Anterior Shoulder Dislocations in the Whitewater Paddler

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Abstract

Whitewater Kayaking is an inherently dangerous sport. One of the most common traumatic injuries to a paddler is anterior shoulder dislocation, which often occurs when the arm is abducted and external rotated, as in the high brace, duffek or roll. The shoulder complex is not at its strongest in these positions and the humerus can slip anteriorly and out of the glenoid fossa. Reduction is then necessary in order to get the humerus back in position, after which surgical or non-surgical treatments exist. Regardless of the treatment, extensive rehabilitation is needed to get the athlete back in the boat. Emphasis is placed on the importance of the phases of rehabilitation and exercise recommendations to maximize shoulder function and reduce chance of recurrence. The following will outline how an exercise therapist can aid in decreasing the chance of dislocation, the athlete's return to sport and reducing the chance of recurrence.

Key Words: Kayak, Glenohumeral Joint, Exercise Therapist, Injuries, Shoulder complex.

The shoulder is one of the biomechanical marvels of the human body. At 1 degree separations the arm is able to be placed in over 16,000 positions (Donatelli, 1997). This flexibility allows the person to put the arm to innumerable uses. The whitewater kayak paddler is able to take advantage of the shoulder design to manipulate a paddle and maneuver the boat down most waterways.

The increasing popularity of kayaking has brought more attention to the number of injuries that are incurred. The most commonly injured area is the shoulder for the paddler, between 21 and 30 percent where 6 to 13 percent of kayak related injuries are dislocations (Fiore & Houston, 2001; Heinrichs, 1991a; Kameyama et al., 1999; Schoen & Stano, 2002).

Anterior dislocations are more frequent than posterior and for that reason this paper will focus on the common anterior aspect. Dislocations are traumatic and take a significant amount of time to recover from (Fiore & Houston, 2001; Paxinos et al., 2001). Although it is possible to fully recover, as in the case of Paul Ratclife who recovered from this injury and in ten months was winning World Cup slalom events, it is important to note that recurrence is common. The role of the exercise therapist will be to assist in prevention, the return to sport, and decrease recurrence.

Anatomy

The shoulder complex includes four joints that are necessary in the positioning of the upper limb. The sternoclavicular joint is the only point where the complex attaches to the axial skeleton. The clavicle is attached to the scapula at the acromioclavicular joint. Scapular stabilization is crucial to efficient functioning of the shoulder. Although not technically a joint, the scapulothoracic "joint" is an important physiologic joint that involves the concave scapula within the convex thoracic cage (Mottram, 1997; Peat, 1986). Stabilization is accomplished through tendons and muscles which surround the scapula (see table 1). Once the scapula is stable, and able to move in a controlled fashion, is it possible for the limb to move from the glenohumeral joint most efficiently.

The most freely moveable joint in the body is the Glenohumeral joint. Flexibility of this synovial joint comes at the expense of stability. The humeral head sits in the shallow glenoid cavity of the scapula. In order to double the depth of the cavity, and reduce unwanted shift, the glenoid labrum forms a ring around the outside of the fossa (Paxinos et al., 2001). Several tendons and ligaments hold the humerus in place (see table 2).

Table 1: Muscles Affecting the Scapula (Marieb 1998. pp 328-30; Mottram 1997. pp 124, 125)

Muscles active in scapular movement	***Importance to the Movement of the scapula***
Levator scapulae	Elevates, retracts and downwardly rotates
Rhomboid major	Retracts, downwardly rotates and elevates
Rhomboid minor	Retracts, downwardly rotates and elevates
Pectoris minor	Protraction and downward rotation
Latissimus dorsi	Depresses scapula
Muscles specific to scapular stabilization	
Serratus anterior	Protracts and holds scapula against the chest wall; rotates scapula so that its inferior angle moves laterally and upwards
Trapezius	***Upper fibers***- Draws scapula and clavicle backwards or raises scapula by rotating clavicle about sternoclavicular joint. ***Lower trapezius***- Upwardly rotates, resists lateral displacement, depresses

The main joint stabilizer in neutral position is the tendon of the long head of the biceps brachi (see table 2). Most of the ligaments are anterior because the joint is weakest in this area. The inferior glenohumeral ligament is the most important ligament to restrict anterior movement in abduction above 90 degree. Posteriorly the joint is more stable due to a 30 to 45 degree anterior angle of the scapular glenoid fossa (Donatelli, 1997).

The most common direction for dislocation of the glenohumeral joint is anteriorly. When the arm is abducted less than 90 degree and internally rotated, the joint is stable due to strong muscle tendons. As abduction and external rotation increases, there comes a greater reliance on the inferior ligaments to maintain the position of the humeral head in the glenoid fossa. At the end range the inferior ligaments will stretch or tear allowing the humeral head to slip forward

In the kayak paddler this abducted, externally rotated position is similar to the high brace stroke, duffek (turning stroke also know as a bow draw), or in the rolling position all of which can be the cause of dislocation while on the water (Heinrichs, 1991b). In a full dislocation the humeral head becomes separated from the glenoid cavity causing pain and immobility. The head remains outside the cavity making it necessary to

reduce. Reduction is the act of placing the humeral head back into the glenoid fossa.

Table 2: Muscles and Ligaments Acting on the Glenohumeral Joint (Marieb 1998. pp 330-333)

Muscles active in humeral movement	***Movement of humerus***
Pectoralis major	Flexion, medial rotation, adduction, and pulls rib cage upwards
Latissimus dorsi	Adduction and medial rotation
Deltoid	***All fibers -*** Abduction ***Anterior fibers -*** flexion, medial rotation ***Posterior fibers -*** extension and lateral rotation
Teres major	Extension, medial rotation and adduction
Biceps brachi	Weak flexion, holds head of humerus in glenoid fossa
Coracobrachialis	Flexion and adduction
Triceps	Stabilization and adduction
Rotator cuff – prime shoulder stabilizers	***Movement of the humerus***
Supraspinatus	Stabilizes joint, prevents downward dislocation of humerus and assists in abduction
Subscapularis	Medial rotation and helps hold head of humerus in glenoid cavity thereby stabilizing the joint
Infraspinatus	Helps to hold head of humerus in glenoid cavity and lateral rotation
Teres minor	Same as infraspinatus

Typical treatment methods

Shoulder reductions should normally be performed by a doctor. This will decrease the chance of nerve and ligamentous damage. Improved recovery can be aided by the quick reduction after injury, preferably at the time and place of injury. Muscles and tendons get progressively tighter over time, making it harder to reduce. X-rays are recommended before reduction to ensure no bony fragments are in the capsule. The acute phase of this pathology occurs from the time of injury until the reduction has taken place. In the case of a surgical intervention the acute phase will last until just after the surgery (Warme et al., 1999).

After reduction, x-rays, magnetic resonance imaging, ultrasound and arthrograms would be preformed to rule out nerve damage and

fractures (Paxinos et al., 2001; Warme et al., 1999). Following this, a non-operative or operative treatment will be chosen.

Non-operative methods of rehabilitation have been the standard in the past for first time dislocations. The goal is to reduce the high number of recurrences. In the under 30 age range dislocations recur at an alarming rate of 68-95 percent (Kranlinger et al., 2002; Paxinos et al., 2001; Warme et al., 1999). These numbers are for active individuals which accounts for a large proportion of this population (Kranlinger et al., 2002). Commonly, a non-operative treatment is attempted, if those do not succeed, then surgery is recommended (Warme et al., 1999).

Operative surgery on primary dislocation is now becoming more popular especially in populations who are at higher risk. Either open surgery or arthroscopic surgery can be performed.

The most common open surgery is the Bankart technique. It involves repairing a torn labrum and reattaching any affected anterior ligaments. The subscapularis muscle is detached and reattached during the operation. The recurrence rates after a Bankart surgery are extremely positive, 0-10 percent (Karlson et al., 2001; Paxinos et al., 2001). The only downside beside the invasive nature of the surgery is that a decrease in external rotation is found, 12 percent less than for the arthroscopic technique (Warme et al., 1999).

Arthroscopic surgery has had its best results using biodegradable tacs to fix lesions in the labrum and ligaments (Donatelli, 1997; Karlson et al., 2001; Paxinos et al., 2001; Warme et al., 1999). The downside to the arthroscopic method is a slightly higher recurrence rate. Some are as low as 5 percent while other studies have showed a 49 percent recurrence rate. (Karlson et al., 2001; Paxinos et al., 2001; Warme et al., 1999). Regardless of the surgical method used, an extensive post-operative rehabilitation program should be implemented.

Therapeutic exercise

Subjective information

At the acute stage of a dislocation the patient will hold the arm internally rotated and adducted. The affected limb will be held with the other arm across the body. There will also be a noticeable step where the humerus will have left the socket and the acromion process will be the highest point. Deltoid muscle shape will be lost and the subject will be in considerable pain until the shoulder can be reduced (Warme et al., 1999).

Usually the client will have gone to a doctor to have the shoulder reduced so the client will know that they have had a dislocation. It is important to find out what the mechanism of the injury was and what the

current symptoms are, so that further aggravation can be avoided during therapy.

Objective information

General pain free range of motion (ROM) should be assessed before exercise is commenced. A complete history of the injury should be obtained from the doctor or physiotherapist. A history of other pathologies should also be obtained to determine if there are other factors which should be taken into account before commencing with an exercise program. Continuous assessments of ROM progress should be taken.

Exercise plan

In the case of a competitive athlete the main consideration is to get him/her back to sport as quickly as possible without losing fitness. Due to the high risk of recurrence it is however important not to rush rehab. High impact activities or those which use the limb in question will not be performed until the rehabilitation has progressed. Individualization of the exercises and progressions are the most important factors to getting the athlete's return to full function. The following are general guidelines to follow as a progression to recovery. Each individual will progress at a different rate.

Sub-acute phases

After an operation/reduction, the arm is immobilized and the sub-acute phase begins. Sub acute can be broken down into six phases of rehabilitation (see table 3) (Donatelli, 1997). These phases are taken from physiotherapy, but all the activities are within the scope of practice of an exercise therapist. Pain is the main contraindicative factor. There is no place for "no pain, no gain" in rehabilitation (Heinrichs, 1991A). The exercise program should be set up in conjunction with the doctor or physiotherapist.

The first phase is characterized by immobilization and management of the inflammation that is present. Some pendulum work can be performed to help re-align collagen fibers that are being laid down. The main active muscular work which will be done during this phase is scapular stabilization using seratus anterior and lower trapezius where the goal is to have the scapula sit without any winging. An unstable scapula can be a common risk factor of dislocation. Reducing the instability will decrease the chance of recurrence.

Active assisted range of motion (AAROM) will begin in phase two while maintaining strict adherence to the idea of pain-free movement.

Table 3: Phases of recovery (Donatelli 1997)

Phase I: Maximum Protection: 1-10 days post-procedure.

5-7days – immobilization of the humerus.
Sling with body wrap sling to prevent movement.
During immobilization reduce inflammation.
Ice or anti-inflammatories as directed by physician.
Scapula setting can begin immediately.
Pendulums begin after the immobilization (Warme et al., 1999).
Gentle hanging rotation so that gravity can act upon the arm.
Isometrics at 0 degrees arm abduction.

Phase II: Protected Mobility: 10 days to 3 weeks

Active-assisted range of motion. (AAROM)
Begin helping the limb to move through **pain-free** ROM. No external rotation or abduction.
Scapula setting continues.

Phase III: Moderate Protection: 3 to 6 weeks

AAROM - Pain-free, no external rotation or abduction.
Passive range of motion (PROM) stretching.
Staying within 30° of external rotation and 45° abduction.
Scapular movement
Elevation/depression, protraction/retraction.
Isometrics
Maintain scapular stability, 90° elbow flexion, humerus in neutral position; internal/ external rotation, flexion/ extension and abduction/ adduction. Goal is to prevent atrophy within the shoulder muscles.

Phase IV: Late Moderate Protection: 6 to 12 weeks

6-8 weeks – PROM - Moving to external rotation in 45° abduction.
8-12 unrestricted, active range of motion (AROM)
Sub-maximal Isotonic internal/ external rotation exercises.
E.g. tubing or light weight.
Protected ROM progressing to overhead. External not to exceed 45°.
Light simulated paddling exercises with paddle in air.

Phase V: Minimal Protection: 12 to 16 weeks

Same exercises as IV, with progression.
Light paddling on flat water.
Low speed plyometrics (Warme et al., 1999)
E.g. Chest passes against plyometric trampoline.

Phase VI: Return to Function: 16+ weeks

Gradual reintroduction to Whitewater.
Biomechanics may want to be assessed to determine if that was a cause of the injury.
Maintenance isotonic exercises (see maintenance phase).
Suggest racing to be allowed at 22 weeks.
Return to sport can range from 3-6 months (Donatelli, 1997; Paxinos et al., 2001)

Scar tissue builds up around the site of injury so the main goal is to build functional scar tissue through movement. Phase three continues with AAROM in and begins to introduce passive range of motion (PROM) to help maintain flexibility.

More intensive PROM can begin in the late moderate protection phase. One must be careful performing external rotation so as not to provide incomplete healing of the anterior capsule (Kranlinger et al., 2002; Schoen & Stano, 2002). Isotonic exercises can also be introduced. Further progression of the exercises will roll into the fifth phase and light paddling on flat water can begin after three to four months of recovery. This huge amount of time out of the boat can be hard mentally on an individual so it is important to gauge progress along the way and keep the athlete well informed of the process.

Finally after four months, again this is dependant on individual progress, the paddlers is able to begin gradual return to whitewater. At this time a biomechanical review might help reduce any poor stroke patterns that could lead to further problems.

Table 4: Specific shoulder exercises for instabilities

Warm–up Exercises (Gambetta, 1993)
Crawling Forward/back, sideways and crossover. Toes on floor, hands wider than shoulder width.
Arm Step Up Use a 10-15cm box, front/back, side to side.
Reach outs Prone on a bench, start with 2 kilogram medicine ball at chest, then reach out at body level, move left, move right, bring back in.
Eccentric ball drop Lay supine on bench, have someone drop a one kilogram medicine ball on to one arm, immediately throw back up.
Tubing External rotation – tube at shoulder height in front, 90° shoulder, 90°elbow, rotate externally. Diagonal pattern – tube below waist height slightly contralateral, pull up and back so that the arm ends up abducted, extended and straight.
Scapular Stabilization Exercises
Serratus anterior Push-up with “a plus” with feet up. At the top of the push up protract the shoulders. (Lear & Gross, 1998; Mottram, 1997)
Trapezius Upper – rowing, shoulder shrug. Middle – prone horizontal abduction in neutral rotation. Lower – prone horizontal abduction in external rotation (Donatelli, 1997).

Maintenance phase

An extensive shoulder program should be given to any athlete who has demonstrated poor posture, muscle imbalances, instability or has previously had a dislocation. Having completed a rehabilitation program will not ensure continued health of the shoulder complex. Warm-ups and specific anti-instability exercises are an important part of an overall strength program (see table 4).

Continued maintenance exercises are crucial to prevent initial and recurrent dislocation. Table 5 has some general exercises that can be used to strengthen the shoulder. Muscular imbalances should be taken into consideration when setting up the strength program by adding and removing exercises where needed. An example of an exercise that may want to be removed from the program of an individual with recent instabilities is the shoulder press because the abducted, externally rotated position is similar to the mechanism for shoulder dislocation.

Aerobic:

Maintaining aerobic fitness through the rehabilitation process is critical to sport reintroduction. For the kayaker, paddling would not be possible but a single arm crank could be one way to maintain some upper body fitness. General lower body aerobic exercise is the easiest way to maintain fitness in an individual recovering from a shoulder dislocation. Running is possible if the arm is secured to the trunk so as to reduce impact. Recumbent cycling is the best method of maintenance and an upright bike could also be used as long as upper body stability was maintained.

During the rehabilitation period, overall health is important to rebuild damaged tissues. A slight reduction in the athlete's normal aerobic program would be optimal to ensure recovery. There is no other reason not to continue with a high level of aerobic exercise and maintain this system for training resumption.

Risk of activity

Whitewater paddling is by definition a high risk sport, considered a level three sport in a three tier shoulder risk classification (Kranlinger et al., 2002). If an athlete is going to resume kayaking then they have to be aware of possibility of recurrence. The shoulder will be at a higher risk

Table 5: Maintenance exercises and stretches.

General Shoulder Exercises – (resistance in stacks can be reduced by lifting the top plate up 10-15 holes. This prevents unwanted shoulder stretch.)
Pectoralis major/ minor Bench press, fly, dumbbell press. To reduce stress to shoulder try: Bench – narrow grip, decline or incline dumbbell (Heinrichs, 1991b).
Latissimus dorsi Lat pull down, chin up, row. To reduce stresses on shoulder do pull downs in front (Heinrichs, 1991b).
Deltoid Military press, arm raises (front, side, back)
Triceps Overhead tricep press (maintain shoulder stability), cable pull down.
Biceps Dumbbell curls, cable curls.
Rhomboids Rowing, prone horizontal abduction in neutral rotation (Donatelli, 1997).
On the road Most of the above muscles can be worked using isometric contractions or tubing/theraband if no weights facilities. Need to work in the muscle in various positions because benefits of isometrics are angle dependent (Heinrichs, 1991b).
Stretches – by muscle (Heinrichs, 1991b; Pearce, 2002)
Pectoralis major/ minor Fly at 90° and 14° abduction. Or, with scapula in position pull straight arm into adduction with belt.
Latissimus dorsi Side-bend with arm above head.
Deltoid Pull opposite across chest at 90° and 45°.
Triceps Overhead bent arm pull behind head with other arm.
Biceps Straight arm, pull thumb away. Or, with scapula in position pull straight arm into adduction with belt.
Rhomboids Grasp hands together in front and push them away and try to pull them apart.
Trapezius Neck side bends.
Wrist Extension – arm straight pull back on inside of fingers. Flexion – arm straight pull back on back of hand.

after the first dislocation and as mentioned earlier recurrence in the under 30 active population is high. The best way to reduce the chance of recurrence is to take up a lower impact sport. Aside from that, the athlete can continue on a shoulder maintenance program as previously mentioned.

Conclusion

With such a high prevalence of anterior shoulder dislocations in whitewater kayaking it is important for therapists to know the major pathology and subsequent treatment methods available. During the sub-acute phase increases in flexibility, improved strength, and decreased risk of recurrence are all goals of the exercise therapist. An inclusive maintenance plan will increase the function of the shoulder. The exercise therapist offers another member to the medical team. If a dislocation occurs the therapist can help in the rehabilitation process to get, and keep, the athlete back on the water.

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