more than 0.10s); the center of gravity of body remains stable (The vertical displacement is near zero.). The batter begins to swing when the distance between the on-coming ball and the front line of rubber is about 3.4m, and the best batting point is at the front line of home plate. In the instant of contact, the arm is bent and the wrist joint isn't over-turning. At this time, the bending range of the right elbow is $90^{\circ} < a < 110^{\circ}$ (a is angle of right elbow.)

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