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Multimode Resistance Training to Improve Baseball Batting Power

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summary

This article reviews a variety of resistance training modes that can be used to increase baseball batting power. These modes include strategies that are biomechanically and velocity specific to batting.

Baseball has 4 primary skill areas: running, fielding, throwing, and hitting. Hitting is perhaps the most exciting part of the game, especially in light of the recent home run hitting prowess demonstrated by Major League Baseball players. Historically, some practitioners have thought that resistance training resulted in slower muscle-contractile velocity and caused athletes to become muscle bound, thereby reducing bat velocity and power. More recently, strength and conditioning professionals and high-profile athletes have started to dispel the previous attitude, exposing some of their current strength and conditioning practices along with their successes. Research on a variety of force- and velocity-developing training strategies, independent of as well as related to baseball, also provides a much clearer picture for how to best train athletes. As a result, a number of modes of training are potentially useful for conditioning baseball players. Ultimately, resistance-training programs must use a variety of training modes to attain sport-specific results. The purpose of this article is to review the literature and recommend ways to improve baseball batting power. We will review the principle of velocity and biomechanic specificity, as well as recommend the use of resistance training, Olympic-style lifting, medicine ball and lower body plyometrics, slide board training, ballistic implement training, and over- and underload bat training.

Velocity and Biomechanic Specificity

Accepted principles of training such as periodization, recovery, variation, overload, and specificity are all important for developing a baseball strength and conditioning program (10). Of the aforementioned principles, specificity is most important in order to determine the best exercises for developing power for batting. The principle of specificity requires consideration of the velocity and biomechanical characteristics of the sport (14, 30).

Baseball batting is a highly ballistic movement (10). For example, hitting an 85 mile per hour (mph) fastball 400 ft under standard conditions (no wind and moderate temperature) requires a bat speed of 76 mph (1). Typically, a baseball bat swing takes about one-fifth of a second (1). Consequently, the principle of specificity suggests that conditioning to improve batting power should include high-velocity methods. High-velocity training strategies are most likely to increase the rate of muscular force development because these exercises require the quick recruitment of the type IIa motor units. This is in contrast to low-velocity training strategies that recruit smaller and type I motor units first and activate type IIb motor units only if the overload is significant enough or if the required rate of recruitment increases. Therefore, programs that have advocated the use of machines and slow controlled movements (6) are less likely to be effective for activities that require speed, such as baseball batting. Currently, a variety of methods are recommended (3, 4, 8, 10, 14, 25, 28). These methods include free weight training, plyometric training, and the use of over- and underload bat swings in addition to normal batting practice.

Training to enhance batting power must also be biomechanically specific. Unlike many sports that are performed primarily in the vertical plane of movement, baseball batting involves mostly rotational movements performed in the horizontal plane (10, 16). Additionally, batting power results from the integration of muscle contractions of the lower body, torso, and upper body. Consequently, training methods such as the use of many machines, which isolate muscle groups and do not allow multiplanar movements, are likely to be least effective (29). The principles of velocity and biomechanic specificity suggest the use of total body, multijoint free weight training emphasizing rotational movement, plyometric training, and over- and underload bat training.

Resistance Training

Conditioning programs that emphasize only traditional weight training exercises are not velocity specific and may ultimately lead to no change or decreased movement velocity over time (23). Additionally, the use of most machines will not match the biomechanic specificity of batting (29). A number of sources recommend the use of free weights and dumbbells for developing batting power (3, 26, 28, 29). More specifically, Weatherly and Schinck (28) report that dumbbells appear to be more functional and allow greater range of motion, unilateral development, and increased involvement of the shoulder-stabilizing muscles. Resistance training is also thought to be important to develop a strength base and remedy and to possibly aid in the prevention of injuries and prepare the body physically for plyometric and ballistic exercises (5).

Ground-based weight-bearing resistance training for the lower body is especially important because these exercises have a higher force requirement and require the athlete to manage the external load and his or her own body mass (28). Resistance training recommendations include squats, split squats, forward and lateral lunges, walking lunges, and forward and lateral step-ups (7, 19, 21, 28). Additional emphasis should be placed on plantar flexion because the rear foot drive in the batting stance uses this movement (14), suggesting that exercises such as the toe extension and heel raise might be important. Finally, hamstring work by knee flexion and hip extension exercises is necessary to ensure balance between the quadriceps and the hamstring muscles (27).

In addition to training the lower body muscles, torso strength training is important because the mechanics of hitting require strong abdominals and lower back (2). Together, the lower body muscles and torso generate more than 50% of the force involved in hitting (6). Torso exercises should include a rotary component such as medicine ball throws, Russian twist, back raises with a twist, and rotational sit-ups. Other torso exercises include crunches, leg lifts, good morning, back hyperextension, sit-ups, Roman chair sit-ups, and lying side bends (3, 24, 28, 29).

Upper body resistance training may include traditional powerlifting exercises such as the bench press as well as triceps extension, chest flies, and bent-over forward and lateral raises. Other areas of emphasis may include wrist flexion and extension, radial and ulnar deviation, and pronation and supination, which can be trained through the use of dumbbells, weighted bats, and the wrist roller exercise (3, 21, 28). Resistance training is thought to increase a variety of measures of forearm strength as well as hand and bat velocity, though some evidence suggests that specific forearm exercises may increase forearm strength but not improve variables such as bat and hand velocity more than traditional resistance-training exercises (26). Similarly, research suggests that training designed specifically to increase grip strength did not result in improved bat velocity (15). Finally, consideration should be given to training internal and external shoulder rotation, as has been previously recommended for strengthening the rotator cuff (4, 19, 28).

The body has been described as a kinetic chain with successive links of interdependent muscles and joints (14). In baseball, batting power begins with the lower body, and forces are transferred through the torso to the upper body. For this reason, resistance training exercises should also include whole body, ground-based, closed kinetic chain exercises such as Olympic-style weight lifting variations, including the hang clean, power clean, and snatch (23).

Olympic-Style Weight Lifting and the Variations

To many casual observers, the most obvious batting movement is that of the arms and bat. However, the body is a successive arrangement of linked joints and muscles. Batting power is produced by force generated from the legs, torso, and upper body working together (14). Given these advantages of greater bat speed, it is necessary to train for increased power. Stone (23) reports that Olympic-style weight lifting exercises (sometimes described as the Olympic-style lifts) such as the clean produce significantly greater power output than do traditional weight training exercises such as the squat or bench press. In fact, power output during the second pull of the power clean is approximately 5 and 18 times greater than for the squat or bench press, respectively (23). As a result, strength training exercises such as the clean and jerk; the snatch; and the variations such as the power clean, hang clean, power pull, push press, and power shrug deserve consideration in a program designed to maximize athletic power. Stone (23) suggests these types of exercises may have a greater transfer of training for many power sports, especially in comparison with high-force, slow-movement exercises such as the bench press and squat. Burgener (4) emphasizes Olympic-style lifting exercises during the preseason training period, reporting 70% of training time is spent on exercises such as the power clean, snatch, push press, and power pulls. Preseason training should focus on training muscular power in a ballistic fashion. Although strength-

training exercises and their variations have their place in development of athlete power, they have limited ability to replicate rotational and lateral movements (17). In sum, strength training exercises such at the power clean are not specific to baseball biomechanically but are baseball specific from the standpoint of the rate of force production. However, other modes of whole body, ground-based, kinetic chain movements such as plyometrics, ballistic resistance, and implement training should be included in a program designed to develop power for baseball batting, for these types of exercises may be more biomechanically specific to baseball.

Medicine Ball Plyometrics

Upper body plyometrics performed with medicine balls allow for the biomechanical and velocity specificity necessary to optimize performance in baseball. Medicine ball plyometrics are useful because they stimulate the stretch shortening cycle, including the stretch reflex and serial and parallel elastic tissues, which may be important for enhancing batting power. Additionally, plyometrics allow acceleration of the training load (medicine ball) and projection into free space without deceleration (17). Batting requires acceleration throughout the swing until contact is made with the ball (28). By comparison, conventional strength training exercises may include the undesirable deceleration of the training load at the end of the exercise (16, 27).

Several sources recommend the use of medicine ball training for baseball (3–5, 10, 14, 21, 24, 28). Recommendations include the use of side throws, overhead throws, the medicine ball overback throw, medicine ball rotations and twists, standing medicine ball rotation, kneeling medicine ball tosses, seated medicine ball tosses, overhead throws, and reverse overhead throws. More specifically, Burgener (4) reports using medicine balls of 6, 8, and 10 lb for exercises such as the "drop and throw" (commonly referred to as the power drop), the overhead throw, and simulated batting throws. The latter involves the athlete simulating a batting stance and then stepping and throwing the ball as far as possible, trying to replicate a batting movement.

Lower-Body Plyometrics

When creatively applied, lower body plyometrics can be designed to be highly sport specific to baseball as well. Plyometrics can be used to train either vertical or horizontal acceleration (5). Baseball batting primarily includes lateral (horizontal) movement (10). During the batting stance, the center of gravity begins over the back foot. In this stance, as the batter prepares to swing, the lead foot moves laterally toward the pitcher as the center of gravity moves laterally toward the pitcher (16). The principle of specificity suggests that lower body plyometric training to develop batting power requires drills with lateral movement and weight transfer similar to baseball batting.

Many of the lower body plyometric drills described in the literature emphasize vertical movement and straight ahead power development. Chu (5), however, describes a number of plyometric drills that may be useful for developing lateral and horizontal lower body explosiveness, including single-foot side-to-side ankle hop, hip-twist ankle hop, lateral jump with 2 feet, lateral jump with single leg, lateral jump over barrier, lateral cone hops, and lateral box jumps. Additionally, Bishop and McFarland (3) report using cone jumps, lateral box jumps, and 90° box jumps to train lateral and rotation component of batting.

Slide Board Training

In addition to lower body plyometrics, the slide board or "lateral movement trainer" is useful in training lateral agility and power because of its emphasis on the leg abductors and adductors (20). Slide boards have useful application to many sports and help develop power, flexibility, and kinesthetic awareness (20). The slide board allows the athlete to perform lead foot lateral movement and lateral weight transfer that is similar to what occurs when a hitter strides toward the pitcher. Although not previously described in the literature, one interesting variation is to combine single repetition slide board training with medicine ball throws, trying to replicate push off, lateral stride, as well as torso rotation and upper body movement of hitting. Because it can be made somewhat specific to the lateral movement associated with hitting a baseball, the slide board deserves consideration as a lower body training method for a baseball hitter.

Ballistic Implement Training

The principle of specificity suggests that the closer the exercise is to the primary activity (batting), the greater the transfer of training effect. As previously indicated, traditional weight training may include a deceleration phase during the concentric portion of each repetition. This deceleration is inconsistent with the velocity required in most athletic activities (17). Newton and Kraemer (17) suggest the problem of deceleration can be overcome through ballistic training, which is defined as actually throwing or projecting the resistance into free space.

Some evidence suggests additional practice swinging a bat without ball contact (sometimes referred to dry swings) improves bat velocity (12, 22). Although dry swings seem effective, they could include an eventual deceleration of the bat through reduced motor unit recruitment of the agonist and increased activation of the antagonist. In contrast, a bat that makes contact with the ball is accelerated until the point of contact as the kinetic energy of the ball absorbs some of the bat momentum, requiring less volitional deceleration of the bat. One solution to the possible problem of reduced motor unit recruitment and deceleration may be to take practice swings where a ball is always (or almost always) struck, such as with a pitching machine. Another training option may be to use medicine ball throws from a batting stance with a simulated batting motion (4). Consid-

Table 1
Continuum of Sport-Specific Conditioning Strategies

I.	**Resistance training** • Squats; split squats; forward and lateral lunges; forward, lateral, and crossover step-ups; plantar flexion (toe extension and heel raises); hamstring training • Russian twists, back raises with a twist, rotational sit-ups, crunches, good mornings, Roman chair sit-ups, lying side bends • Bench press; chest flys; tricep extension; forward, lateral, and bent-over raises; wrist flexion and extension, radial and ulnar deviation, pronation and supination, internal and external shoulder rotation
II.	**Olympic-style strength training and variations** • Clean and jerk, snatch • Power clean, hang clean, power pull, push press, and power shrug
III.	**Medicine ball plyometrics** • Side throws, overhead throws, rotations and twists, power drop, batting-stance throws, kneeling medicine ball tosses, combined slide-board slides and medicine ball throws
IV.	**Lower body plyometrics** • Single-foot side-to-side ankle hop, hip-twist ankle hop, lateral jump with 2 feet, lateral jump with single leg, lateral jump over barrier, lateral cone hops, lateral box jumps, and 90° box jumps
V.	**Slide board training** • Slide board training with medicine ball throws
VI.	**Ballistic implement training** • Baseball-bat throws
VII.	**Over- and underload bat training** • Swinging over- and underload baseball bats within +12% of normal game-bat weight

eration should also be given to ballistic resistance training with the most sports-specific implement, namely the bat. This method involves practice bat swings with the release of the bat allowing its projection into free space and is more mechanically specific than medicine ball throws, without the potentially undesirable deceleration associated with dry swings.

Overload and Underload Bat Training

Another important component of power development includes the use of weighted bats, underweighted bats, and overload devices such as the donut ring and power sleeve. To be effective, sport-specific training should closely mimic the actual skill to be performed (14). It would seem logical that training to enhance the power of baseball batting would include the use of bats and devices added onto a bat.

DeRenne and Okasaki (13) report that training with a 34-oz weighted bat and a "power swing" (air-resistance device) resulted in increased bat velocity. Sergo and Boatwright (22) found that in addition to normal practice bat swings, training with extra swings with a regular bat, Fungo bat (underweight), or 62-oz bat resulted in improved bat velocity. However, other studies (11–13, 18) have revealed that training with bats greater or less than 12% of original bat velocity have demonstrated adverse effects on bat velocity. For example, the use of donut rings, bats heavier than 42 oz, and power sleeves produced bat velocity slower than when swinging bats of lesser weight (11, 13, 18). These studies revealed that the mass of the bat and degree of bat overload is inversely related to bat velocity.

Overload and underload bat training appears to be most effective when the training load of the bat closely approximates actual bat weight (12). One recommendation includes bat overload and underload within 12% of a standard (30-oz) bat (12). DeRenne et al. (12) obtained statistically significant improvement in bat velocity of research subjects who performed dry swings as well as a group who performed batting practice with overload bats of 31–34 oz and underload bats of 27–29 oz in addition to training with a standard 30-oz bat. In this training study, the mass of overload and underload implements changed by 1 oz every 4 weeks for 12 weeks. Results reveal that the dry-swing group had an average improvement in bat velocity of 6%, whereas the group who trained with overload and underload bats improved by 10%.

Overload and underload training for bat speed may be theoretically similar to methods of training for sprinting speed, which often relies on overload (resisted running) and underload (assisted running, such downhill running) strategies (2). In both cases, overload training may result in strength, and underload (overspeed) training may result in neural adaptations and speed.

Conclusion

Principles of velocity and biomechanic specificity should guide the design of a baseball batters' resistance training program, with exercises becoming increasingly sport specific as the baseball season approaches. Ultimately, resistance training must use a multimodal approach that attempts to closely replicate rotational and ballistic movements associated with baseball batting. Table 1 describes a number of conditioning strategies that progress from general to sport-specific resistance training. ♦

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