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RESEARCH ARTICLE

THE EFFECT OF EARLY RANGE OF MOTION AND POWER EXERCISES IN OVERHEAD ATHLETES WITH A SLAP LESION REPAIR

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ABSTRACT

Superior Labrum Anterior to Posterior (SLAP) tears are a common injury seen in the overhead athlete population and are described as injury to the superior portion of the glenoid labrum from 10 o'clock to 2 o'clock when referencing the face of a clock. Erikson *et al*. (2006) propose two accepted theories of mechanism of injury which include the eccentric load that occurs at the long head of the biceps tendon (LHBT) during the deceleration phase of throwing as it pulls on the superior portion of the labrum. Since the LHBT originates on the supra-glenoid tubercle (50%) and the superior labrum (50%) itself, there may be a separation of both structures causing a tear. The other proposed mechanismoccurs during the late-cocking phase of throwing that causes a torsional force between the LHBT and the superior aspect of the labrum which may also result in a tear as the athlete prepares to enter the acceleration phase (Erikson *et al*, 2016). It is likely that a combination of eccentric load during the deceleration phase and torsional forces during the late cocking phase result in a SLAP tear. It is important to distinguish between types of SLAP tears. There are 4 recognized types of SLAP tears but as many as 10 sub-types have been identified in the literature (Snyder *et al*., 1990). Since type two tears are most common in overhead athletes, they will be the focus of this study.We will construct a rehabilitation protocol based on the most current literature; add one range of motion (ROM) modality and one power output modality for a total of two groups (control and experimental) in a between group experimental design. The control group will be progressed through a rehabilitation protocol as deemed standard by the author and orthopedic surgeons. The experimental group will include the addition of proprioceptive neuromuscular facilitation patterns D1 and D2 starting in week 5 and the addition of the push press week 20 at a rep scheme of 5 sets of 5 repetitions. The purpose of PNF will be to increase ROM and the purpose of the push press will be to increase strength and power output. The working hypothesis of the author is that through the addition of the two modalities the experimental group will have better functional outcomes as measured by the Kerland-Jobe Orthopedic Clinic Shoulder Score (KJOC) and UCLA shoulder score. The subjects were chosen from two universities due to their classification as overhead athletes (convenience sampling). A total of 15 (n=15) subjects were recruited voluntarily from two division 2 baseball programs. Each of the 15 participants had a type 2 SLAP tear repair and was no longer than 2 weeks post-surgery at the time of recruitment. All exercises and progressions were supervised by a certified Athletic Trainer with at least 3 years' experience in their field.

INTRODUCTION

The shoulder (Gleno-humeral) is a paradoxical joint that must function in both stability and mobility. Anatomically, the shoulder is inherently unstable due to the significant size difference between the humeral head and glenoid fossa. The humeral head is much larger than glenoid fossa and has been compared to a golf ball sitting on a tee. In static postures, the glenoid labrum is a fibro-cartilaginous tissue which envelops the entire fossa serving to deepen it and increase the contact area between the humeral head and fossa. Dynamically, the rotator cuff serves to pull the humeral head into the glenoid

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fossa to increase shoulder stability. Through the glenoid labrum and rotator cuff musculature, the shoulder is able to meet the various demands of activities of daily living, recreational sports, and competitive sports. However, shoulder injuries are common in overhead athletes during throwing. These injuries commonly result in labral injuries reported first by Andrews *et al*. (1985) and later classified by Snyder *et al*. (1990). Snyder described these injuries as a superior labral anterior to posterior injury. Type 1 is described a fraying of the labrum with no involvement of the LHBT. Type 2 is most common in overhead athletes and is described as a peel-back lesion where the labrum peels off the glenoid fossa with involvement of the LHTB. Type 3 is described as a bucket-handle tear of the labrum without involvement of the LHBT. Type 4 is described as a bucket-handle tear with involvement of the LHBT. Type 2 SLAP tears are most common in overhead athletes and are thought to occur through two mechanisms (Erikson *et al*., 2016). Mechanism one proposes increased eccentric load during the deceleration phase of throwing which puts tension on the LHBT and the Biceps-labral complex (BLC) causing injury. The second mechanism is reported to occur at the late-cocking phase of throwing when the shoulder is in maximal abduction and external rotation. This motion causes torsion at the BLC and injury to the labrum. SLAP tears most likely occur from a combination of the mechanisms discussed above. After injury, patients may report various symptoms such as catching, locking, or clicking with pain, pain is usually described as "deep" in the shoulder, and overhead athletes will report the feeling of a dead arm. Physical exam may reveal limited range of motion in the shoulder due to pain, a feeling of instability, and loss of power/speed during activity. Current literature supports the use of anterior apprehension, anterior slide, crank (compression-rotation), biceps load two, and yergason's test as orthopedic exams for diagnosis. When two of these five tests are positive (sensitivity is 85 and specificity is 88) and when three of these five tests are positive (sensitivity is 92 and specificity is 96) as compared to the gold standard of magnetic resonance arthrogram (MRA). One challenge with SLAP tears is if surgical treatment is indicated immediately or conservative care may be warranted and for how long. Recently, sports medicine has witnessed a paradigm shift from first-line surgery to first-line conservative management. SLAP tears are now treated for 3-4 months conservatively using a multi-disciplinary approach which includes physical therapy, manual therapy, and therapeutic exercise. The athletic population is unique because simply returning to activities of daily living (ADL) is not enough, these patients must be able to produce and handle large amount of forces when throwing and hitting within the demands of their sport. Thus, The First World Congress in Sports Physical Therapy has created a return to play spectrum which includes return to participation, return to sport, and return to performance (Ardern *et al*., 2016). Return to performance encompasses the full demands of any athlete and their sport at pre-injury levels, being cleared for performance indicates the patient is ready to perform without restrictions (Ardern *et al*., 2016). If the SLAP injured patient can't return to performance within 3-4 months than surgery is performed to repair the labrum. Surgical techniques vary but the standard treatment for a type two injury is a repair of the labrum with sutures placed anterior and posterior in relation to the repair. Length of recovery and return to performance vary upon patient physical fitness, orthopedic surgeon recommendation, and rehabilitation protocol. The average time into return to performance are 6-9 months. Recently, there has been transition into earlier initiation of movement in related procedures such as ACL reconstruction, MCL repair, and Hip replacement. Furthermore, the outcomes in overhead athletes, mainly pitchers have less than ideal in terms of function and performance. This begs the question if initiating earlier range of motion (ROM)and power exercises into a rehabilitation program could yield better outcomes. Proprioceptive Neuromuscular Facilitation (PNF) is a technique used to increase ROM by imposing an isometric contraction of the target muscle followed by a latent period of relaxation in which the clinician performs a static stretch to new muscle set point. By using contraction of the target muscle, the golgi tendon organs of the target muscles are activated casing relaxation and further increase in ROM compared to static stretching alone. While the target muscle is being isometrically contracted, this stimulates the golgi tendon organ which serve to relax the muscle and consequently prone to being stretched further when the subject ceases the contraction (contract-relax method). On the other hand, return to performance encompasses a pre-injury status and in overhead athletes means throwing at high angular velocities. Research shows the fastest movement the human body can produce is throwing a ball where the peak angular velocity can reach 7000 degrees per second at the gleno-humeral joint. When the speed, power, and strength needs of the overhead athlete are taken into consideration, it seems there is a gap in rehabilitation programs. This is where power exercises may be beneficial in late-phase rehabilitation. Power is defined as work over time (Power= Work/Time). Power is how quick an object can be moved through space. Power applies to overhead athletes since they must throw objects through space at high speeds. Among other factors, speed is an important factor in the success of an athlete. For example, current major league baseball scouts in right-handed pitchers look for a fastball of 92-94 miles/hour and 90-92 miles/hour in left-handed pitcher. In the human body, power is developed from proximal to distal indicating the trunk (lumbo-pelvic-hip complex) to the shoulder and finally the hand (McGill, 2015). If an overhead athlete is to have a successful rehabilitation program, power exercises should be included. In recent years, there has interest in to include Olympic lifts in strength and conditioning programs. The Olympic lifts are defined as the Clean and Jerk and the Snatch (Haff & Triplett, 2015). The Clean and Jerk is performed when the subject lifts the barbell from ground to shoulders in one motion, then lifts the bar from shoulders to overhead in one motion (Haff & Triplett, 2015). The Snatch is performed by lifting the bar from ground to overhead in one motion (Haff & Triplett, 2015). Strength and Conditioning may choose to incorporate all or part of each lift in programs. It is most common to see athletes performing Power Cleans and Clean Pulls in the weight room. However, it seems overhead lifting is not performed as often. Overhead power exercises may include the push press, push jerk, or split jerk. The common theme in these exercises is the use of the legs and trunk to generate power in order to lift weight overhead in greater amounts than could be achieved using a strict press (shoulder press) technique. The literature at

the time of this dissertation being written reveals no information the use of PNF techniques and power exercises concurrently in the rehabilitation of SLAP tears in overhead athletes. The purpose of this dissertation will be to explore if using PNF techniques to restore ROM sooner and power exercises to restore normal strength and speed in sport yield superior outcomes in overhead athletes with a SLAP type 2 repair.

MATERIALS AND METHODS

15 male athletes (n=15) from two Division 2 universities were recruited based on their history of injury and surgical intervention (non-random sampling). The subjects had suffered fromtype two SLAP tears that were diagnosed by magnetic resonance arthrogram (MRA). SLAP tears were classified according to the Snyderclassification (1990). Snyder *et al*. (1990) describe a type two tear as a peel back lesion where the glenoid labrum has separated from the glenoid fossa with involvement on the long head of the biceps tendon. Each subject underwent 3 months of conservative management that consisted of manual therapy, rotator cuff strengthening, and scapular stability exercises. However, the course of conservative management was not deemed enough by the subjects for return to performance(Confidence Interval 95%). Return to play has recently been put on a continuum by Harris, Wong, &Lintu (2014) that ranges from return to participation, play, and performance. Participation is when the subject can't return to their pre-injury sport but can still participate in physical activity (Harris *et al*., 2014). Play is when the patient can return to their pre-injury sport but not at the same level of competition (Harris *et al*., 2014). Participation is when the patient return to their pre-injury sport at least at the same level of competition pre-injury status (Harris *et al*., 2014). Subjects were treated with a surgical repair by orthopedic surgeons (N.W., E.B.) who repaired the labrum using sutures placed anterior and posterior the SLAP lesion.

Subject Demographic

A total of 15 subjects were recruited for the study (n=15) who were 20 years old (+/- 3 years), body mass of 77 kg (+/- 5 kg), height 72 inches (+/- 4 inches) and average playing experience of 10 years. All subjects were baseball athletes, n1(pitchers)= 10 (66%), n2(field position)=5 (33%). The inclusion criteria was diagnosis of a type two SLAP tear diagnosed by MRA with conservative management for at least 3 months. The exclusion criteria included a history of shoulder dislocation, concurrent injury to the shoulder, bankart lesion, hill-sachs lesion, or surgical complication. Two orthopedic surgeons with at least 10 years experience performed all 15 subject surgeries according to pre-established protocols. The subjects had their orthopedic consultations and it was decided to repair the labrum and long of the biceps tendon. After the surgical procedure the subjects were randomized into two groups (control and experimental) using NIS statistical software.

Rehabilitation Protocols

Group 1 (Control): This group consisted of 8 subjects (n1=8): 5 pitchers, 3 position athletes (53%). Both orthopedic surgeons met and agreed upon a rehabilitation protocol. It included a general progression of site protection, ROM, strength, and interval throwing program. At a pre-determined, the subjects would be released from the rehabilitation program and initiate their return to performance progression with the strength and conditioning staff pending medical clearance and functional tests set a priori (power .82)

Group 2 (Experimental):This group consisted of 7 subjects (n2=7): 5 pitchers, 2 position athletes (47%). The rehabilitation protocol was similar to the control however range of motion was initiated earlier and power exercises were included towards late phase rehab. It was theorized that these two factors would result in superior return to performance outcomes. The hypothesis was set a priori (power .80) and not changed once the recruitment process began.

Outcome Measures: The outcome measures used for both groups had to encompass the unique aspect of the overhead athlete and go beyond pain and activities of daily living. It was decided to use the Kerland-JobeOrthipedic Clinic Score (KJOC), UCLA shoulder score (UCLA), and Visual Analog Scale (VAS). The KJOC (sensitivity .90, specificity .93) was used because it is extremely specific to the overhead athlete and has been validated by literature. This was used as the primary outcome measure. The UCLA (sensitivity .90, specificity .85) was used for general function of the affected upper extremity that extended beyond the scope of sport. Lastly, VAS was used to assess pain levels throughout the rehabilitation program. Although pain is not an objective measure of progress, it takes into account the subjective experience of the patient in accordance with the biopsychosocial model. The outcome measures were given to the subjects before surgery and every two weeks until completion of the study (week 26) before being care was turned over to the respective strength and conditioning staff.

RESULTS

Statistical Analysis: The subjects were randomized into two groups using the software randomize (NSI, 2012). Both groups were deemed homogenous and no difference was noted pre-surgery or before the rehabilitation program was to begin (p-value=.02). Statistical analysis was performed at every two weeks with emphasis on different aspects. During the first ten weeks of each rehabilitation protocol the analysis was performed on shoulder range of motion (ROM) and pain levels (VAS)(confidence interval .95, Alpha .05). The experimental group was deemed to have greater ROM at weeks 4 (p=.01), 6 (p=.01), 8 (p=.03),10 (p=.03), and 12 (p=.05). The experimental group was able to achieve full ROM as established by goniometry at the end of week 8 (p=.04) while the control group achieved full ROM week 11 (p=.03). The biggest ROM differences were seen in shoulder abduction and internal rotation (p=.02). After week 12 when both groups had achieved full ROM, the measurements shifted into power produced by the upper extremity. The experimental group began power exercises in week 20 while the experimental group only continued their plyometric exercises. The KerlandJobe Orthopedic Clinic (KJOC) was used to assess shoulder function as late-phase rehab began. Speed of a fastball was also used a measure of effectiveness of the power exercises. Prior to injury, average fastball speed for the experimental group was 90 mph +/-2 (Power .85). The control group had an average of 92 mph +/-2

(Power .80). Both groups began their interval throwing group at week 16. Measurements using the KJOC and fastball speed were used every two weeks from weeks 20-26. The experimental groups measured higher KJOC scores and fastball scores (CI .95). At week 26, the experimental group had attained 90% (power. 85) of their pre-injury speed. The control group had attained 80% (power. 80) of their pre-injury speed. At week 26, the experimental group had achieved 95% of their uninvolved extremity (power .80) while the control group had achieved 85% of their uninvolved extremity (power .82).

DISCUSSION

The outcome measures in overhead athletes following conservative management of SLAP tears range from 35-55%. Even after a surgical SLAP repair, return to performance range from 40-65%. This may indicate there is a lack in rehabilitation protocols and exercises within the literature. Recently, there has been a shift in the field of rehabilitation science to initiate early movement in conservative and surgical management of injuries. It seems in other injuries and regions of the body such as the knee (ACLR), ankle fracture (ORIF), hip (THR) have had success with outcomes measures and ADLs in patients who initiate early motion and physical activity. It seems to follow that in the athletic population, early motion and physical activity would be more important in returning to high level sport. As described by Harris *et al*. (2014), the return to play continuum follows return to play, return to participation, and return to performance. Return to performance places the highest demands on the body making rehabilitation all the more important. Currently, return to performance in SLAP tears ranges from 6-9 months. Rehabilitation programs seem to follow a protection phase, ROM phase, strengthening phase, power phase, plyometric phase, interval throwing program, and return to play protocol. Post-surgically, the patient is put into a sling for 4-6 weeks. ROM is initiated 4 weeks into post-surgery with no activation of the long-head biceps the first 6 weeks for protection. Full ROM of the shoulder should be established between 10-14 weeks with 5/5 strength of the rotator cuff within 10-12 weeks. Interval throwing programs are initiated ranging from week 16-20. They begin off the mound before progressing to the mound. If the player has a field position, they can be integrated back into their position while controlling their throwing volume, distance, and intensity. For example, a second baseman may be able to handle a higher training volume throwing to first base since the distance is shorter as compared to an outfielder performing a crow-hop to second base or home plate. Pitchers are handled in a different manner however have similar variable parameters in regard to throwing volume, intensity, and type of pitch. Pitchers will initiate mound throwing with fastballs only being limited to 20 pitches. Progression is based upon types of pitches that increase strain on the shoulder with curveballs, sliders, etc. The findings agree with previous findings by James and Willow (2005) where early ROM leads to superior outcomes in SLAP repairs. James and Willow found the biggest deficit to be horizontal adduction and internal rotation in patients. Hernandez *et al*. (2014) initiated active ROM exercises of the shoulder in week 5 and reported full active ROM of the shoulder by week 12. Smith and Yang (2013) performed a study in patients with SLAP type 4 repairs that were more conservative due to surgical repair of the biceps tendon. Smith and Yang recommend active biceps protection until week 12. Brighams and womens's hospital have similar protocols when the biceps tendon is repaired stating it should be protected until weeks 12-16. Power exercises are not described in the literature thus a combination of "plyometric programs" and "active strengthening" were used to compare integration of power exercises. Brighams and Womens's hospital integrates full plyometric training at week 20 while the Boston sports medicine institute integrates full plyometric training from weeks 16-20. Recreational weight lifting and sport-specific resistance training is able to begin at week 14 according to Mafet and Likes (2013).

Limitations

The convenience, non-random sampling style of this study reduces its external validity. The subject population only includes division 2 baseball athletes between the ages of 18-22 years old. Findings from this study should be taken with caution as the internal validity only applies to this population. The outcome measures were given to subjects once every two weeks before commencing the rehabilitation session. Outcomes measures may have been different if the KJOC, UCLA, and VAS were given more frequently to subjects. Establishing a "normative" rehabilitation program was difficult to establish due to variability in research, surgeon, and rehabilitation clinician preference. The normative rehabilitation program was created by consulting with the two orthopedic surgeons and using their clinical experience to make a conservative rehabilitation program. Power exercises vary and the literature for SLAP tears only specify the start of interval throwing programs and plyometric programs. Power exercises of the upper extremity may include the push press, push jerk, or split jerk. While any of these exercises are viable, the push jerk and split jerk were deemed too difficult to teach and learn in the time-frame of this study. It was deemed the latter exercises would be too technically complex and time would be spent on learning and correcting form rather than increasing power. The push press was used with dumbbells as opposed to a barbell due to the decreased ROMrequirements and decreased stress dumbbells impose on the shoulder. The subject sample was 15 (n=15) was small and had a statistical power of .75 which is not sufficient to draw final conclusions or make general recommendations.

CONCLUSIONS AND CLINICAL IMPLICATIONS

To the knowledge of the author, this is the first study that investigates implementing early ROM and early power exercises after a SLAP repair. The subjects enrolled in the experimental group regained their full shoulder ROM quicker than the experimental groups and reported lower scores at all points during weeks 2, 4, 6, and 10 in the VAS. The subjects regained their throwing and pitching speed subjectively quicker than the experimental group. The use of power exercises seem to be safe and may be used as a modality in a return to performance rehabilitation protocol within athletes. ROM exercises may be initiated earlier than previously thought without compromising the surgical repair. Power exercises may aid in increasing force production throughout the entire body. In many athletic activities, such as throwing force is produced from the lower extremity, to the trunk, and finally the arm.

Similarly, an exercise like the push press requires this movement pattern and may translate into athletic performance. In athletes with a type two SLAP tear, initiation of early ROM and power exercises seem to be safe, result in lower pain levels, andyield higher outcome measures.

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