THE EFFECT OF THROWERS TEN PROGRAM ON SHOULDER MOBILITY IN OVERHEAD-THROWING ATHLETES

by

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I. INTRODUCTION

Introduction

Many may consider the shoulder as the most complicated anatomical structure of the body.[1] Athletes who participate in overhead sports put their shoulders through an extreme range of motion and repetitive movements, which often stresses and overuses the shoulder complex. In contrast, athletes that are not dominantly involved in overhead sports are less likely to experience the same injuries as those involved with overhead sports. The shoulder complex must be mobile to perform an overhead throwing motion; however, the joint has to be stable to prevent from subluxation.[1,2] Thus, overhead throwing athletes' shoulder movements are considered to be a natural contradiction.[1]

Within the sport of softball, every position has an overhead throwing mechanism except for the pitcher. The pitcher throws in a windmill motion, which causes less stress on the shoulder girdle.[3] In addition, female overhead throwing athletes have to use more energy throughout the kinetic chain to produce more force and velocity to throw a ball. This stressful and repetitive motion can lead to fatigue, which can result in micro trauma to the shoulder.

There are six different phases to throwing: wind-up, stride, arm cocking, arm acceleration, arm deceleration, and follow through. The wind-up allows the athlete to generate momentum to help accelerate the ball to create kinetic activity to the elbow then goes to the shoulder for deceleration to the follow through.[4] The demands of high-velocity repetitive motion demanded of overhead-throwing athletes can alter the stability and mobility relationship and can lead to injury.[2] Engaging in this type of motion leads many athletes to develop injury or impairments, and they often have to compensate in a variety of ways for the sake of performance.

Overuse injuries are the most common injuries for athletes. The common injuries that overhead athletes endure are tendonitis, tendonosis, and impingement.[5] Tendonitis is inflammation that occurs in the tendon or in the tendon sheath of the joint. Impingement occurs when there is swelling around the acromion and rotator cuff, which can cause pain and neurological issues. There are many injuries that follow from these minor injuries including: SLAP lesions, rotator cuff tears, and Bankart lesion.

These types of injuries can often be managed with a successful rehabilitation exercise program.[5] In order to avoid surgical intervention, rehabilitation can be used to treat an athlete before the injury progresses. Rehabilitation plays an important role: it strengthens the muscles around the shoulder, which helps keep the shoulder stable enough with normal range of motion.

Functional Movement Screening™ (Functional Movement Systems, Danville, VA) has become a new trend in the world of sports. Multiple professional teams, universities, military services, and first responders have used this type of testing to help identify functional movement impairments to improve performance and prevent injury.[6,7,8] Before Functional Movement Screening™ (FMS) was created, training programs would test an athlete's strength and physical condition using bench press, squats, vertical leap, linear speed, and agility.[8] While informative, the outcomes of the traditional training program tests do not provide functional data to effectively reduce or prevent injury to athletes[8] because there is no specific standardized results to compare traditional training tests to.

Functional Movement Screening™ has been designed to challenge the functional movement patterns of an individual in order to assess the mobility and stability interactions of the kinetic chain in the fundamentals of athletic performance.[6] Mobility describes the ability of an individual to move freely through a full range of motion. Stability is defined as the ability for a body part to resist movement and remain firm. [6] Finally, basic fundamental patterns for an individual are described as a deep squat, push-ups, and hurdle steps. Individuals that perform high level athletic activities have been reported to have trouble performing basic fundamental patterns.[6] This can result in traumatic injury because of the compensation used to overcome the basic patterns of movement. In response, physical therapists, athletic trainers, and strength conditioning trainers have worked together to create rehabilitation and exercise programs based off of the FMS scores, with the idea that the focus should be on impairments in order to prevent injuries.

Functional Movement Screening™ is comprised of seven individual tests to assess asymmetrical functional impairments. These include: deep squat, in-line lunge, hurdle step, shoulder mobility, active straight leg raise, trunk stability push up, and quadruped rotatory stability. Once the assessment is complete, the resulting scores indicate asymmetries of the body and provide the main focus of where an individual's rehabilitation should begin. In addition, Functional Movement Screening™ may show past history of an injury and impairments with each individual.[6,9] The FMS tool can show asymmetry between extremities and identify whether a shoulder is more mobile than another and which ankle is more stable when performing tasks that involve functional movement. With this information, rehabilitation can be a focused effort which improves the mobility and strengthens the areas that have been compromised throughout the athlete's life.

Rehabilitation programs for overhead throwers should focus on the changes that occur due to loss of internal rotation and muscle weakness of the external rotator and scapular muscles that are commonly seen in overhead throwers.[5,10,11] There are different types of rehabilitation exercises designed to strengthen and increase mobility of the shoulder by increasing mobility, such as the Throwers Ten Program (Throw 10). This program is designed to help overhead throwing athletes strengthen and support the mechanics of the shoulder complex musculature.

The Throwers Ten Program is designed to be specific to a thrower and improves endurance, strength, and power for the shoulder.[12] The Throw 10 involves specific exercises focusing on the external and internal rotation along with flexion and extension for the shoulder girdle. The ten exercises include: diagonal shoulder flexion and extension, internal and external rotation at 0° abduction, external and internal rotation at 90° abduction, shoulder abduction at 90°, scaption external rotation, prone horizontal abduction (neutral, full external rotation, 100° abduction), seated press-ups, prone rowing, push-ups, elbow flexion and extension, and wrist extension and flexion and supination and pronation.[5,13,14] This exercise program has been observed to be effective for rehabilitation and prevention of shoulder injuries for overhead athletes.[12] Therefore, the purpose to this study is to determine the effect of Throwers Ten program on shoulder mobility in overhead throwing athletes.

Hypothesis

The Throwers Ten Program will result in greater improvement of mobility in FMS scores in overhead throwing athletes.

Key Words

Shoulder, body mapping, flexibility, laxity

Delimitations

This experiment has certain delimitations that may affect the data collection or interpretation of the study.

1. The subjects are NCAA division I collegiate female athletes ranging between the ages of 18 to 23.

2. Subjects with any upper extremity orthopedic injuries during the duration of the study and throughout the study will be noted and depending on severity of injury, may be disqualified from the study. Injuries that could result in disqualification include a torn ligament or tendon needing surgical repair.

3. The subjects will be healthy and experienced overhead-throwing athletes.

4. The study is a 6- week exercise training protocol due to constraints with the data collection timeframe.

Limitations

The limitations of this investigation reflect the effect of the delimitations on the collection and interpretation of the data, as well as the ability to expand the scope of inference beyond the sample population. Generalizations made from the results will be compromised by the following limitations:

1. This study cannot be applied to the non-overhead throwing athletes.
2. The results of the study cannot be applied to individuals suffering from upper extremity orthopedic injury through an extended period of training.
3. This study cannot be applied to physically active or inactive males or overhead throwing males.
4. Generalizations should not be made outside the investigation population of subjects younger than 18 years of age or older than 23 years old.

Assumptions

The basic assumptions of the study include:

1. The subjects were randomly distributed among the treatment groups.
2. Subjects will complete the questionnaires to the best of their knowledge.
3. Subjects will perform resistance exercise training program and evaluation with maximum efforts.
4. Subjects will not complete any strenuous activities outside of their designated sport and supplement investigative exercise routine.

Significance of Study

Many collegiate athletes that play an upper extremity sport using the overhand throwing motion commonly complain of shoulder pain due to overuse. This pain can be linked to inflexibility or instability to the shoulder complex.[2] After experiencing an injury, athletes are advised to complete therapeutic exercises which focus on flexibility.[5,10] The purpose to this study is to determine the effect on mobility of a 6 week Throw 10 measured by FMS testing. This study may present a new way of testing functional movement for competitive athletes, one that may allow them to focus on their functional weaknesses to improve their athletic performance. The results will help further researchers' knowledge and could lead to new strategies aimed at decrease injury via Functional Movement Screening™ and therapeutic resistance programs. The study and implementation of these two could potentially improve overall performance for competitive athletes. [6,7]

II. REVIEW OF LITERATURE

Introduction

Shoulder injuries are the most common type of sports injuries experienced by overhead throwing athletes. A throwing motion requires flexibility, muscular strength, coordination, and neuromuscular control, which is strenuous and demanding on the shoulder complex. Throwing athletes perform extremely high velocity, repetitive motions that potentially wear the shoulder joint down, leading to injury. In response, many interventions and rehabilitation programs have been designed to help prevent shoulder injuries in athletes.

Shoulder Injuries

The shoulder can be considered one of the most complicated anatomical structures of the body. Athletes who participate in overhead sports subject their shoulders to extreme motion and repetitive movements, which causes stress and overuse to the shoulder complex. Athletes that do not practice overhead sports dominantly are less likely to endure the same injuries as an overhead sports participant. The shoulder complex must be hypermobile enough to perform an overhead throwing motion. However, the joint has to be stable enough to prevent from subluxation[1,2]. The overhead-throwing athletes' shoulder is considered to be a natural contradiction[1].

For an overhead-throwing athlete, it is important to keep the full range of motion throughout the competitive season. Researchers have theorized that the loss of internal rotation and full range of motion is caused by the damage of the external rotator muscles.[15] The external rotators are eccentric muscles that help to decelerate the arm during the throwing motion. The loss of internal rotation is known as glenohumeral internal rotation deficit (GIRD), which is described to be a progression of "internal impingement like" changes of the shoulder.[2] The posterior capsule develops where the head of the humerus on the glenoid shifts posterior and superiorly. The anterior and inferior part of the capsule becomes diminished with the glenohumeral and increases the length of the anterior aspect of the capsule.[2] '

A group of researchers studied forty-eight healthy overhead throwing athletes that played for an NCAA Division I and II for GIRD.[16] Researchers examined the changes of range of motion over the athletic season and monitored the prevalence of GIRD. They studied internal and external rotation along with the total arc of the shoulder all three seasons (prefill, pre-spring, and post spring). The results suggested there were no changes to internal rotation during the athletic season. However, external rotation and the total arc gained range of motion in both shoulders.[16] If GIRD were to progress, it could result into rotator cuff tears and superior labrum anterior-posterior (SLAP) lesions, which are a common occurrence amongst overhead-sport athletes.[2,11,15] A shoulder that has a range of internal rotation motion <180° and >25° is at risk for the development of SLAP lesions.[2]

There are four different types of lesions that can occur. Type I is a small tearing in the attachment of the superior aspect of the labrum, where the origin of the biceps tendon starts. Type II is observed the most among throwing athletes,[11] this is a tearing of the biceps tendon anchor. Type III manifests itself as a bucket-handle tear in the upper portion of the labrum. However, the labrum and biceps tendon remain attached to the glenoid. Type IV is classified as a superior bucket-handle tear of the labrum that extends to the biceps tendon.

SLAP lesions occur during the cocking phase, when the arm is in full maximum external rotation.[2] Depending on the severity and type of the injury, SLAP lesions may require surgical repair. If an athlete has non-operative treatment, it is essential that rehabilitation be initiated with immobilization to speed up recovery and increase play time. Recently, researchers studied forty-four pitchers with a Type II SLAP lesion and 87% of the pitchers returned to pre-injury performance level activity after undergoing operative treatment.[2] With a safe yet aggressive approach, a rehabilitation regimen can excel at returning athletes to play.[2,15]

Rotator cuff tears tend to affect 4% to 32% of population and become more prevalent with age.[17] When deciding on a treatment plan, several factors such as age, level of activity, and severity of the tear should be taken into account when considering surgical approaches. When a non-operative decision is made, rehabilitation for the rotator cuff is often the alternative. The rotator cuff consists of four tendons: supraspinatus, infraspinatus, subscapularis, and teres minor. These muscles allow the glenohumeral joint to abduct externally and rotate internally. When an examiner is evaluating an overhead-throwing athlete, it is important to note when the shoulder pain is present, either during the windup or deceleration phase of throwing. Pain or loss of function during a specific phase can identify which muscle of the rotator cuff suffers from injury.[10]

Surgical repair to the rotator cuff occurs when there is full or partial thickness tear. Rehabilitation guidelines depends on the size of tear, tendons involved, tissue quality, and repair method.[17] The initial phases of healing for rehabilitation should focus on protecting the tissue. Depending on the integrity of the tissue, passive range of motion of the glenohumeral joint begins to reduce joint stiffness. As rehabilitation progresses through various phases is it important to be aggressive while remaining safe in order to effectively and efficiently return the athlete to play.[2,10,17]

Throwers Ten Program

Athletes that participate in overhead-sports put their shoulders through extensive ranges of motion and repetitive mobility, leading to stress and overuse to the shoulder complex. Because of this, they are at risk of many different injuries. The areas that are most frequently affected are the posterior and superior glenoid impingement.[5,18] These type of injuries often result from failure or fatigue in the kinetic chain.[19] The body's kinetic chain is composed of the legs, hips, trunk, glenohumeral joint, upper arm, forearm, and hands.[19]

Overhead-throwing athletes can be categorized into three types based on the motions performed: softball pitching (windmill motion), baseball pitching, and in-field/out-fielder throwers. All three throwing techniques place a demanding amount of force to the shoulder joint. The shoulder must have enough laxity for external rotation yet be stable enough to prevent subluxations to the humeral head.[5,18] In this case, repetitive motions can cause microtrauma and, with time, can lead to serious damage to the shoulder without treatment or rehabilitation.

In the past 25 years, exercises for the shoulder for overhead-throwing athletes have not changed much.[12] A group of researchers developed an exercise program based on evidence that suggested isotonic exercises for the overhead athlete increases strength and endurance for the shoulder, known as the Thrower's Ten.[12] The Throwers Ten Program (Throw 10) was designed to help overhead throwing athletes strengthen and support the mechanics and physiology of the shoulder complex musculature. The program is tailored to develop strength in the major throwing muscles of the shoulder. It is specifically meant for a thrower and improves shoulder endurance, strength, and power. The Throw 10 involves specific exercises focusing on the external and internal rotation along with flexion and extension for the shoulder girdle. Evidence supports the idea that the Throw 10 is effective in improving the strength, endurance, and power of the shoulder complex musculature.[12]

It is recommended that overhead-throwing athletes utilizing a non-operative procedure use a rehabilitative program that involves a progressive and sequential approach.[5] The Throw 10 has ten distinctive exercises incorporated in the exercise program. These specific exercises focus on the external and internal rotation along with flexion and extension for the shoulder girdle. The regime of ten exercises consists of: diagonal shoulder flexion and extension, internal and external rotation at 0° abduction, external and internal rotation at 90° abduction, shoulder abduction at 90°, scaption external rotation, prone horizontal abduction (neutral, full external rotation, 100° abduction), seated press-ups, prone rowing, push-ups, elbow flexion and extension, and wrist extension and flexion and supination and pronation.[5,13,14]

Individuals that exhibit weakness in external rotation may be attributed the posterior muscles of the rotator cuff.[19] The rotator cuff of the shoulder includes the supraspinatus, infraspinatus, subscapularis, and teres minor. Each muscle is highly important when it comes to the throwing mechanism. Increasing strength in the internal rotators without strengthening the stabilizers of the scapula has been theorized to put the shoulder severe risk of injury.[5,12]

There are four different phases of rehabilitation. The first phase is the acute phase, aimed at decreasing pain and inflammation while regaining range of motion, as well as re-establishing dynamic stability and controlling functional stress and strain. This phase includes increasing flexibility and stretching the posterior muscles of the shoulder by increasing internal rotation and horizontal adduction. Strengthening exercises are used to strengthen the rotator cuff and scapular muscles. In addition, closed kinetic exercises are used to gain range of motion, increase strength, and flexibility.

Phase two is the intermediate phase, where the aim is to progress with strengthening while restoring muscular balance and improving dynamic stability as well as controlling flexibility via stretching. This phase is where the Throw 10 is incorporated as the individual will progress from isometric exercises to isotonic exercises to concentrate on eccentric and concentric contraction.

The third phase of rehabilitation is the advanced strengthening phase, focusing on aggressive strengthening and improving neuromuscular control and muscular strength while also initiating light throwing. The Throw 10 can be implemented here as well and plyometric exercises are introduced for further developing shoulder strength and endurance. This is followed by the return to activity phase, where the goal is progression of a throwing program that allows a return to competitive throwing. Improving strength and flexibility remains a focus as well. The Throw 10 will continue to be used for flexibility and stabilization and should be used after returning to activity to prevent the shoulder from getting re-injured.

Researchers have reported that athletes' throwing velocity increases by 2% within six weeks of Throw 10 implementation and demonstrates an enhancement in performance.[12] Given its effectiveness, the designers of the Throw 10 have also created an advanced program. It is a continuation of the regular Throwers Ten but it incorporates more functional and plyometric based-training. This program will increases ball velocity of an athlete while maintaining the strength and endurance of the shoulder complex.

Functional Movement Screening™

The purpose of Functional Movement Screening™ (FMS) is to decrease injuries, enhance performance, and improve quality of life.[6,7] Functional Movement Screening™ has been designed to challenge the functional movement patterns of the mobility and stability interactions of the kinetic chain within the fundamentals of performance.[6] Multiple professional teams, universities, military services, and first responders have used this testing to identify functional movement impairments in order to improve performance and prevent injury.[6,7,8] The seven functional patterns include a deep squat, in-line lunge, hurdle step, shoulder mobility, active straight leg raise, trunk stability push up, and quadruped rotatory stability.

As FMS has evolved over the years, research has increasingly supported the significance of the screening. Researchers have also suggested that the screening is a reliable tool that identifies which individuals are most likely to get injured.[20] Another study completed an inter-rater reliability test before conducting the FMS on their participants. This study investigated the performance between males and females, with or without previous history of injury, while analyzing the reliability of FMS.[21] The researchers used the Intra-class correlation coefficient (ICC) and Kappa statistics to establish reliability. The ICC results demonstrated excellent reliability with a 0.971 composite score for FMS and the Kappa statistic demonstrated substantial to excellent agreement (0.70-1.0) for individual test components of the FMS.[21] Research studies that shown different results with FMS results when compared to research studies. Furthermore there is limited research focusing on female athletes utilizing FMS.

The FMS has been used on firefighters to alter their exercise-training program. Investigators conducted a research study and reported no change after a twelve week program with firefighters when compared to firefighters in the control group.[22] Researchers mentioned the possibility that interventions for the firefighters in the experimental group could have altered the results.[22] Firefighters require a great amount of strength and flexibility during the act of duty. Forcible entry and recuses are prone to injury that involve trunk stability and hazardous conditions on the body.[23] When compared to professional athletes, firefighters sustain more sprains and strains during act of duty.[23] However, researchers used FMS to help design an intervention to decrease injuries of 433 firefighters.[23] Researchers analyzed the correlation between FMS performance and injuries of the firefighters with selected intervention parameters.[23] The intervention was a training program that focused on the flexibility and core strength as measured by FMS. Results determined that the 62% of injuries decreased to 42% over a twelve month period when compared to a historical control group.[23] After separating the scores to either a passing score (>16/21) or a failing score (<16/21), firefighters with history of injury were 1.68 times more likely to fail a FMS test.[23, 24] The study also noted the age, rank, and gender of the firefighters, which could correlate to different sports or occupations that require high intense body movement.

University and professional teams use FMS to indicate which individuals are more prone to injury. As mentioned, FMS identifies asymmetries in individuals, which can leads to poor biomechanics if not corrected. This ultimately leads to micro- or marco-traumatic injury.[6] On average, a participant must receive a score higher than a 14 in order to "pass" a FMS test. Anything lower than a 14 indicates right and left asymmetries and the individual is identified as predisposed to injury.[6, 7, 22, 23, 25]

One study investigated the relationship between 46 professional football players and predisposition to serious injury as measured by FMS.[25] The results of the study implied that individuals who scored 14 or less had an 11-fold increased chance of injury and a 51% chance of experiencing a serious injury during the competitive season.[24, 25] Another group of researchers examined the effectiveness of an off season intervention to improve the scores of FMS.[26] Within this study, 62 participants completed a 7 week personal off-season intervention based on their baseline FMS scores. Results indicated there was a significant improvement of functional asymmetries during the pretest and posttest with a seven-week intervention.[26]

Studies that have been conducted have mostly dealt with male athletes. However, female athletes subject their bodies through extreme high intensity movements within specific sports they participate in. One notable study was conducted on female collegiate athletes in order to determine the movement patterns to injury using the FMS tool. Results revealed a 4-fold increase in risk of lower extremity injury in female collegiate athletes.[24] Individuals that scored lower than a 14 with FMS were predicted to sustain a major musculoskeletal injury.[24]

Functional Movement Screening™ has evolved over the decades to further increase the accuracy of this type of testing. A study to determine the reliability of FMS studied forty healthy individuals and videotaped those performing FMS.[20] Novice raters were paired with expert raters and determined that the data FMS was providing could confidently assess the movement patterns and create interventions to increase performance and identify risk of injury for athletes.[20]

Conclusion

There is a significant amount of evidence supporting FMS tests and the Throw 10 regime as effective at improving throwing performance in overhead throwing athletes. Many athletic trainers and physical therapists have incorporated Throw 10 in their rehabilitation treatments with positive results. Multiple professional teams, universities, military services, and first responders have implemented FMS testing to help identify functional movement impairments and improve performance as well as prevent injury.[6,7,8] With positive results from both functional exercises, predictions from clinicians suggest implementation of the two would lead to beneficial results for overhead throwing athletes' performance. However, there has been limited research for FMS with the intervention of the Throw 10. As FMS becomes better known in sport medicine arenas, many injuries could be avoided or treated more effectively. There are possibilities that in the future, researchers will discover that the FMS tool and Throw 10 will be efficient in clinical settings.

III. METHODOLOGY

An intercollegiate National Collegiate Athletic Association (NCAA) Division I collegiate softball team was recruited to participate in a research project examining the effect of a shoulder strengthening program in functional assessment screening. The players signed an informed consent to participate in the study. There was an inclusion and exclusion criteria that was necessary for the participants to be eligible for the study. If a participant had any previous injury, it would be documented. The Throw 10 focused on strength, power and endurance of the shoulder complex musculature.[7] The study focused on mobility for the shoulder complex, which was measured via Functional Movement System™ (FMS).

Purpose

The purpose to this study was to determine the effect of Throwers Ten Program on shoulder mobility in overhead throwing athletes measured by Functional Movement Screening™.

Setting

The research study took place at the University of the Incarnate Word Athletic Department's Strength and Conditioning facility (San Antonio, TX). A majority of the FMS testing and paperwork took place in the strength and conditioning facility. The Throw 10 exercise routine however, was assigned as a take home exercise for participants.

Participants

An intercollegiate NCAA Division I softball team (n=20) formally consented to participate in the study (appendix A). Participants of the study had to complete a questionnaire that was administered to document demographics (appendix B) and history of previous injuries (appendix C). For the participants to be included in the study, they could not have experienced a severe orthopedic upper extremity injury within the past 6 months, such as a fracture or torn ligament. If the participant had an upper extremity orthopedic injury and was undergoing rehabilitation, he or she would be allowed to participate in the study. Participants were excluded from the study if he or she suffered a serve upper extremity orthopedic injury and surgery was required. If an injury were to occur during the duration of the study, depending on the severity of the injury, the participant may be disqualified from the study.

The participants regularly engaged in a set softball exercise program provided by a team strength and conditioning coach. This program could improve the flexibility or mobility of the participants throughout the duration of this investigation. To account for this, the control group continued with the normal exercise given by their strength coach, while the experimental group utilized Therabands to complete the Throw 10 before their normal softball workouts and practice.

Procedure

To participate in the investigation, participants read and signed a consent document (appendix A) approved by the Institutional Review Board at Texas State University (Code #2014B9160). The participants completed all preliminary paperwork and received an explanation of the investigative procedures before the testing began. The FMS test was measured at the beginning of the study to measure the mobility and flexibility of the participant's shoulders. The FMS tool consisted of seven challenging exercises for the body (Appendix E). The seven functional patterns include a deep squat, in-line lunge, hurdle step, shoulder mobility, active straight leg raise, trunk stability push up, quadruped rotatory stability including three clearing test for shoulder and trunk stability. The clearing test was to ensure there was a negative pain for the participant while in specific position. Each participant would complete all seven tests; however the main focus of testing was on the shoulder mobility of the shoulder complex. A Certified FMS instructor interpreted the scores for each movement pattern during testing. There was a raw score of the seven patterns, however five patterns tested the right and left sides of the body individually. If the individual received a three on the left side and a two on the right side of the body the final score would be a two, therefore the scores were averaged as a final score. The lowest score of the raw score was carried over into the final score. The overall scores of FMS were out of 21 of right and left side of the body.

Fielding positions of the athletes were documented in the demographics, but would affect the research data. When FMS testing was completed, the participants were randomly split into two groups by drawing a number without looking. The participants either drew a number 1 or 2, which determined the group the participant was assigned to. Once the groups were divided, group one (experimental group) received the Throw 10 program and group two (control group) did not.

Group one completed the Throw 10 program (Appendix F) using therapeutic rubber tubing known as Therabands and continued their normal softball workouts with their strength coach. The participants received instructions and demonstrations how to complete the Throw 10 by the research supervisor. The ten exercises included diagonal shoulder flexion and extension, internal and external rotation at 0° abduction, external and internal rotation at 90° abduction, shoulder abduction at 90°, scaption external rotation, prone horizontal abduction (neutral, full external rotation, 100° abduction), seated press-ups, prone rowing, push-ups, elbow flexion and extension, and wrist extension and flexion and supination and pronation. Group one completed the Throw 10 three times a week (Monday, Wednesday, Friday) for six weeks doing 3 sets of ten repetitions on each exercise (Appendix D). The participants completed the Throw 10 in the Athletic Training room of the University of the Incarnate Word before reporting to practice or games. The participants filled out a chart documenting the Throw 10 exercises that were completed at each visit. The chart was kept in the Athletic Training room with the Athletic Trainer of the team. The chart showed which participants were keeping up with the Throw 10. When the participants were performing the Throw 10 in the Athletic Training room they were under the supervision of the Head Athletic Trainer of the University of the Incarnate Word.

Group two continued their regularly scheduled softball-conditioning program without using the Throw 10. The participants had 6-weeks after the initial testing before being tested again using the FMS tool. At the end of the study duration, FMS testing was conducted to evaluate the each participant's mobility with the functional patterns mainly focusing on the shoulder mobility.

Design and Analysis

The dependent variables in this study were: 1) the Functional Movement Screening total score, and 2) the shoulder mobility score. The two independent variables were: 1) the treatment (control versus Throwers Ten Program treatment), and 2) trials (pre- versus post-tests). The treatment variable was a between-subjects variable, while the type of trial was a within-subjects (repeated) variable. A MANOVA was used for the pre-test FMS scores to determine the group difference in performance before the treatments were administered. A two-way 2x2 repeated measures ANOVA was used to determine improvement between the treatment and control conditions as well as pre- and post-test differences between trials for each dependent variable.

Since all tests between treatment and trial combinations were between two sample means (one degree of freedom), no post-hoc tests and no adjustment of probability for any variation in sphericity among the trials were needed. Partial eta^2 was used to determine effect size for each statistical test. Overall statistical significance was defined as $p < 0.05$.

IV. MANUSCRIPT

Abstract

Context: Participation in athletics includes an inherent risk of injury related to the nature of the games and activities of the players.

Objective: The objective was to determine the effect of Throwers Ten (Throw10) on the shoulder mobility of overhead-throwing athletes. The Functional Movement Screening™ (FMS) was utilized to measure mobility to permit its developers to assert that it can be used to practically and accurately identify vulnerable athletes. In addition, the Throw 10 was designed to strengthen the shoulder girdle of an overhead-throwing athlete.

Design: Randomized Control Trial

Setting: Field-based investigation.

Patients or Other Participants: Twenty National Collegiate Athletic Association (NCAA) Division I softball players (age range 19.6 $\pm$1.04 years; Classification: Freshmen=8, Sophomore= 5, Junior=4, Senior= 3; height: 166.37 $\pm$ 5.17cm; throwing hand right (R)= 19, left (L)=1; batting stance R=10, L=10) without a history of shoulder pain in the previous six months volunteered to participate in this investigation. Participants were randomly assigned to an experimental group and control group.

Intervention(s): FMS scores were examined before and after six weeks of Throw 10 training when compared to a control group.

Main Outcome Measure(s): Each participant completed the FMS pre-test and post-test and the ten participants in the experimental group utilized the Throw 10 as an intervention for six weeks between the pre-test and post-test. The remaining ten participants did not complete the Throw 10 during the six-week intervention.

Results: Functional Movement Screening™ ANOVA indicated no significant overall difference between trials (pre-test versus post-test), F (1, 18) = 0.12, p = 0.733, partial eta^2 =0.007. Shoulder mobility, 2x2 repeated measures ANOVA indicated a significant overall difference between the shoulder trials (pre-test versus post-test), F(1, 18) = 5.06, p = 0.037, partial eta^2 = 0.519. Shoulder mobility significantly improved from 1.95±0.759 in pre-test compared to 2.30±0.801 in post-test. There was no significant difference in improvement in shoulder mobility between the groups.

Conclusions: Participants that utilized the Throw 10 showed no significant improvement in shoulder mobility when compared to control participants. There was a significant overall shoulder mobility score increase from the post-test versus the pre-test in FMS testing for both groups combined. Other research has suggested The Throw 10 as potentially effective in increasing overhead-throwing athletes' mobility within prevention and rehabilitation contexts. However, the results of this study did not support this hypothesis.

Key Words: upper extremity, muscle imbalances, muscle strength, shoulder laxity

Introduction

Participation in athletics includes an inherent risk of injury due to the nature of the games and activities of the players. Varying demands of specific sports subject athletes to certain demographics of injuries. Athletes who participate in overhead sports extend their upper extremities through extreme ranges of stressful and repetitive motion, causing stress and overuse to the shoulder complex. When examined biomechanically, upper extremity kinematics and kinetics differ between individual baseball and softball players.

The shoulder complex must be mobile enough to perform an overhead throwing motion. However, the joint has to be stable to resist subluxation.[1,2] Therefore, overhead throwing athletes' shoulder are considered to be a natural contradiction.[1]

Female overhead-throwing athletes have to use more energy throughout the kinetic chain to produce more force and velocity to throw a softball.[18] This repetitive motion can lead to fatigue, which can result in micro trauma to the shoulder. Many athletes grow accustomed to specific movements due to injury or impairments and have to compensate for the sake of performance. The common injuries that overhead athletes endure are tendonitis and impingement. Overuse injuries are the most common type of injuries and can be managed effectively with a successful rehabilitation exercise program.[5]

Functional Movement Screening™ is a recent development within sports medicine. Multiple professional teams, universities, military services, and first responders have used this testing to help identify functional movement impairments and to improve performance as well as to promote injury prevention.[6,7,8] Functional Movement Screening™ has been designed to challenge the functional movement patterns of mobility and stability interactions within the kinetic chain in the fundamentals of athletic performance.[6] Many have suggested that individuals who perform high level athletic activities struggle to perform basic fundamental patterns.[6] This includes activities such as a deep squat, push-ups, and hurdle steps. This can result in traumatic injury because athletes must compensate to overcome these basic patterns of movement.

Physical therapists, athletic trainers, and strength and performance specialists have worked together to create rehabilitation and exercise programs to help prevent injuries of athletes based on FMS scores. Functional Movement Screening™ may show past history of injuries and impairments with each individual.[6,9] In conjunction with this, rehabilitation can improve mobility and strengthen the areas that have been compromised throughout the athlete's life. For this investigation, the main focus is athletes' shoulder complex.

Rehabilitation programs for overhead throwers should focus on the changes that stem from loss of internal rotation and muscle weakness of the external rotator and scapular muscles commonly seen in overhead-throwers.[5,10,11] There are different types of rehabilitation exercises that are designed to strengthen the shoulder by increasing mobility and stability, such as the Throw 10. It is designed to be specific to a thrower and improves endurance, strength, and power within the shoulder.[12] The Throw 10 involves specific exercises focusing on the external and internal rotation along with flexion and extension for the shoulder girdle. This approach has been observed as effective for rehabilitation and prevention of shoulder injuries for overhead athletes.[12] Thus, the purpose to this investigation was to determine the effect of the Throw 10 program on improving shoulder mobility within overhead-throwing athletes.

Methods

Experimental Approach

To investigate the effects of the Throw 10 on shoulder mobility within overhead-throwing athletes, an experimental and control group were used in the investigation.

Participants

Twenty intercollegiate NCAA DI softball players (age range: 19.6 ±1.04 yrs; Classification: Freshmen=8, Sophomore= 5, Junior=4, Senior= 3; height: 166.37 ±5.17cm; Throwing hand R= 19, L=1; batting stance R=10, L=10) were recruited to participate in the investigation. For the participants to be included in the investigation, they could not have a suffered from any orthopedic upper extremity injury within the past six months. If a participant had an upper extremity orthopedic injury but was undergoing rehabilitation, he or she would be eligible to participate in the investigation. If potential participants experienced upper extremity orthopedic injury where surgery was required, he or she would be excluded from the investigation. If an injury were to occur during the duration of the investigation, depending on the severity of the injury, the participant would be disqualified from participating in the rest of the investigation. The participants had a set softball exercise program with their team strength and conditioning coach. This is a factor that could improve the flexibility of the participants. In order to account for this, the control group continued with the normal exercise provided by their strength coach while the experimental group used Therabands to complete the Throw 10 before their normal softball workouts and practice.

The dependent variables in this investigation were: 1) the FMS total score, and 2) the shoulder mobility score. The two independent variables were: 1) the treatment (control versus Throw 10 treatment), and 2) trials (pre-versus post-tests). The treatment variable is a between-subjects variable, while the type of trial is a within-subjects (repeated) variable.

Procedure

Overview

To participate in the investigation participants read and reviewed an informed consent document (appendix A) approved by the Institutional Review Board at Texas State University (Code #2014B9160). Participants also completed a questionnaire administered to document demographics (appendix B) and injury history (appendix C). All testing was completed in San Antonio, Texas at The University of Incarnate Word Strength and Conditioning Field House. The participants did not receive any form of financial gains for participating in the investigation.

The investigation was completed over a six-week period during the competitive season. The participants completed all required preliminary paperwork before the testing began. Before the investigation began, an intra-rater pilot investigation was conducted to test the reliability of the FMS and consistency of the certified FMS interpreter. Once the pilot investigation was tested on five of the participants, each participant was tested by the FMS. Data for all FMS measurements were collected during two visits at the strength and conditioning weight room. The first session consisted of the project supervisor recording the participant's age, height, dominant batting hand, and fielding position. The FMS test was conducted before and after the six-week intervention.

The FMS test was used at the beginning of the investigation to measure the mobility and flexibility of participants' shoulders. As described, the FMS consists of seven challenging exercises for the body. The seven functional patterns include a deep squat, an in-line lunge, a hurdle step, shoulder mobility assessment, an active straight leg raise, a trunk stability push up, and quadruped rotatory stability movements including three clearing tests for shoulder and trunk stability. The clearing test is to ensure presence of a negative pain for an individual while in specific positions. Each participant completed all tests, with the main focus on the shoulder complex /shoulder mobility. A Certified FMS instructor interpreted the scores for each movement pattern during testing. There was a raw score of the seven patterns, with five patterns testing the right and left sides of the body individually. The lowest of the raw scores were carried over into the final score. The overall final score out was of 21.

After the baseline FMS testing was completed, participants were randomly divided into two groups via a random number draw. Participants drew either a one or a two, which determined group assignments. Group one completed the Throw 10 program using therapeutic rubber tubing known as Therabands. The research supervisor provided these participants with instructions and demonstrations covering the Throw 10. The ten exercises included diagonal shoulder flexion and extension, internal and external rotation at 0° abduction, external and internal rotation at 90° abduction, shoulder abduction at 90°, scaption external rotation, prone horizontal abduction (neutral, full external rotation, 100° abduction), seated press-ups, prone rowing, push-ups, elbow flexion and extension, and wrist extension and flexion and supination and pronation. Group one completed the Throw 10 three times a week (Monday, Wednesday, Friday) for six weeks, completing three sets of ten repetitions on each exercise (Appendix D). Group two was the control group and they continued their softball conditioning program without using the Throw 10. The participants had six weeks after the initial testing before being tested again using the FMS tool. At the end of the investigation, FMS testing was conducted to re-evaluate each participant's mobility with the functional patterns mainly focusing on the shoulder complex/shoulder mobility.

Statistical Analysis

All analyses were calculated using STATA (version V:13, College Station, TX) for the statistical analysis. Means and standard deviations were calculated for all dependent measures. A MANOVA was used for the pre test scores to determine the group difference in performance before the treatments were administered. A two-way 2x2 repeated measures ANOVA was used to determine improvement between the treatment and control conditions as well as pre- and post-test differences between trials for each dependent variable. All tests between treatment and trial combinations were between two sample means (one degree of freedom) requiring no post-hoc tests and nor adjustment of probability for any variation in sphericity. Partial eta^2 was used to determine effect size for each statistical test. There was a moderate effect size between groups for the FMS scores. The difference in improvement between groups for the shoulder mobility tests was a small effect size. The overall statistical significance was defined as $p < 0.05$.

Results

Table 1 reports the descriptive values across treatment conditions, for both pre- and post-test measures. The MANOVA indicated no significant pre-test group differences for the two dependent variables. Wilks' Lambda = 0.718, $F(2,17) = 3.34$, $p = 0.060$, indicated the random assignment of subjects to treatment groups effectively prevented any pre-test performance bias.

Table 1: Descriptive Values for the Treatment Conditions

FMS Total Scores	Pre-Test		Post-Test	
	Mean	Stand. Dev.	Mean	Stand. Dev.
Control	14.09	3.39	13.45	4.91
Treatment	16.22	1.20	17.33	1.41
Shoulder Mobility	Pre-Test		Post-Test	
	Mean	Stand. Dev.	Mean	Stand. Dev.
Control	1.64	0.67	2.00	0.77
Treatment	2.33	0.71	2.66	0.71

For FMS total scores, 2x2 repeated measures ANOVA indicated no significant overall difference between trials (pre-test versus post-test), $F(1, 18) = 0.12$, $p = 0.733$, partial $eta^2 = 0.007$, a small effect. There was also no significant difference in improvement in FMS total scores between treatment groups across trials, $F(1, 18) = 1.63$, $p = 0.219$, partial $eta^2 = 0.083$, a moderate effect.

In regards to the shoulder mobility test, 2x2 repeated measures ANOVA indicated a significant overall difference between trials (pre-test versus post-test), $F(1, 18) = 5.06$, $p = 0.037$, partial $eta^2 = 0.519$, a large effect. Shoulder mobility significantly improved from 1.95 ± 0.759 for the pre-test to 2.30 ± 0.801 for the post-test (Figure 1). There was no significant difference in improvement in shoulder mobility between treatment groups across trials, $F (1, 18) = 0.01$, $p = 0.923$, partial $eta^2 = 0.001$, a very small effect.

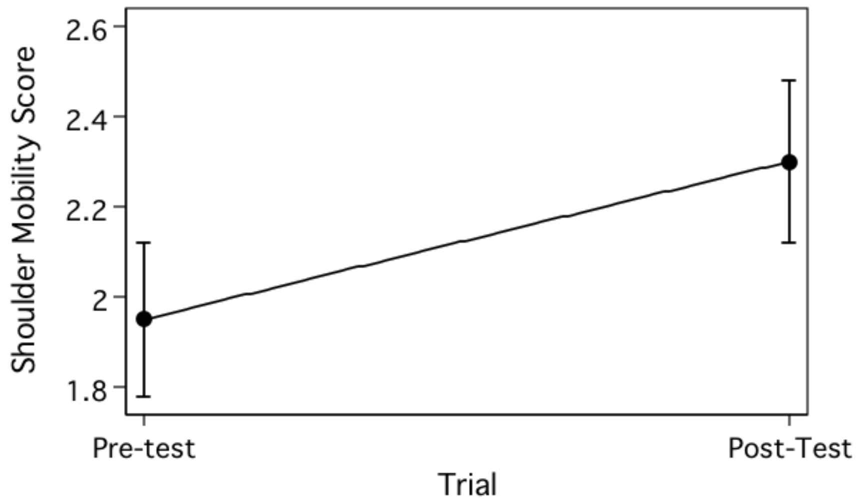


Figure. 1 Shoulder Mobility Test

Conclusion

The statistical analysis did not demonstrate a significant difference in improvement between the Throw 10 group and control group for either the FMS or shoulder mobility tests. Therefore the Throw 10 program provided no improvement when compared to the control.

Discussion

The primary objective of this investigation was to determine the effect of Throw 10 on shoulder mobility in overhead-throwing athletes as evaluated by FMS. There was no significant improvement in shoulder mobility pre-tests and post-tests between the groups. In addition, there were no significant differences during the trials between the control and experimental group with the shoulder mobility test. Furthermore, there were no significant differences in FMS pre-test and post-test scores between the participants, as well as was no significant improvement of FMS scores between the pre-test and post-test. Finally, this investigation indicated there was a significant improvement during the pre-test and post-test of FMS to mobility of the shoulder during a six-week period.

Functional Movement Screening™ was designed to assist in predicting which individuals are at risk for injury. Using this type of investigative testing indicates risk by identifying functional asymmetries. The FMS has been advertised to help athletes understand their functional impairments with a potential to predict injury.[6] Previous investigations did not examine FMS testing alongside the Throw 10 intervention. Previous research in application of FMS testing to athletic populations has supported the idea of injury prevention.

Kiesel et al, conducted a study where FMS measured a football team during the off-season.[26] FMS scores increased due to the use of a traditional personalized strength and conditioning intervention between FMS post-test and retest.[26] Increasing symmetrical functional movements during the FMS testing concluded that FMS is a positive predictor to injuries.[26] This current investigation was conducted during the competitive season and the duration of the investigation was short. These variables potentially affected the treatment when compared between groups. That said, Functional Movement Screening™ is clinically relevant to any athletic program or physically active individuals because it provides a functional approach in decreasing potential injury, in addition to improving performance and promoting overall wellness.[6,7]

Researchers have studied the dynamics of the Throw 10 mainly on male collegiate and professional athletes, with minimal studies of female athletes. The Throw 10 was developed by Wilk et al, from an exercise program based on evidence that isotonic exercises increase overhead athlete strength and endurance within the shoulder.[12] Throughout off-season and competitive season, the shoulder complex experiences repetitive stress with excessive repeated motion caused by throwing. Thus, it is important to implement effective restoration rehabilitation programs focusing on overhead-throwing athletes. Focusing on the mobility of the shoulder, the Throw 10 gradually increases the demands on the shoulder to enhance the endurance and strength, as well as to maintain a preventative injury during competitive season.

Engaging athletes with the Throw 10 while in-season could improve players' strength and endurance into post-season play. Participants that were in the experimental group stated that during post-testing, their shoulders felt stronger than before, when they had yet to begin their in-season training. The outcomes from the Throw 10 indicated that athletes applying this specific intervention regularly throughout an off-season to in-season could potentially help increase strength and prevent the shoulder from injury or further injury. The Throw 10 is relevant to clinical practice because it promotes stability, mobility, strength, and endurance in overhead throwing athletes through progressive demands on the shoulder during rehabilitation.[12]

The participants of this investigation were collegiate overhead-sports athletes and were active in a competitive season while throughout the duration of the testing and intervention. Due to a small sample size and the short-term duration of the research, future research should consider a general population subject pool. Functional Movement

Screening™ does measure pain within the testing indirectly; however, it is worth noting that pain was not measured within the investigation. Further research may include pain as a factor while using FMS. The research focused on mobility of the shoulder complex. The Throw 10 facilitates the dynamic stabilization, neuromuscular control, strength, and coordination specific exercises to enhance the shoulder complex in a progressive technique.[12] Each overhead throwing athlete has a unique shoulder complex, thus, it is imperative to develop a specific rehabilitation regimen to prevent shoulder pathologies to occur.

V. CONCLUSION & FUTURE RESEACH

Conclusion

Twenty female intercollegiate softball players served as subject for this investigation. Each subject was randomly assigned either to one of two treatment groups, either partaking in the Throw 10 exercise program for shoulder mobility or being placed in a control group. A Functional Movement Screen™ evaluation was completed prior to the six-week period, during the pre-competition season, and at the conclusion of the training period. The data was analyzed through a two-way 2x2 repeated measures ANOVA to determine the differences between Throw 10 exercise program and control group on FMS scoring for shoulder mobility. There was no difference in the effect of Throw 10 exercise program or control group between FMS scoring for shoulder mobility. Recognizing that caution should be observed when generalizing from these results, it was concluded that Throw 10 exercise program had no effect on FMS scoring for shoulder mobility in female intercollegiate softball players during the competitive season. Previous literature has illustrated the positive results of utilizing the Throw 10 in preventing injuries or strengthen the shoulder.[5,12,13] However, results gathered from this study do not support previous research outlining these positive results.

Many competitive athletes perform sports-specific activities and despite their skills within their sport, some competitive athletes are unable to complete a basic functional movement such as an overhead lunge or deep squat. Thus, implementing FMS into the prescreening of each season targets the asymmetries providing a foundational overview of the individual's functional movement patterns and correct them via personalized strengthening programs. FMS testing has been used in many different settings and previous research has supported the idea that FMS is an effective tool in predicting injuries and determining asymmetry in individuals.

The Throw10 intervention was created to build stability and increase mobility within overhead-throwing athletes. This program is designed to help overhead throwing athletes strengthen and support the mechanics and physiology of the shoulder complex musculature to improve strength and endurance. Over the years, rehabilitation has developed as many continue to seek a perfect shoulder rehabilitation intervention. For now, The Throw 10 has become the universal shoulder intervention throughout clinics and sports rehabilitation settings.

Future Research

The following recommendations are made based on the realization that this study could have been conducted differently in several aspects. In the hope that future research will explore further the problem at hand, it is recommended that research to be conducted during the non-competitive season, which might have confounded the results. It is recommended to complete the FMS pretesting before the offseason training because it will give individuals specific impairments that need to be improved on. Therefore by the time competitive season comes, the impairments should be limited and could help prevent potential injuries that can happen.

Providing a greater population of competitive athletes can increase the validity of the research. Each softball player is an overhead-throwing athlete, however, in this current investigation the fielding positions were not compared to each other. Hence for future research, incorporating each fielding position and comparing each one to each other can give a variety of results. Each participant's shoulder placed an impact on the results of the investigation.

Furthermore, individuals that play sports recreationally could benefit from using the Throw 10 or FMS testing. The Throw 10 can be used on all populations who have instability or decreased mobility in there shoulder complex. Throw 10 can be used as an injury prevention or shoulder injury rehabilitation being used in all settings where competitive or recreational athletes perform. Recreational athletes to use FMS testing will need to be accompanied by a certified FMS instructor for complete testing. Access to FMS testing is limited whereas the Throw 10 is simple to research.

Although, FMS has been found to be reliable in predicting injury risk,[1] there are other systems being used to help predict injury risks for athletes. Future technologies may have more sensitive assessment tools such as high-speed video, force plate assessment, and kinetic motion sensor systems. These technology systems are being used to record movements and measure biomechanics. However, the system is good at measuring specific areas, FMS are more specific to functional movement for athletic individuals and evidence shows how injuries are predicted.

APPENDIX SECTION

Appendix A

IRB: 2014B9160

Consent Form

I hereby give consent to participate in the research study entitled: The effects of mobility of a 6-week Throw 10 measured by FMS test. I understand the person responsible for this research study is Giovanna Nuanes, LAT, from the Department of Health and Human Performance at Texas State University; (915) 491-1197. Giovanna Nuanes, LAT, can be also be reached by email at gln13@txstate.edu.

Purpose

The purpose to this study is to determine the effects on mobility of a 6 week Throw 10 measured by the FMS test. Functional Movement Screening™ has been created to measure the mobility of the body's kinetic chain. Literature has shown positive results that FMS may predict and prevent future injuries. This study can be added to the limited information regarding female subjects using FMS and the Throw 10. The possible benefits for this search may help clinicians provide the best prevention treatment and ensure the safest training to prevent injury.

The population of the study consisted of 20 healthy females (between 18-24 years old) that play softball at the University of the Incarnate Word. Subjects with a previous upper extremity orthopedic injury will be excluded from the study; however, if an injury occurs during the duration of the study, depending on the severity of the injury may be excluded. This study will put the individuals into extreme functional movements and may cause soreness.

I understand that I will be in good health and a certified FMS instructor and health care professional will evaluate me. During the initial questionnaires will be determined if, for any reason, which would make it undesirable or unsafe for me to complete the FMS test. I will provide accurate responses for the questionnaires and if I fail to do so it can lead to potential injury to my self during the testing and intervention of the study. I am allowed to refuse to answer any questions. I understand the pre-test and post-test will take about 20 minutes to complete.

I consent to being a subject tested for the FMS program while completing the take home Throw 10 intervention on an honor code. I am allowed to stop participation at any time during the 6 weeks. I have been advised if I have any pain during the pre-test and post-test during the FMS testing and the intervention, I can inform Giovanna Nuanes that I wish to stop my participation for the study. I understand this study is a 6 week long duration of my full participation.

After I complete the study a summary of findings will be provided upon my request by contacting Giovanna Nuanes, LAT (gln13@txstate.edu).

Risks

I understand that I will be put into functional movements that can cause soreness for the upper and lower extremities. If an injury occurs during a practice or game, I could be disqualified from the study depending on the severity. If an upper extremity orthopedic injury occurs during the study, disqualification may be addressed. A Certified

FMS instructor and a Texas Licensed Athletic Trainer will be on site during the pre-test and post-test of FMS. If this study causes me any harm to physical injury or psychological/emotional distress I can meet with the my team's Athletic Trainer, Team Doctor, or Student Health Services provided to me for free for registered students for the University of the Incarnate Word. I understand the risks that have been provided to me, therefore I am allowed stop at any time during the study.

The study administrator is Giovanna Nuanes, a State Licensed Athletic Trainer, CPR/AED and First Aid certified, and a certified FMS Instructor. She is trained to identify emergency situations and knows how to properly provide emergency treatment if any injury were to happen. She will be present during the pre-test and post-test of the FMS testing.

Benefits expected of study

The potential benefits of the study include the therapeutic effects of the Throw 10 to increase mobility of the shoulder. Functional Movement Screening™ provides to evaluate the movement patterns and create interventions to increase performance and identify potential risk of injury to athletes. Benefits of the results of this study may give the individual a better understanding how the functional movement and how they can improve their functional mobility and improve their performance as an athlete.

Compensation

I understand that there will be no compensation provided for my participation of completion of the study. If I should to drop out of the study there will be no penalty. This study will not be funded.

Confidentiality and Use of Information

I have been informed that the information that has been obtained during the testing procedures will be treated as confidential information and will not be released to any person without my written consent. For the study, the student's school ID will be sure for confidentiality. The files containing the demographics, health history questionnaire, and all the data collected will be kept in a locked cabinet in Dr. Ransone's Office at Texas State University for three years, after which, will be destroyed. I agree that any data collected for the research will be used for statistical purposes as long as it does not provide my identification. Only Giovanna Nuanes and study chairman, Dr. Jack Ransone, will have access to use the information to evaluate my performance. To obtain a summary of the findings of the study, please contact Giovanna Nuanes at gln13@txstate.edu.

Inquiries and Freedom of Consent

I understand that my participation in the study is voluntary and I have the right to refuse participation and will not be penalized and can discontinue my participation during the duration of the study at any time without penalty.

I understand that further risks may be associated during the study, the potential risks that are provided I still desire to proceed with the test.

If I have any questions regarding the research, the rights of the research participants', and research related injuries to the participants I can be directed to contact the IRB chair Dr. Jon Lasser (512-245-3413, lasser@txstate.edu) or to Ms. Becky Northcutt, Compliance Specialist (512-2452102).

I acknowledge that I have read this form in its entirety or it has been read to me because I was unable to read the form.

I consent to participate in this study based on the information that is provided for the research study.

_______________________________________ Date ______________

Participant's Signature

_______________________________________ Date_______________

Project Supervisor's Signature

_______________________________________ Date_______________

Project Chairman Signature

APPENDIX B

Demographic Information

Last Name:_____________________________ First Name:_________________________

I.D #__________________________________

Date of birth:________________________

Classification:________________________

Height:_________________

Throwing: **R / L**

Batting: **R / L**

Position:________________________________

APPENDIX C

Health History Questionnaire

1. Have you sustained any major injury in the past 6 months prior to testing?
N / Y

If yes, please
explain:____

2. Have you ever had any orthopedic surgery in your upper or lower extremities?
N / Y

If yes, Please
explain:____

3. Do you have any current or past impingements to upper extremities?
N / Y

4. Have you ever been diagnosis with multiple directional instability (MDI)?
N / Y

5. Are you undergoing any current rehabilitation?
N / Y

If yes, please
explain:____

.

APPENDIX D

Throwers Ten Program 6 Week Calendar

Please document the days you completed the Throw 10. It is essential that you keep track of your rehabilitation for the next six weeks. This will show either improvement or no improvement of your shoulder mobility.

Throw Ten: 3sets X 10 Reps each exercise

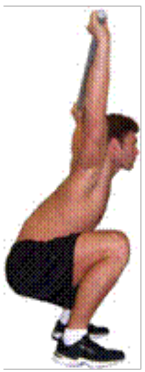
*If a day was missed please indicate the day you missed and completed each day.

	Monday	Wednesday	Friday
Week 1			
Week 2			
Week 3			
Week 4			
Week 5			
Week 6			

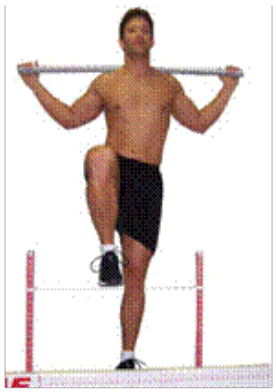
APPENDIX E

Functional Movement Screening

Deep Squat

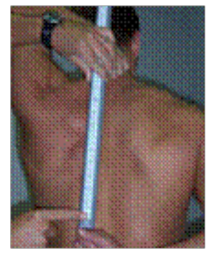


Hurdle Step



In-Line Lunge

Shoulder Mobility



Active Straight leg Raise

Trunk Stability Push Up

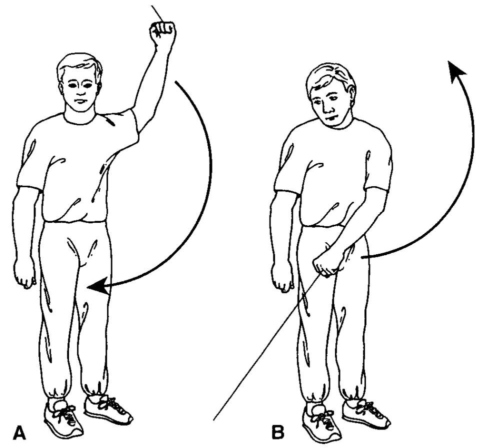
Rotary Stability

APPENDIX F

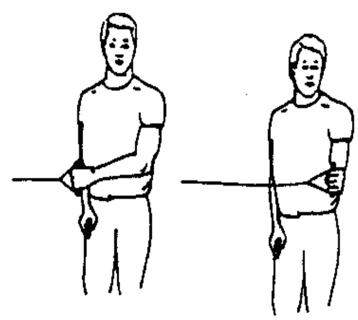
Throwers Ten Exercise Program

1A. **Diagonal Pattern D2 Extension:** Involved hand will grip tubing handle overhead and out to the side. Pull tubing down and across your body to the opposite side of leg. During the motion, lead with your thumb. Exercise should be performed _____ sets of _____ repetitions _____ daily.

1B. **Diagonal Pattern D2 Flexion:** Gripping tubing handle in hand of involved arm, begin with arm out from side 45o and palm facing backward. After turning palm forward, proceed to flex elbow and bring arm up and over involved shoulder. Turn palm down and reverse to take arm to starting position. Exercise should be performed _____ sets of _____ repetitions _____ daily.

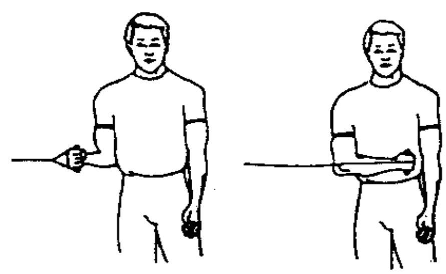


2A. **External Rotation at 0o Abduction:** Stand with involved elbow fixed at side, elbow at 90o and involved arm across front of body. Grip tubing handle while the other end of tubing is fixed. Pull out arm, keeping elbow at side. Return tubing slowly and controlled. Perform _____ sets of _____ repetitions _____ times daily.



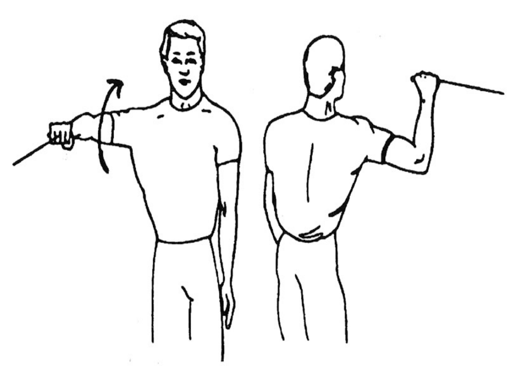
Exercise 2a

2B. **Internal Rotation at 0o Abduction:** Standing with elbow at side fixed at 90o and shoulder rotated out. Grip tubing handle while other end of tubing is fixed. Pull arm across body keeping elbow at side. Return tubing slowly and controlled. Perform _____ sets of _____repetitions _____ times daily.



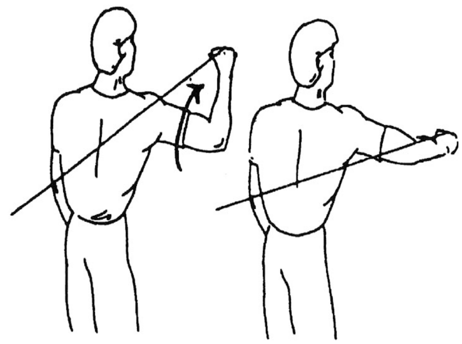
Exercise 2b

2C. (Optional) **External Rotation at 90o Abduction:** Stand with shoulder abducted 90o. Grip tubing handle while the other end is fixed straight ahead, slightly lower than the shoulder. Keeping shoulder abducted, rotate shoulder back keeping elbow at 90o. Return tubing and hand to start position.



I. Slow Speed Sets: (Slow and Controlled) Perform _____ sets of _____ repetitions _____ times daily.
II. Fast Speed Sets: Perform _____ sets of _____ repetitions _____ times daily.

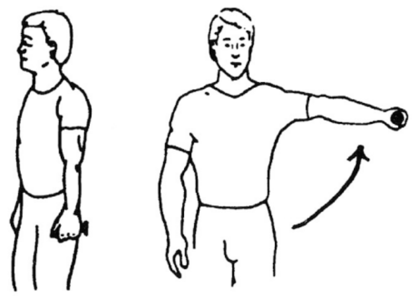
2D. (Optional) **Internal Rotation at 90o Abduction:** Stand with shoulder abducted to 90o, externally rotated 90o and elbow bent to 90o. Keeping shoulder abducted, rotate shoulder forward, keeping elbow bent at 90o. Return tubing and hand to start position.



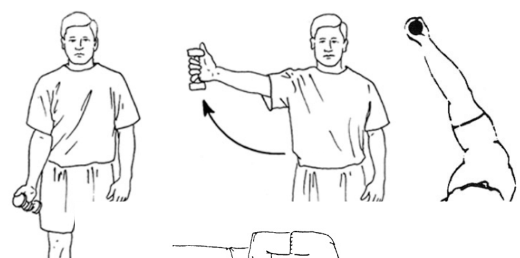
I. Slow Speed Sets: (Slow and Controlled) Perform _____ sets of _____ repetitions _____ times daily.
II. Fast Speed Sets: Perform _____ sets of _____

repetitions _____ times daily.

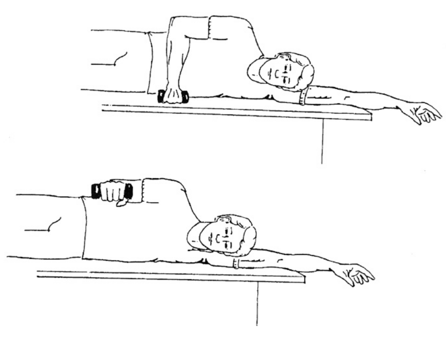
3. **Shoulder Abduction to 90o:** Stand with arm at side, elbow straight, and palm against side. Raise arm to the side, palm down, until arm reaches 90o (shoulder level). Perform _____ sets of _____ repetitions _____ times daily.



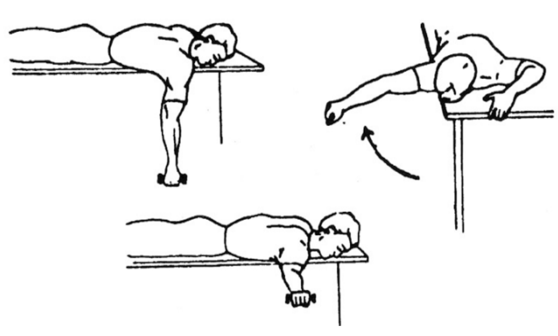
4. **Scaption, External Rotation:** Stand with elbow straight and thumb up. Raise arm to shoulder level at 30o angle in front of body. Do not go above shoulder height. Hold 2 seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.



5. **Sidelying External Rotation:** Lie on uninvolved side, with involved arm at side of body and elbow bent to 90o. Keeping the elbow of involved arm fixed to side, raise arm. Hold seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.

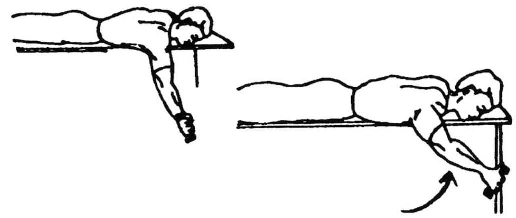


6A. **Prone Horizontal Abduction (Neutral):** Lie on table, face down, with involved arm hanging straight to the floor, and palm facing down. Raise arm out to the side, parallel to the floor. Hold 2 seconds and lower slowly.

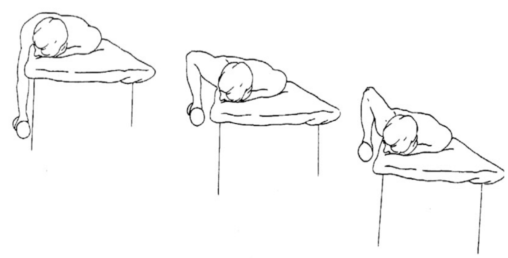


Perform _____ sets of _____ repetitions _____ times daily.

6B. **Prone Horizontal Abduction (Full ER, 100o ABD):** Lie on table face down, with involved arm hanging straight to the floor, and thumb rotated up (hitchhiker). Raise arm out to the side with arm slightly in front of shoulder, parallel to the floor. Hold 2 seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.

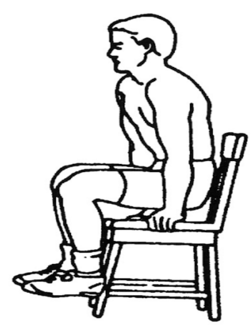


6C. **Prone Rowing:** Lying on your stomach with your involved arm hanging over the side of the table, dumbbell in hand and elbow straight. Slowly raise arm, bending elbow, and bring dumbbell as high as possible. Hold at the top for 2 seconds, then slowly lower. Perform _____ sets of _____ repetitions _____ times daily.

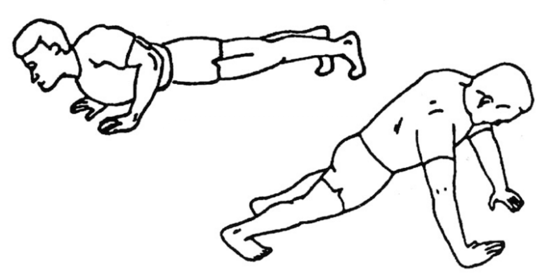


6D. **Prone Rowing into External Rotation:** Lying on your stomach with your involved arm hanging over the side of the table, dumbbell in hand and elbow straight. Slowly raise arm, bending elbow, up to the level of the table. Pause one second. Then rotate shoulder upward until dumbbell is even with the table, keeping elbow at 90°.
Hold at the top for 2 seconds, then slowly lower taking 2 – 3 seconds. Perform _____ sets of _____ repetitions _____ times daily.

7. **Press-ups:** Seated on a chair or table, place both hands firmly on the sides of the chair or table, palm down and fingers pointed outward. Hands should be placed equal with shoulders. Slowly push downward through the hands to elevate your body. Hold the elevated position for 2 seconds and lower body slowly. Perform _____ sets of _____ repetitions _____ times daily.

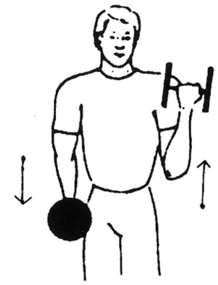


8. **Push-ups:** Start in the down position with arms in a comfortable position. Place hands no more than shoulder width apart. Push up as high as possible, rolling shoulders forward after elbows are straight.

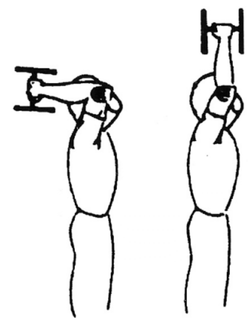


Start with a push-up into wall. Gradually progress to table top and eventually to floor as tolerable. Perform _____ sets of _____ repetitions _____ times daily.

9A. **Elbow Flexion:** Standing with arm against side and palm facing inward, bend elbow upward turning palm up as you progress. Hold 2 seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.

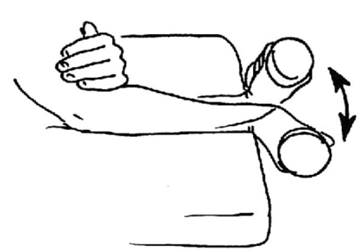


9B. **Elbow Extension (Abduction):** Raise involved arm overhead. Provide support at elbow from uninvolved hand. Straighten arm overhead. Hold 2 seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.



10A. **Wrist Extension:** Supporting the forearm and with palm facing downward, raise weight in hand as far as possible. Hold 2 seconds and lower slowly. Perform _____ sets of _____ repetitions _____ times daily.

10B. **Wrist Flexion:** Supporting the forearm and with palm facing upward, lower a weight in hand as far as possible and then curl it up as high as possible. Hold for 2 seconds and lower slowly.



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