The effect of Crossover Symmetry versus Jaeger J-Bands on shoulder strengthening

Matthew T. Sims; Jennifer L. Volberding PhD, ATC, LAT;

Matthew S. O'Brien PhD, ATC, LAT

Key Points: **(1)** Both programs significantly increased internal and external rotation range of motion and strength. **(2)** Increases were not dependent on the shoulder strengthening program performed. **(3)** Duration of the program is the main factor in strengthening.

Key Words: resistance training, overhead, throwing

Abstract: Shoulder injuries are common in baseball due to the rotator cuff's repetitive eccentric contractions through the deceleration phase. Shoulder strengthening programs are crucial in overhead throwing athletes to strengthen the concentric and eccentric arm musculature for performance enhancement and injury prevention. The purpose of the study was to compare Crossover Symmetry and Jaeger J-Bands to determine if significant internal and external rotation range of motion (ROM), strength and torque increases occurred. The results demonstrated significant increases in internal and external rotation ROM and strength in the experimental groups. Overall, the findings suggest time is the main factor in shoulder strengthening rather than the program.

INTRODUCTION

The National Collegiate Athletic Association (NCAA) is comprised of 1,120 colleges and universities of which 950 (84.8%) schools have baseball teams and 1,003 (89.6%) schools have softball teams.[1,2,3] With a high level of participation, it is crucial to understand and prevent the multidimensional injury patterns of the shoulder joint in overhead throwing athletes. According to the NCAA Injury Surveillance System (ISS), 12.1% of varsity men's baseball programs reported 1,623 shoulder injuries over a 16-year period (1988-2004).[4] Of the 1,623 recorded shoulder injuries, 972 (59.5%) injuries were associated with a throwing mechanism, with pitching accounting for 709 (73.0%) of the cases.[4] ISS data has shown that shoulder injuries account for 39.4% of all baseball injuries and 15.8% of softball injuries at the collegiate level.[4,5] Forty-two percent of game injuries were due to a no-contact mechanism, such as pitching which accounted for 15.3% of injuries and throwing (non-pitching) at 5.3% of injuries.[4] Pitchers, alone, accounted for 20.9% of all game injuries.[4]

The overhead throwing motion causes extreme forces and torques on the muscles, ligaments, capsule, and labrum of the shoulder.[6] The phases of the overhead throwing motion prior to the baseball being released consist of the windup, early cocking, late cocking, and acceleration phase.[7,8] Large forces generated throughout these phases are counteracted during the deceleration phase. During overhead throwing, it is reported that the arm is capable of reaching speeds greater than 10,000°/s during internal rotation with counteracting, compressive forces of greater than 1000 N, adduction torques of 110 N-m and horizontal abduction torques of 97 N-m during the deceleration phase.[6,9,10] The glenohumeral (GH) internal rotators are responsible for the torque production throughout the first four phases of the throwing motion while the posterior GH capsule and the GH external rotators are responsible for the force absorption during the deceleration phase.[11] Therefore, the strength of shoulder muscles are important for both the athletic abilities of baseball players as well as the health of their shoulder structures.

Healthcare professionals utilize different forms of shoulder exercise protocols for athletic-related shoulder injury prevention and rehabilitation. Previous studies demonstrated that shoulder strengthening exercises of the shoulder rotators and scapular stabilizers can be as effective as surgery in treating athletic-related shoulder injuries especially in the throwing population.[8,12,13,14] There are a wide range of strengthening protocols and systems that are currently utilized in the healthcare field to prevent injuries, rehabilitate injuries, and/or improve performance. Crossover Symmetry[15] (CS) and Jaeger J-Bands[16] (JJB) are two new resistance band-based systems utilized within high school, collegiate, and professional baseball clubs for shoulder strengthening, injury prevention and rehabilitation purposes. CS is a band-based program modeled on rotator cuff and scapular strengthening that is structured around seven (row, reverse fly, punch plus, 90/90, scaption, incline plus, victory) different exercises that are broken down into three (activation, recovery, and plyometric) phases.[17] JJB is an eleven exercise rotator cuff strengthening program. The first five (over-the-head forearm extensions, side extensions, diagonal extensions, forward flies, and reverse flies) exercises are dual-arm exercises while the following six (internal rotation, external rotation, elevated internal rotation, elevated external rotation, reverse throwing, and forward throwing motion) exercises are throwing arm specific exercises.[18] The purpose of this study was to compare CS and JJB to determine if they provide a significant increase in shoulder ROM and torque in internal rotation and external rotation.

METHODS

Participants

Thirty-six (males 18, females 18; age: 21.56 ± 1.58 years) healthy, moderately active college students from a large southern institution volunteered for the study and were randomly assigned to one of three groups (JJB, CS, or Control). Participants were excluded if they had any of the following: (1) over the age of 30 years or younger than 18 years; (2) history of an upper extremity injury in either arm in the last six months; (3) loss of sensation or muscle function in either arm; (4) brain related condition or injury that influences arm function, (5) uncontrolled asthma; or (6) a known heart condition. Procedures were explained in detail to the participants while they completed a health history questionnaire and signed an informed consent form approved by the Institutional Review Board for Human Subjects Research.

Instrumentation

Two different resistance band-based systems were utilized in this study. The CS system used a 7-lb and 15-lb set of resistance bands with handles while the JJB system was comprised of one set of resistance bands with Velcro wrist straps. An isokinetic dynamometer, Biodex System 4 Pro, was used to assess active range of motion (AROM) and torque production.

Tasks

CS and JBB participants performed a pre-determined exercise regimen each session. The CS program consisted of 8 normal repetitions, 10 four-second negative (slowly resisting the release of the band’s tension throughout the ROM) repetitions and 25 plyometric (maximal muscular contraction over a short, end ROM) repetitions for each exercise. CS participants performed three exercises (row, reverse fly & pulldown) at eye level and four exercises (90/90, scaption, incline plus & victory) at knee level. JBB participants performed five dual-arm exercises (over-the-head forearm extensions, side extensions, diagonal extensions, forward flies & reverse flies) and six throwing arm specific exercises (internal rotation, external rotation, elevated internal rotation, elevated external rotation, reverse throwing & forward throwing motion). Control group (CG) participants only performed the three dynamometer assessments.

Procedures

Participants reported to the testing area wearing athletic attire for all dynamometer assessments and the exercise physiology lab for all strengthening sessions. The first session consisted of a health screening, informed consent, familiarizing the participant to the procedures, and group assignment. Baseline data for range of motion and torque was collected. Participants assigned to the CS or JJB groups completed three supervised strengthening sessions per week for four weeks. Control group participants just maintained their normal workout regimen. All participants completed a mid-participation dynamometer assessment following the sixth strengthening session and the exit dynamometer assessment following the twelfth strengthening session. To eliminate the influence of fatigue, participants were not allowed to complete workout sessions on the same day as their dynamometer assessments.

Each dynamometer assessment of the dominant shoulder was performed twice in each rotational pattern – internal (IR) and external (ER) – with a 30 second rest period between each repetition and protocol. All of the testing procedures were performed while the participant was in a seated position with 90° of shoulder abduction, 90° of elbow flexion and the axis of rotation of the isokinetic dynamometer's attachment arm aligned with the midline of the shaft of the humerus. During the AROM measurements participants actively rotated their shoulder internally and externally as far as possible beginning at 90° of shoulder IR. Following, participants performed maximum voluntary isometric contractions (MVIC) starting in a position of 45° of shoulder IR. Finally participants performed 60°/s and 120°/s isokinetic contractions beginning at 0° of shoulder rotation for ER isokinetic measurements and 90° of shoulder IR for IR isokinetic measurements.

Statistical Analysis

A one-way repeated measures ANOVA with a Bonferroni correction for multiple comparisons was performed using IBM SPSS Statistics 21 (Armonk, NY.) to evaluate the effect of each shoulder strengthening protocol on AROM and strength gains between the different groups. The independent variable was the workout protocol assigned to the subject: CS, JJB, or control group. The dependent variables were shoulder internal and external AROM (degrees), maximum voluntary isometric contraction (torque – ft/lbs), 60°/s isokinetic contraction (torque – ft/lbs), and 120°/s isokinetic contraction (torque – ft/lbs) of the dominant limb. MVIC and isokinetic measurements were recorded based on the highest peak torque value (ft·lbs) during the contraction.

RESULTS

ANOVAs for AROM IR, isometric IR, isometric ER, 60°/s IR, 60°/s ER, and 120°/s IR increases were all statistically significant ($P < .05$) when compared over time (Table 1). Means and standard deviations at the pre-participation, mid-participation and exit participation dynamometer measures are reported in Table 2 for each research group. Pairwise comparisons

Test	F	Significance
AROM IR	9.347	0.000
AROM ER	1.459	0.242
Isometric IR	3.638	0.020
Isometric ER	4.344	0.004
60°/s IR	6.348	0.001
60°/s ER	6.725	0.000
120°/s IR	7.658	0.000
120°/s ER	2.151	0.084

Table 1 – *F-value and statistical significance associated to each testing parameter.*

Test	Measure	Crossover Symmetry Mean	Crossover Symmetry Std. Dev.	Jaeger J-Bands Mean	Jaeger J-Bands Std. Dev.	Control Mean	Control Std. Dev.
AROM IR	**1**	73.38	10.11	74.67	8.48	73.63	11.71
	2	84.54	10.72	79.25	11.33	75.17	10.47
	3	89.13	14.71	82.38	10.03	73.42	9.27
AROM ER	**1**	141.79	10.11	146.13	5.62	146.63	2.60
	2	142.67	10.27	145.00	5.52	145.33	4.63
	3	147.46	1.08	147.75	0.62	147.13	1.73
Isometric IR	**1**	30.46	12.91	34.75	14.39	36.00	17.66
	2	33.83	15.19	36.88	15.65	36.08	17.20
	3	36.54	16.63	40.04	16.92	35.96	17.17
Isometric ER	**1**	19.67	8.59	22.38	7.77	24.00	11.94
	2	21.08	9.68	22.25	7.03	22.71	11.51
	3	21.88	8.47	23.17	7.00	23.04	11.73
60°/s IR	**1**	24.88	11.64	27.33	8.22	30.17	15.77
	2	29.96	13.90	29.46	11.17	28.54	14.00
	3	32.79	15.65	31.42	11.32	26.92	13.38
60°/s ER	**1**	13.83	5.33	15.67	5.28	16.88	8.93
	2	16.25	8.29	17.08	6.33	14.75	7.48
	3	16.42	7.47	17.25	5.53	15.13	8.18
120°/s IR	**1**	25.04	12.86	24.38	8.42	26.38	13.04
	2	29.00	14.31	26.92	10.25	23.33	13.44
	3	31.04	14.84	28.71	10.11	23.63	13.57
120°/s ER	**1**	12.63	6.57	14.46	5.06	13.50	6.63
	2	14.54	8.02	14.79	5.48	12.25	6.59
	3	14.46	6.60	15.42	5.78	12.54	6.56

Table 2 – *Means and standard deviations of each testing parameter at the pre-participation (1), mid-participation (2), and exit participation (3) dynamometer measures.*

of mean difference ANOVAs performed found only two cases of statistical significance ($P < .05$) in the 1st versus 2nd time pairwise comparisons which occurred in AROM IR and isometric IR (Table 3).

Time Pairwise Comparisons		Test: AROM IR	AROM ER	Isometric IR	Isometric ER	60°/s IR	60°/s ER	120°/s IR	120°/s ER
	1st vs 2nd	-5.764***	0.514	-1.861*	0.000	-1.861	-0.569	-1.153	-0.333
	1st vs 3rd	-7.750***	-2.597	-3.778**	-0.681	-2.917*	-0.806	-2.528*	-0.611
	2nd vs 3rd	-1.986	-3.111*	-1.917**	-0.681	-1.056	-0.236	-1.375*	-0.278

Table 3 – *Time pairwise comparisons of the mean difference between each testing parameter and the pre-participation (1st), mid-participation (2nd), and exit assessment (3rd). *P < .05, **P < .01, & ***P < .001*

In 1st versus 3rd time pairwise comparisons, statistical significance ($P < .05$) was noted in AROM IR, AROM ER isometric IR, 60°/s IR, and 120°/s IR. 2nd versus 3rd comparisons were statistically significant ($P < .05$) in AROM ER, isometric IR and 120°/s IR (Table 3).

DISCUSSION

Shoulder injuries have been noted to be the most common injury in baseball due to the repetitive eccentric contractions of the rotator cuff through the deceleration phase of a pitch.[19] Several studies have focused on the concentric strength of arm musculature due to the performance enhancement rather than the eccentric strength which is the most critical aspect in injury prevention. Shoulder strengthening is an important area of focus in overhead throwing athletes for performance enhancement as well as injury prevention due to the repetitive forces and muscular fatigue throughout the motion. Our goal was to determine if either CS or JJB provided a significant increase in ROM, strength and torque pertaining to internal and external rotation and aimed to identify whether one strengthening protocol proved superior. The main finding noted in this study was that ROM and strength increases occurred with both protocols but were not dependent on the program performed. Instead the findings suggest the amount of time over which the strengthening protocol is performed is the main factor in shoulder strengthening. Contrarily, Swanik et al[20] reported there were no findings of significant isokinetic strength differences between experimental and control groups; however, the different forms of resistance – rubber tubing, dumbbells, and body weight – and highly trained subject population attribute to this insignificance. In a recent study by Hibberd et al[21], a 6-week shoulder strengthening program using resistive bands also found significant strength differences. Findings by Magnus et al[22] support this data with strength increases in shoulder internal and external rotation when using an at-home resistance-tubing shoulder strengthening program.

Limitations

Individual effort could not be assessed. The exercise programs were explained to the participants and each session was monitored; however, a participant's self-motivation and effort put forth towards each session was dependent upon themselves. Additionally, the researchers lacked the ability to control strength and flexibility training participation outside of the research subjects. While these strength programs were compared across the same parameters, they are both different from one another in structure and performance. Finally, eccentric strength was not tested which prevents this study from statistically supporting the effectiveness of CS or JJB in preventing injury.

Clinical Implications

This study showed the effectiveness of resistance band shoulder programs in strengthening shoulder musculature used in the overhead throwing motion. Clinicians can use Crossover Symmetry, Jaeger J-Bands and many other resistance bands in arm conditioning sessions for overhead athletes to improve internal and external rotation strength. Additionally, the time dedicated to a shoulder strengthening program is a key component to the effectiveness of the program and the resultant strength increases.

Future Research

In future studies, researchers should attempt to conduct a study of longer duration to determine if there is a significant difference in strength increases between the two, Crossover Symmetry and Jaeger J-Bands resistance band shoulder programs. Researchers should also increase the number of participants of both sexes to allow for a pairwise comparison between sexes to determine if either of the shoulder strengthening programs were statistically significant to one sex or the other.

REFERENCES

1. NCAA Members By Division – All Active Members. National Collegiate Athletic Association. http://web1.ncaa.org/onlineDir/exec2/divisionListing. Accessed April 19, 2015.
2. NCAA Sports Sponsorship: Baseball – All Divisions. National Collegiate Athletic Association. http://web1.ncaa.org/onlineDir/exec2/sponsorship. Accessed April 19, 2015.
3. NCAA Sports Sponsorship: Softball – All Divisions. National Collegiate Athletic Association. http://web1.ncaa.org/onlineDir/exec2/sponsorship. Accessed April 19, 2015.
4. Dick R, Sauers EL, Agel J, et al. Descriptive epidemiology of collegiate men's baseball injuries: National Collegiate Athletic Associate Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Training.* 2007;42(2):183-193.
5. Cole AK, McGrath ML, Harrington S, Padua DA, Rucinski TJ, Prentice WE. Scapular bracing and alteration of posture and muscular activity in overhead athletes with poor posture. *J Athl Train.* 2013;48(1):12-24.
6. Werner SL, Gill TJ, Murray TA, Cook TD, Hawkins RJ. Relationships between throwing mechanics and shoulder distraction in professional baseball pitchers. *Am J Sports Med.* 2001;29(3):354-358.
7. Laudner KG, Moline M, Meister K. Lack of relationship between glenohumeral external-rotation strength and posterior shoulder tightness in baseball players. *J Sport Rehabil.* 2012;21:12-17.

8. Meister K. Injuries to the shoulder in the throwing athlete, part one: biomechanics/pathophysiology/classification of injury. *Am J Sports Med.* 2000;28-265-275.

9. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. *Am J Sports Med.* 1995;23:233-239.

10. Fleisig GS, Kingsley DS, Loftice JW, et al. Kinetic comparison among the fastball, curveball, change-up, and slider in collegiate baseball pitchers. *Am J Sports Med.* 2006;34:423-430.

11. Jobe FW, Tibone JE, Perry J, Moynes D. An EMG analysis of the shoulder in throwing and pitching, a preliminary report. *Am J Sports Med.* 1983;11:3-5.

12. Wilk KE, Meister K, Andrews JR. Current concepts in the rehabilitation of the overhead throwing athlete. *Am J Sports Med.* 2002;30(1):136-151.

13. Meister K, Andrews JR. Classification and treatment of rotator cuff injuries in the overhand athlete. *J Orthop Sport Phys.* 1993;18(2):413-421.

14. Wilk KE, Obma P, Simpson CD, Cain EL, Dugas J, Andrews JR. Shoulder injuries in the overhead athlete. *J Orthop Sport Phys.*2009;39(2):38-54.

15. Partners/Clients. Crossover Symmetry. http://crossoversymmetry.com/9171-2/. Accessed March 21, 2015.

16. Jaeger Sports Participants. Jaeger Sports. http://www.jaegersports.com/Participants/. Accessed March 21, 2015.

17. Fusion Solo. Crossover Symmetry. http://crossoversymmetry.com/product/fusion-solo-8/. Accessed April 19, 2015.

18. J-Band Baseball Exercise Sheet. Jaeger Sports. http://www.jaegersports.com/pdf/J-Band_Baseball_Exercise_Sheet_01132015.pdf. Accessed April 19, 2015.

19. Lachowetz T, Drury D, Elliot R, Evon J, Pastiglione J. The effect of an intercollegiate baseball strength program on the reduction of shoulder and elbow pain. *J Strength Cond Res.* 1998;12(1):46-51.

20. Swanik K, Swanik C, Lephart SM, Huxel K. The effect of functional training on the incidence of shoulder pain and strength in intercollegiate swimmers. *J Sport Rehabil.* 2002;11(2):142-154.

21. Hibberd EE, Oyama S, Spang JT, Prentice W, Myers JB. Effect of a 6-week strengthening program on shoulder and scapular-stabilizer strength and scapular kinematics in division 1 collegiate swimmers. *J Sport Rehabil.* 2012;21:253-265.

22. Magnus CRA, Boychuk K, Kim SY, Farthing JP. At-home resistance tubing strength training increases shoulder strength in the trained and untrained limb. *Scan J Med Sci Sports.* 2014;24:586-593.