Resistance Training to Develop Increased Bat Velocity

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Over the past 15 years the sport of baseball has changed tremendously in the way players prepare in the off season. Today they are training multidimensionally. Training consists of strength/power, speed, agility, plyometric, nutrition, and regeneration. In order for baseball players to enhance hitting performance, they can and should work on two items during the off season. One is swing mechanics and the other is strength/power. Strength/power is going to be addressed in this article as it pertains to increasing bat velocity.

Strength/power can be developed by implementing various forms of resistance training. Baker (1) stated that resistance training exercises can be classified into three categories; general, special, and specific. In order to develop strength/power, a combination of the three resistance training exercises should be implemented. "General" resistance training increases overall strength by using traditional exercises such as squats, deadlift, bench press, and rows. "Special" resistance training is designed to develop power, once strength has been improved, through the use of explosive exercises such as the snatch and clean and jerk lifts, ballistic resistance training like throwing medicine balls, and plyometric exercises. Finally, "specific" resistance training incorporates a training stimulus that mimics actual game motions and their velocities. For hitting, this can be accomplished by using underweighted and overweighted baseball bats.

This article will discuss ways to develop power (bat velocity) for the baseball hitter, and it will be assumed that strength has already been developed. Power is the combination of strength and speed. When the baseball is hit on the sweet spot of the bat, increased power will allow a player to hit the ball with greater velocity resulting in a hard line-drive, hitting the ball farther, or both. The intent of this article is to supply a theoretical rationale for resistance training by identifying the neuromuscular factors that affect bat velocity, and briefly review the relative success of general, special, and specific training exercises that increase bat velocity. Additionally, the application of these different exer cise classifications will be discussed for players at various levels.

Factors Affecting Bat Velocity

Bat velocity depends on the coordination of a sequential, rotational, explosive movement (contractile properties of various muscles), as well as the stretch-shortening cycle (4, 9). In general, hitters tend to move or shift their weight backwards before striding towards the pitcher. This movement backwards is called "loading" by coaches. This is when the stretch-shortening cycle is initiated. Loading should allow a batter to swing with more velocity, most likely through utilization of stored elastic energy and the neural stimulation of muscles in a sequential manner (4, 9). Therefore, it could be said that bat velocity is improved, in part, by training the muscle fibers and the efficiency of the stretch-shortening cycle.

In today's sports media driven society, it appears that maximal strength is one of the most important variables in offensive baseball performance (bat velocity); however, bat velocity is characterized by explosive, rotational force production in a short period of time (power). The fact that explosive, rotational forces in

bat velocity must be produced by the entire body (lower to upper body muscle groups) in about 0.3 s, highlights the need for general, special, and specific resistance training. Consequently, a sound strategy for increasing bat velocity would be to periodize the various types of exercises described previously. This program would be based on the biomechanics of the swing, electromyographic activity of the muscles that contribute to swinging a baseball bat, and the short amount of time for explosive, concentric force production.

Effects of Resistance Training

The effect of various resistance training programs on bat velocity has been studied by a few researchers (4, 5, 8, 10 – 15). Research indicates that to increase bat velocity, one could use various training programs. It is theorized by this author that to develop optimal bat velocity one should incorporate all three types of resistance training methods described by Baker (1). "General" resistance training, for the most part, attempts to increase the muscle's contractile capabilities, "specific" resistance training tries to more efficiently utilization of the stretch reflex and the use of stored elastic energy, while "special" resistance training combines both the contractile and stretch-shortening cycle mechanisms (1).

Periodized "general" resistance training appears to be effective in increasing bat velocity for high school baseball players. Szymanski and colleagues (12, 14, 15) have demonstrated that for high school baseball players a stepwise (% change every 4 wk) periodized full-body resistance training program significantly increases bat velocity on average of 3 – 4% or 2 – 4 mph. What does this mean? If a pitched baseball is thrown at 85 mph and is hit on the "sweet-spot" of the bat, it will travel 375 ft with a bat velocity of 70 mph and 410 ft with a bat velocity of 75 mph.

The amount of "general" strength gained through resistance training may affect the amount of increase in bat velocity of high school baseball players. However, the increase in bat velocity may also be explained by the strength training process per se and not to the amount of change in maximal strength. Bat velocity results for collegiate baseball players who were trained with a "general and special" undulating (% change daily) periodized resistance program did not increase mean bat velocity after 12 weeks of training like the high school players described above (13). Results may be due to position players not having the large gains in maximal strength compared to the high school players, indicating that the college players already had a good strength base. The high school players, on the other hand, were initially much weaker than the college players. Furthermore, the college players did not have access to medicine balls or underweighted or overweighted implements that emphasized the rotational aspect of the baseball swing in the weight room. It may be that "general" strength training alone is insufficient for, or may limit, the amount of increase in bat velocity in college or more advanced baseball players. For example, this may be due to differences in the biomechanical and/or neuromuscular attributes of heavy squats and bat velocity.

The search for better ways to increase bat velocity has led researchers to compare other methods of resistance training, including both "special" (medicine balls) and "specific" (underweighted and overweighted implements). Recent research (14) reported that additional "special" (rotational medicine ball exercises) resistance training provided significantly greater improvements in bat velocity (6.4% vs 3.6%) in high school baseball players compared to resistance training and swinging a regulation baseball bat alone. This is an improvement of an additional 2 mph (5 mph vs 3 mph). This research supports the theory of adding "special" resistance training to a "general" program to increase bat velocity. The combination of "general" and "special" resistance training (traditional weight training and rotational medicine ball exercises) may produce greater bat velocity due to predominantly training both the contractile and stretch-shortening cycle (neuromuscular) components that are used when swinging a bat.

When "general" strength levels are sufficient, a more effective use of the stretch reflex and elastic energy, accomplished with "general and special" resistance training, could provide a better training stimulus. In this regard, when including additional "special" resistance training, such as medicine balls, it appears beneficial to increasing bat velocity (14).

Effects of Overweight and Underweight Training

In addition to the above results, DeRenne et al. (4, 5) reported that for advanced (collegiate and professional) baseball players, "specific" resistance training improved bat velocity by 6 – 10% or 5 – 8 mph. The underweighted and

overweighted resistance training used placed emphasis on the speed of the contraction, force production, and the utilization of stored elastic energy. It may be that the advanced, physically mature baseball players had sufficient "general" strength. Thus, the increased bat velocity could have resulted from a better use of elastic energy and the sending of quicker signals from the brain to the muscles to fire (swing the bat). It is possible that advanced baseball players, who are generally stronger and more powerful than high school players, may benefit more from training with faster contraction velocities or with greater stretch loads to further improve their use of the contractile and stretch reflex/elastic properties of the muscle that occur during the stretch-shortening cycle (6, 7). This may not occur for baseball players with lower strength levels since improvements in bat velocity have occurred with almost any form of consistent training or simply swinging a regulation baseball bat itself (10).

Combining training methods may allow a greater transfer of effects by improving the neuromuscular system (contractile and stretch reflex/elastic properties of the muscle). One must also take into account the specific patterns of motor unit recruitment, the number of motor units recruited, temporal sequencing, and neural firing frequency and rate when performing "specific" underweighted and overweighted bat swings (3).

In agreement with previous research on power development, Bobbert and Van Soest (2) indicate that an increase in strength alone may decrease vertical jump power if the ability to "control" the new degrees of force has not been enhanced. They concluded that "muscle training exercises should be accompanied by exercises in which the athletes may practice with their changed muscle properties" (2). Basically, this supports the use of "general" resistance training to increase muscular strength, and "special and specific" training to "fine tune" muscular control needed to swing the baseball bat.

Training Program

Although the resistance training exercises listed in the first paragraph may help increase bat velocity, an increase in maximal strength itself does not necessarily correlate to increased bat velocity for more advanced players. It should be understood that an increase in squat or bench press (lower and upper body) strength will not automatically increase bat velocity. The ability of the advanced baseball player to transfer the effects of "general" resistance training to the explosive, rotational movement of hitting is questionable. Therefore, it seems appropriate to use not only the traditional "general" resistance training exercises, but to also perform "special and specific" resistance training exercises to produce maximal bat velocity. This may be exactly what the advanced baseball player needs who already has a lot of strength training experience.

In order to develop greater bat velocity, athletes should use a continuum of exercises that incorporate "general," "special," and "specific" forms of resistance training. For example, a resistance training continuum for increasing bat velocity should utilize squats (general), rotational medicine ball exercises (special), and underweighted and overweighted bat swings (specific).

Practical Applications

Reasons to use "general," "special," and "specific" resistance training to increase bat velocity have been provided. A player's training age may dictate which types of exercises are needed to increase bat velocity.

Several recommendations can be from this article:

1. Bat velocity can be increased by implementing a full-body "general" resistance training program for high school or novice baseball players. See Table 1 for "general" resistance training protocol. See Table 2 for schedule of "general" exercises.
2. Combined methods of resistance training may provide the greatest training effect. See Tables 1 and 2 for "special" rotational medicine ball training. See Table 3 for "specific" overweight and underweight bat swing training protocol. Advanced players should incorporate all three forms of resistance training into their program.
3. If not using a combined method, the best approach to increase bat velocity seems to be "general" resistance training for high school players or "specific" (underweighted and overweighted bats) resistance training for more advanced (collegiate and professional) players.
4. Based on previous research (4), do not use loads that are any more than 4 oz lighter or heavier that your game bat (i.e., 30 oz for a college player) when implementing "specific" resistance training. See Table 3. Heavier or lighter loads (bats) have shown not to allow a

player to swing with greater bat velocity.

5. "Specific" resistance loads progress gradually by 1 oz heavier and lighter every 3 weeks over a 12-week training cycle. See Table 3.
6. The role of "general" resistance training programs remains unclear for more advanced players. Although players are getting stronger, their on-field (bat velocity) performance may not be any better than if they did not resistance train, since their bat swing mechanics are already advanced.

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Table 1. "General" and "Special" Resistance Training Protocol (14)

	Weeks 1 – 4			Weeks 5 – 8			Weeks 9 – 12		
	Sets	Reps	%RM	Sets	Reps	%RM	Sets	Reps	%RM
Core Assistance	2 WU	10	45, 50	2 WU	10	45, 50	2 WU	10	45, 50
	3	10	65, 70, 75	3	8	70, 75, 80	3	6	75, 70, 85
	3	10		3		8		3	6
	Medicine Ball Exercises								
	Sets	Reps	Mass	Sets	Reps	Mass	Sets	Reps	Mass
	2	6	5 kg	2	8	4 kg	2	10	3 kg

Reps = Repetitions RM = Reptition Maximum WU = Warm-Up Rest Time Between All Sets = 90 sec.

Table 2. Schedule of "General" and "Special" Exercisese

"General" Exercises	Monday	Wednesday	Friday
Parallel Squat*	X		X
Stiff-Leg Deadlift	X		X
Barbell Bench Press*	X	X	X
Bent-Over Row	X	X	X
Barbell Shoulder Press	X	X	X
Lying Triceps Extension	X	X	X
Barbell Biceps Curl	X	X	X
"Special" Exercises	**Monday**	**Wednesday**	**Friday**
Hitter's Throw	X		X
Standing Figure 8	X		X
Speed Rotation	X		X
Standing Side Throw	X		X

** Core exercise. All other lifts are assistance exercises. This program was kept simple since many of the high school facilities were limited by equipment.*

Table 3. Overweight and Underweight Bat Swing Training Protocol (4)

Weeks	Total Swings	Sequence of Swings	Weight of Bat (oz)
1 – 3	150	50/50/50 (H, L, S)	31, 29, 30
4 – 6	150	50/50/50 (H, L, S)	32, 28, 30
7 – 9	150	50/50/50 (H, L, S)	33, 27, 30
10 – 12	150	50/50/50 (H, L, S)	34, 27, 30

Note: Baseball players either hit batting practice or took dry swings 4x/wk. H = Heavy Bat; L= Light Bat; S = Standard 30 oz Bat