

Plyometric Supraspinatus Strengthening in High School Baseball Players

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Complex coordination of numerous muscle contractions is required to effectively throw a baseball. The complexity of the task is heightened during a game, during which the velocity and location of the pitch determine success. The inherent instability of the shoulder makes baseball players highly susceptible to injury, and adolescent players are especially susceptible.¹ Shoulder injuries in baseball range in severity from general tenderness to Little Leaguer's shoulder, which involves a stress fracture of the proximal humeral epiphysis.^{2,3} Such injuries are often associated with overuse and pitching while fatigued.⁴ Previous research has demonstrated that type of pitch, number of pitches thrown per game, and number of pitches thrown during the season can contribute to shoulder pain in youth baseball pitchers.⁵ Fleisig et al.⁶ reported that fundamental pitching mechanics remain constant during progression through youth, high school, college, and professional levels of competition, but joint forces increase as an athlete matures. Thus, players at high levels of competition possess elevated risk for injury. Fortunately, increasing strength as the body matures can help prevent such injuries.

The incidence rate of injuries requiring medical intervention in adolescent baseball players appears to be increasing,⁷ which is believed to be associated with an increase in both the intensity and frequency of competition.⁸ Many overuse shoulder injuries do not develop until the mid to late teens (i.e., high school age).⁹ Guidelines for injury prevention in baseball have been focused on limitation of the total number of

pitches thrown during a game or season and regulation of the types of pitches thrown.^{4,5}

Research has demonstrated that proper preparation and strengthening of the shoulder musculature can prevent injuries in throwing athletes.^{7,10-12} Many of the training programs developed exclusively for baseball players have focused on strengthening the rotator cuff muscles (i.e., subscapularis, supraspinatus, infraspinatus, and teres minor),^{13,14} which dynamically stabilize the glenohumeral joint.¹⁵ The supraspinatus tendon is especially vulnerable to injury during performance of the throwing motion due to its anatomical proximity to the inferior surface of the acromion. Both overuse tendinosis and also impingement of the supraspinatus tendon between the head of the humerus and the acromion are associated with muscular weakness.¹⁶ Supraspinatus weakness has been related to the incidence of shoulder injury in professional baseball players.¹⁷ Yanagisawa et al.¹⁸ identified increased MRI signal intensity in the supraspinatus muscle after a pitching session. Thus, adequate strength of the supraspinatus muscle appears to be an important factor for prevention of throwing injuries in baseball players.

Plyometric exercises, which involve rapid transitions from eccentric to concentric muscle contractions, have been advocated for rotator cuff strengthening.¹⁹ Rapid transition in contraction mode during the stretch-shortening cycle is believed to enhance muscle reactive capabilities that improve dynamic joint stability.²⁰ Plyometric training regimens often use medicine balls for performance of exercises that replicate the eccentric and concentric forces associated with pitching.

Despite widespread use of plyometric training, very little research has been done to assess the effectiveness of such programs. The “Ballistic Six” is a sport-specific plyometric training program designed to strengthen the rotator cuff muscles in the throwing athlete.²¹ Carter et al.²² found that this program significantly improved throwing velocity in college baseball players, but the strength increase that resulted was not significantly greater than that observed in players who performed an alternate off-season strengthening program that involved elastic resistance and dumbbells, and they did not specifically assess strength increase in the supraspinatus muscle. We examined the effectiveness of the “Ballistic Six” for strengthening of the supraspinatus musculature in high school baseball players.

Procedures and Findings

Four high school baseball players were recruited from two high schools in Portland, Maine: one catcher, one pitcher, one infielder, and one outfielder (average 16.25 years of age, 174.1 cm height, 71.4 kg weight). Three of the participants played at the varsity level and one was on a freshman baseball team. One participant who was also engaged in a separate off-season program of exercises and baseball pitching was dismissed after shoulder fatigue precluded continued participation in the “Ballistic Six” training program.

Hand-held dynamometry was used to obtain two pretraining assessments of the supraspinatus strength that were at least seven days apart (Figure 1). Kelly et al.²³ demonstrated that isolated activation of the supraspinatus muscle is best achieved in a position of 90 degrees of scapular elevation and 45 degrees of glenohumeral external rotation, and hand-held dynamometry is an accepted method for determination of upper extremity strength.²⁴⁻²⁸ The two pretraining strength assessments were averaged to establish baseline strength level, after which participants completed a 10-week training program (Table 1). The “Ballistic Six” program consists of six plyometric exercises that are performed two times per week (Figure 2).²¹ Each exercise session was supervised by the principal investigators to ensure program completion and to monitor participant safety. A single post-training strength assessment was performed within one week of completion of the 10-week training program. All three of the athletes demonstrated an increase in supraspinatus strength (Table 2), which averaged 4.28 kg of increased force output.

Discussion

Numerous studies have documented that high school baseball players are at high risk for the occurrence of a shoulder injury,^{2,8,29} which is primarily due to the ballistic nature of the throwing motion.^{6,15} The supraspinatus muscle is particularly susceptible to injury.^{17,18}



Figure 1 Positioning for hand-dynamometer measurement of supraspinatus strength.

TABLE 1. PROGRESSION OF THE BALLISTIC SIX EXERCISE PROGRAM

Phase	Volume	Intensity
Weeks 1-4	3 sets of 10 repetitions, 30 seconds rest between sets	2.2-lb ball for one-handed throws 6 lb-ball for two-handed throws
Weeks 5-7	3 sets of 15 repetitions, 30 seconds rest between sets	2.2-lb ball for one-handed throws 8-lb ball for two-handed throws
Weeks 8-10	3 sets of 20 repetitions, 30 seconds rest between sets	2.2-lb ball for one-handed throws 10-lb ball for two-handed throws