ABSTRACT

Effects of Postural Restoration Therapy Compared to Traditional Therapy on Internal Rotation in Collegiate Overhead Athletes

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Glenohumeral internal rotation deficit (GIRD) is a condition characterized by a decrease in internal rotation when compared bilaterally (Lintner, Mayol. Uzodinma, Jones, Labossiere, 2007). The purpose of this study was to evaluate the efficacy of differing rehabilitation programs on internal rotation in athletes who commonly present with Glenohumeral Internal Rotation Deficit. Participants were randomly assigned to a treatment group, Postural Restoration or Thrower's Ten and Sleeper Stretch, and asked to perform the respective rehabilitation program on their own three times a week. Glenohumeral internal rotation was measured prior to beginning the exercise protocol as well as, once a week for four consecutive weeks following the initiation of exercises. There were no statistically significant differences between the two groups in how they affect glenohumeral internal rotation. It cannot be concluded that the groups are different across time, between groups, or that there is an interaction between the two groups.

The Effects of Postural Restoration Therapy Compared to Traditional Therapy on Internal Rotation in Collegiate Overhead Athletes

by

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A Thesis

Approved by the Department of Health, Human Performance, and Recreation

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Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of

Master of Science

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August 2015

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LIST OF ABBREVIATIONS

GIRD: glenohumeral internal rotation deficit

IROT: internal rotation

ROM: range of motion

PRI: postural restoration institute

TT: thrower's ten

TA: traditional approach

HEP: home exercise program

AIC: anterior interior chain

ANOVA: analysis of variance

GLOSSARY

The following definitions have been adopted for the purpose of this research study:

1. Range of Motion (ROM): the degree to which a joint is able to move through a motion either actively, via muscle contraction, or passively.

2. Internal rotation (IROT)/ External rotation: movement of the humeral head in the glenoid fossa when the shoulder is abducted 90 degrees and the elbow is flexed to 90 degrees.

3. Glenohumeral internal rotation deficit (GIRD): characterized by a decrease in glenohumeral internal rotation on the dominant side when compared bilaterally (Lintner, Mayol. Uzodinma, Jones, Labossiere, 2007).

4. Thrower's Ten (TT) exercise program: a specific series of active exercises designed to strengthen and improve dynamic stability for the overhead athlete.

5. Sleeper Stretch: a stretch aimed to isolate soft tissue of the posterior glenohumeral joint that may be causing an internal rotation deficit.

6. Athlete: Any member of a sports team listed on a roster at Baylor University within the past 12 months.

ACKNOWLEDGMENTS

First, I would like to express my appreciation to my committee chair and mentor, Dr. Andrew Gallucci. This thesis would not have been possible without his support, input, and guidance. I am grateful to have worked with Dr. Gallucci who has helped me grow personally and professionally.

I would also like to thank my committee members Dr. Grant Morgan and Dr. Deborah Johnston for their assistance and feedback throughout this process. Their encouragement kept me motivated and focused, while their individual areas of expertise allowed this thesis to be complete.

In addition, I would like to thank Mr. Paul Bradshaw for his support in this research and the approval to use the student-athletes at Baylor University, as this thesis would not have been possible otherwise.

Finally, I am indebted to my family, friends, and boyfriend, Josh, for their immense support and wonderful encouragement through this process. I could not have completed this thesis without their love and reassurance over the past two years.

CHAPTER ONE

Introduction

Background

Glenohumeral internal rotation deficit (GIRD) is an issue that overhead athletes may experience due to the repetitive forces placed on their shoulder. GIRD is a decrease in internal rotation of the shoulder and is a problem as it is a result of tightness of the posterior capsule, posterior deltoid, infraspinatus, teres minor, and latissimus dorsi; all of which are muscles that provide dynamic stabilization of the shoulder (Laudner, Sipes, & Wilson, 2008). Tightness through these areas can lead to decreased performance and injuries of the joint capsule, labrum, rotator cuff muscles, and ligaments (Aldridge, Guffey, Whitehead, & Head, 2012). To meet the demands of an overhead sport, these athletes require a balance of mobility and stability in their shoulder (Borsa, Laudner, Sauers, 2008). Collegiate overhead athletes often present with decreased internal rotation (IROT), which may be classified by a decrease in IROT when compared bilaterally (Lintner, Mayol, Uzodinma, Jones, & Labossiere, 2007; Borsa et al., 2008). GIRD is most commonly defined by either the percent of the total arc or the difference when compared bilaterally and often occurs due to the repetitive stress unilaterally that overhead athletes put on their dominant shoulder (Aldridge et al., 2012). Limitations in IROT of the shoulder may be caused from a tight posterior glenoid capsule, tight muscles that make up the posterior rotator cuff, a shift in the total arc range of motion (ROM), or as new research suggests, an asymmetry of the body's positioning (Tenney, HR., Boyle, KL., & DeBord, A., 2013). Currently, GIRD is treated by many orthopedic health care

providers with static stretching and a series of active exercises such as, the Thrower's Ten (Wilk, Yenchak, Arrigo, & Andrews, 2011). The result of decreased IROT in active individuals is often a drop in performance and increased risk of injury.

Overhead sports rely on the glenohumeral joint and scapulothoracic complex to work in sync to produce the necessary amount of force for performance (Wilk et al., 2011). In the athletic population, a lack of glenohumeral IROT is commonly seen among overhead athletes who participate in football, baseball, softball, tennis, and volleyball (Borsa et al., 2008). When there is a muscular imbalance between these two areas injuries of the labrum, joint capsule, rotator cuff, and surrounding ligaments may arise.

The Postural Restoration Institute (PRI) introduces the concept of asymmetry amongst various systems in the body leading to dysfunctional movement patterns that result from primarily using only one side of the body (Tenney et al., 2013). Ron Hruska introduced PRI in 1999 although; it has recently gained greater recognition in sports medicine (Spence, 2008). PRI incorporates breathing techniques, manual therapy, and active exercises to improve range of motion, decrease pain, strengthen the core, and allow the respiratory and neuromuscular systems to function at a higher level for conditions such as, decreased passive ROM, lumbopelvic pain, sciatica, sacroiliac joint dysfunction, exercise induced asthma (Boyle, 2013). PRI recognizes that all systems in the body are connected and that repetitive stress on the dominant side of the body, as seen in the shoulder of overhead athletes, may lead to asymmetry. The objective of PRI is to restore ROM and decrease pain, while strengthening the core and training the body across the entire kinetic chain. However, there is a lack of published research that evaluates the efficacy of PRI, and there are no known published studies that have compared the

efficacy of this treatment approach to more traditional methods used to reduce pain and increase range of motion.

Overhead activities require the muscles surrounding the shoulder and scapula to work together to hold the humeral head in the glenoid fossa; in other words, dynamic stability of the scapular stabilizers and the rotator cuff muscles is required (Borsa et al., 2008). The Thrower's Ten (TT) exercise program consists of a set of rehabilitation exercises that address the rotator cuff muscles of the shoulder, elbow, and wrist through various ranges of motion (Wilk et al., 2011). The goals of the Thrower's Ten program are to strengthen the musculature of the shoulder and improve dynamic stability of the shoulder. Patel, Arunmozhi, and Arfath (2014) conducted a study that supports improved scapular retractor strength, throwing distance and throwing accuracy following the TT exercises. In addition, Aldridge et al. (2012) concluded that a program dedicated to stretching the posterior capsule of the glenohumeral joint might be beneficial in increasing internal rotation. The sleeper stretch is a passive exercise aimed at stretching the posterior capsule of the shoulder and is a routine stretch for overhead athletes to perform when attempting to increase shoulder internal rotation. Laudner et al. (2008) reported significant increases in acute internal rotation following three sets of thirty seconds of the sleeper stretch. The traditional approach (TA) consists of the TT exercises, which are used to strengthen the muscles that provide dynamic stability for the shoulder and the sleeper stretch, which is commonly applied to maintain mobility.

To date, the effectiveness on these two treatment paths on the reduction of GIRD have not compared. As stated, research suggests that PRI (Boyle, 2013), TT (Wilk et al., 2011), and sleeper stretch (Laudner et al., 2008) have the ability to improve the condition.

This study aims to compare the effects of PRI and TA on the ability to increase glenohumeral ROM in collegiate overhead athletes.

Problem Statement

Many collegiate overhead athletes experience GIRD, which may lead to injury of their labrum or rotator cuff, and possibly a decrease in performance (Aldridge et al., 2012). Traditional therapy, such as static stretching and active exercises specific to shoulder, are commonly used although other rehabilitative exercises exist to aide in increasing strength and restoration of motion. PRI presents the idea that increased range of motion of the glenohumeral joint can be achieved with repositioning through a series of active exercises and breathing techniques. It is expected that no significant difference on internal rotation of the shoulder in collegiate overhead athletes will be seen following either PRI or TA. Based on the lack of published research on PRI, this thesis serves to give athletic trainers, physical therapists, and other healthcare providers a better understanding of the effects of PRI techniques compared to traditional therapy with the intent to use this research as evidence based practice in the workplace.

Purpose

This study is important to further knowledge of body mechanics, especially internal rotation of the shoulder and to expand the toolbox from which health care providers can work to improve deficits in range of motion. There is no research available that addresses the concern of decreased internal rotation of the collegiate overhead athlete with PRI, let alone a comparison of the effects of different types of therapy for the specified parameters. In fact, there is minimal research in general on PRI. For that

reason, the purpose of this study is to determine the effects of PRI compared to the TA exercise program. Athletic trainers, physical therapists, and other health care providers will be able to use this information to help improve the care of patients and reduce the risk of injury in overhead athletes. The findings of this study may be directly and immediately applied to the daily practice of orthopedic health care providers, especially in the athletic setting by providing an alternative way to treat the common issue that is GIRD.

Hypothesis

Null: There will be no significant difference in the amount of glenohumeral internal rotation after four weeks of a self-assisted, at-home postural restoration program compared to the at-home static stretching and Thrower's Ten exercise program in collegiate overhead athletes.

Delimitations

The treatment conditions for this study were postural restoration techniques from the PRI and the TA, which is a combination of the Sleeper Stretch and the TT exercise program. The duration of the study was a total of four weeks consisting of an initial instructional session in the athletic training room, performing a home exercise program three times a week between measurements, and four follow up visits to measure internal rotation of the dominant shoulder. This research study was subject to the following delimitations:

1. Each participant was a collegiate overhead athlete (e.g. softball, tennis, or volleyball) currently enrolled in a private university and between the ages of 18-24.

2. Changes in internal rotation of the shoulder were measured using a standard twelve-inch, Baseline goniometer where measurements were dependent upon user validity.

3. All therapy treatments and measurements were performed by a certified and licensed athletic trainer trained in using the standard 12 inch, 360 degree goniometer and taking goniometric measurements of the shoulder.

Assumptions

For the purpose of this study, the researcher made the assumptions that:

1. The participants did not make any significant changes to their current stretching and training routine for the duration of the study.

2. Participants were truthful regarding previous injury or surgery to the involved shoulder as well as pain level.

3. Those performing the therapy intervention executed the techniques correctly and consistently throughout the study, and in the amount requested by the researcher.

4. Participants would notify the researcher of any injuries that occurred during the study, which affected their ability to perform the home exercise program assigned in this study.

CHAPTER TWO

Literature Review

Introduction

Overhead athletes frequently present with decreased internal rotation of the glenohumeral joint that may lead to structural changes within the joint capsule, labrum, ligaments, and rotator cuff musculature (Aldridge et al., 2012). This deficit can be defined as decreased internal rotation when compared bilaterally (Aldridge et al., 2012). Often times by increasing glenohumeral range of motion and strengthening the muscles that provide dynamic stability the chance of injury is lessened. Exercise programs coupled with stretching are employed to increase joint range of motion and to strengthen the stabilizing muscles of the joint. Two approaches to reduce glenohumeral internal rotation deficit (GIRD) are implementing the traditional approach (TA) program and postural restoration (PRI). The TA includes commonly used methods to strengthen and stretch the shoulder although, PRI has been recently identified to employ active exercises and breathing techniques that lead to decreased pain and increased range of motion in several cases (Spence, 2008).

Glenohumeral Joint

The glenohumeral joint is one of two ball-and-socket joints in the human body that relies heavily on static and dynamic stabilization from the surrounding ligaments and muscles, respectively. The ligaments that provide stability to the shoulder are the coracohumeral, transverse humeral, and superior, middle, and inferior glenohumeral

(Terry & Chop, 2000). All of these ligaments assist the surrounding muscles in providing stability to this joint. The muscles that cross this joint and help provide dynamic stability to the glenohumeral joint are supraspinatus, subscapularis, infraspinatus, teres minor, and the long head of the biceps brachii. Scapular stability and strength also plays an important role in healthy glenohumeral joint movement and is especially important for overhead athletes (Patel et al., 2014; Terry & Chop, 2000). The trapezius and serratus anterior are major contributors to fluid scapular movement; other scapulothoracic muscles include the rhomboids, levator scapulae, pectoralis minor, and deltoid (Terry & Chop, 2000).

Overhead Athlete

Athletes competing in overhead sports are required to produce powerful movements in the glenohumeral joint that requires flexibility, strength, coordination, and neuromuscular control (Wilk, Obma, Simpson II, Cain, Dugas, & Andrews, 2009 and Aldridge et al., 2012). The glenohumeral and scapulothoracic joints must work together in order to produce the force needed to complete overhead motions required for participation in many sports (e.g. tennis, baseball, softball). Overhead athletes must train their rotator cuff muscles to provide dynamic stability throughout shoulder range of motion. These muscles are most important during deceleration in which the posterior musculature, including the teres minor, infraspinatus, and posterior deltoid muscles, are eccentrically loaded to slow down the overhead motion (Seroyer, Nho, Bach, Bush-Joseph, Nicholson, & Romeo, 2010).

The movement required to complete these overhead motions involves forceful external rotation, which creates laxity in the anterior aspect of the shoulder and tightness

in the posterior aspect overtime. The combined degrees of internal and external rotation of the shoulder make up the total arc of motion. The repetitive motion of forceful external rotation can result in an increase in external rotation with a subsequent decrease in internal rotation (Wilk et al, 2009). This compensatory pattern can cause a shift in the total arc towards external rotation (Aldridge et al., 2012). The limitations in internal rotation due to a tight posterior capsule cause an increase in anterior translation and shearing forces at the glenohumeral joint during movement and may lead to injury (Downar & Sauers, 2005; Herrington, 1998).

It is also worth noting that repetitive overhead motion can cause rounded shoulders and a forward head posture, which is associated with weakness in the scapular retractors and flexors of the neck (Reinold, Gill, Wilk, & Andrews, 2010). Specifically, weakness in the trapezius, rhomboid major, and rhomboid minor muscles can result in a posture that causes the scapular position to change which may affect performance in the overhead athlete and lead to injury (Patel et. al., 2014).

Glenohumeral Internal Rotation Deficit (GIRD)

GIRD is characterized as a decrease in internal rotation that exceeds the gains in external rotation (Dwelly, Tripp, Tripp, Eberman, & Gorin, 2009; Aldridge et al., 2012; Wilk et al., 2009). This deficit may be a result of adaptive changes in contractile tissue, non-contractile soft tissue, and bony anomalies (Aldridge et al., 2012). Perhaps the most common theory is that a loss of glenohumeral IROT is due to contracture of the posterior joint structures (Borsa et al., 2008). The degree of GIRD in the shoulder can be evaluated passively by taking a goniometric measurement with the athlete supine, shoulder abducted to ninety degrees, and scapula stabilized against a table (Borsa et al.,

2008; Downar et al., 2005). Dwelly et al. (2009) calculated GIRD by comparing internal rotation bilaterally between dominant and non-dominant shoulders and by the percent of the total arc (internal and external rotation combined). At the same time, Aldridge et al. (2012) further defines GIRD as exhibiting a difference of greater than 20 degrees, or 20%, of internal rotation between the dominant and non-dominant shoulder. Aldridge et al. (2012) also states that GIRD can be classified by presenting with a ROM difference of 10% or greater of the total arc of motion between shoulders.

Common Injuries to the Glenohumeral Joint

Herrington (1998) reported that 75% of injuries seen in sports injuries clinics involved the upper extremity with a majority involving the glenohumeral joint specifically. Overhead athletes present with hypermobility of the anterior capsule, hypomobility of the posterior capsule, excessive external rotation, decreased internal rotation, and ligamentous laxity (Herrington, 1998). The "thrower's paradox" is an example of this concept. This paradox exists because one must increase external rotation to increase velocity in throwing but in doing so the stability of the joint decreases (Wilk et al., 2009; Downar et al., 2005). In other words, to gain mobility one may lose stability, which often causes injury to the involved joint. Muscle imbalances, in addition to scapular dyskinesis increase the risk for injury in the overhead athlete (Patel et al., 2014). Excessive external rotation of the shoulder adds additional stress to the muscles of the rotator cuff leading to strains of these muscles (Herrington, 1998). Furthermore, due to the resulting posterior and superior positioning of the humerus in the glenoid fossa from a tight posterior capsule internal impingement may be caused (Aldridge et al., 2012) as well as superior labrum anterior to posterior (SLAP) lesions (Downar et al., 2005).

Additionally, overhead athletes typically experience inequality between the muscles responsible for internal and external rotation. This often causes an anterior translation of the humeral head, which can lead to shoulder impingement.

Stretching and Thrower's Ten

Internal rotation deficits of the glenohumeral joint may be treated with static stretching and active exercises, such as the sleeper stretch and TT program. An athletic trainer or other healthcare provider may manually stretch an athletes' glenohumeral internal rotation or have the athlete stretch the posterior capsule on their own. The other component to treating GIRD is resistance exercise to help strengthen the surrounding muscles and stabilize the joint.

In a recent study by Aldridge et al. (2012) the effects of daily stretching on internal rotation in 28 Division I overhead athletes (20.0 ± 1.5 years old) was evaluated and found a significant increase in dominant shoulder internal rotation as well as in the total arc of the dominant shoulder. In this same study, there was a 15% decrease in the number of athletes who presented with GIRD prior to the study (Aldridge et al., 2012). Dwelly et al. (2009) observed glenohumeral range of motion over an entire year in collegiate baseball and softball players and saw a decrease in internal rotation among the athletes between pre-spring and post-spring. However, the results were not statistically significant and there were no changes in internal rotation throughout the year.

Many allied healthcare professionals teach their patients to utilize a passive stretch called the "sleeper stretch". This stretch isolates the soft tissue of the posterior glenohumeral joint and elongates the contractures that are causing the internal rotation deficit. This stretch is named so because the athlete is positioned on their side as if they

were sleeping with their shoulder and elbow flexed to 90 degrees (Laudner et al., 2008). The sleeper stretch position allows for stability of the scapula which helps isolate the posterior aspect of the glenohumeral joint. Laudner et al. (2008) measured horizontal adduction, external rotation, and internal rotation of the glenohumeral joint following a bout of static stretching in the "sleeper stretch" position. Results of this study indicated that the "sleeper stretch" was effective in acutely increasing internal rotation of the glenohumeral joint without decreasing external rotation.

Strengthening the dynamic stabilizers of the shoulder (e.g. rotator cuff muscles) throughout the entire range of motion is essential to preventing injuries, especially in the overhead athlete (Reinold et al., 2010). Some exercises that are beneficial to the throwing athlete include external rotation at 90 degrees of abduction, shoulder flexion and extension, scapular rows, and the scapular punch because they target muscles involved with throwing (Reinold et al., 2010). The TT incorporates similar exercises and consists of ten exercises designed to increase strength, endurance, stability, and neuromuscular control of the glenohumeral joint in overhead athletes (Wilk, 2001). These exercises include diagonal pattern (D2) flexion and extension with theraband, internal and external rotation at 0 and 90 degrees of abduction with theraband, shoulder abduction to 90 degrees, scaption, prone horizontal abduction in neutral and full external rotation, chair press ups, prone rows, push-ups, elbow flexion and extension, wrist flexion and extension, and finally supination and pronation (Wilk, 2001). Patel et al. (2014) compared a scapular retractor strengthening program to the thrower's ten exercise program over 4 weeks in 25 overhead recreational athletes and ultimately concluded that

both programs were successful at improving scapular retractor strength, and throwing distance and accuracy.

Postural Restoration

The Postural Restoration Institute (PRI) was founded to explore and explain the science of postural adaptations, asymmetrical patterns and the influence of polyarticular muscles chains on the human body (Boyle, n.d.). Asymmetrical patterns are based on a shift in a persons' center of gravity, rotation of lumbar and thoracic vertebrae, rotation of the pelvis, and muscular imbalances. The most common pattern of asymmetry described by the PRI is the Left Anterior Interior Chain (AIC). This approach focuses on the effects of posture on the body systems (Tenney et al., 2013; Boyle, n.d.). PRI utilizes manual techniques along with active exercises as a means of treatment. The basis of this therapy is to realign the body and train it to work in a more symmetrical and therefore functional manner. When the athlete's body is imbalanced and asymmetrical it is limited in the ROM it can achieve which may further lead to injury.

PRI utilizes two techniques to correct posture, non-manual techniques and manual techniques. Non-manual techniques incorporate muscle position, respiration, and specific concomitant muscle activity to restore the body's position. These active exercises are often used prior to manual techniques. However, they may be used alone as well to help reposition the body and allow muscles to work more efficiently (Boyle, n.d.). Manual techniques involve hands-on repositioning of the thoracic cavity or pelvic girdle in order to put the diaphragm and ribcage in a more functional position and maximize the zone of apposition (Boyle, n.d.). The zone of apposition (ZOA) is the area of the diaphragm that

directly apposes the ribcage (Boyle, n.d.). PRI focuses on improving the function of body systems together while increasing core strength at the same time.

Common PRI exercises include the 90/90 Hip Lift with a balloon, 90/90 Hemibridge with a balloon, and Right Sidelying Left Respiratory Adductor Pull Back (Tenney et al., 2013; Boyle, n.d.). Balloons are used as a tool in a number of PRI exercises to enhance abdominal muscle recruitment and activation. PRI interventions usually take between 2-15 visits and noticeable results are expected within 4 visits (Boyle, n.d.). One case study involving the use of PRI to manage pain consisted of 16 total treatments over a 6 month period. The PRI regimen was performed twice a week for the first 4 weeks, once a week for the next 4 weeks, and then once a month for the last 4 months. After only 6 weeks of treatment the patient in this study reported being pain free (Spence, 2008). Pain level was also reportedly decreased following the use of either the 90/90 Hip Lift with balloon or the 90/90 Hemibridge with balloon, two PRI exercises (Tenney et al., 2013). The goal of these exercises is to recruit hamstring and abdominal muscles so as to decrease forward rotation of the pelvis allowing for restored ROM. Passive hip adduction was measured bilaterally using Ober's test for all participants. Participants who exhibited a positive Ober's test on both sides were assigned the 90/90 Hip Lift with balloon, which activates the abdominal muscles and the hamstrings bilaterally. Participants were assigned the 90/90 Hemibridge with balloon if Ober's test was positive only on one side since this exercise recruits the ipsilateral hamstrings (Tenney et al., 2013). In this same study, acute improvements in ROM were also seen after implementing either the 90/90 Hip Lift with balloon or the 90/90 Hemibridge with balloon for a total of five repetitions (Tenney et al., 2013). The Right Sidelying Left

Respiratory Adductor Pull Back is another PRI exercise suggested to address postural asymmetry, specifically in a person who falls into the left AIC pattern of asymmetry (Boyle, 2013). The left hemi-diaphragm, iliopsoas, tensor fascia latae, vastus lateralis, and bicep femoris make up the left AIC, which is the most common pattern of asymmetry (Boyle, 2013).

Summary

The studies assessed in this review of literature highlight aspects of glenohumeral joint movement as well as injuries and treatments directly related to the overhead athlete. It has been noted that overhead athletes typically have decreased internal rotation when compared bilaterally, which may or may not include a decrease in total arc range of motion, and may be classified as having GIRD (Aldridge et al., 2012; Borsa et al., 2008; Dwelly et al., 2009; Lintner et al., 2007). An IROT deficit of the glenohumeral joint can be caused from tightness of the posterior musculature of the shoulder (Borsa et al., 2008), bony anomalies (Aldridge et al., 2012), or changes in the body's positioning (Tenney et al., 2013). Injuries that result can include but are not limited to internal impingement, rotator cuff strains, biceps tendonitis, or injury to stabilizing ligaments. Whether a person wants to function for sport performance or activities of daily living, injury prevention is the key and exercise programs are used as the primary tool. Studies have shown that stretching protocols are beneficial in the treatment GIRD (Aldridge et al., 2012; Laudner et al., 2008).

Increasing ROM as well as maintaining and building strength in the glenohumeral joint is important for overhead athletes to reduce the risk of injury. The TA including the TT and the "sleeper stretch" are often used to improve glenohumeral ROM and strength.

This program has been shown to improve stability of the joint in the overhead athlete (Patel et al., 2014). At the same time, PRI incorporates breathing techniques with active exercises and has been shown to increase joint range of motion and core strength as well (Tenney et al., 2013; Spence, 2008). There is hardly any research on postural restoration therefore, the effects it may have on pain, strength, and range of motion should be studied further.

This research study was aimed towards evaluating changes in glenohumeral joint range of motion over four weeks while completing either a TA home exercise program (HEP) or a PRI HEP. The research shows that both the thrower's ten and PRI methods have positive results on decreasing pain, preventing injury, and increasing range of motion (Spence, 2008; Tenney et al., 2013; Patel et al., 2014). The goal of the current study was to establish the most effective way to meet the aforementioned goals.

CHAPTER THREE

Effects of Postural Restoration Therapy Compared to Traditional Therapy on Internal Rotation in Collegiate Overhead Athletes

Abstract

Glenohumeral internal rotation deficit is a condition characterized by a decrease in internal rotation when compared bilaterally (Lintner et al., 2007). The purpose of this study was to evaluate the efficacy of two rehabilitation programs on internal rotation in athletes who commonly present with Glenohumeral Internal Rotation Deficit. Participants were nine collegiate overhead athletes (2 male, 7 female; age = 20.4 $\pm$ 1.1 years) with no prior surgery to the dominant shoulder. Subjects were randomly assigned to Postural Restoration or Thrower's Ten with a Sleeper Stretch. Then, participants were asked to perform a home rehabilitation program three times a week for four consecutive weeks to reduce GIRD. We recorded glenohumeral internal rotation measurements on the dominant shoulder a total of five times. Results failed to identify a statistically significant difference between the two groups effect on increasing glenohumeral internal rotation. It cannot be concluded that the groups are different across time, between groups, or that there is an interaction between the two groups. Key words: Glenohumeral joint, range of motion, rehabilitation.

Introduction

Internal and external rotation of the overhead athlete is a critical range of motion for sport performance. However, collegiate overhead athletes often present with decreased internal rotation (IROT) in their shoulder. This may be classified as

Glenohumeral Internal Rotation Deficit (GIRD) when there is a decrease in IROT on the dominant side compared to the non-dominant side (Lintner et al., 2007; Dwelly et al., 2009). A common cause of GIRD is the repetitive stress unilaterally that overhead athetes put on their dominant shoulder (Aldridge et al., 2012). Decreased IROT is a result of tightness of the posterior capsule, posterior deltoid, infraspinatus, teres minor, and latissimus dorsi which assist in providing dynamic stability to the shoulder (Laudner et al., 2008). Further, GIRD has been associated with shoulder pathologies such as, labral tears, strains of the rotator cuff muscles, and structural changes of the joint capsule. Static stretching and a specific series of active exercises, the Thrower's Ten, are traditionally used to maintain current range of motion (ROM) or work to increase ROM in the shoulder while strengthening the surrounding structures (Wilk et al., 2011). Recently, new techniques have been introduced that may be beneficial in increasing ROM and strengthening the core. Theoretically, this could aid overhead athletes in increasing shoulder ROM and strengthening the core, which may assist in force production and reduce the risk for injury. The Postural Restoration Institute (PRI) presents the concept of asymmetry amongst various systems in the body leading to "imbalances and dysfunctional movement patterns as a result of overuse of one side of the body at the expense of the other" (Tenney et al., 2013). The goal of PRI is to recognize and correct asymmetrical patterns of the body's positioning and strengthen the musculature up the polyarticular chain (Boyle, n.d.). The most common pattern of asymmetry is the Left Anterior Interior Chain (AIC) which is demonstrated by an increase in rib external rotation on the left, a right shoulder lower than the left, and a function leg length difference (Boyle, 2013).

In a recent study by Aldridge et al. (2012) the effects of daily stretching on IROT in overhead athletes was evaluated and found a significant increase in dominant shoulder IROT as well as in the total arc of the dominant shoulder. In this same study, there was a 15% decrease in the number of athletes who presented with GIRD prior to the study (Aldridge et al., 2012). In addition, Patel et al. (2014) compared a scapular retraction strengthening program to a traditional shoulder strengthening program (i.e. thrower's ten) and found that both programs were effective at improving scapular retractor strength, as well as throwing distance and accuracy. However, there is a paucity of research with regards to PRI. Spence (2008) reported a case in which PRI was successfully used for pain management over a six week time period. Similarly, a study by Tenney et al. (2013) evaluated the effects of a PRI exercise (90/90 Hip Lift with Balloon or 90/90 Hemibridge with Balloon) and saw improvements in hip ROM and decreased pain in patients who previously reported lumbopelivc pain.

The current study is important to further knowledge of body mechanics, especially IROT of the shoulder and to expand the toolbox from which health care providers can work to improve deficits in ROM. There is no research available that addresses the concern of decreased IROT of the collegiate overhead athlete with new age therapy, let alone a comparison of the effects of different types of therapy for the specified parameters. Due to the lack of research on PRI, the purpose of this study was to determine the effects of PRI compared to the TA on internal rotation of the shoulder in overhead athletes.

Materials and Methods

Institutional Review Board approval was obtained for this study prior to beginning the research. Recruitment of participants was conducted via flyer, email, and personal contact. All participants signed an informed consent and completed a participant questionnaire prior to taking part in this study. Each subject was randomly assigned to a treatment group by pulling a number out of a bag (PRI=1; TA=2). Baseline internal rotation measurements were taken of the dominant and non-dominant shoulders to assess the degree of internal rotation deficit. Participants then learned and showed comprehension of the assigned treatment program. Each participant was asked to perform the respective exercise program three times a week on their own between measurements and to report once a week for four consecutive weeks to have internal rotation measurements taken. This was an experimental study evaluating changes in internal rotation, measured in degrees, following either the TA or the PRI program. This is a factorial design study where ANOVA was used to evaluate the effects of each treatment group on internal rotation within groups, between groups, and across time.

Nine overhead collegiate athletes (2 male, 7 female; age = 20.4 $\pm$ 1.1 years) were included in this study. The participants were volunteers from a convenience sample of Division 1 collegiate overhead athletes who participated in softball, tennis, and volleyball. Baseball athletes were not included in this study due to current participation in a PRI program that would interfere with the results of this study. Exclusion criteria included previous surgery to the dominant shoulder and/ or a current injury to the dominant shoulder. Participants were asked not to change their normal exercise and stretching program.

Group 1 completed a PRI home exercise program and Group 2 completed the TA home exercise program for a total of four weeks. Both exercise programs consisted of 10 exercises as well as a breathing exercise for Group 1 (see Appendix D) and a static stretch for Group 2 (see Appendix E). The PRI exercises chosen were based on the Left AIC pattern, which is the most common pattern of asymmetry recognized by the PRI (Boyle, 2013). The Quadraped Breathing with Posterior Pelvic Tilt exercise is performed prior to the rest of the PRI program to aid in recruitment of abdominal muscles used throughout the HEP. The Sleeper Stretch is a static stretch used to stretch the posterior capsule of the shoulder that is performed upon completion the TT program. The null hypothesis was that there would be no significant difference in the amount of glenohumeral internal rotation after four weeks of a self-assisted, at-home PRI program (see Appendix D) compared to the at-home TA program (see Appendix E) in collegiate overhead athletes.

The participants were individually taught the randomly assigned home exercise program (HEP). Following the instruction of the HEP every participant was asked to demonstrate each exercise to show that they understood the techniques involved.

Additionally, the number of known exercises from the assigned HEP were recorded by the researcher for every participant. An exercise was considered a "known exercise" if the participant had performed it at least once a week in the month prior to taking part in this study. Known exercises were accounted for to establish participant familiarity with exercises in the assigned program. Participants who are adapted to specific exercises may not show as great of results as those who are not adapted to exercises in the respective program. Some of the PRI exercises were performed without

additional resistance to account for the beginner's learning curve. As seen in Table 3.1, the TA group consisted of an average of 0.60 known exercises compared to the PRI group where there were 0.00 known exercises. For a majority of the subjects, the TT has been performed before, as they are routine exercises for overhead athletes where PRI was new to all participants in this study.

Table 3.1

Demographics

Group	Group 1 (PRI)	Group 2 (TA)	All
Number of Participants	4	5	9
Mean Age	20.50	20.40	20.44
Gender	Female: 4	Female:3 Male: 2	Female: 7 Male: 2
Sport	Volleyball: 2 Softball: 2	Volleyball: 2 Softball: 1 Tennis: 2	Volleyball: 4 Softball: 3 Tennis: 2
Arm Dominance	Right: 4	Right: 4 Left: 1	Right: 8 Left: 1
Compliance	2.50	1.50	1.95
Known Exercises	0.00	0.60	0.33

Each participant was provided with the materials needed to complete the exercises in the assigned HEP. For the PRI and TA groups, all therabands used were the same brand (Theraband), strength (green/heavy), and length (one arms length). A double knot was tied at one end so it could easily stay when closed in a door, which the participants were instructed to do for each exercise that required a theraband to be affixed at one end.

The TA program requires a light hand weight for a number of exercises as well. Participants assigned to this group were given a full, twenty-ounce water bottle and instructed to use it in place of the hand weight for exercises that required one. In the PRI program where a ball or foam block were required for support under the ankles or between the knees, participants were instructed to use a rolled up hand towel instead.

Measurements

All measurements were taken with a standard 12-inch, 360-degree plastic goniometer manufactured by Baseline Evaluation Instruments. A certified Athletic Trainer took all measurements while the researcher recorded the data. All measurements were taken in the supine position with the dominant arm abducted to 90 degrees and supported on a treatment table. The center of the goniometer was lined up at the olecranon process with the stationary arm perpendicular to the ground and the moving arm in line with the ulna. The glenohumeral joint and scapula were stabilized against the table while each measurement was taken. IROT measurements of the dominant and non-dominant shoulder were measured and recorded as a baseline for each subject prior to beginning the treatment protocol. Participants were asked to complete the HEP three times per week for four weeks. Each week an IROT measurement was taken and recorded for the dominant arm. A total of two measurements were taken with the average recorded for data analysis.

Data Analysis

We calculated a factorial analysis of variance (ANOVA) to evaluate the effects of each treatment group on internal rotation within groups, between groups, and across time

(4 weeks). Based on a priori power analysis a sample of 20 was recommended for a power of 0.827. Due to a number of limitations, nine subjects were included in the analysis. No subjects were lost due to follow up measurements. Mean and standard deviation of internal rotation were calculated for each group on five different occasions as shown in Table 3.2. Increases in IROT were seen for both groups although the results were not significant. Figure 3.1 exemplifies the mean differences in IROT between groups from baseline to Week 4.

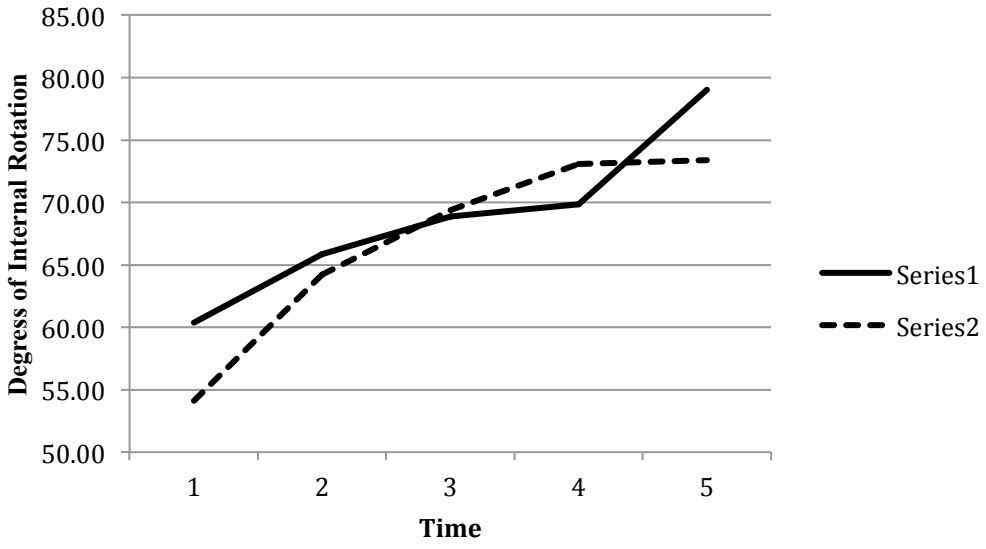


Figure 3.1 Mean Difference in Internal Rotation

Table 3.2 illustrates that the greatest increase in IROT for Group 1 was seen from week three to week four; on the other hand, Group 2 showed the greatest increase in IROT from baseline to week one. This observation should be evaluated further to determine if the immediate effects of the TA are greater while the long term effects of PRI are more substantial. Within-between interactions of treatment groups and time were evaluated. ANOVA repeated measures was used to compare changes in the dependent

variable over time with the level of significance set at 0.05. We ran an ANOVA test of hypotheses for between subjects' effects and ANOVA univariate test of hypotheses for within subjects' effects (p>.05).

Table 3.2

Mean and Standard Deviation Results of Internal Rotation

Group	Group 1 (PRI)	Group 2 (TA)	All
Baseline (Degrees IROT)	60.38 ± 15.88	54.10 ± 7.35	56.89 ± 11.51
Week 1 (Degrees IROT)	65.88 ± 13.10	64.20 ± 11.84	64.94 ± 11.63
Week 2 (Degrees IROT)	68.88 ± 3.97	69.40 ± 5.65	69.17 ± 4.68
Week 3 (Degrees IROT)	69.88 ± 5.54	73.10 ± 4.25	71.67 ± 4.84
Week 4 (Degrees IROT)	79.00 ± 6.65	73.40 ± 3.78	75.89 ± 5.69

Values presented are mean ± SD.

Results

The data was statistically analyzed with ANOVA using SAS. Both rehabilitation programs lead to changes in glenohumeral IROT on the dominant shoulder in overhead collegiate athletes. However, no significant increases in ROM were found for dominant shoulder internal rotation between groups (p=0.0926) or within groups and across time (adjusted p= 0.4783). Table 3.3 represents the comparison of Groups 1 and 2.

Table 3.3

ANOVA Test of Hypotheses for Between Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F
GROUP	1	0.02058601	0.02058601	3.79	0.0926
Error	7	0.03801512	0.00543073		

In addition, Table 3.4 displays the comparison of scores across time and, the interaction between the groups and time. Based on these results, the null hypothesis was not rejected and therefore it cannot be assumed that there is a difference between PRI and TA on improving glenohumeral IROT over four weeks in overhead athletes.

Table 3.4

ANOVA Univariate Tests of Hypotheses for Within Subject Effects

Source	DF	Type III SS	Mean Square	F Value	Pr > F	Adj Pr > F G-G	Adj Pr > F H-F-L
Time	4	0.01071650	0.00267912	0.02	0.9988	0.9850	0.9975
Time*GROUP	4	0.39261106	0.09815276	0.88	0.4883	0.4472	0.4783
Error(time)	28	3.12203922	0.11150140				
Greenhouse-Geisser Epsilon				0.5747			
Huynh-Feldt-Lecoutre Epsilon				0.8717			

Discussion

It is common for overhead athletes to present with GIRD (Dwelly et al., 2009) but often this lack of ROM may lead to pain, injury, or decreased function of the shoulder (Herrington et al., 1998). This study was a pre-post intervention, using a within-between

subjects' comparison of a convenience sample. Glenohumeral joint IROT of the dominant shoulder of 9 NCAA Division 1 overhead athletes was measured using a universal goniometer. Determinations were made as to the degree of GIRD in the throwing shoulder as the difference between dominant and non-dominant shoulders was measured prior to beginning the study. Participants were given a HEP consisting of either the PRI program (N = 4) or the TA (N= 5) to be completed three days per week for four weeks. In addition to baseline measurements, glenohumeral joint IROT was measured one time a week over the course of four weeks.

To our knowledge, this is the first study that has compared the efficacy of PRI and TA programs. Previous studies show a decrease in the prevalence of GIRD following a daily stretching routine that included the sleeper stretch as it was implemented in the current study (Aldridge et al., 2012; Laudner et al., 2008). Patel et al., 2014 also compared a scapular retractor strengthening program to the TT where gains in strength, throwing distance, and accuracy were seen in both groups. Furthermore, decreased pain (Spence, 2008 and Tenney et al., 2011) as well as increased ROM (Tenney et al., 2011) were seen in patients following a PRI program that utilized similar exercises to those in the current study.

In this study the PRI program and the TA program increased glenohumeral IROT; however there were no significant results within or between groups, and no significant differences were seen across time. Although, our results are in line with previous studies that state a program designed to stretch the posterior capsule of the glenohumeral joint may beneficial in increasing glenohumeral IROT (Aldridge et al., 2012).

We hypothesized that there would be no difference between the two treatment groups. This hypothesis was not rejected, as there was no significant increase in glenohumeral IROT from the PRI GROUP when compared to the TA GROUP. This research shows that active exercises, whether PRI or the TA, can lead to changes in IROT of the shoulder. By increasing IROT, overhead athletes have a reduced risk for injury and may experience an increase in performance. The insignificant results of this study may be attributed a number of factors considered to be limitations in this study. The participants in this study were collegiate athletes involved in very active lifestyles and took part in daily conditioning, practice, and treatment. The limitations of this study were as follows:

1. The daily stretching and training routines performed by participants outside of the study may have affected the glenohumeral ROM measurements taken.

2. Patient compliance with the HEP was not consistent and thus, may have hindered results.

3. A smaller than desired sample size due to repeated measures over the course of four weeks as well as, the fact that a majority of the desired population were involved with in-season sports during the period in which this study was conducted limited the results of this study.

4. The time of day for each measurement varied person-to-person, and week-to-week based on the busy schedules of the student- athletes involved in this study, which could have affected subject ROM.

5. The same Athletic Trainer was not available for every participant's measurement, which may have affected reliability of measurements.

To our knowledge, we are the first investigators to compare the effects on glenohumeral IROT between a PRI program and the TA program. This study warrants further investigation on the effects of postural restoration therapy on ROM at the glenohumeral joint. The following recommendations are made based on this research study:

1. Future research should include a control group that does not receive any intervention to more effectively evaluate PRI as a means of increasing glenohumeral ROM over time.

2. More research should be done to determine the most effective PRI program for increasing glenohumeral ROM.

3. Research to investigate the lasting effects of the PRI program on glenohumeral ROM in overhead athletes should be completed.

4. Future studies should evaluate pain level, injury prevalence, strength, and throwing velocity in addition to ROM following a PRI program.

APPENDICES

APPENDIX A

Participant Questionnaire

Name: _____

Age: _____

Gender: _____ Male _____ Female

Sport: _____

Phone number (for contact regarding the study only): _____

How many years have you played your sport at the collegiate level?

_____
_____

Have you ever had a surgical procedure performed on your dominant shoulder?

_____ Yes _____ No

Do you currently have an injury to your dominant shoulder?

_____ Yes _____ No

APPENDIX B

INSTITUTIONAL REVIEW BOARD – PROTECTION OF HUMAN SUBJECTS IN RESEARCH

NOTICE OF EXPEDITED APPROVAL – INITIAL REVIEW

Principal Investigator: Meagan Faulk
Study Title: Effects of Postural Restoration Therapy Compared to Traditional Therapy on Internal Rotation in Collegiate Overhead Athletes
IRB Reference #: 676375

Date of Conditional Approval: 02/20/2015
Date Response Accepted: 03/06/2015
Date of Expiration: 02/20/2016

Expedited Category: 4

The above referenced human subjects research project has been approved by the Baylor University Institutional Review Board (IRB). Specifically, the IRB reviewed and approved the following documents:

- IRB Application submitted on 02/11/2015
- Response to Required Modifications, submitted on 02/26/2015
- Protocol, dated 02/09/2015 (submitted on 02/26/2015)
- Consent Form, dated 02/09/2015
- Recruitment Email, submitted 02/11/2015
- Flyer, submitted 02/09/2015
- Letter of Support, submitted 01/06/2015
- Participant Questionnaire, submitted on 01/15/215

This approval is limited to the activities described in the approved protocol and application, and extends to the performance of these activities at each respective site identified in the IRB Application. In accordance with this approval, the specific determinations for the conduct of this research are listed below. General conditions for the conduct of research are attached.

Per your submission, your approved enrollment is: 40.

Any change to the approved research (including changes to targeted enrollment), must receive prior IRB approval.

For questions concerning this approval, contact Deb Penney at 254-710-3708 or Debbie_Penney@Baylor.edu

Sincerely,

David W. Schlueter, Ph.D.
Chair, Baylor IRB

APPENDIX C

Baylor University
Health, Human Performance, and Recreation

Consent Form for Research

PROTOCOL TITLE:	Effects of Postural Restoration Therapy Compared to Traditional Therapy on Internal Rotation in Collegiate Overhead Athletes
PRINCIPAL INVESTIGATOR:	Meagan Faulk, ATC, LAT
SUPPORTED BY:	Andrew Gallucci, PhD, ATC, LAT, CSCS, Deborah Johnston, PhD, and Grant Morgan, PhD (Baylor University)

Introduction

Please read this form carefully. The purpose of this form is to provide you with important information about taking part in a research study. If any of the statements or words in this form are unclear, please let us know. We would be happy to answer any questions. You have the right to discuss this study with another person who is not part of the research team before making your decision whether or not to be in the study.

Taking part in this research study is up to you. If you decide to take part in this research study we will ask you to sign this form. We will give you a copy of the signed form.

The person in charge of this study is Meagan Faulk, who is being overseen by Dr. Andrew Gallucci. We will refer to this person as the "researcher" throughout this form.

Why is this study being done?

The purpose of this study is to evaluate the effects that two different therapeutic rehabilitation programs have on glenohumeral internal rotation.

We are asking you to take part in this study because you are a collegiate athlete between the ages of 18 to 25 participating in an overhead sport and may meet the requirements specified in this study.

About 40 subjects will take part in this research study at Baylor University.

How long will I take part in this research study?

We expect that you will be in this research study for a total of 4 weeks. During this time, we will ask you to make 5 study visits to the Simpson-Highers Athletic Training Room at Baylor University.

What will happen if I take part in this research study?

If you decide to participate in this study you will be asked to fill out a questionnaire to determine if you meet the study requirements. Those meeting the studies' requirements and choose to participate will be randomly assigned to one of two therapeutic rehabilitation program groups designed to increase strength, decrease pain, and increase shoulder range of motion. The only measure for this study will be shoulder internal rotation. Prior to your group assignment, measurements of your shoulder internal rotation will be made on both your dominant and non-dominant side. Once in your designated group, you will be instructed on how to perform the assigned exercises. Then, you will be asked to show the researcher that you understand and are able to perform these exercises. Once we are confident that you understand the exercise program, you will be given a home exercise program to follow. The home exercise program should take approximately 45 minutes to complete. You will be asked to adhere to the exercise program given and return once a week for the next three weeks to measure changes in your shoulder internal range of motion.

For the duration of the study you will be asked not to change your normal exercise and stretching program. You will also be asked to inform the researcher of any injury that occurs to the involved shoulder for the duration of the study.

Any and all information regarding your contact information or personal health history will be kept in a locked cabinet in the office of one of the committee members.

If you agree to take part in this study, we will ask you to sign the consent form before we do any study procedures.

Study Visits

Visit 1 will take about 45 minutes to complete. At this visit, we will ask you to do the following procedures:

- Complete a questionnaire to identify your age, sport, surgical history of your dominant shoulder, as well as any current dominant shoulder injury.
- Measure the glenohumeral internal rotation of both the dominant and non-dominant sides.

Visit 2 will take about 60 minutes to complete. At this visit, we will ask you to do the following procedures:

- Measure the glenohumeral internal rotation of both the dominant and non-dominant sides.
- Learn and perform the home exercise program assigned to you.
- Re-measure the glenohumeral internal rotation of both the dominant and non-dominant sides.

Visits 3, 4, and 5 will take about 30 minutes to complete. At this visit, we will ask you to do the following procedures:

- Measure the glenohumeral internal rotation of both the dominant and non-dominant sides.

We will assign you by chance (like a coin toss) to one of two study groups. One group will complete an at-home exercise program consisting of traditional exercises and stretches while the other group will complete an at-home exercise program consisting of postural restoration techniques. You and the researcher cannot choose your study group. You will have an equal chance of being randomly assigned to either study group.

What are the risks of taking part in this research study?

No foreseeable risks: Participants may experience some physical discomfort in completing the stretching or rehabilitative exercises included in this study. Light weights (e.g. soup can) will be used in therapeutic exercises, which could cause minor injury if not handled appropriately.

Risks of Completing Tasks
You may get tired during the tasks. You can rest at any time. Light weights may be used in some of the exercises. Stretching may be uncomfortable.

Questionnaire/Survey Risks
You may be uncomfortable with some of the questions and topics we will ask about. You do not have to answer any questions that make you feel uncomfortable.

Loss of Confidentiality
A risk of taking part in this study is the possibility of a loss of confidentiality. Loss of confidentiality includes having your personal information shared with someone who is not on the study team and was not supposed to see or know about your information. The researcher plans to protect your confidentiality. Their plans for keeping your information private are described later in this consent form.

Are there any benefits from being in this research study?

You may or may not benefit from taking part in this study. Possible benefits include greater glenohumeral range of motion, improvements in strength, increasing functional capacity of the shoulder.

Others may benefit in the future from the information that is learned in this study by applying it to their practice.

What alternatives are available?

You may choose not to take part in this research study.

How Will You Keep My Study Records Confidential?

We will keep the records of this study confidential by keeping the questionnaires in a closed envelope in a locked cabinet. We will make every effort to keep your records confidential. However, there are times when federal or state law requires the disclosure of your records.

The following people or groups may review your study records for purposes such as quality control or safety:

- The Researcher and any member of her research team
- Authorized members of Baylor University who may need to see your information, such as administrative staff members from the Office of the Vice Provost for Research and members of the Institutional Review Board (a committee which is responsible for the ethical oversight of the study)
- Federal and state agencies that oversee or review research (such as the HHS Office of Human Research Protection or the Food and Drug Administration)

The study data will be stored in a closed envelope in a locked cabinet.

The results of this study may also be used for teaching, publications, or presentations at professional meetings. Your individual results will not be discussed; only group data will be reported.

Study Participation and Early Withdrawal

Taking part in this study is your choice. You are free not to take part or to withdraw at any time for any reason. No matter what you decide, there will be no penalty or loss of benefit to which you are entitled. If you decide to withdraw from this study, the information that you have already provided will be kept confidential. You cannot withdraw information collected prior to your withdrawal.

You may choose not to be in the study or to stop being in the study before it is over at any time. This will not affect your class standing or your grades at Baylor University. You will not be offered or receive any special consideration if you take part in this research study.

The researcher may take you out of this study without your permission. This may happen because:

- The researcher thinks it is in your best interest
- You can't make the required study visits
- Other administrative reasons

Will I get paid for taking part in this research study?

You will not be paid for taking part in this study.

What will it cost me to take part in this research study?

There are no costs to you for taking part in this research study.

What happens if I am injured as a result of participating in this research study?

If you become ill or injured as a result of your participation in the study, you will have access to allied health care providers. You should promptly tell the researcher about any illness or injury.

There are no plans for Baylor University to pay you or give you other compensation for your injury or illness. You do not give up any of your legal rights to seek compensation by signing this form.

What if I have any questions or concerns about this research study?

You can call us with any concerns or questions about the research. Our telephone numbers are listed below:

You may contact the faculty advisor listed below Monday-Friday between the hours of 9:00 a.m. to 5:00 p.m.

Andrew Gallucci, PhD, ATC, LAT, CSCS
Director, Athletic Training Program
Health, Human Performance, and Recreation
Baylor University
Office: (254) 710- 4026
Email: Andrew_Gallucci@baylor.edu

If you want to speak with someone **not** directly involved in this research study, you may contact the Baylor University IRB through the Office of the Vice Provost for Research at 254-710-1438. You can talk to them about:

- Your rights as a research subject
- Your concerns about the research
- A complaint about the research

Statement of Consent

SIGNATURE OF SUBJECT:

I have read the information in this consent form including risks and possible benefits. I have been given the chance to ask questions. My questions have been answered to my satisfaction, and I agree to participate in the study.

_____ _____

Signature of Subject Date

Signature of Person Obtaining Consent:

I have explained the research to the subject and answered all his/her questions. I will give a copy of the signed consent form to the subject.

_____ _____

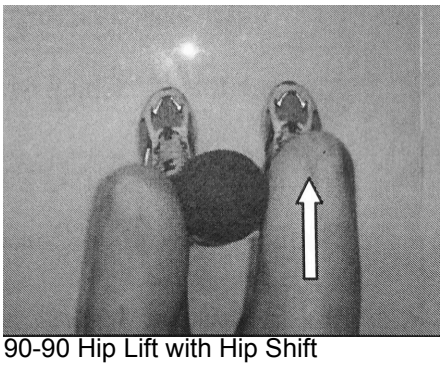
Signature of Person Obtaining Consent Date

APPENDIX D

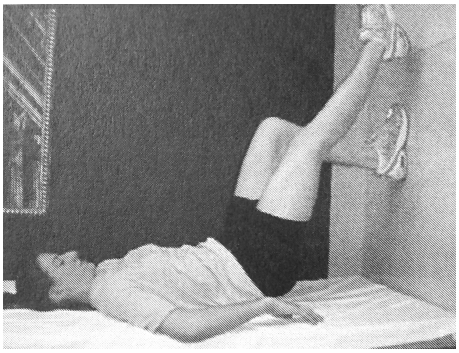
Postural Restoration Program

Perform each exercise at the specified number of sets and repetitions 3 days per week.

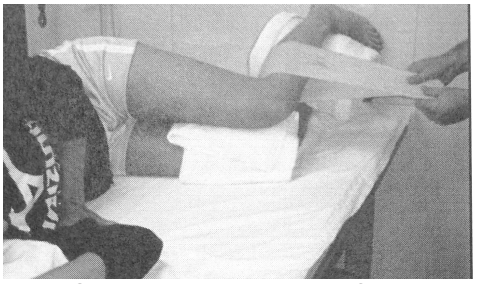

1. Quadraped Breathing With Posterior Pelvic Tilt
    a. Begin on all fours with hands directly under shoulders and knees directly under hips.
    b. Inhale through your nose and as you exhale through your mouth, performing a pelvic tilt as if you are pushing your low back towards the ceiling.
    c. Maintain this position until you have completed 4-5 breaths in and out. Attempt to push your low back further towards the ceiling with each breath.
    d. Relax back to the starting position and repeat 4 more times.



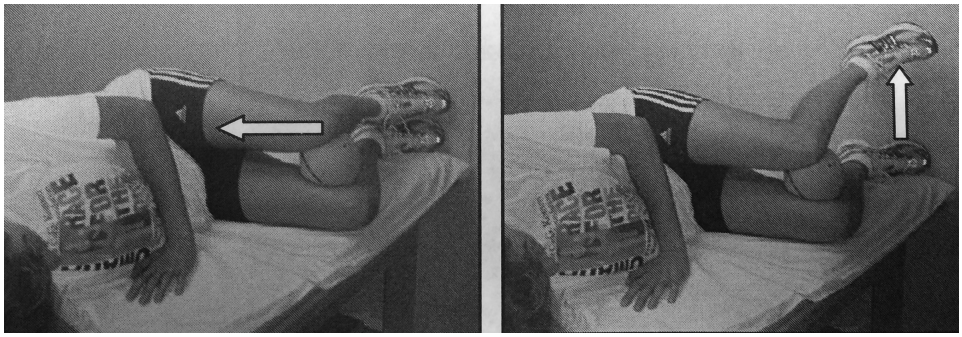
2. 90-90 Hip Lift with Hip Shift
    a. Lie on your back with your feet flat on a wall and your knees and hips bent at a 90-degree angle.
    b. Place a 4-6 inch ball between your knees.
    c. Inhale through your nose and exhale through your mouth, performing a pelvic tilt so that your tailbone is raised slightly off the mat. Keep your back flat on the mat.
    d. As you maintain a hip lift, shift your left hip down and your right hip up so that your right knee is slightly above the left.
    e. Slowly take your bent right leg on and off the wall so that your right thigh comes toward your chest. You should feel the muscle behind your left thigh and left inner thigh engage.
    f. Perform 3 sets of 10 repetitions.



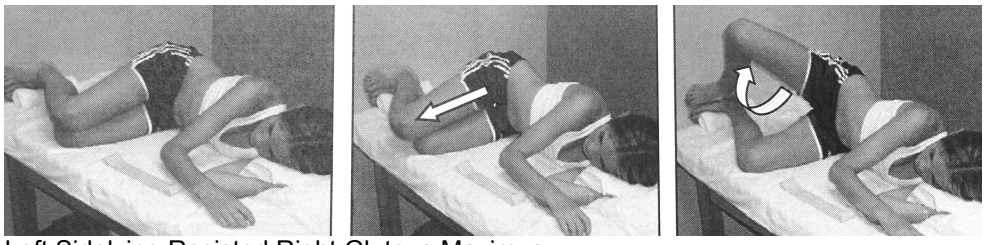
3. 90-90 Supported Hip Lift with Hemibridge
    a. Lie on your back with your feet flat on a wall and your knees and hips bent at a 90-degree angle.
    b. Inhale through your nose and as you exhale though your mouth, perform a pelvic tilt so that your tailbone is raised slightly off the mat. Keep your low back flat on the mat. Do not press your feet flat into the wall instead dig down with your heels.
    c. Maintain the pelvic tilt with your left leg on the wall and straighten your right leg.
    d. Slowly take your straight right leg on and off the wall as your breathe in through your nose and out through your mouth. You should feel the muscles behind your left thigh engage.
    e. Perform 3 sets of 10 repetitions.



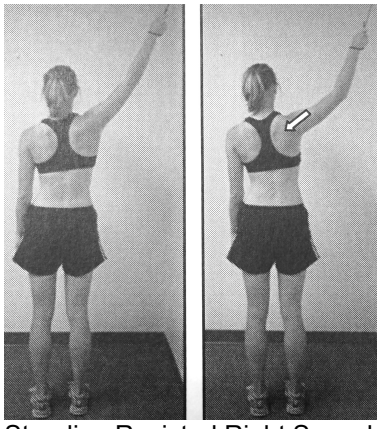
4. Right Sidelying Respiratory Left Adductor Pull Back
    a. Lie on your side with your feet on a wall, hips and knees at a 90-degree angle, ankles and knees together and your back rounded. Place a pillow under your head and keep back and neck relaxed.
    b. Place an appropriate size bolster between your feet and a towel between your knees. Your left knee should be lower than your left hip and ankle.
    c. Push your right foot into the wall.
    d. Begin by inhaling slowly though your nose as you pull back your left leg.
    e. Exhale through your mouth as you squeeze your left knee down into the towel for 3 seconds.
    f. Inhale again as your pull back your left leg further. You should begin to feel your left inner thigh engage.
    g. Exhale and squeeze your left knee down.
    h. Continue the sequence until you have completed 4-5 breaths in and out. Attempt to pull back your left leg further each time you inhale.
    i. Relax your knees back to the starting position and repeat the sequence 4 more times.



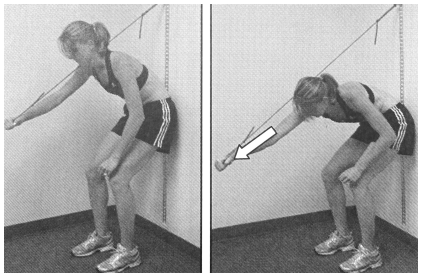
5. Right Sidelying Supported Left Gluteus Medius
    a. Lie on your right side with your feet on a wall, hips and knees at a 90-degree angle and your back rounded.
    b. Place your lower arm or a pillow under your head and upper hand on the floor in front of you to help stabilize your trunk.
    c. Place a 4-5 inch ball between your knees.
    d. Push your right foot into the wall.
    e. Slide or shift your left hip back as far as you can without arching your back.
    f. Press your left knee down into the ball. You should feel your left inner thigh engage.
    g. Rotate your left thigh "in" by lifting your left lower leg towards the ceiling. You should feel your left outside hip (buttock) engage.
    h. Hold this position for 4-5 deep breaths, inhaling through your nose and exhaling through your mouth.
    i. Relax and repeat 4 more times.



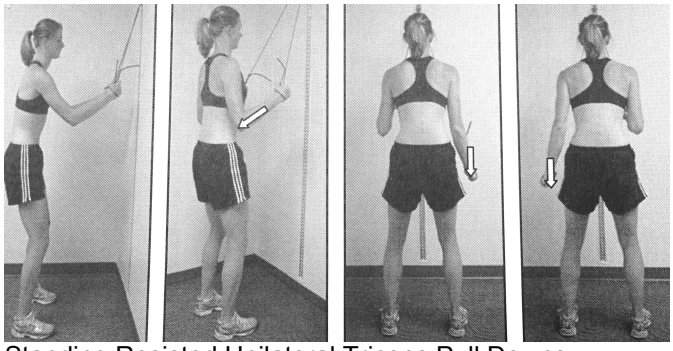
6. Left Sidelying Resisted Right Gluteus Maximus
    a. Lie on your left side with your hips and knees bent at a 60-90-degree angle.
    b. Place your ankles on top of a 3-5 inch bolster and place your feet firmly on a wall.
    c. Shift your right hip forward until you feel a slight stretch or pull in your left outside hip.
    d. Keeping your feet on the wall, raise your right knee keeping it shifted forward. You should feel your right outside hip (buttock) engage.
    e. Hold this position while you take 4-5 deep breaths, in through your nose and out through your mouth.
    f. Relax and repeat 4 more times.



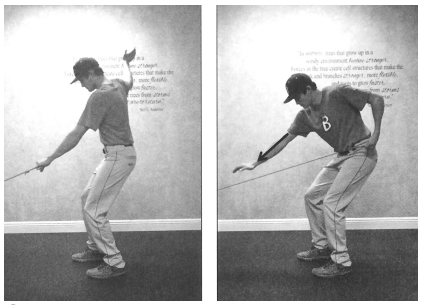
7. Standing Resisted Right Scapular Set
    a. Anchor a small piece of tubing in the top of the door and stand with the door to your right.
    b. Raise your right hand above your head and place the other end of the tubing in your right hand.
    c. Reach towards the floor with your left hand, side-bending your trunk to the left.
    d. Pull your right shoulder blade down and back against the resistance of the tubing. You should feel the back of your right shoulder blade engage.
    e. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
    f. Relax and repeat 4 more times.



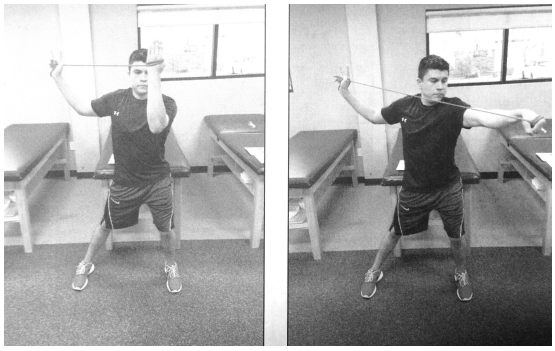
8. Standing Supported Resisted Serratus Punch
    a. Anchor a piece of tubing in a door slightly above shoulder level.
    b. Stand facing away from the door and place the end of the tubing in your right hand.
    c. Place your bottom on the wall and squat down so your knees are slightly bent.
    d. Shift your left knee back behind your right. You should feel the muscles in your left inner thigh engage.
    e. Inhale through your nose and exhale through your mouth as you reach forward and down with your right hand.
    f. Hold this position and inhale again filling the back of your right chest wall with air. Exhale and reach forward further. You should feel the muscle underneath your right shoulder blade engage.
    g. Continue this sequence for 3 breaths in and out maintaining position as you inhale and reaching as you exhale.
    h. Relax and repeat 4 more times.



9. Standing Resisted Unilateral Triceps Pull Downs
    a. Anchor a piece of tubing in the top of a door.
    b. Stand facing the door and place ends of the tubing in each hand.
    c. Pull your shoulder blades down and together.
    d. Keeping your shoulder blades pulled together, pull your elbows back to your sides.
    e. Straighten your right elbow against the resistance of the tubing. You should feel the muscles in the back of your right arm engage.
    f. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
    g. Slowly bend your right arm and straighten your left elbow against the resistance of the tubing. You should feel the muscles in the back of your left arm engage.
    h. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
    i. Relax and repeat 4 more times with both arms.



10. Standing Pull
    a. Place your right foot slightly in front of your left, and shift your left hip back. You should feel the muscles on your left outer hip (buttock) engage.
    b. Keeping your left hip back, begin to rotate your trunk to the left by reaching across the midline of the body with your right hand as your right palm rotates down toward the floor and pulling back with your left hand as your left palm opens up to face forward. You should feel the muscles on the back of your left shoulder and arm engage.
    c. Hold this position while you take 4-5 deep breaths, in through your nose and out through your mouth.
    d. Relax and repeat 4 more times.



11. Standing Throw
    a. Stand with feet shoulder width apart and back rounded, shoulders flexed to 90-degrees with left palm turned in and right arm abducted to shoulder level while turned away.
    b. Shift left hip back and bend left knee, keeping weight through left mid-foot/heel. Turn your left knee in slightly. You should feel the muscles on your left outer hip, left inner thigh and the front of your left thigh engage. Side-bend your trunk to the left so your left shoulder is slightly below your right. Should feel left abdominals engage.
    c. Press right foot and turn right ankle out as you being to move your right foot away from left.
    d. Reach forward with left hand and exhale while you simultaneously face your palm down and flex your wrist while rotating your trunk to the right.
    e. Maintain your trunk rotated right while inhaling and returning your left arm to the starting position with left elbow bent and palm turned in.
    f. Repeat steps 5-6 for a total of 5 breaths.
    g. Relax and repeat 4 more times.

APPENDIX E

Thrower's Ten plus Sleeper Stretch

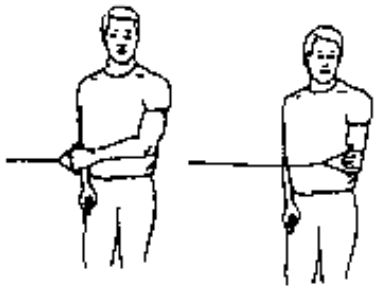
Perform each exercise at the specified number of sets and repetitions 3 days per week.

Exercise 1a

1a. PNF D2 Extension: Affix tubing overhead, pull tubing down and across your body to the opposite side of leg. During the motion, lead with your thumb __3__ sets of __10__.

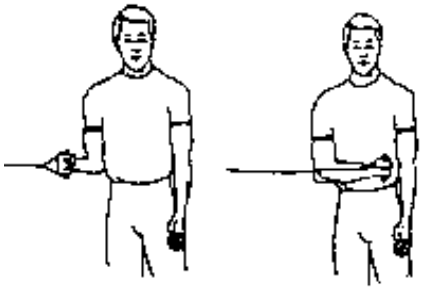
Exercise 1b

1b. PNF D2 Flexion: Affix tubing to door or stand on with opposite foot, start with palm facing behind you. Pull arm out, up, and across body. Rotate arm as you move so palm continues to face behind you. __3__ sets of __10__.



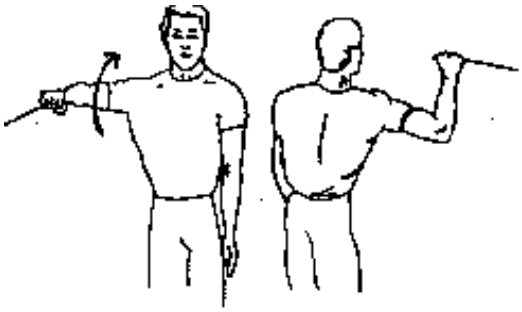
Exercise 2a

2a. External Rotation at 0° Abduction: Stand with your uninvolved side next to a closed door, tubing attached to the doorknob With elbow at 90° and at your side, pull out to side, hold 5 sec. 3 sets of 10 .



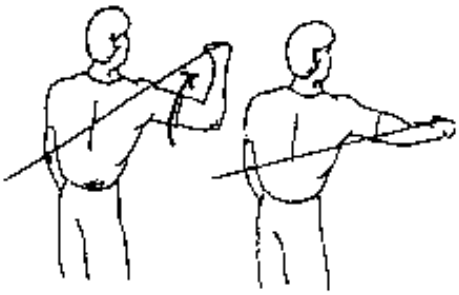
Exercise 2b

2b. Internal Rotation at 0° Abduction: Stand with your involved side next to a closed door, tubing attached to the doorknob With elbow at 90° and at your side, pull across your body, slowly return to starting position. 3 sets of 10 .



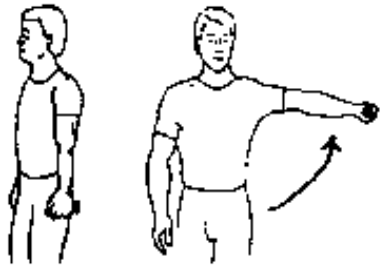
Exercise 2c

2c. External Rotation at 90° Abduction: Standing with shoulder abducted at 90° and elbow flexed at 90°. Grip tubing with affixed end straight ahead slightly lower than shoulder. With shoulder abducted, rotate shoulder back keeping elbow at 90°. Return tubing and hand to starting position. 3 sets of 10 .



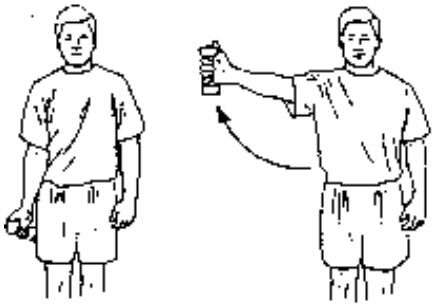
Exercise 2d

2d. Internal rotation at 90° Abduction: Stand with shoulder abducted at 90° and elbow flexed to 90°. Grip tubing with affixed end straight ahead and slightly lower than shoulder. With shoulder abducted, rotate shoulder forward keeping elbow at 90°. Return tubing and hand to starting position. 3 sets of 10 .



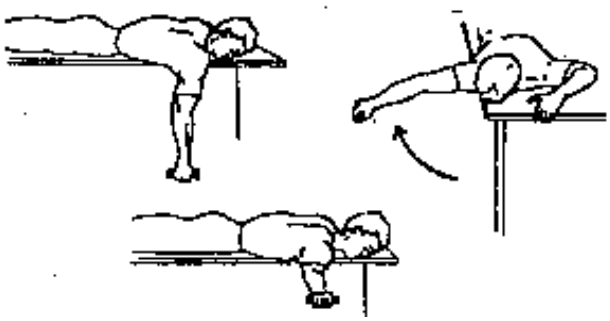
Exercise 3

3. Shoulder Abduction to 90°: Stand with arm at side, elbow straight, and palm against side. Raise arm to the side, palm down, until arm reaches 90° (shoulder level) Hold 2 sec. 3 sets of 10 .



Exercise 4

4. Scaption (Full Can) Standing with elbow straight and thumb up. Raise arm to shoulder level at 45° angle in front of body. Do not go above shoulder height. Hold for 2 seconds and then lower slowly. 3 sets of 10 .



Exercise 5a

5a. Prone Horizontal Abduction (Neutral) Lie on table, face down, with involved arm hanging straight to floor, palm facing down. Raise arm to the side, parallel to the floor. Hold 2 seconds and slowly lower. 3 sets of 10.

Exercise 5b

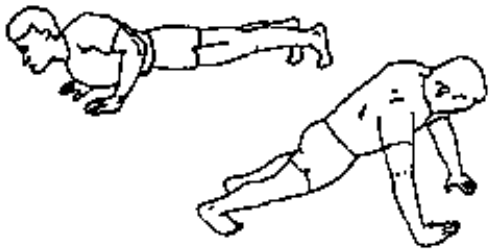
5b. Prone Horizontal Abduction (Full ER, 100° Abduction) Lie on table, face down, with involved arm hanging straight to the floor, thumb rotated up. Raise arm out to the side slightly in front of shoulder parallel to the floor. Hold 2 seconds, lower slowly. 3 sets of 10.

Exercise 6

6. Press-ups Seated on a chair or on a 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 for 2 sec and lower body slowly. 3 sets of 10.

Exercise 7

7. 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 2 seconds then lower slowly. 3 sets of 10 .

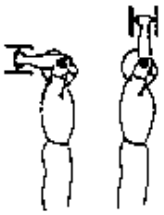


Exercise 8

8. Push-ups Start in the down position with arms in a comfortable position. Place hands shoulder width apart. Push up as high as possible, rolling shoulders forward after elbows are straight. Start with a push-up on the wall, progress to table top and gradually progress to the floor as tolerable. 3 sets of 10 .

Exercise 9a

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. 3 sets of 10 .



Exercise 9b

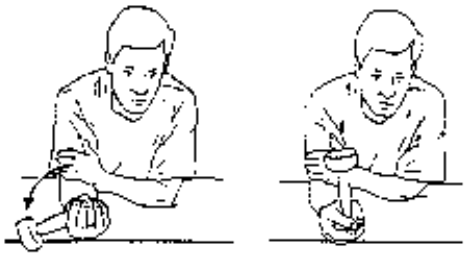
9b. Elbow Extension Raise involved arm overhead. Provide support at the elbow from uninvolved hand. Straighten arm overhead. Hold 2 sec and lower slowly. 3 sets of 10 .

Exercise 10a

10a. Wrist Extension Supporting the forearm and with palm facing down, raise the weight in hand as far as possible. Hold 2 seconds and lower slowly. 3 sets of 10 .

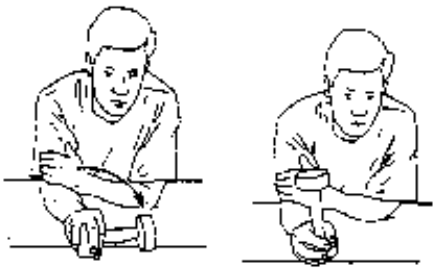
Exercise 10b

10b. Wrist Flexion Supporting the forearm and with palm facing up, lower the weight in hand as far as possible and then curl up and far as possible. Hold for 2 sec and return to start. 3 sets of 10 .



Exercise 10c

10c. Supination Forearm supported on table with wrist in neutral position. Using a weight or hammer, roll wrist taking palm up. Hold 2 seconds and return to starting position. 3 sets of 10 .



Exercise 10d

10d. Pronation Forearm should be supported on a table with wrist in neutral position. Using a weight or hammer, roll wrist taking palm down. Hold for 2 seconds and return to starting position. 3 sets of 10 .

11. Sleeper Stretch: Lay on the side of your dominant arm. Place your elbow in front of you, in line with your shoulder. Place your non-dominant hand on the top of your dominant hand and apply pressure down towards the table. You should reach a point of mild discomfort and hold. 3 sets of 30 seconds.

REFERENCES

Aldridge, R., Guffey, JS., Whitehead, MT., & Head, P. (2012). The effects of a daily stretching protocol on passive gelnohumeral internal rotation in overhead throwing collegiate athletes. The International Journal of Sports Physical Therapy, 7(4), 365-371.

Borsa, PA., Laudner, KG., & Sauers, EL. (2008). Mobility and stability adaptations in the shoulder of the overhead athlete: A theoretical and evidence-based perspective. Sports Medicine, 38(1), 17-36.

Boyle, K. (2013). Clinical application of the right sidelying respiratory left adductor pull back exercise. The International Journal of Sports Physical Therapy, 8(3), 349-358.

Boyle, K. (n.d.). Postural Restoration. Retrieved from http://www.posturalrestoration.com

Downar, JM., & Sauers, EL. (2005). Clinical measures of shoulder mobility in the professional baseball player. Journal of Athletic Training, 40(1), 23-29.

Dwelly, P., Tripp, B., Tripp, P., Eberman, L., & Gorin, S. (2009). Glenohumeral rotational range of motion in collegiate overhead-throwing athletes during an athletic season. Journal of Athletic Training, 44(6), 611-616.

Herrington, L. (1998). Glenohumeral joint: Internal and external rotation range of motion in javelin throwers. British Journal of Sports Medicine, 32, 226-228.

Laudner, K.G., Sipes, R.C., & Wilson, J.T. (2008). The acute effects of sleeper stretches on shoulder range of motion. Journal of Athletic Training, 43(4), 359-363.

Lintner, D., Mayol, M., Uzodinma, O., Jones, R., Labossiere, D. (2007). Glenohumeral internal rotation deficiets in professional pitchers enrolled in an internal rotation stretching program. The American Journal of Sports Medicine, 35(4), 617-621.

Patel, H.A., Arunmozhi, R., & Arfath, U. (2014). Efficacy of Scapular retractor strength training vs thrower's ten programme on performance in recreational overhead athletes-A comparative study. International Journal of Therapies and Rehabilitation Research, 3(1).

Reinold, MM., Gill, TJ., Wilk, KE., & Andrews, JR. (2010). Current concepts in the evaluation and treatment of the shoulder in overhead throwing athletes, part 2: Injury prevention and treatment. Sports Health, 2(2), 101-115.

Seroyer, ST., Nho, SJ., Bach, BR., Bush-Joseph, CA., Nicholson, GP., & Romeo, AA. (2010). The kinetic chain in overhand pitching: Its potential role for performance enhancement and injury prevention. Sports Health, 2(2), 135-146.

Spence, H. (2009). Postural Restoration: An effective physical therapy approach to patient treatment. Techniques in Regional Anesthesia and Pain Management, 12(2), 102-104. Doi: 10.1053/j.trap.2008.01.003

Tenney, HR., Boyle, KL., & DeBord, A. (2013). Influence of hamstring and abdominal muscle activation on a positive Ober's test in people with lumbopelvic pain. Physiotherapy Canada, 65(1), 4-11.

Terry, GC., & Chopp, TM. (2000). Functional anatomy of the shoulder. Journal of Athletic Training, 35(3), 248-255.

Wilk, KE., Yenchak, AJ., Arrigo, CA., & Andrews, JR. (2011). The advanced throwers ten exercise program: A new exercise series for enhanced dynamic shoulder control in the overhead throwing athlete. The Physician and Sportsmedicine, 39(4), 90-97.

Wilk, KE., Obma, P., Simpson II, CD., Cain, EL., Dugas, J., & Andrews, JR. (2009). Shoulder injuries in the overhead athlete. Journal of Orthopaedic and Sports Physical Therapy, 39(2), 38-54.