Shoulder Rehabilitation for the Injured Overhead-Throwing Athlete

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ABSTRACT

SHOULDER REHABILITATION FOR THE INJURED

OVERHEAD-THROWING ATHLETE

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Baseball incorporates the violent motion of throwing as a main act of physical exertion. The shoulder joint is vulnerable to injury during this movement. The overall purpose of this study was to produce a rehabilitation program for injured overhead-throwing athletes and have it evaluated by healthcare professionals. A paper and pen style questionnaire was sent through the mail to a network of professionals in California. Eighteen of the 20 questionnaires were returned. The quantitative feedback of the Likert scale questions indicated that the program was effective and usable while the qualitative feedback indicated the opposite. The additional comments allowed experts to direct their criticisms towards particular aspects of the program. The conclusions are based on the qualitative comments and states that the program is not usable or effective. The recommendations are to conduct more research, make the immediate changes advised by the professionals, and improve the validity and the reliability of the questionnaire.

Keywords: shoulder, rehabilitation, overhead, throwing, athlete

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Chapter 1

INTRODUCTION AND REVIEW OF LITERATURE

Background of the Study

The shoulder is arguably the most important joint in the human body. The shoulder functions as the axis point for every motion related to the upper limb. The ability for vast amounts of motion brings opportunity for injury. There is now knowledge that certain motions compromise the stability at the shoulder joint. The advances in health sciences have allowed for progression in the understanding of the shoulder.

The shoulder is the primary joint involved in the throwing motion. Throwing is the main act of physical exertion in the game of baseball. When baseball was first established, almost 150 year ago, the pitcher stood just 45 feet from the plate, and the batter called for his pitch. It wasn't until 1884 that the pitcher was permitted to deliver the ball in an overhand motion towards home plate. A few years later, the pitching mound was invented and the pitcher stood the new distance, 60 feet six inches, from home plate (Ray, 2007). Today, pitchers manipulate the ball so that it flies faster than 100 miles per hour, curves inwards, screws outwards, slows down, cuts, sinks, and knuckles. These throwing aspects have made baseball more exciting, but have increased the rates of injury to the shoulder.

The entire body generates force to throw, but the shoulder bears the brunt of that force. Numerous injuries occur to the shoulder because of fatigue, weakness, and overuse. Shoulder injuries can occur in one pitch, over the course of a game, or build over a career. Some typical shoulder injuries are dislocations, separations, bursitis, and tendonitis. All serious shoulder injuries require time to heal, rehabilitation, and in some

cases even surgery. Once an injury occurs proper assessment is critical in terms of predicting the next steps (Andrews, Carson, & Zarins, 1985; Andrews, Reinold, & Wilk, 2009; Powers, 1998).

A void lies in diagnosing the injury and deciding the next steps for the injured athlete. There is controversy between rehabilitation versus surgery for the injured shoulder. Pitchers often opt for rehabilitation instead of surgery during their career because surgery drastically impairs the ability to throw at high velocities. For people who do not throw professionally, surgery is often the better option. If the decision for rehabilitation is made for the pitcher, another void in research is the development of a proper rehabilitation program specifically for the athlete.

This study evaluated the functional muscle anatomy of the shoulder in overhead throwing athletes. The hypothesis was that specialized rehabilitation programs for the injured thrower were imperative due to anatomical differences. There were rehabilitation programs already developed for shoulder injuries, but pitcher have anatomical differences that could render them inadequate. Therefore, the justification for this study was to tailor a specialized rehabilitation program for pitchers with shoulder injuries and have the program evaluated by expert evaluators.

Review of Literature

This review of literature was conducted in San Luis Obispo. Multiple different forms of literature were found at Cal Poly's Kennedy Library. The researcher had access to books and online article databases. The primary databases used were SPORTDiscus database and Sage Premier database. These databases had articles from The American

Journal of Sports Medicine and Journal of Sport Rehabilitation. These two journals provided numerous articles related to the topics addressed in this study. This review of literature was divided into two major reviews, functional muscle anatomy of the shoulder, and rehabilitation programs for the injured overhead-throwing athlete. Both related to the rehabilitation of an injured baseball pitcher's shoulder.

Functional muscle anatomy of the shoulder. The first review of literature was based on the functional muscle anatomy of the shoulder. The anatomy of the shoulder, the motions of an overhead-throwing baseball athlete, the opportunity for injury, the baseball athlete's anatomical differences, and the assessment of injury for the baseball athlete were topics covered.

The amount of motion required to throw a baseball is the result of the combined motion of the glenohumeral and scapulothoracic joints. These are the two primary joints of the shoulder complex. It is the shoulder complex that provides the upper limb with a range of motion that exceeds any other joint mechanism in the body. The glenohumeral joint is the most complex joint in the entire human body (Andrews et al., 2009).

Movement occurs because muscles pull on bones. The type of muscular tension that occurs when a muscle shortens is called concentric tension. Concentric tension *causes* motion. The type of muscular tension that occurs when a muscle lengthens is called eccentric tension. Eccentric tension *controls* motion. A muscle that generates force without segmental motion is called isometric tension (Andrews et al., 2009; Powers, 1998). Isometric tension *prevents* motion by muscles generating force without lengthening or shortening. The entire purpose of functional muscles is to cause motion, control motion, or prevent motion. The movement at the shoulder joint is due to

concentric, eccentric, and isometric muscle forces pulling on the humerus, clavicle, and scapula, the bones of the shoulder joint.

The round head of the humerus articulates with the sunken cavity of the glenoid fossa creating what is called a multiaxial ball-and-socket synovial joint, known as the glenohumeral joint. This ball-and-socket joint allows the arm to move in every possible plane of motion (Andrews et al., 2009; Powers, 1998; Sethi, Tibone, & Lee, 2004). Unfortunately, with the ability to move in all different directions comes the opportunity for instability. This instability is because the humerus head is larger than the glenoid fossa it articulates with. This causes the axis of rotation to constantly move according to where the humerus is positioned inside the fossa. The surrounding muscles have the tumultuous task of maintaining stability around the joint (Andrews et al., 2009). Strength and stability results mainly from the group of muscles called the rotator cuff muscles (Napolitano & Brady, 2002).

The rotator cuff is made up of the supraspinatus, the infraspinatus, the teres minor and the subscapularis (Andrews et al., 2009; Powers, 1998). The major purpose of the rotator cuff is to form a hood surrounding the head of the humerus. This hood is responsible for the stabilization of the glenohumeral joint during activities with co-contraction (Andrews et al., 2009; Powers, 1998; Sethi et al., 2004). According to multiple sources, the humeral rotation velocities of a pitcher can reach up to 8,000 degrees per second. For a pitch to reach 90 miles per hour, the hand, during the time of release, needs to be going 90 miles per hour. This puts an extraordinary amount of pressure on the rotator cuff (Andrews et al., 2009; Powers, 1998).

The rotator cuff muscles keep the humeral head in the glenoid cavity during the

entire motion of an overhead throw, but there are other muscles also responsible for the motions throughout the pitching sequence (Andrews et al., 2009; Escamilla et al., 2007; Powers, 1998; Sethi et al., 2004). Every reference had different ways of describing the pitching sequence. There was no definitive definition of the pitching sequence. The simplest pitching sequence researched for this study consisted of two phases, the cocking phase and the deceleration phase (Powers). A more detailed study divided the pitching sequence into four motions (Escamilla et al.). The motions were the windup through the toe contact phase, the arm cocking phase, the arm acceleration phase, and the ball release phase (Escamilla et al.). During every phase different functional muscle groups are activated.

For this study, the pitching sequence was divided into the cocking phase, the arm acceleration phase, and the arm deceleration phase. During the first phase, in which the pitcher winds up and cocks the arm, the pitcher primarily externally rotates at the shoulder joint, abducts the pitching arm, as well as transversely extends the arm behind the trunk (Andrews et al., 2009). As the pitcher cocks the arm back, the shoulder externally rotates. Because the forward stride of the pitcher rotates the trunk and shoulder much faster than the arm is able to whip around, the forearm and hand lag behind the spin, producing the point of maximum external rotation. This point is the completion of the cocking phase (Andrews et al.; Escamilla et al., 2007; Powers, 1998). The pitching shoulder simultaneously horizontally adducts, moving from transverse extension to transverse flexion at the moment of maximum external rotation (Andrews et al.).

As the arm begins to come forward from the point of maximum external rotation, the arm acceleration phase begins (Andrews et al., 2009; Escamilla et al., 2007; Powers,

1998). The shoulder begins to internally rotate as the pitcher brings the ball forward. When the internal rotators contract concentrically, the arm is able to reach its maximum internal rotation velocity near the point of ball release of 6,000 to 8,000 degrees per second (Andrews et al.; Powers). The shoulder is abducted throughout the arm acceleration phase. According to biomechanical analysis, the best way to throw is directly overhead. Ninety degrees allows for the most power and also limits the chance of injury. The maximum amount of shoulder horizontal adduction is reached at the point of maximum external rotation. The shoulder then internally rotates as the hand moves forward and the ball is released (Andrews et al). This phase ends with the release of the ball.

The arm deceleration phase begins at the point of ball release. In order to slow the arm down, eccentric forces need to prevent the motion of the arm (Andrews et al., 2009; Escamilla et al., 2007; Powers, 1998). The muscles in the arm all violently contract once the ball is released. At the point after the release, the pitchers arm is extended at the elbow, and abducted at the shoulder. In this position, the rotator cuff eccentrically decelerates the arm (Andrews et al.). This eccentric tension keeps the humeral head from popping out of the socket anteriorly and superiorly. All the energy generated to propel the ball forward needs to be dissipated (Andrews et al.). This phase ends at the point of maximum internal rotation.

The opportunity for injury is plentiful throughout the pitching sequence. The first and most common functional muscle group that gets injured is the rotator cuff muscle group, because they are constantly forced to stabilize the entire joint (Andrews et al., 1985; Andrews et al., 2009; Powers, 1998). Overuse conditions, known as instability and

impingement, are attributed to rotator cuff weakness and fatigue. During weakness or fatigue, the rotator cuff's ability to protect the glenohumeral joint decreases (Andrews et al., 1985; Andrews et al., 2009; Powers). A pitcher with weakness or fatigue in his rotator cuffs will adapt by decreasing the use of these muscles. But, this adaptation can lead to more injury (Powers). The acceleration phase generates lots of rotational force. This is due to the large powerful muscles that internally rotate the shoulder. The strong force of internal rotation is halted during the deceleration phase by much smaller, weaker muscles.

The opportunity for injury to the rotator cuff during the deceleration phase is due to the eccentric contraction of the rotator cuff while the rest of the muscles in the shoulder joint are violently concentrically contracting simultaneously. The chronic demands and repetitive microtrauma of dealing with the jolt of contracting muscles can lead to weakness and fatigue and eventually to injury. Powers' (1998) case study concluded that for a pitcher with chronic discomfort in the throwing arm, the most commonly weakened or atrophied muscles were the supraspinatus and the infraspinatus. Impingement was associated with relative weakness of the external rotators. Shoulder pathology was a result of an imbalance between internal and external rotators (Powers).

Professional overhead-throwing athletes had significant anatomical differences when compared to the average human. This was attributed to the constant physical demands of throwing a ball. Pitchers and position players both had increased maximum external rotation and a decreased maximum internal rotation of their dominant arm compared to the average person (Sethi et al., 2004). The pitchers averaged a 10 degree increase in maximum external rotation of the dominant arm when compared to the

position players dominant arm (Powers, 1998). When the pitchers dominant and non-dominant arms were compared to each other, the dominant arm had an increase of seven degrees in maximum external rotation and a seven degree decrease in maximum internal rotation. The pitchers dominant arm was a stronger internal rotator than the non-dominant arm because of this increase in external rotation (Powers; Sethi et al.). The pitcher is able to bring the ball back farther during the cocking phase so to sling it faster during the acceleration phase. These simple anatomical differences can impact an entire rehabilitation program.

According to Sethi et al. (2004) science has allowed for the progressive understanding of the throwing shoulder in terms of pitching mechanics, pathomechanics, and anatomy. Therefore, examination of the shoulder needs to improve. There are accurate and reliable methods to clinically identify humeral head translation for a comprehensive shoulder examination. In order to identify the glenohumeral joint translation, one must have evaluated the throwing athlete's shoulder in 90 degrees of abduction with anteriorly directed force. There were many other ways to examine the shoulder, but the relative differences in those examination techniques rendered results less useful, and possibly inaccurate, especially when analyzing pitchers. The important thing to remember when assessing pitchers with injury is that their shoulders are not symmetrical in the amount of translation (Sethi et al.).

The first review of literature covered topics directly related to the functional muscle anatomy of the shoulder. The shoulder joint was introduced as arguably the most important joint in the human body. The shoulder generates forces using concentric, eccentric and isometric tension. type of forces generated by muscles. The pitching

sequence was defined in terms of what motions occur in the overhead-throwing athlete at the shoulder joint. Anatomical differences and injury can result from the physical demanding task of heaving a ball numerous times. Lastly, assessing injury to the shoulder joint was introduced.

Rehabilititation programs for the overhead-throwing athlete. Rehabilitation programs for the overhead-throwing athlete were researched for the second review of literature. Rehabilitation is considered treatment used on injuries to restore normal health. The two subjects researched for this review were the diagnosis and assessment of the injured athlete, and the development of rehabilitation programs for pitchers with a glenohumeral joint injury.

Effective treatment for the overhead-throwing athlete is dependent on the ability to correctly identify the injury. A doctor is usually responsible for diagnosis. Doctors usually use the patient's medical history, physical examination, routine diagnostic imaging, isokinetic profiling, and examination of throwing mechanics to decipher the problem within the shoulder (Napolitano & Brady, 2002). Communication with the injured athlete is important for finding out what happened, what kind of pain is being experienced, and how the subject is feeling. This is usually done during physical examination. During physical examination, one can test the athlete's ability to bear weight, and measure the angles at the shoulder with certain measuring devices (Logerstedt, 2004). Napolitano and Brady wrote a systematic approach to developing a rehabilitation program**.** They stated that the examination was to include inspection, palpation, range of motion, strength testing, and neurological testing. After diagnosis an appropriate treatment regimen can be designed.

The most common complaints about the glenohumeral joint are associated with pain, muscle weakness, dysfunction, instability, and stiffness (Napolitano & Brady, 2002; Powers, 1998). Pain associated with late cocking or acceleration usually involves anterior instability. Pain during excessive and progressive activity is associated with rotator cuff tendinitis (Napolitano & Brady). The majority of glenohumeral injuries occur anteriorly and inferiorly (Logerstedt, 2004; Napolitano & Brady; Powers).

Once injured, the shoulder requires lengthy rehabilitation and time without use. Playing through an injury will only worsen the injury (Powers, 1998). Many studies have suggested that the first course of action for an injury should not be an operative procedure. The initial treatment needs to be moderate and rehabilitation should be utilized (Hackney, 1996; Logerstedt, 2004; Napolitano & Brady, 2002; Williams & Kelley, 2000).

Many rehabilitation programs (Hackney, 1996; Logerstedt, 2004; Napolitano & Brady, 2002; Williams & Kelley, 2000) were analyzed for this review of literature, and all had the same progressive focus. First the focus was on eliminating pain, followed by restoring motion. Then the focus turned to correcting strength deficits and restoring normal muscle activity. Lastly, the rehabilitation programs focused on returning the athlete to the best possible level of function (Hackney; Logerstedt; Napolitano & Brady; Williams & Kelley).

Most studies agreed that the first phase of rehabilitation needed to be to reduce symptoms (Hackney, 1996; Logerstedt, 2004; Napolitano & Brady, 2002; Williams & Kelley, 2000). Strategies for decreasing pain and inflammation included; rest of the involved area, cryotherapy, ultrasound electric stimulation, and phonophoresis

(Napolitano & Brady). Logerstedt stated that the first phase should be immobilization. He said that the shoulder should be adducted and internally rotated in a sling for up to three weeks depending on the severity of the injury (Logerstedt). One study claimed that stretching within a pain-free range during the initial phase would be beneficial to avoid contracture (Napolitano & Brady).

The second phase of rehabilitation was to restore motion. Logerstedt (2004) called this phase range of motion (ROM) and muscle activation. According to his research this phase was to include ROM exercises, shoulder isometrics, rhythmic stabilization exercises, active oscillating techniques for isometric stabilization, and scapulothoracic proprioceptive neuromuscular facilitation. This phase was to occur during weeks three through five (Logerstedt). Napolitano and Brady (2002) had similar ideas regarding the second phase of rehabilitation. They included kinetic chain initiation early in the rehabilitation process to activate all the other muscles involved with the throwing motion. They attributed most of the power behind the throwing motion to the linkage of action from the ground through the trunk (Napolitano & Brady).

Closed kinetic chain exercises were introduced in the third phase of rehabilitation (Logerstedt, 2004; Napolitano & Brady, 2002). These exercises focused on normal physiologic co-contraction patterns of the stabilizing muscles in the rotator cuff. These exercises are critical for the restoration of early rotator cuff strength needed for progression (Napolitano & Brady). Logerstedt called this phase of rehabilitation dynamic joint stability, and it was to take place during week five through week seven. He also included muscle endurance exercises during this phase (Logerstedt).

The fourth phase of rehabilitation was titled reactive neuromuscular control.

According to Logerstedt (2004) it involved variable resistance strengthening, plyometrics and simulated throwing activities (Logerstedt). These exercises allowed the athlete to develop the ability to generate power. With power came instability, so re-injury was possible during this phase (Logerstedt; Napolitano & Brady, 2002). In order to start this phase it was imperative that complete anatomic healing has occurred. A patient needed to be able to display full ROM without any pain to progress to this phase. This phase was to occur from week seven to week nine (Logerstedt).

Logerstedt (2004) aptly titled the last phase of rehabilitation the throwing phase. This phase consisted of proprioceptive neuromuscular facilitation with elastic tubing, plyometrics, and interval throwing progression (Logerstedt). Researchers analyzed the effects of the elastic tubing that Logerstedt involved in his final phase of rehabilitation using an electromyographical study based on resistance-tubing exercises for throwers (Meyers et al., 2005). The conclusions of this study stated that there were seven exercises that resulted in effective activation of all the muscles tested. The seven exercises were: external humeral rotation at 90 degrees of abduction, throwing deceleration, shoulder flexion, shoulder extension, low scapular rows, throwing acceleration, and scapular punches. The muscles these seven exercises affected were the deltoids, pectoralis major, latissimus dorsi, biceps brachii, triceps brachii, trapezius, rhomboid, serratus anterior, subscapularis, supraspinatus, teres minor, and infraspinatus (Meyers et al.).

With the information gained through the second review of literature, the researcher could take proactive steps towards forming a rehabilitation program for the throwing shoulder. First, by diagnosing the injury, then by developing a rehabilitation program for the specific injury.

Summary. There were two reviews of literature conducted for this study. The first review was based on the functional muscle anatomy of the glenohumeral joint. The shoulder allows for an extensive range of motion. The movements involved with the pitching motion were defined as violent. The anatomical differences between the throwing athlete and the normal human were pointed out. And lastly, the possibility for injury was assessed.

The second review of literature was based on developing a rehabilitation program. The first step addressed in this review was the evaluation of a patient. The rehabilitation program was then broken down into five steps. Though exact exercises were not established, the objectives of the potential exercises were described. These reviews provided information on the functional muscle anatomy of the shoulder and the necessary steps to be taken in order to diagnose and prescribe a rehabilitation program for the injured overhead-throwing athlete.

Purpose of the Study

The purpose of this study was to research the functional muscle anatomy of the glenohumeral joint, develop a rehabilitation program for injuries acquired by overhead-throwing pitchers, and have the rehabilitation program evaluated by qualified professionals.

Research Questions

This study attempted to answer the following research questions:

1. Was an effective rehabilitation program developed?
2. Was a usable rehabilitation program developed?

Delimitations

This study was delimited to the following parameters:

1. Conclusions were drawn about a rehabilitation program for baseball athletes with shoulder injuries in need of rehabilitation in California.
2. The quality and effectiveness of the program, the importance of certain portions of the program, the overall usefulness of the program, and the ease of the program were measured post development of a program.
3. This study was conducted during the summer of 2009.
4. The study involved expert evaluators and a self-administered questionnaire.

Limitations

This study was limited by the following factors:

1. The access to people with shoulder injury was not granted due to HIPAA requirements, so the developed program will not be tested on patients for usability or effectiveness.
2. Expert evaluators had limited availability to review the program developed.

3. The long-term memory of expert evaluators was necessary when reviewing the program.
4. Participants in this study were not randomly sampled.
5. Instruments were not tested for reliability or validity.
6. Some positive response results introduced double negatives making interpretation of the results difficult.

Assumptions

This study was based on the following assumptions:

1. It was assumed that the physical therapists involved were licensed physical therapists.
2. It was assumed that after receiving the program, the instruments were used, and results were given, accurately.
3. It was assumed that answers from expert evaluators were given honestly and to the best of their knowledge.

Definition of Terms

The following terms are defined as used in this study:

Abduction. movement of the shoulder away from the trunk in the frontal plane, caused by the deltoid, supraspinatus, and infraspinatus

Adduction. movement of the shoulder toward the trunk in the frontal plane, caused by the pectoralis major, teres major, and latissimus dorsi

Anterior. towards the front of, in the front portion of a body part

Co-contraction. two muscles contracting at the same time to stabilize a joint

Concentric. muscle produces force by shortening

Cryotherapy. the use of extreme cold during a phase in rehabilitation

Eccentric. muscle produces force by lengthening

Extension. straightening movement at shoulder bringing arm down in sagittal plane, caused by the deltoid, latissimus dorsi, pectoralis major, and the teres major

External rotation. rotary movement, caused by deltoid, infraspinatus and teres minor, around the longitudinal axis of the humerus away from the trunk

Flexion. bending movement, caused by the pectoralis major from zero to 90 degrees, and the deltoid from 90 degrees to above the head, at shoulder raising arm over head in sagittal plane

Frontal plane. plane divides body into front and back halves

Horizontal abduction (transverse flexion). movement of shoulder towards trunk in horizontal plane, caused by the pectoralis major, coracobrachialis and deltoid

Horizontal adduction (transverse extension). movement of shoulder, caused by the deltoid, infraspinatus and teres minor, away from trunk in horizontal plane

Horizontal (transverse) plane. plane that divides body into upper and lower halves

Impingement. tendons painfully caught underneath certain bones in the shoulder joint

Internal rotation. rotary movement, caused by the latissimus dorsi, teres major, deltoid, subscapularis, and pectoralis major, around longitudinal axis of the humerus towards the trunk

Inferior. below, in relation to another body part

Isokinetic profiling. specialized exercise with apparatus that provides variable resistance to movement so that no matter how much effort is put in, the movement takes place at a constant speed

Isometric. muscle generates force without segmental motion

Phonophoresis. the use of ultrasound to increase the rate of healing in the shoulder

Posterior. towards the back of, in the back portion of body part

Sagittal plane. plane divides body into left and right symmetrical halves

Scapulothoracic proprioceptive neuromuscular facilitation. form of stretching that physical therapists implement

Superior. above in relation to another body part

Chapter 2

METHODS AND PROCEDURE

The purpose of this study was to research the functional muscle anatomy of the shoulder, develop a rehabilitation program for shoulder injuries acquired from throwing, and have experts evaluate the usability and effectiveness of the rehabilitation program developed. This chapter includes a description of the reviewers evaluating the program, description of the instrument used to evaluate the program, the procedure for obtaining results from the reviewers, and the method of analyzing data.

Description of Reviewers

Twenty expert evaluators reviewed the shoulder rehabilitation program developed for this study. All evaluators had a Masters, Doctorate, or M.D. in physical therapy, athletic training, or another sports medicine or sports rehabilitation related field. The reviewers also had to be licensed in physical therapy, athletic training, or another sports rehabilitation related field in the state of California. The education and licensure required to work in these professions indicated that the evaluators had expert knowledge on the subject of rehabilitation and therefore they were qualified to review the program. Demographics of the reviewers were not a concern for this study. The researcher had access to a network of physical therapists from a past internship. Some expert evaluators voluntarily offered to review the program, while some were sampled out of convenience.

Description of Instrument

A questionnaire was used for evaluating the developed shoulder rehabilitation program. The questionnaire was a one-sided sheet of paper consisting of three major questions and 11 subsequent questions. The contents of the questionnaire were designed to address the two research questions from this study. The responses from the expert evaluators could directly contribute to the finalization of the rehabilitation program.

The instrument was organized according to initial reaction of the reviewer, effectiveness of the program, and usability of the program. The first question of the questionnaire was created to gage the initial reaction of the reviewer after reading the rehabilitation program. It was a close-ended, "check all that apply" type of question. The second question consisted of five subsequent statements relating to the effectiveness of the program. The reviewer was to strongly agree, agree, remain neutral, disagree, or strongly disagree with these statements. The third question consisted of six subsequent statements relating to the usability of the program. Once again, these six statements had five options ranging from strongly agree to strongly disagree. The final statement on the instrument asked the reviewer to include any additional comments and indicate whether there were errors in the program.

The instrument used for this study had not been previously used. It was not field tested, nor tested for reliability or validity. Two licensed medical doctors as well as an academic advisor reviewed it before it was administered. The two medical doctors had dealt with health-professions related questionnaires regularly. The cover letter, instrument, and informed consent letter were initially reviewed and approved by Cal Poly's Human Subjects Committee on June 12, 2009. The cover letter, informed consent

letter, and instrument appear in the Appendixes as Appendix A, Appendix B, and Appendix C.

Description of Procedure

Research for this study was conducted over a six-week period in San Luis Obispo, California. The first three weeks, April 1 through April 21 of 2009, were dedicated towards researching and completely understanding the anatomy and function of glenohumeral joint. Numerous books and articles from professional journals were read regarding the anatomy and function of the shoulder. From April 22 through May 13 of 2009 the researcher reviewed the function of the shoulder in baseball, as well as many different shoulder rehabilitation programs. After researching the wear and tear that the shoulder assumed in baseball, and reviewing many possible rehabilitation programs, the researcher had some knowledge necessary to develop a rehabilitation program for the overhead-throwing athlete.

The rehabilitation program was developed from May 13 through the end of June of 2009. During this time period the researcher used sources found at Kennedy Library to design a rehabilitation program (Bigliani et al., 1997; Escamilla et al., 2007; Hershman, Nicholas, & Posner, 1990; Jackson, 1985; Logerstedt, 2004; Myers et al., 2007; Myers et al., 2005; Napolitano et al., 2002; Peters & George, 2007, Powers, 1998; Reider, 2006). The researcher also discussed various entities of the study with kinesiology professors, anatomy and physiology professors, professional physical therapists, medical doctors, and collegiate level baseball athletes. One medical doctor provided valuable insight regarding evaluator participation. He recommended that the researcher use incentive to

encourage participation. In order to use this expertise, the researcher rewrote his procedure to include incentive, and obtained re-approval from Cal Poly's Human Subjects Committee on July 27, 2009. With the knowledge gained from research, input from credible sources, and a re-approved procedure, a shoulder rehabilitation program for the injured pitcher was drafted and prepared for distribution.

Once the shoulder rehabilitation program was drafted, it was finalized using Adobe InDesign by July 29, 2009. On August 1, 2009, the final draft of the program was printed at FedEx Kinko's. A copy of the final draft can be seen in Appendix D. William Raskoff financed the printing of 21 programs. The final cost was $260.00. The packets were sent the same day, August 1, to a network of physical therapists that the researcher communicated with before distribution. Previous to receiving a program, each evaluator was contacted to confirm that they were experts, that they were going to review the program, and inform them that they would receive a packet. In the packets mailed to these expert evaluators were the following: one shoulder rehabilitation program, one pen, one stamped envelope with return address, one questionnaire regarding the effectiveness and usability of the program, a five dollar gift card to Starbucks, an informed consent letter, and a cover letter.

The instructions for completing the questionnaire were written on the cover letter. The directions summarized into a three-step process were (a) read over the rehabilitation program, (b) fill out the questionnaire, and (c) place it in the prepaid and preaddressed envelope and return it (see Appendix A).

The researcher was unable to personally administer and collect questionnaires, therefore participants were instructed to return the filled out questionnaire in the mail by

August 12, 2009. A phone call was made August 6, 2009 to each individual that received the questionnaire. The phone call served as a courteous reminder to complete the questionnaire. The returned questionnaires were then evaluated. The results were entered into Microsoft Excel and tabulated according to effectiveness of the program and usability of the program. With the data gained from the input of professionals in the field who completed the questionnaire, the shoulder rehabilitation program could be edited, and finalized.

Method of Data Analysis

The ultimate goal of the questionnaire was to find answers to the research questions. Research question one of the study questioned whether the shoulder rehabilitation program developed was effective at rehabilitating the injured throwing shoulder. Research question two of the study questioned whether the program was usable by physical therapists, athletic trainers, and patients. Questions one and two of the questionnaire addressed the effectiveness of the program. Questions one and three of the questionnaire addressed the usability of the program (see Appendix C). The results were coded and analyzed along the two variables of effectiveness and usability.

The mode was tabulated for the first question on the questionnaire in order to determine the most popular initial reaction when one viewed the program. The five subsequent statements regarding effectiveness in question two, and the six subsequent statements regarding usability in question three, were coded and measured according to a Likert one to five scale using Microsoft Excel. The mean scores of each subsequent statement were tabulated. If the question was answered “unsure” it was not accounted for

when using the Likert one to five scale, but it was addressed in Chapter 3 using frequency and percentage.

The negative responses regarding effectiveness were analyzed first. A negative response score was considered anything below or above a Likert mean score of 3.0 depending on the nature of the question. A negative response score here indicated that the experts found the program ineffective. More research on the functional muscle anatomy of the shoulder, and rehabilitation programs for the shoulder was necessary to fix errors in the program regarding effectiveness. The positive responses regarding effectiveness meant that the developed program did not need to be adjusted in that particular area. The negative responses regarding usability were then analyzed. A negative response score here indicated that the program was not usable. If any part of the program received a negative response score in terms of usability, more research had to be conducted regarding rehabilitation programs, and more input from credible sources was necessary in order to change the program to make it more usable. The positive response scores for usability meant that the developed program was usable.

The final question of the questionnaire was open-ended, and allowed evaluators to leave comments and indicate whether there were any errors in the program. These responses were categorized into positive and negative feedback. The negative feedback from expert evaluators was considered to be the most important information received from completed questionnaires. The qualitative nature of this negative feedback allowed the evaluators to pinpoint any errors in the program. This clear indication would allow the researcher to edit the program accordingly.

Chapter 3

PRESENTATION OF THE RESULTS

The purpose of this study was to research the functional muscle anatomy of the glenohumeral joint, to develop a rehabilitation program for injuries acquired by overhead-throwing pitchers, and to have the rehabilitation program evaluated by qualified professionals for effectiveness and usability. After the rehabilitation program was developed, 20 were distributed for experts to evaluate. These evaluators represented professionals in the field of physical therapy and other related healthcare professions. A questionnaire accompanied every program issued. Eighteen (90%) of the 20 administered questionnaires were returned.

The Rehabilitation Program

The rehabilitation program was split into four different phases. General timelines were introduced for each phase, but because every injury is different, specific rehabilitation could not be assigned to exact dates. For example some injuries require more time spent in phase 1 than others, therefore phase 1 was to be conducted for one to two weeks depending on the nature of the injury. The fact that every injury is different foreshadows a problem that many experts claimed was not addressed in the developed program. The goal of the first phase was to reduce symptoms. It involved rest, immobilization, anti-inflammatory modalities, transverse friction massage, and minimal stretching. Some very basic exercises were described during this phase such as circumduction exercises and pendulum swings. Kinetic chain exercises were also

introduced to keep the rest of the body active during the initial phase.

Phase 2 was the second phase of the program and was dedicated towards scapular stabilization. The movement and position of the scapula create the boundaries that provide for normal physiology and biomechanics of the shoulder. This phase was to take place between weeks two and four. During this phase, rhythmic stabilization exercises, active oscillating techniques, scapular stability exercises, closed chain exercises, and some open chain exercises were introduced. Resistance equipment that would be useful during this phase was listed as well.

Endurance was the goal of phase 3, and it was to take place between weeks four and six. This phase consisted of the "thrower's ten." These rehabilitative motions were specifically developed for the injured overhead-thrower. There was an emphasis on eccentric activity during this phase. One gained endurance and strength during this phase to advance to full range with maximal resistance.

The final phase was aimed at preparatory activation and reflexive contraction. Phase 4 was to take place between the seventh and ninth weeks. One was to advance to the final phase only after one gained the ability to perform the "thrower's ten" and display full range of motion with no pain or instability. The goal of the final phase was to continue to build endurance and strength necessary for throwing, and to gradually return to the sport. The phase consisted of a more rigorous "thrower's ten", plyometrics, strength training, combination training, high-speed eccentric training, and an interval throwing program.

Initial Reaction

Question one on the instrument was designed for the researcher to determine the initial reaction that was most frequent among the given set of expert evaluators after they had looked over the rehabilitation program. This was a "check all that apply" style of question. Of the 10 possible initial reactions, four were checked by more than half of the experts. Fourteen out of 18 experts (77.78%) put a mark next to "Very Detailed," the most popular initial reaction. The other three initial reactions selected often were "Organized," "Effective," and "Difficult for Patient." The frequency and percentage of the four most popular initial reactions can be seen in Table 1.

Table 1
Top Four Initial Reactions According to Frequency and Percentage

Initial Reactions	*f*	%
Very Detailed	14	77.78
Organized	13	72.22
Effective	12	66.67
Difficult for Patient	10	55.56

Effectiveness

Question two of the instrument was designed for the researcher to determine if the program was effective. Expert evaluators circled a number on a scale from one to five indicating the degree to which they agreed with the statement. The mean score was calculated for all five statements pertaining to effectiveness. The most positive mean response score for effectiveness received a 4.07 on a scale from one to five. This score

was associated with the statement that claimed the program allowed for complete rehabilitation. The scores above 3.00 for the statements, "allowed for complete rehabilitation", a "prompt rehabilitation", and "allowed the pitcher to once again throw at high velocities," meant that experts agreed with these statements, all positive responses pertaining to the effectiveness of the program. The score below a 3.00 for "did not allow for proper rest," meant that experts disagreed with this fact, also a positive response score relating to the effectiveness of the program. Only one of the five statements dealing with effectiveness of the program earned a negative response score. The statement regarding the program skipping important steps earned a mean score of 3.11 indicating that experts agreed with the fact that the program "skipped important steps." All of the mean Likert scores regarding effectiveness can be seen in Table 2.

Table 2
Positive and Negative Responses Regarding Effectiveness According to Mean Score

	Mean Score	
Effectiveness	Positive	Negative
Allow Complete Rehabilitation	4.07	
Result in Prompt Rehabilitation	4.00	
Re-Allow Pitcher to Throw at High Velocity	3.69	
Skips Important Steps		3.11
Not Allow for Proper Rest	2.47	

Usability

None of the Likert scale questions on the instrument regarding the usability of the program earned negative response scores. All the questions regarding usability earned a

mean response that indicated that experts agreed that the program was usable. Of all the Likert scale questions of the instrument, the statement claiming the program was aesthetically pleasing earned the highest mean score of 4.71. The mean scores above 3.00 indicated experts agreed that the program was "aesthetically pleasing," "easy to follow," and "easy to read," and thus were considered positive responses. It was also a positive response when experts disagreed with the facts that the program was "too long," "too detailed," and "unrealistic. These statements had mean scores below 3.00. All mean Likert scores regarding usability can be seen in Table 3.

Table 3
Positive and Negative Responses Regarding Usability According to Mean Score

	Mean Score	
Usability	Positive	Negative
Aethetically Pleasing	4.71	
Easy to Follow	4.11	
Easy to Read	4.12	
Too Long	2.73	
Too Detailed	2.73	
Unrealistic	2.00	

The "Unsure" Response

Experts did have the option of selecting "unsure" indicating they were not able to agree or disagree with a statement. If "unsure" was selected it could not be factored into the Likert mean scale. The "unsure" selections indicated that the Likert scale questions on

the instrument did not correctly measure the levels of effectiveness and usability of the shoulder rehabilitation program. In order to display the effect of the "unsure" responses, the frequency and percentage of evaluators that selected "unsure" can be seen in Table 4.

Table 4
"Unsure" Selection to All Likert Scale Questions According to Frequency and Percentage

	"Unsure" Responses	
Effectiveness	*f*	%
Allow Complete Rehab.	3	16.67
Result in Prompt Rehab.	5	27.78
Re-Allow High Velocity	5	27.78
Skips Important Steps	3	16.67
Not Allow Proper Rest	3	16.67
Usability		
Aesthetically Pleasing	1	5.56
Easy to Follow	0	0.00
Easy to Read	1	5.56
Too Long	3	16.67
Too Detailed	3	16.67
Unrealistic	4	22.22

Additional Comments

According to the Likert scale, disregarding the "unsure" selections, the only negative response earned through instrument questions two and three was that the program "skipped important steps." But, the experts implied through their additional qualitative comments that there were other things wrong with the program as well.

Fifteen (83.3%) of the 18 returned questionnaires provided additional comments. Thirteen (72.2%) had negative comments, two (11.1%) had solely positive comments, and three (16.7%) questionnaires were returned without any additional comments. Table 5 clearly displays the nature of the additional comments.

Table 5
Nature of the Additional Comments According to Frequency and Percentage

	Returned Questionnaires	
Nature of the Additional Comments	*f*	%
Negative Response	13	72.22
Positive Response	2	11.11
No Response	3	16.67
Total	18	100.00

Of the 13 questionnaires with negative comments, six (46.2%) stated that there were problems solely regarding the usability, two (15.4%) claimed that there were problems regarding purely the effectiveness, and five (38.5%) declared that there were problems with both the effectiveness and the usability of the program. For a complete presentation of the negative response type within the additional comments see Table 6.

Table 6
Type of Negative Response in the Additional Comments According to Frequency and Percentage

	Returned Questionnaires	
Negative Response Type	*f*	%
Usability	6	46.15
Effectiveness	2	15.38
Both Effectiveness and Usability	5	38.46
Total with Additional Comments	13	99.99

Note. Due to rounding of numbers, percentages are less than 100%.

The qualitative results from the additional comments were divided into four categories and were presented according to negative responses regarding usability, negative responses regarding effectiveness, positive responses, and expert advice. Direct quotes were taken from questionnaires and have been displayed in the following as a presentation of the results.

Negative Responses Regarding Usability

There were four types of negative comment regarding the usability of the program. The first, common to three of the returned questionnaires, was that the pictures were incorrect. One evaluator stated, "#12 not external rotation, #8??, and #15 not shoulder abduction – it's in flexion." Another evaluator noticed, "Flexion and extension

with the bands [was] labeled wrong." A third evaluator also commented, "Pictures flexion and extension photos reversed."

Another common comment pertaining to the program's lack of usability regarded the description of certain activities. One claimed the program had a "poor interpretation of PNF (proprioceptive neuromuscular facilitation)." Another stated that there were "missing words in phase 1, and a typo in phase 3." A third wrote that clarification between "immobilization vs. rest" was necessary.

The third reoccurring comment made relating to usability was with regard to the vocabulary in the program. Four complaints experts often made included, "language too difficult for patient," "vocabulary too technical for patient to understand," "too detailed," and "too much info."

This problem, regarding terminology, introduced the last major negative comment, deemed by one expert the "supervised vs. stand-alone problem." Evaluators were not sure if the program was to be supervised by a professional in the field, or if a patient was supposed to pick up the program and rehabilitate alone. More than one evaluator "[wasn't] sure if the program [was] going to be given directly to athletes, or to their physical trainers or physical therapists." Most also agreed that "a key variable [was] the degree of supervision."

Negative Responses Regarding Effectiveness

There were two major types of negative comment regarding the effectiveness of the rehabilitation program. The first was with regard to inappropriate elements in the program. One evaluator claimed that instead of phase 1 lasting two weeks, in order to be

effective, it needed to be four weeks. Another claimed, “Standing circumduction may irritate an acute patient.” And, “Transverse friction massage [was] probably not appropriate in [the] acute phase.” Another evaluator wrote, “avoid some beginning exercises” because they were usually “too aggressive for most.

The last and most pointed negative comment with respect to the effectiveness was that a rehabilitation program for the “injured overhead-throwing athlete” was “too generic.” Experts needed to know, “What exactly was the injury?” Numerous experts asked if, “the patient injured the rotator cuff?”, was there “a labral tear, or tear tendonitis?”, was it “an overuse injury?”, or was the patient “post-surgery?” The experts were never informed of the precise injury and could not decidedly claim that the program was effective. The program lacked specificity, a murderous blow to its level of effectiveness.

“The key variable would be the specific diagnosis,” stated one expert. Some experts even lambasted some of the exercises as being “harmful” and “contraindicated in some injuries.” “What [was] appropriate for one injury was not appropriate for another,” an expert articulated. Not only was the effectiveness of the program contingent upon the type of injury, one expert informed that there are specific “protocols to follow” depending on the injury. The same expert that stated the success of a rehabilitation program was dependent on “the specific diagnosis” summed up the ineffectiveness of the program in one quite comprehensible statement: “One size won’t fit all.”

Positive Responses

Not all the qualitative responses were negative. There were some positive remarks scattered amongst the constructive criticisms. More than half of the completed questionnaires with additional comments slipped a praiseworthy characteristic into the response. The most common positive qualitative response was with respect to the aesthetic aspect of the program. One claimed it was a "very visually pleasing pamphlet," while another exclaimed that it was a "beautifully done handout with great pictures" and "an amazing looking handout overall!" Multiple evaluators commended the picture quality and admired the presentation. One stated that she "thoroughly enjoyed reading the program – it look's like you're well on your way to becoming a PT!"

Another type of positive response was that it would be an "excellent tool." One claimed that it "would be a good teaching tool for physical therapy students." Another claimed that "as an adjunct to individual visits with an experienced trainer or therapist, and allowing for individual variation and adjustment, it seems like an excellent tool."

Expert Advice

The last category of response in the additional comments was the most important with regard to finalizing an effective and usable shoulder rehabilitation program. The expert advice was not considered a positive or negative response. The instrument was not designed to gain advice, yet 12 (80.0%) of the 15 returned questionnaires with additional comments had some form of it. Most of the aforementioned negative comments were accompanied by methods to change the problem so that the program could become effective and usable.

Experts offered advice next to their critiques. For example, one expert suggested next to a negative response of phase 1 to "consider adding compression to the phase 1 modalities." And, "provide ice plus intermittent compression," and that there are now "special wrap[s] for shoulders" that can be added to "equipment." Another expert suggested, "One thing to consider for warm up is to apply a heating pack prior to exercises to increase elasticity of the soft tissue." Commonly experts accompanied their criticisms with a "you should consider…" type of comment. The expert that introduced the fact that there are certain protocols for specific injuries wrote one of the protocols directly down on the questionnaire. The example was "labral repair patients cannot abduct [the] shoulder passed 90 degrees in the 1st 3-4 weeks."

Numerous experts tried to answer the "supervised vs. stand-alone problem." Most gave advice leaning towards the creation of a "stand-alone" product. Some experts maintained that if the vocabulary was changed, and much of the detail was refined, an athlete would be able to successfully rehabilitate the shoulder. The best advice to resolve this issue involved "check boxes." The expert wrote, "Perhaps having check-box areas next to the exercise pic[tures] would be good. This way, PTs can check-off exercises that would apply to a patient's particular case. (To help individualize the program.)" The last piece of advice was to contact the expert evaluator. Two experts gave their contact information and said feel free to contact them.

Summary

The information presented in this chapter indicated some contradictions regarding the results of the completed questionnaires. The results from questions two and three of

the instrument indicated that the program was usable and effective. But, the additional comments that accompanied most questionnaires indicated problems with the program's effectiveness and usability. The additional comments included in the returned questionnaires revealed that there were mistakes in the program. The contradiction between the quantitative and qualitative responses, and the significance of the additional comments, were discussed in detail in the following chapter.

Chapter 4

DISCUSSION AND CONCLUSION

Summary

The purpose of this study was to research the functional muscle anatomy of the shoulder joint and create a rehabilitation program for injured pitchers. After creating a rehabilitation program it was evaluated by professionals in the field. The study was conducted in California between April 1, 2009, and August 29, 2009.

Baseball, America's national past time, incorporates throwing as a major part of the game. The shoulder joint has the greatest range of motion in the human body and is very vulnerable. The motion of throwing can be harmful to the shoulder joint and often injuries occur. There are many rehabilitation programs for shoulder injuries, but most of them do not take into account the anatomical differences that baseball pitchers have in comparison with the average human. The average pitcher has a greater range of motion and differing functional muscle capabilities compared to non-pitchers. Therefore, they need different rehabilitation programs. The major topics covered in the literature review were the functional muscle anatomy of the shoulder joint, and rehabilitation programs for the injured shoulder. The justification for this study was to produce a rehabilitation program unique to the injured overhead-throwing athlete and have it evaluated by professionals.

The researcher had access to a network of expert evaluators. After research had been conducted and a specialized rehabilitation program was developed, the program was mailed to experts along with a cover letter, an Informed Consent Letter, a pen, a

questionnaire, a stamped self-addressed envelope, and a five-dollar gift card. Eighteen of the 20 questionnaires were returned.

All the responses from the Likert scale questions regarding usability indicated positive results. All except one of the responses from the Likert scale questions regarding effectiveness indicated positive results. But, the additional comments revealed that there were factors that rendered the program unusable and ineffective, and therefore indicated negative results.

Discussion

In the following section the researcher first discusses the contradiction that arose from the Likert scale responses and the additional comments. The negative responses regarding usability, and the negative responses regarding effectiveness are discussed. Then, the positive responses are summarized. The expert advice given via the additional comments will then be articulated. Finally, the effects of the limitations on the study are examined. Conclusions are deduced from the findings, and recommendations are drawn from the conclusions.

An intriguing conundrum presented itself after tabulating the data received from the completed questionnaires. All Likert scale mean scores indicated positive responses except for the one concerning skipping steps. According to the methods and procedures in Chapter 2, positive Likert scale results for question two and three on the instrument indicate that the developed program was effective and usable. The confusing and difficult problem became evident after considering the additional comments the experts made. The vast majority of the additional comments introduced complications regarding the

program's effectiveness and usability. The positive nature of the Likert scale mean responses of questions two and three of the instrument contradicts the negative nature of the qualitative responses of question four on the instrument. Also, the selection of "unsure" for the Likert scale questions provided no insight at all. The original hypothesis was that the qualitative feedback from experts would provide for more accurate evaluation of the program. Because of the initial hypotheses, and the invalid and unreliable nature of the questionnaire, the discussion, conclusions, and recommendations have been based on the additional comments received from question four of the instrument.

There were four categories of comment made regarding the usability of the program. First, the findings revealed that there were incorrect pictures in the program. If a program has incorrect pictures, it is unusable. A patient would not achieve the result necessary for recovery if they follow the wrong images. Also, physical therapy facilities would not be able to employ the program if the pictures are incorrect. The researcher had adequate knowledge of exercises and this mistake should have been noticed previous to the distribution of the program.

Second, the findings revealed that there were poor descriptions of certain activities in the program. This is characteristic of a rehabilitation program that is unusable. If the verbiage does not accurately represent the intended actions, patients would not be able to understand the actions without additional interpretation. This program is supposed to simplify the process of rehabilitation, not complicate it. The review of literature did not adequately address the description of specific activities for the

layman. Addition research on the descriptions of rehabilitative procedures should be conducted to improve the usability of the rehabilitation program.

Next, the findings reveal that poor vocabulary was used though out the program. Many complained that the vocabulary was too technical and too detailed for patients to understand. If a patient cannot understand the program, a patient will not be able to use the program. The review of literature included the definition of rehabilitative terminology, but a glossary of these terms should have been appended to the program for the uninformed reader.

The final common negative response regarding usability revealed that there was confusion concerning how the program was supposed to be used. The program was created with the intention that a patient would be able to use it alone after an initial consult with a physical therapist. But, experts were unsure of this fact due to the poor descriptions of certain procedures, and the difficult vocabulary. This "supervised vs. stand-alone problem" could have been eliminated if there had been more research on unassisted rehabilitation programs in the review of literature. Only professionally assisted rehabilitation programs have been researched for this study. Also, the degree of supervision should have been specified before phase 1 of the program.

There were two major categories of concern regarding the effectiveness of the rehabilitation program. The first was with regard to inappropriate elements in the rehabilitation program. Certain aspects of the program should be disregarded in order to make the program more effective. These aspects would have been made evident through human resources after the development of the program. The researcher utilized doctors,

professors, and therapists during the review of literature, but should have approached them after the development of the program as well, before the distribution.

Lastly, the negative responses regarding effectiveness revealed that the program lacked specificity. Different injuries require different exercises. This program incorporates nearly every rehabilitative maneuver there is for shoulders. Unfortunately, some maneuvers are detrimental for some injuries. If an exercise injures a patient it is not only ineffective, it is dangerous. This mistake could be corrected through additional research of shoulder injuries and specific programs in conjunction with those specific injuries. The review of literature for this study did not adequately relate specific injury to specific rehabilitation.

The positive remarks state that the program was visually pleasing and could be used as a tool. The response regarding the visual aspect of the program was the only one that was not contradicted between the Likert scale and the additional comments. These findings revealed that adequate research on the presentation of rehabilitation programs has been conducted for this study. The program seems to be an accurate census of all the steps involved in shoulder rehabilitation as well. This would serve as an excellent tool for physical therapy students, but not necessarily those in need of rehabilitation.

The last category of response was the expert advice. The expert advice revealed many possible options that would make the program more usable and effective. Some of the advice can be directly implemented to immediately benefit the program. Other types of advice indicated what types of literature needed to be more heavily researched. A common suggestion was to research the "types of injury that occur to the shoulder." Another type of expert advice was who to call for help. Some left their phone numbers,

their addresses, and their emails for the researcher to utilize as human resources. Although the questionnaire was not designed to gain expert advice, this type of response may have been the most productive in terms of finalizing a usable and effective shoulder rehabilitation program.

The first limitation that directly impacted the results of the study was that the questionnaire developed for this study was not tested for reliability or validity. This limitation may have rendered questions one, two, and three of the instrument useless, because the Likert scale means indicated the program was usable and effective when that was not the case. Fortunately the qualitative nature of question four of the instrument has led to direct expert evaluation. Also, some of the Likert scale questions on the instrument were formatted in a way that made interpreting the results difficult. Some positive response scores introduced double negatives into the results. An example being, experts *did not* agree that the program *did not* allow for proper rest. A Likert score below 3.0 meant that experts did not agree, but in certain cases, an expert disagreeing was a positive result. The result indicated that the experts agreed that the program allowed for proper rest. If this formatting issue was corrected, all positive results would be above 3.0, and all negative results would be below 3.0.

Another limitation that may have impacted the findings of this study was that the long-term memory of professionals in the field was in question. For example, one expert claimed in the additional comments to be "no expert on shoulders but has some experience on early ortho[pedic] rehab." Lastly, two of the total 20 distributed questionnaires were not returned. Three of the 18 total returned questionnaires did not

have additional comments. This was most likely due to the limited availability of expert evaluators, another limitation of study.

The findings of the study indicate that the literature reviewed was insufficient, and more research needed to be conducted in order to produce a better shoulder rehabilitation program. Additional research concerning specific injuries to the shoulder, specific rehabilitation terminology, unassisted rehabilitation programs, and rehabilitative procedures is necessary in order to make the program more usable and effective. With more knowledge regarding these subjects, along with the knowledge gained through the initial review of literature, one would be able to tailor specific rehabilitative procedures to specific injuries for the overhead-throwing athlete.

Conclusion

Based on the findings of the study, the following conclusions are drawn:

1. The shoulder rehabilitation program developed for this study is not effective at rehabilitating all injured overhead-throwing athletes.
2. The shoulder rehabilitation program developed for this study is not usable by all injured overhead-throwing athletes.

Recommendations

Based on the conclusions of this study, the following recommendations are made:

1. Continue to research specific injuries to overhead-throwing athletes, utilizing literature resources and human resources available to specify the rehabilitation program to the type of injury.

2. Apply the advice pertaining to effectiveness and usability given by the experts in the field as follows:
    a. Specify whether the program is to be conducted under professional supervision or unsupervised.
    b. Add check boxes for physical therapists to advise patients which exercises to perform.
    c. Adjust the details and vocabulary to be more understandable to the layman patient.
    d. Correct the mistakes such as missing words and incorrect pictures.
    e. Remove or alter items and elements that are deemed inappropriate by experts.
3. Conduct a more valid and reliable survey so the Likert scale means can be more usable at determining positive and negative responses.

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APPENDIXES

Appendix A

Cover Letter

To Whom It May Concern:

Thank you for taking the time to review the shoulder rehabilitation program I have developed. In this packet you will receive this cover letter, an informed consent letter, the shoulder rehabilitation program, a five-dollar gift card, a questionnaire, a prepaid envelope with return address, and a pen. After you have looked over the rehabilitation program please complete the voluntary questionnaire regarding the program's effectiveness and usability. It will only take a few minutes of your time and your responses will remain completely confidential. Following the completion of the questionnaire, please place the questionnaire in the prepaid envelope and return it by August 12, 2009. The shoulder rehabilitation program is yours to keep if you wish to do so. Thank you in advance for your participation in this study.

Sincerely,

Joshua Raskoff

Appendix B

Informed Consent Letter

INFORMED CONSENT TO PARTICIPATE IN AN EVALUATION OF A SHOULDER REHABILITATION PROGRAM

Josh Raskoff in the Natural Resources Management Department at Cal Poly, San Luis Obispo, is conducting a research project on the development of a shoulder rehabilitation program. The purpose of the study is to evaluate the functional muscle anatomy of the shoulder, develop a rehabilitation program for the shoulder, and evaluate the effectiveness of the program developed.

You are being asked to take part in this study by completing the enclosed questionnaire regarding the rehabilitation program developed. After reviewing the rehabilitation program (which will take approximately ten minutes), please complete the questionnaire. It will take less than 10 minutes. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty. You may also omit any items on the questionnaire you prefer not to answer.

There is no risk associated with completing this questionnaire. The responses will be kept confidential to protect the privacy of the respondents. Potential benefits associated with the study include providing insight and expertise towards creating a shoulder rehabilitation program for injured athletes.

If you have questions regarding this study or would like to be informed of the results when the study is completed, please feel free to contact Josh Raskoff at (650) 823-3621, jraskoff@calpoly.edu. If you have questions or concerns regarding the manner in which the study is conducted, you may contact Dr. Susan Opava, Dean of Research and Graduate Programs, at (805) 756-1508, sopava@calpoly.edu.

If you agree to voluntarily participate in this research project as described, please indicate your agreement by completing and returning the attached questionnaire. Please retain this consent cover form for your reference, and thank you for your participation in this research.

Joshua M. Raskoff

Appendix C

Questionnaire

Physical Therapy Questionnaire: Shoulder Rehabilitation Program

The purpose of this questionnaire is to evaluate the shoulder rehabilitation program developed for the overhead- throwing athlete. After reviewing the shoulder rehabilitation program please fill out the following questionnaire. Your responses will help the researcher develop a specialized rehabilitation program for the injured baseball pitcher. Completing this questionnaire is voluntary and responses will remain confidential. Thank you for your participation.

1) What was your first impression of the rehabilitation program? (Check all that apply)

___Effective	___Ineffective
___Very Detailed	___Very general
___Organized	___Unorganized
___Easy for patient	___Difficult for patient
___Easy to facilitate	___Difficult to facilitate

2) Use the scale provided to rate the overall effectiveness of the rehabilitation program developed. (Circle one)

	strongly disagree	disagree	neutral	agree	strongly agree	
The program developed would …						
allow for complete rehabilitation	1	2	3	4	5	unsure
result in prompt rehabilitation	1	2	3	4	5	unsure
re-allow the pitcher to throw at high velocity	1	2	3	4	5	unsure
skip important steps	1	2	3	4	5	unsure
not allow for proper rest	1	2	3	4	5	unsure

3) Use the scale provided to rate the usability of the rehabilitation program developed. (Circle one)

	strongly disagree	disagree	neutral	agree	strongly agre	
The program developed was…						
aesthetically pleasing	1	2	3	4	5	unsure
easy to follow	1	2	3	4	5	unsure
easy to read	1	2	3	4	5	unsure
too long	1	2	3	4	5	unsure
too detailed	1	2	3	4	5	unsure

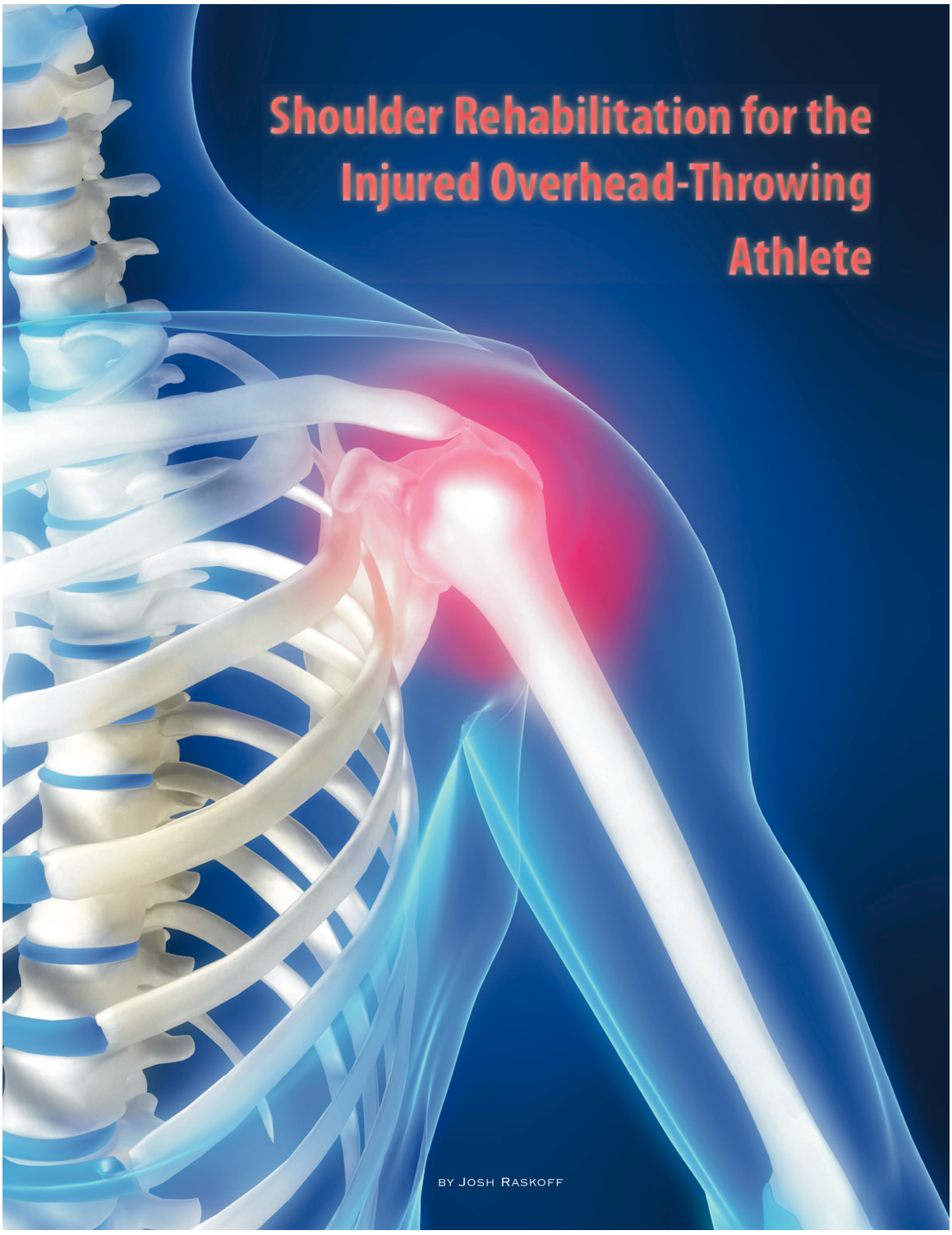
unrealistic 1 2 3 4 5 unsure

4) Please include any additional comments, and indicate if there were any errors in the program, in the space provided or on the back.

Thank you

Appendix D

Shoulder Rehabilitation Program


Shoulder Rehabilitation for the Injured Overhead-Throwing Athlete
BY JOSH RASKOFF

Phase 1

Main goal: Reduce symptoms

When: Week 0-2

Why: To avoid further injury, to get to a point where one can start to resolve pain, inflammation and discontinue modalities

How:

REST: Discontinue use

IMMOBILIZATION: Sling shoulder in internal rotation and 90 degrees of elbow flexion.

ANTI-INFLAMMATORY MODALITIES: The most common methods are ice, possible medication.

TRANSVERSE FRICTION MASSAGE: This is a method used on inflamed tendon to avoid scar tissue build up.

Test for success:

1) Examine pain with resisted motions (particularly elevation).
2) Apply the transverse friction massage for 3-5 minutes
3) Examine the percentage difference in pain with same motions

STRETCH: Passive/Active assisted range of motion (ROM) exercise.
~Progression is based on symptom improvement
~Done within a pain free

Exercises:

(3x/week)

1) Circumduction exercises: Mechanoreceptor stimulation to decrease shoulder discomfort. (clockwise and counterclockwise circles)

2) Pendulum swings: Increase movement of the humeral head in glenoid cavity.

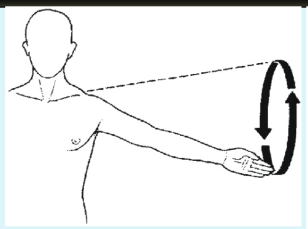
3) Flexion: (active assisted) Supine position, or with rope and pulley exercise.

4) External Rotation stretching (active assisted) Done in supine position at 90 degrees, 135 degrees, and full abduction.

5) Internal Rotation stretching: (active assisted)

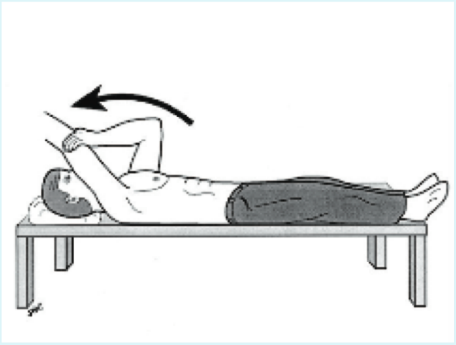
KINETIC CHAIN EXERCISES: It takes the entire body to throw because power is generated through the legs and transferred through a kinetic chain all the way to the shoulder. The rest of the body needs to be conditioned. Gymballs, agility drills with running and jumping, jumping jacks, and mini trampoline exercise condition the kinetic chain.

Note: Do not progress to strength training until normal return of passive and active range of motion has been achieved.

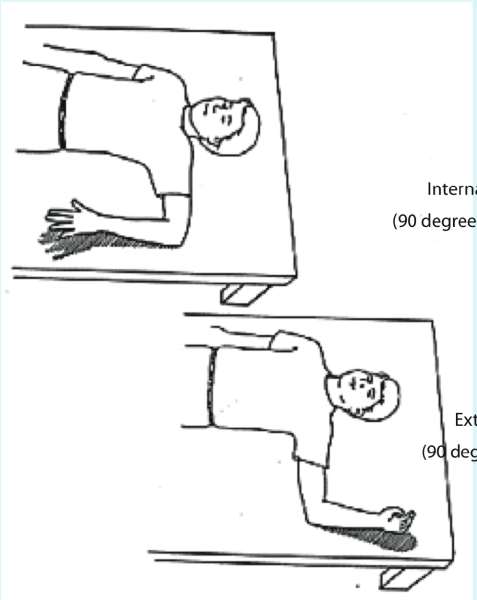


Circumduction
Exercises

Pendulum Swings



Flexion
(Self Assisted)



Internal Rotation
(90 degrees of abduction)

External Rotation
(90 degrees of abduction)

NOTES: _____

Phase 2

Main Goal: Scapular Stabilization

When: Week 2-4

Why: The scapula's movements and position create the boundaries that provide for normal physiology and biomechanics of the shoulder.

How:

RHYTHMIC STABILIZATION EXCERSISES: Restores neurosensory properties, enhance sensitivity in mechanoreceptors, preparatory reactive muscle activity

ACTIVE OSSILATING TECHNIQUES FOR ISOMETRIC STABILIZATION
Teaches to not alter normal joint motion with compensatory movements

Change can stress healing tissues and alter input to the central nervous system

SCAPULAR STABILITY EXCERSISES: Throwing athletes reported scapular instability when abducted and externally rotated while isometrically resisted at 90 degrees.

Exercises:
(3x/week)

Week 2

CLOSED CHAIN EXCERSISES: Restore normal muscle firing patterns

Scapular stability exercises:

1) Scapula protraction
2) Scapula retraction
3) Scapula elevation
4) Scapula depression

Note: Avoid positions that induce pain. If athlete can utilize the scapular and glenohumeral muscle patterns, begin open chain excersises

Exercises:
(3x/week)

Week 3

OPEN CHAIN EXCERSISES: Focus initially on concentric activity then progress to eccentric training.
Note: Must have mastered closed chain while remaining pain free.

1) External rotation/ retraction

2) Plyometric exercises

3) Triplanar conditioning

4) Scapulothoracic Proprioceptive neuromuscular facilitation

RESISTANCE EQUIPTMENT:
Elastic bands/light weights: Integrate the scapula by slightly retracting the scapula. (Bolster if needed to achieve normal motion)

1) Internal rotation

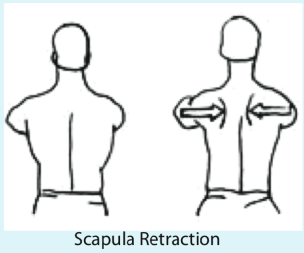
2) External rotation

3) Abduction

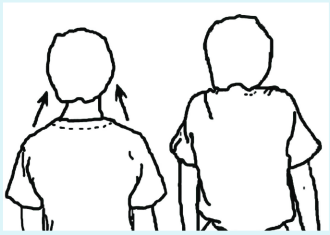
4) Extension

5) Flexion

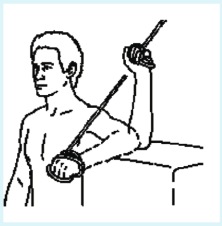
Note: Athlete moves from closed chain, to dynamic closed chain activity, to rotator cuff strengthening exercises, to functional sport-specific positions.



Scapula Retraction

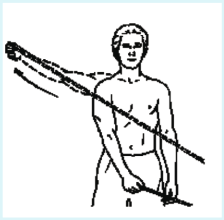


Scapula Elevation

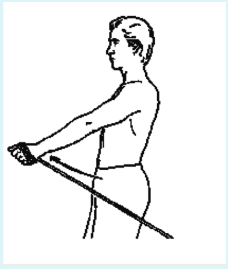


Internal Rotation with Elastic Band

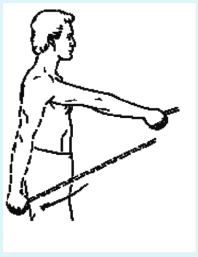
External Rotation with Elastic Band



Abduction Rotation with Elastic Band



Extension



Flexion

NOTES: _____

Phase 3:

Main goal: Endurance

When: Week 4-6

Why: One must have endurance and strength built up to advance to full range maximal resistance.

How: Emphasis on eccentric activity weight training (procative to provocative progress)

Week 4

BEGIN ENDURANCE
(4x/week)
FOCUS:
Lighter resistance
More repetitions
2 sets, 12-15 repetitions
3 sets, 15-20 repetitions

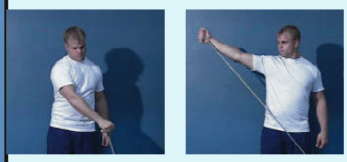
Week 5

BEGIN STRENGTH
(3x/week)
FOCUS:
Heavier resistance
Less repetitions
2 sets, 10 repetitions
3 sets, 10 repetitions

Exercises:

1) Diagonal pattern Extension

2) Diagonal pattern Flexion



3) External rotation at 0 degrees of abduction

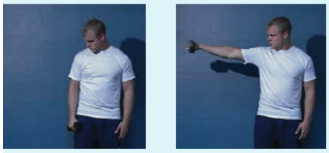
4) Internal rotation at 0 degrees abduction

5) External rotation at 90 degrees abduction

"The Thrower's 10"

6) Internal rotation at 90 degrees abduction

7) Shoulder abduction to 90 degrees

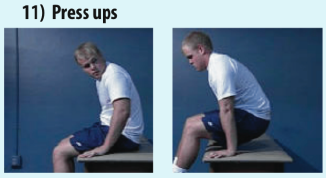


8) Scaption, internal rotation

9) Prone horizontal abduction (neutral)

10) Prone horizontal abduction (full external rotation)

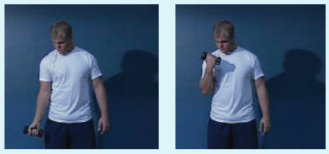
11) Press ups



12) Prone rowing into external rotation

13) Push ups

14) Elbow flexion



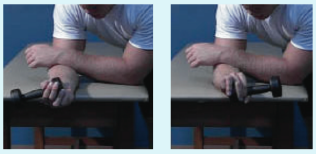
15) Elbow extension (shoulder abduction)

16) Wrist extension

17) Wrist flexion

18) Wrist Supination

19) Wrist Pronation



Phase 4:

Main goal: Preparatory activation and reflexive contraction

When: Week 7-9.

Note: The patient must show full ROM with no pain, have minimal instability, and be able to perform the "Thrower's 10" with good technique.

Why: With endurance and strength built up in the muscles necessary for throwing, one can gradually return to the sport.

How: Continue with the "Thrower's 10", but with more repetitions and less time between sets. Also incorporate the scapular stability excersises.

Preparatory activation:
Wall dribble, 2-arm chest pass, medicine ball

Week 7
STRENGTH TRAINING
(3x/week)
8-6-4 repetitions
5 lb. increase per set

Warm up: Internal and external rotations with elastic bands.

Note: If the patient is able to get six repetitions on the final set, increase the resistance by two pounds. If four repetitions cannot be completed in the final set, decrease the resistance so that four repetitions can be completed.

Week 8
COMBINE ENDURANCE AND STRENGTH
(3x/week)

Designed to increase endurance, strength, and power, shoulder musculature.

Warm up: Internal and external rotations with elastic band

Day 1: 3 sets, 10 repetitions
Day 2: 3 sets, 15 repetitions
Day 3: 3 sets, 20 repetitions

Note: select weight so can reach total repititions.

Week 9
HIGH-SPEED ECCENTRIC TRAINING/BEGIN THROWING
(3x/week)

Designed to increase endurance and prepare athletes for reflexive contraction.

Warm up: Internal and external rotations with elastic bands.

Slow & steady: slow (5 sec.) eccentric phase.

INITIATE INTERVAL THROWING PROGRAM:

(3x/week)

Note: Only begin throwing after satisfactory clinical examination, non-painful range of motion, satisfactory isokinetics, and have made progress through rehabilitation.

Day 1: Warm up: Internal and external rotations with elastic band
25' (15 throws)
Rest 5 minutes
25' (25 throws)

Day 2: Warm up: Internal and external rotations with elastic band
50' (25 throws)
Rest 5 minutes
50' (25 throws)
Rest 5 minutes
50' (25 throws)

Day 3: Warm up: Internal and external rotations with elastic band
50' (25 throws)
Rest 5 minutes
75' (25 throws)

Day 4: Warm up: Internal and external rotations with elastic band
75' (25 throws)
Rest 10 minutes
90' (25 throws)
Rest 10 minutes
90' (25 throws)

Week 10

CONTINUE INTERVAL THROWING PROGRAM

Day 5: Warm up: Internal and external rotations with elastic band
100' (25 throws)
Rest 5 minutes
100' (25 throws)

Day 6: Warm up: Internal and external rotations with elastic band
100' (25 throws)
Rest 5 minutes
125' (25 throws)
Rest 10 minutes
150' (25 throws)

DRAFT

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