Rotational power and hitting speed in baseball – a case study

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Introduction

Athletic performance, such as throwing, kicking and hitting, can be quantified by the accuracy and velocity of the performance. For a batter in baseball this is to hit and give the ball high velocity in the right direction. High velocity of the ball after impact with the bat is dependent upon both the speed of the bat at impact and the type of collision between the bat and the ball. Speed of the bat is dependent upon the ability of the body to generate force and speed (power) throughout the body.

Throwing and hitting are mechanically similar movements where the biomechanics of throwing has been studied more extensively than for hitting. Due to this similarity, and that more studies have been conducted on throwing, the biomechanics of throwing will be used to describe the sequential transfer of force and energy between the different segments. In throwing there is a coupling of joint motions, or coordination, where there is a distinct proximal to distal sequence of joint rotations from the lower extremity through the trunk and to the upper extremity (Atwater, 1979; Hirashima, Kudo, Watarai, & Ohtsuki, 2007; Liu, Leigh, & Yu, 2010; Putnam, 1993; Wight, Richards, & Hall, 2004). The sum of these different joint rotations allows the body to place the hand in an optimal starting position, as well as executing the throw in an efficient manner (Hirashima et al., 2007; Wight et al., 2004). Ball velocity is therefore dependent on an effective segmental transfer of force and energy from the lower extremities through the trunk to the upper extremity (Atwater, 1979; Toyoshima, 1974). These sequential motions are also reflected in a sequential onset of muscle activation from the trunk to the shoulder and elbow muscles in throwing (Hirashima, Kadota, Sakurai, Kudo, & Ohtsuki, 2002) and hitting (Shaffer, Jobe, Pink, & Perry, 1993).

Hitting the ball in baseball is also largely based upon rotational movement in the transverse plane throughout the body (Escamilla et al., 2009). Consequently, specific rotational tests of force, speed and power should be used when testing baseball players for the physical factors important to hitting, however the authors were unable to find such tests used when systematically searching PubMed. On the contrary, traditional tests such as bench press (Miyaguchi & Demura, 2012) have been used to test baseball players for hitting performance. Based upon the principle of specificity, there would be a great benefit to implement rotational tests of force, speed and power when testing baseball players for the physical factors important to hitting performance.

The purpose of this case study is to determine the effect of rotational force and power training on hitting speed in baseball.

Subject description

BJ (97kg, 185cm) used to be a professional baseball player that has competed both nationally and internationally. He has remained active in his sport for more than twenty years. Now at the age of 37 BJ wants to see if he could beat his personal best in hitting speed with the help of new technology and an even more systematic approach to training.

Examination

Force, speed and power was tested in the following exercises; squat jump, rotation to the right from the left foot and rotation to the left from the right foot. All tests were done in 1080 Quantum. The robotic technology embedded in 1080 Quantum allows for the valid and reliable testing of not only vertical, but also horizontal, generation of force, speed and power. Ball speed from a hitting tee with a wood bat was measured to 137 km/h or 85 mph (stalkerradar, www.stalkerradar.com). See table 1 for details on the other tests.

Test	Load concentric phase (kg)	Load eccentric phase (kg)	Power (W)	Force (N)	Speed (m/s)	Power ((W/kg)*0,67)
Squat Jump	25	25	2216	1293	1,8	34,1
Left leg stance right rotation	10	10	1357	270	5,3	20,9
Right leg stance left rotation	10	10	1553	298	5,5	23,9
Left leg stance right rotation	5	5	1509	226	6,9	23,2
Right leg stance left rotation	5	5	1682	238	7,3	25,9

Table 1. Test results at initial visit. Load in concentric and eccentric phase have different columns since these loads can be set independent in 1080 Quantum.

Intervention

BJ did the following exercises once a week for 4 months; rotational pulls right and left, diagonal posterior to superior pulls with both right and left hand, anterior and inferior push with both right and left hand, single leg squats bilateral and left and right lunges. 1080 Quantum was used for all the strength and power training. Initially the concentric speed limit was set low for all exercises to focus on strengthening through full range of motion. 1080 Quantum has an isokinetic function when the concentric speed is set low. The progression was to gradually increase the speed limit to no speed limit at all with low loads (10-30% of body weight). All exercises were done 5 repetitions and 3 sets.

Outcome

There is a significant improvement in ball speed from a hitting tee, increasing by 5.8% to 145 km/h or 89 mph. Improvements in the rotational power tests ranged from 26-52%. It is interesting to note that there is a decrease of 9% in vertical power. Summary of all results presented in Table 2. Percentage change for each parameter from initial examination is identified in parenthesis.

Test	Load concentric phase (kg)	Load eccentric phase (kg)	Power (W)	Force (N)	Speed (m/s)	Power ((W/kg)*0,67)
Squat Jump	25	25	1912 (-14%)	1147 (-11%)	1,70 (-6%)	31,0 (-9%)
Left leg stance right rotation	10	10	1955 (44%)	346 (28%)	5,7 (8%)	31,7 (52%)
Right leg stance left rotation	10	10	2062 (33%)	372 (25%)	5,9 (7%)	33,5 (40%)
Left leg stance right rotation	5	5	1972 (31%)	287 (27%)	7,0 (1%)	32,0 (38%)
Right leg stance left rotation	5	5	2011 (20%)	283 (19%)	7,2 (-1%)	32,6 (26%)

Table 2. Test results at visit after 4 months. Load in concentric and eccentric phase have different columns since these loads can be set independent in 1080 Quantum. Percentage change in measurements from initial examination.is identified in parenthesis.

Discussion

There is a great improvement in rotational power that coincides with an increase in ball speed from a peg. All rotational power measures showed an increase after training, but vertical power did not. This is an indication that horizontal training, specifically rotational, should receive a greater focus if the goal is to improve power in batting.

Power and strength of upper body exercises have been found to be important in generating bat swing speed (Miyaguchi & Demura, 2012). One study found bench press strength and power to be important. These measures were not normalize to body weight in the analysis, and the average swing bat speed in this study was found to be 123 $km \cdot h^{-1}$ with a standard deviation of 7,9 $km \cdot h^{-1}$ (Miyaguchi & Demura, 2012). This means that BJ upon conclusion of the training program is at least in the upper 2,5% of such a group of athletes.

It seems that the bench press is a common measure of strength and power in baseball (Miyaguchi & Demura, 2012; Szymanski et al., 2010). This test lacks construct validity from a specificity principle based upon movement, since the test neither reflects the asymmetrical nature of arm and hand movement nor trunk rotation. However, other researches have integrated a rotational test, rotational medicine ball throw, into a testing battery to be used in baseball (Kohmura, Aoki, Yoshigi, Sakuraba, & Yanagiya, 2008). The tests we employed are based upon rotational movement from the right and the left foot. These tests with an accurate measures of force, speed and power in the 1080 Quantum, might be a better and more specific tool to be employed to developing and testing in baseball for hitting performance.

Conclusion

Rotational force and power training in 1080 Quantum had a positive effect on ball speed from a peg in a baseball player.

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