The Comprehensive Care of the Overhead Athlete

Presented by: Zach Kirkpatrick, PT, MPT, SCS

Introduction

- 7 years of clinical practice in sports medicine and orthopedics
- Graduated from Northern Illinois University in 2011 with a Master's degree in Physical Therapy
- Began Sports Clinical Specialist residency with Evidence in Motion in July of 2015 – completed in March of 2017

Introduction

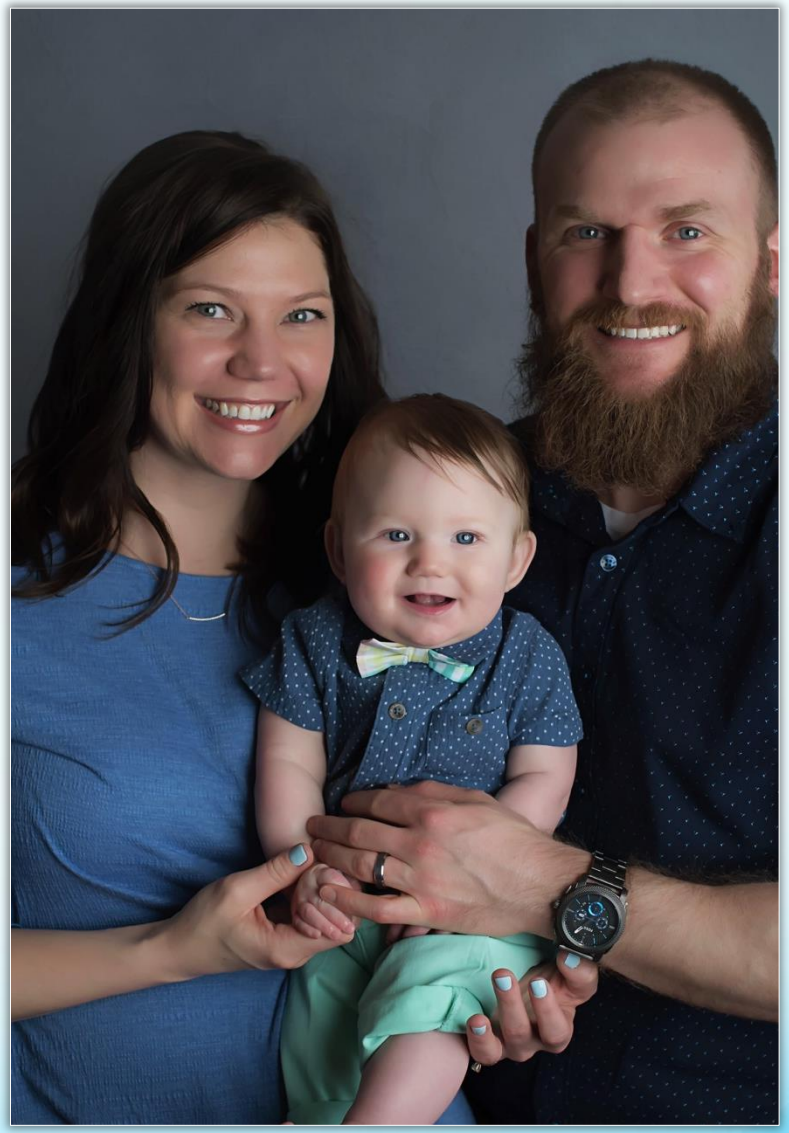
- Certifications and Training
  - Selective Functional Movement Assessment certified
  - Functional Movement Screen Level 1 & 2 certified
  - ASTYM certified
  - Functional Dry Needling Level 1 certified through Kinetacore
  - CrossFit Level 2 trainer
  - USAW Level 1 sports performance coach
  - Blood Flow Restriction trained through B Strong

My Family

My wife Tiffany

My son Knox (15 months old)

Another on the way due in January



Objectives

- Discuss the prevalence of injuries in overhead athletes, especially in baseball
- Provide an overview of the comprehensive evaluation of the overhead athlete
- Discuss the different treatments that can be provided to overhead athletes ranging from various manual therapies to exercise progressions
- Discuss the discharge measures for the overhead athlete

Injury Epidemiology

- Pitchers miss days at a rate 34 times higher than all other players due to elbow injuries[1]
- In 1 season alone for a MLB team in 2010-2011
  - Long head of the biceps tendonitis resulted in 243 days missed[1]
  - Shoulder SLAP and bicep tendon instability in another 88 days missed[1]

Injury Epidemiology

- In Major League Baseball from 1998-2015[3]
  - Shoulder injuries resulted in 26.2% of DL days
  - Arm/Elbow injuries resulted in 28.2% of DL days
  - This totaled 129,800 days missed and 120,739 days for elbows and shoulders respectively
    - Let's puts some money on this
      - $6.7 billion paid to players on the DL
      - $886 million paid to replacement players
      - Totaling – 7.1 billion dollars

Young Injury Epidemiology

- A study found that 5% of young baseball players (9-14 years old) had a “serious” shoulder or elbow injury with in the first 10 years of playing baseball (serious is requiring surgery)[5]

Injury Risk Factors

- 3x greater risk of injury if throwing more than 100 inning/year[4]
- 4x greater risk of injury if you average more than 80 pitches/game[4]
- 5x greater risk if pitching greater than 8 months/yr[4]
- Overuse injuries
  - Pitch more months, games, and pitches/year
  - Pitch more inning, games and warm-ups
- Throwing a baseball is not good for your body
- Forces involved with throwing create forces at 1.5 times the athlete's BW going through the anterior portion of the shoulder – BW going through shoulder with every pitch[2]
- Most players are micro-injured at all times

Differential Diagnosis of Pain in Overhead Athletes[6]

Extrinsic	Intrinsic	Neurovascular
Rotator cuff	Bone	Thoracic outlet syndrome
Tendinitis	Bony Bankart	Neurogenic, arterial, venous
Tear	OCD	Axillary artery
Subacromial impingement	Posttraumatic/ osteoarthritis	Thrombosis, aneurysm
Scapular dysfunction	Bennett's lesion	Effort thrombosis
Scapular dyskinesis	Biceps tendon	Quadrilateral space syndrome
SICK scapula	Tendinitis/tendinopathy	Long thoracic nerve palsy
Snapping scapula	Soft tissue	Suprascapular nerve palsy
Scapulothoracic bursitis	SLAP	Brachial neuritis
Scapular winging	Bankart/anterior instability	
	Posterior labral tear/ posterior instability	
	HAGL	
	MDI	
	GIRD	

Evaluation Process

- Outside of the referring diagnosis based on the physician's evaluation with imaging I'm going to perform a detailed evaluation of the athlete.
- KISS method – I'm going to treat what I find, not dig too deep into it.
- After I find what I'm going to be addressing, I will then educate the athlete on how this can affect their throwing mechanics.

Pathomechanics of Pitching Motion[7]

Phase / Event	Proper Mechanics	Pathomechanics → Consequences
Windup	Lift front leg.	
Maximum knee height 	Pitcher is balanced.	
Stride	Front leg goes down and forward. Arms separate, swing down, and up.	↓ Push off rubber → ↓ Ball velocity[24]
Foot contact 	Front foot is planted slightly to third-base side (for a right-handed pitcher). Front foot is pointed slightly inward. Shoulder is abducted approximately 90°, with approximately 60° of external rotation.	↓ Stride length → ↓ Ball velocity[28] Front foot open (position or angle) → ↑ Shoulder and elbow force[12] Improper shoulder external rotation → ↑ Shoulder and elbow kinetics[12] Excessive shoulder external rotation → ↓ Ball velocity[3,40] ↓ Shoulder horizontal abduction → ↓ Ball velocity[11,36]

Pathomechanics of Pitching Motion[7]

Arm cocking	Pelvis rotation, followed by upper trunk rotation. Shoulder externally rotates, and trunk arches.	Early pelvis rotation → ↓ Ball velocity[35,40] Late pelvis rotation → ↑ Shoulder and elbow kinetics[40] ↓ Pelvis rotation velocity → ↓ Ball velocity[8,40] Poor timing between pelvis rotation and upper trunk rotation → ↓ Ball velocity[23,35] Poor timing between pelvis rotation and upper trunk rotation → ↑ Shoulder internal rotation torque[1]
Maximum external rotation 	Shoulder external rotation is approximately 180°. Elbow flexion is approximately 90°.	↓ Shoulder external rotation → ↓ Ball velocity[8,23,29] Excessive shoulder horizontal adduction and elbow flexion → ↑ Shoulder kinetics[12]
Arm acceleration	Elbow extends, followed by shoulder internal rotation. Front knee extends.	

Pathomechanics of Pitching Motion[7]

Phase / Event	Proper Mechanics	Pathomechanics → Consequences
Ball release 	The throwing shoulder is abducted approximately 90°	↓ Knee extension velocity → ↓ Ball velocity[23] Improper shoulder abduction → ↓ Ball velocity[25] Improper shoulder abduction → ↑ Elbow varus torque[26] ↓ Forward trunk tilt → ↓ Ball velocity[6,9]
Arm deceleration	Shoulder internal rotation and front knee extension continue. Trunk tilts forward.	
Maximum internal rotation 	Shoulder external rotation is approximately 0°.	
Follow through	Arm crosses in front of body. Trunk flexes forward.	

Cause of Pathomechanics

- In my experience these pathomechanics are caused from a multitude of factors
  - Lack of strength
  - Lack of ROM
  - Asymmetries
  - Poor coaching in pitching mechanics

Asymmetries in Pitchers

- A study in 2015 found the 75% of baseball players under the age of 12 had some form of scapular asymmetry[8]
- Of these players, 24% of them had experience some sort of shoulder pain during the season[8]

Scapular position of the throwing side compared with non-throwing side		
Scapular position	number of subjects	percentage
anterior tilt	70	31.4
posterior tilt	63	28.3
superior deviation	60	26.9
inferior deviation	87	39.0
abduction	31	13.9
adduction	52	23.3
upward rotation	50	22.4
downward rotation	72	32.3

Asymmetries in Pitchers

- In a 2014 study, it was found that pitchers had more internal rotation of the stance hip as well as having more external rotation of the stride hip[9]
- Loss of IR of the shoulder was the ROM deficit that had the highest relationship with injury risk
  - Pitchers that had a greater than 20 degree decrease in shoulder IR were more likely to sustain an injury[11]
  - Other findings: a gain in ER ROM, posterior shoulder tightness and loss of total ROM were unrelated to injury risk[11]

Strength Asymmetries in Pitchers

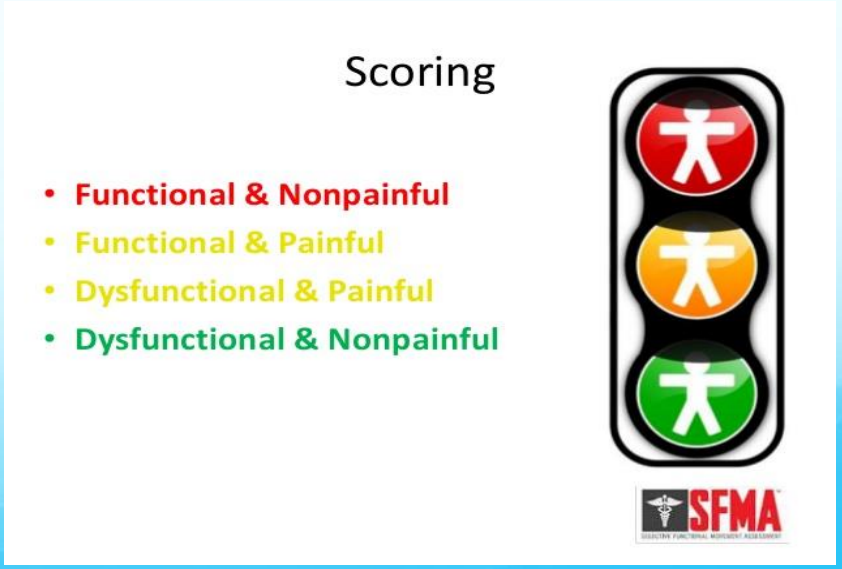
- Youth pitchers also demonstrate excessive contralateral trunk lean which may be associated with an imbalance between oblique muscles on the dominant and nondominant side which can also lead to increased joint loading
  - Youth pitchers typically develop this strategy in order to achieve high velocity[10]
- Strength deficits in dominant and nondominant supraspinatus strength tended to have a increased injury risk[11]

Evaluation of the Overhead Athlete

- Detailed history
  - How many seasons played? What positions?
  - How many innings or pitches throw/game?
  - Factors leading up to the injury?
- Neurological screening
  - Chance to catch TOS
- Breathing
- Strength testing
- Selective Functional Movement Assessment
  - ROM measurements are then taken at this point
- Special Testing
  - Although I track special testing, it does not really change treatment

Selective Functional Movement Assessment

- A comprehensive assessment used to classify movement patterns and discover local biomechanical dysfunctions during the examination which ultimately will direct manual therapy and exercise prescription
- Takes 7 top tier movements and classifies them as functional or dysfunctional and painful or not-painful



Selective Functional Movement Assessment

- Movements that are functional and nonpainful are not broken down
  - There's nothing wrong
- Movements that are dysfunctional and nonpainful are broken down further
  - Something is going on to make movement this way
- Movements that are dysfunctional/painful and functional/painful are broken down lastly and with caution
  - Maybe leading to what is wrong but with SFMA we avoid pain
- By breaking down patterns you find local dysfunctions
- The beauty of SFMA is you can make change by attacking movements that are painful by movement into nonpainful patterns

SFMA Findings

- SFMA Findings are listed at either Mobility Dysfunctions (MD) or Stability Motor Control Dysfunctions (SMCD)
- SMCD's are not just strength issues but also timing and control issues with movement
- Typical findings, in a pitcher
  - Thoracic spine extension/rotation MD
  - Shoulder flexion, IR, ER MD's or SMCD's
  - Hip ER/IR MD's or SMCD's

SFMA Top Tier Movments

Trigger Points and Dry Needling

- Trigger points are thought to be caused by dysfunctional motor endplates[12]
- Leads to a release in acetylocholine at neuromuscular junction resulting in shortened muscle fibers[12]
  - This results in tissue hypoxia – primary cause of increased pain[12]
- Proposed mechanics of DN effectiveness[12]
  - Mechanical stretch due to local twitch response
  - Opens gate of afferent neurons
  - Possible release of opioid-like peptides
  - Change in chemical state following twitch response
  - Improved blood flow to area resulting in improved muscle recovery

Dry Needling

- Trigger point dry needling has been found to be an effective tool at improving not only joint ROM but muscle fiber recruitment as well.
- In a case study in the management of elite volleyball players with anterior shoulder pain, DN was found to be an effective tool.
  - All athletes in the study had immediate decrease in pain as well as improved shoulder ROM[12]
  - Primary muscles that were treated were teres minor and infraspinatus given the eccentric and concentric action with overhead activity
    - Although this study was on volleyball players this can be carried over to baseball

Dry Needling

- Dry needling also appears to improve neuromuscular recruitment of motor units
  - Can be performed on lower trapezius, deltoids
- Can also be used to reduce tension throughout muscles and help to reduce over-recruitment
  - Pectoralis Major
  - Upper Trapezius

Upper Extremity Dry Needling

UE Patterns 1 & 2 afterDry Needling

Instrument Assisted Soft Tissue Mobilization

- I am an ASTYM certified clinician and I have had great success with ASTYM in treating overuse injuries
- A study in 2014 found that IASTM had acute improvement in glenohumeral horizontal abduction and internal rotation ROM following treatment[22]

Joint Mobilizations

- Joint mobilizations are also an effective tool at providing improved mobility in the glenohumeral joint
  - Patients with primary shoulder impingement had better functional outcomes, AROM and decreased pain scores with GH mobilization in anterior, posterior, inferior and LAD compared to the control group who underwent same exercises, stretches and modalities[23]
- Thoracic spine manipulation also has been a valuable tool at reducing shoulder impingement pain
  - Also a study has shown it can result in improved lower trapezius strength following thoracic spine manipulation[24]

Eccentric Strengthening in Injury Prevention

- Eccentric strength training of the external rotators resulted in no loss of strength in internal rotation concentric strength, but also helped reduce injury in female collegiate tennis players[13]
- Focusing on eccentrics can help muscles by changing to optimal muscle length[14]
- Eccentric help to strengthen the muscle-tendon system which helps to dissipate energy used in muscles[14]
- Most importantly helped to decelerate the forces through the shoulder at ball release[14]

Exercises After Mobilizations

- After performing manipulations or mobilizations I then prescribe exercise to reinforce this new found motion
- First with movement based exercises
- Followed by loaded exercises

Sidelying Thoracic Rotation

Downward Dog

Barbell Overhead Opener

Quadruped Thoracic Rotation with Assistance and with Resistance

Kettlebell Arm Bars

Double Kettlebell Front Rack Walk

Waiter’s Carry

Waiter's/Farmer's Carry

Exercises to Focus on for Overhead Athletes[15,16]

- Based on the information for the study performed by Mike Reinold, PT, ATC and Kevin Wilk, PT in 2009
- Performed EMG studies on common glenohumeral and scapulothoracic muscles based on anatomical, biomechanics and clinical implications

TABLE

Recommended Exercises for Glenohumeral and Scapulothoracic Muscles Based on Anatomical, Biomechanical, and Clinical Implications

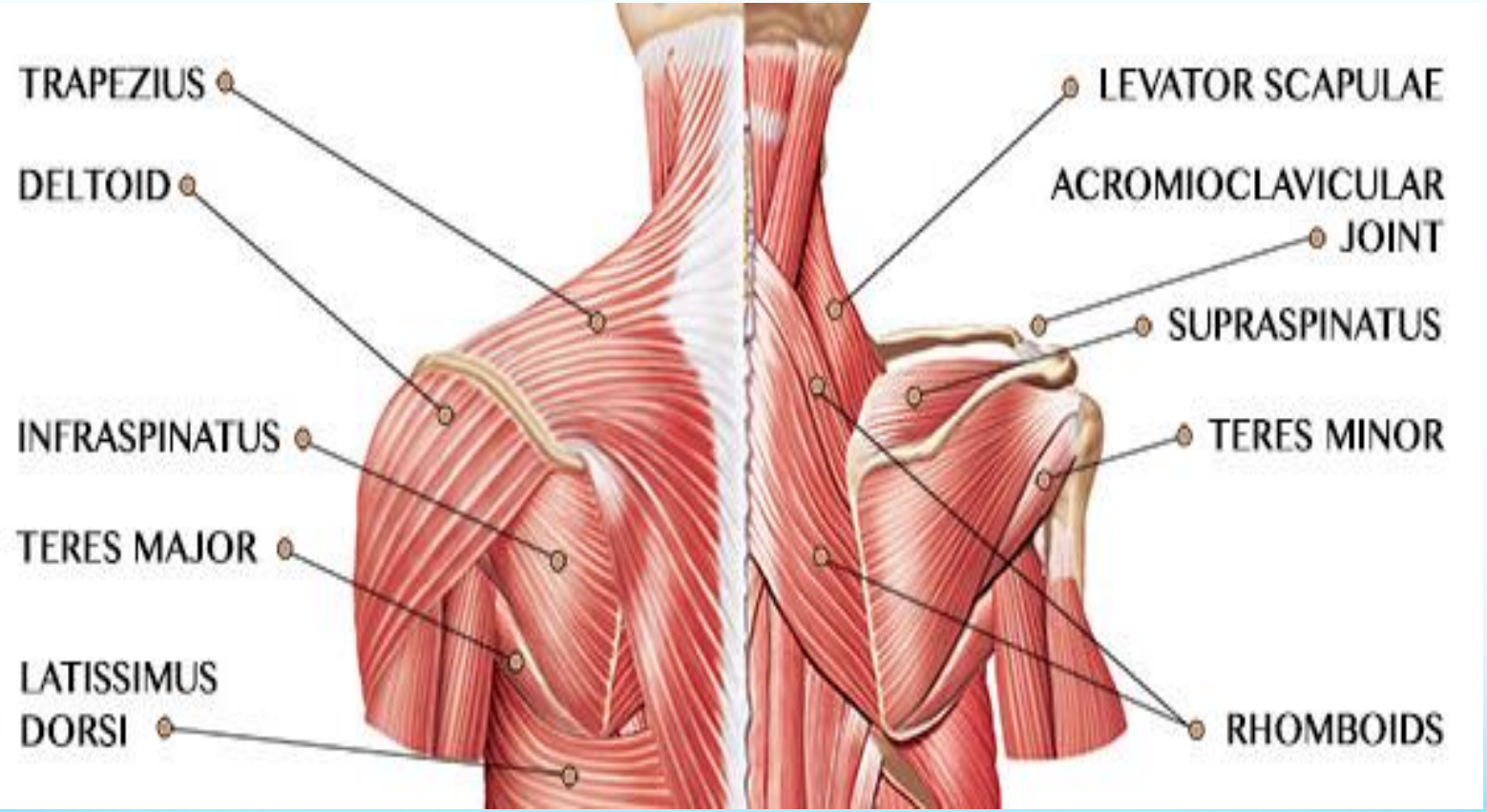
Muscle	Exercise	Anatomical Implications	Biomechanical Implications	Clinical Implications
Supraspinatus	1. Full can	1. Enhances scapular position and subacromial space	1. Decreased deltoid involvement compared to empty can	1. Minimizes chance of superior humeral head migration by deltoid overpowering supraspinatus
	2. Prone full can	2. Enhances scapular position and subacromial space	2. High posterior deltoid activity with similar supraspinatus activity	2. High supraspinatus activity and also good exercise for lower trapezius
Infraspinatus and teres minor	1. Side-lying ER	1. Position of shoulder stability, minimal capsular strain	1. Increased moment arm of muscle at 0° abduction. Greatest EMG activity	1. Most effective exercise in recruiting infraspinatus activity. Good when cautious with static stability
	2. Prone ER at 90° abduction	2. Challenging position for stability, higher capsular strain	2. High EMG activity	2. Strengthens in a challenging position for shoulder stability. Also good exercise for lower trapezius
	3. ER with towel roll	3. Allows for proper form without compensation	3. Increased EMG activity with addition of towel, also incorporates adductors	3. Enhances muscle recruitment and synergy with adductors
Subscapularis	1. IR at 0° abduction	1. Position of shoulder stability	1. Similar subscapularis activity between 0° and 90° abduction	1. Effective exercise, good when cautious with static stability
	2. IR at 90° abduction	2. Position of shoulder instability	2. Enhances scapular position and subacromial space. Less pectoralis activity	2. Strengthens in a challenging position for shoulder stability
	3. IR diagonal exercise	3. Replicates more functional activity	3. High EMG activity	3. Effective strengthening in a functional movement pattern
Serratus anterior	1. Push-up with plus	1. Easy position to produce resistance against protraction	1. High EMG activity	1. Effective exercise to provide resistance against protraction, also good exercise for subscapularis
	2. Dynamic hug	2. Performed below 90° abduction	2. High EMG activity	2. Easily perform in patients with difficulty elevating arms or performing push-up. Also good exercise for subscapularis
	3. Serratus punch 120°	3. Combines protraction with upward rotation	3. High EMG activity	3. Good dynamic activity to combine upward rotation and protraction function

Lower trapezius	1. Prone full can	1. Can properly align exercise with muscle fibers	1. High EMG activity	1. Effective exercise, also good exercise for supraspinatus
	2. Prone ER at 90° abduction	2. Prone exercise below 90° abduction	2. High EMG activity	2. Effective exercise, also good exercise for infraspinatus and teres minor
	3. Prone horizontal abduction at 90° abduction with ER	3. Prone exercise below 90° abduction	3. Good ratio of lower to upper trapezius activity	3. Effective exercise, also good exercise for middle trapezius
	4. Bilateral ER	4. Scapular control without arm elevation	4. Good ratio of lower to upper trapezius activity	4. Effective exercise, also good for infraspinatus and teres minor
Middle trapezius	1. Prone row	1. Prone exercise below 90° abduction	1. High EMG activity	1. Effective exercise, good ratios of upper, middle, and lower trapezius activity
	2. Prone horizontal abduction at 90° abduction with ER	2. Prone exercise below 90° abduction	2. High EMG activity	2. Effective exercise, also good exercise for lower trapezius
Upper trapezius	1. Shrug	1. Scapular control without arm elevation	1. High EMG activity	1. Effective exercise
	2. Prone row	2. Prone exercise below 90° abduction	2. High EMG activity	2. Good ratios of upper, middle, and lower trapezius activity
	3. Prone horizontal abduction at 90° abduction with ER	3. Prone exercise below 90° abduction	3. High EMG activity	3. Effective exercise, also good exercise for lower trapezius
Rhomboids and levator scapulae	1. Prone row	1. Prone exercise below 90° abduction	1. High EMG activity	1. Effective exercise, good ratios of upper, middle, and lower trapezius activity
	2. Prone horizontal abduction at 90° abduction with ER	2. Prone exercise below 90° abduction	2. High EMG activity	2. Effective exercise, also good for lower and middle trapezius
	3. Prone extension with ER	3. Prone exercise below 90° abduction	3. High EMG activity	3. Effective exercise, unique movement to enhance scapular control

Progressions of Common Shoulder Exercises

- 3x10 with 10-30” hold at end of final rep
- Add rhythmic stabilization at varying rep schemes
  - Every 5 to 10 reps
  - Every other rep?
- Perform sidelying exercises in side plank position
- Remember our athlete’s do not live in a 3x10 world
  - Always change it up
    - Add holds, more reps

Shoulder Priming Exercises



Quadruped Reach, Rotate, Lift

Prone Shoulder Angels

Prone Swimmers

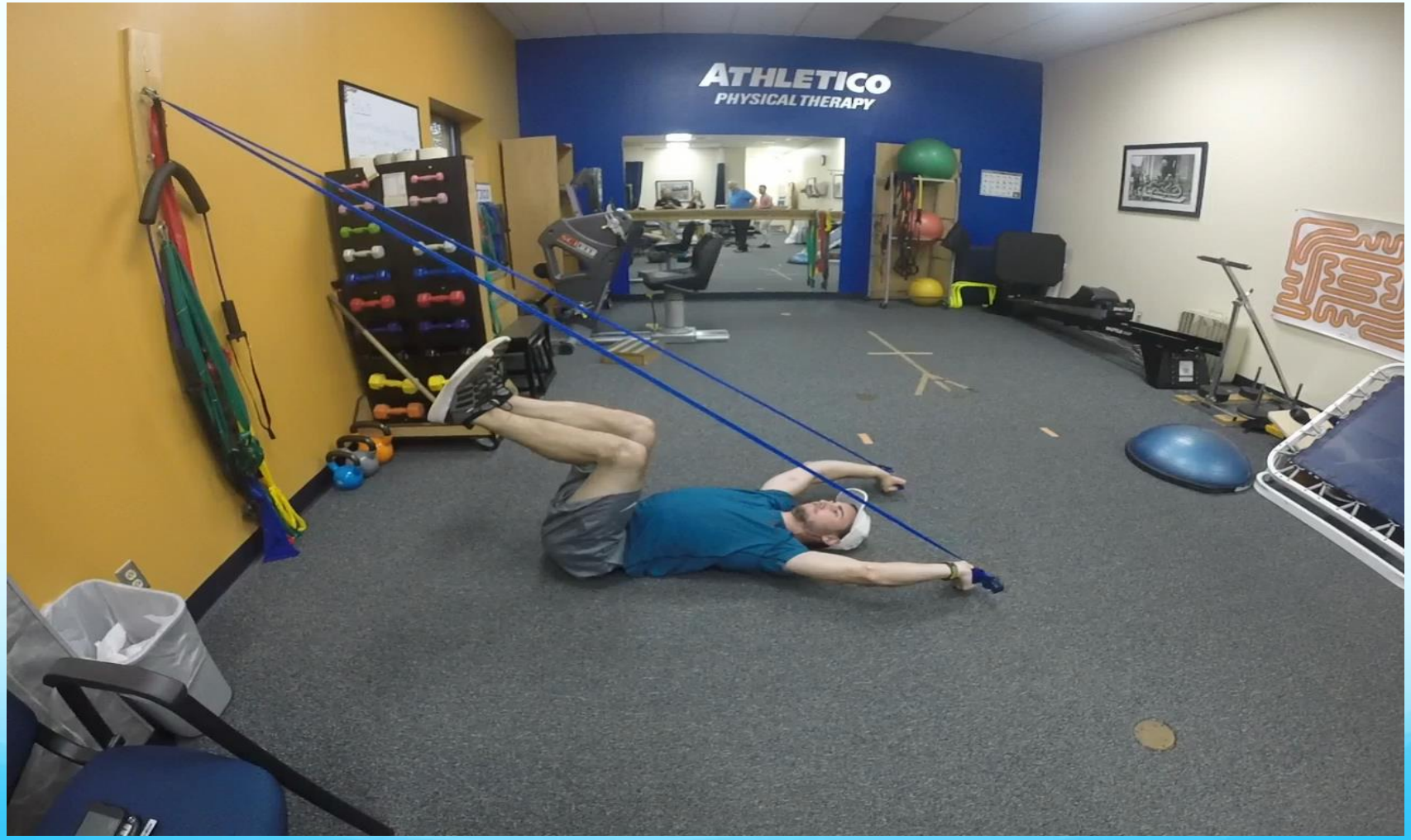
Sidelying Shoulder External Rotation in Side Plank

Sidelying Shoulder Abduction with Rhythmic Stabilization
(3x10-15 w/ RS every 5th rep)

Sidelying Shoulder Flexion with Hold (3x10-15 w/ 10” hold every 5th)

Posterior Shoulder Trio (3xME)

90/90 Shoulder Raises (3x20, maintain flat lumbar)



Half Turkish Get Up (x10-15 each side)

Lower Extremity Strength in Overhead Throwing

- At this point it is clear how important it is to incorporate the lower extremities into throwing in order to transfer more power into the ball without injuring the rotator cuff
- A study found that the gastrocnemius, vastus medialis, rectus femoris, gluteus maximus and biceps femoris EMG activity increases throughout the throwing motion[17]
- Moderate to high EMG activity was noted in the trail leg at maximum stride leg knee height to stride foot contact (SFC) and in the stride leg at max stride knee height through ball release[17]

Lower Extremity Strength in Overhead Throwing

- This high level of EMG activity is due to the shear force created while throwing a baseball[18]
  - Shear forces at .35 body weight is created in the direction of the pitch on the push off leg
  - Shear forces at .72 body weight is created on the stride leg

Cross Training

- This is how I get my overhead athletes to learn how to transfer power from their legs through their torso
- A study found that strength training in combination with plyometrics resulted in the greatest percent change in 20, 40, 60 yard dash, vertical jump, standing broad jump and T-agility drill compared to heavy resistance or plyometric training[19]
- Whereas plyometric training only saw the greatest change in vertical jump compared to heavy resistance and cross training[19]
- Cross Training consisted of squats, lunges, split squats with plyometric exercise of box jumps, depth jumps and split squat jumps

Plyometrics
Drop Jumps

Plyometrics
Lateral Drop Jumps

Plyometrics
Medicine Ball Slams

Plyometrics
Rotational Medicine Ball Slams

Plyometrics
Step Back MB Shot Put

Upper Extremity Plyometrics
BUE Overhead Dribble

Upper Extremity Plyometrics Single Arm 90/90 ER Dribbles

Upper Extremity Plyometrics
Single Arm 90/90 IR Dribbles

Blood Flow Restriction Training

- Vascular affects of BFR
  - Restrict, impede, and make venous outflow more pulsatile
  - Engorge capillaries distal to BFR cuff
  - Maintain arterial inflow
  - Evidence of angiogenic stimulation from BFR – can make new/better blood vessels
- Easy exercise w/ BFR – Disturbance of Homeostasis
  - Decreased pO2, pH, PC/ATP
  - Increase Lactate
  - Together changes produce metabolic crisis
  - As early motor unit fatigue, faster and bigger units must take over the work
- Systemic Neuro-Immuno-Homoral anabolic response
  - The systemic response amplifies the local anabolic response
  - Because little damage was done, increases in strength and fitness come quickly
  - All tissues involved in the exercise, proximal and distal to the BFR enjoy the anabolic action

Benefits of Blood Flow Restriction Training

- Increase in cross sectional area and strength of the muscle proximal and distal to the BFR cuffs[20]
- There is also research to show increase in intramuscular EMG in muscles both proximal and distal to the BFR cuffs[21]
- In my practice I have used the B Strong BFR cuffs not only with conventional shoulder and leg exercises but also with all the previously mention plyometric exercises

Where do we go from here?

- Once we have addressed asymmetries by improving hypomobilities, neuromuscular control and overall strength, how do we truly know when the athlete is ready to return to sport?
- Are they progressing well through their return to throwing protocol?
- What other functional tests and measures can be used to determine readiness for return to sport?

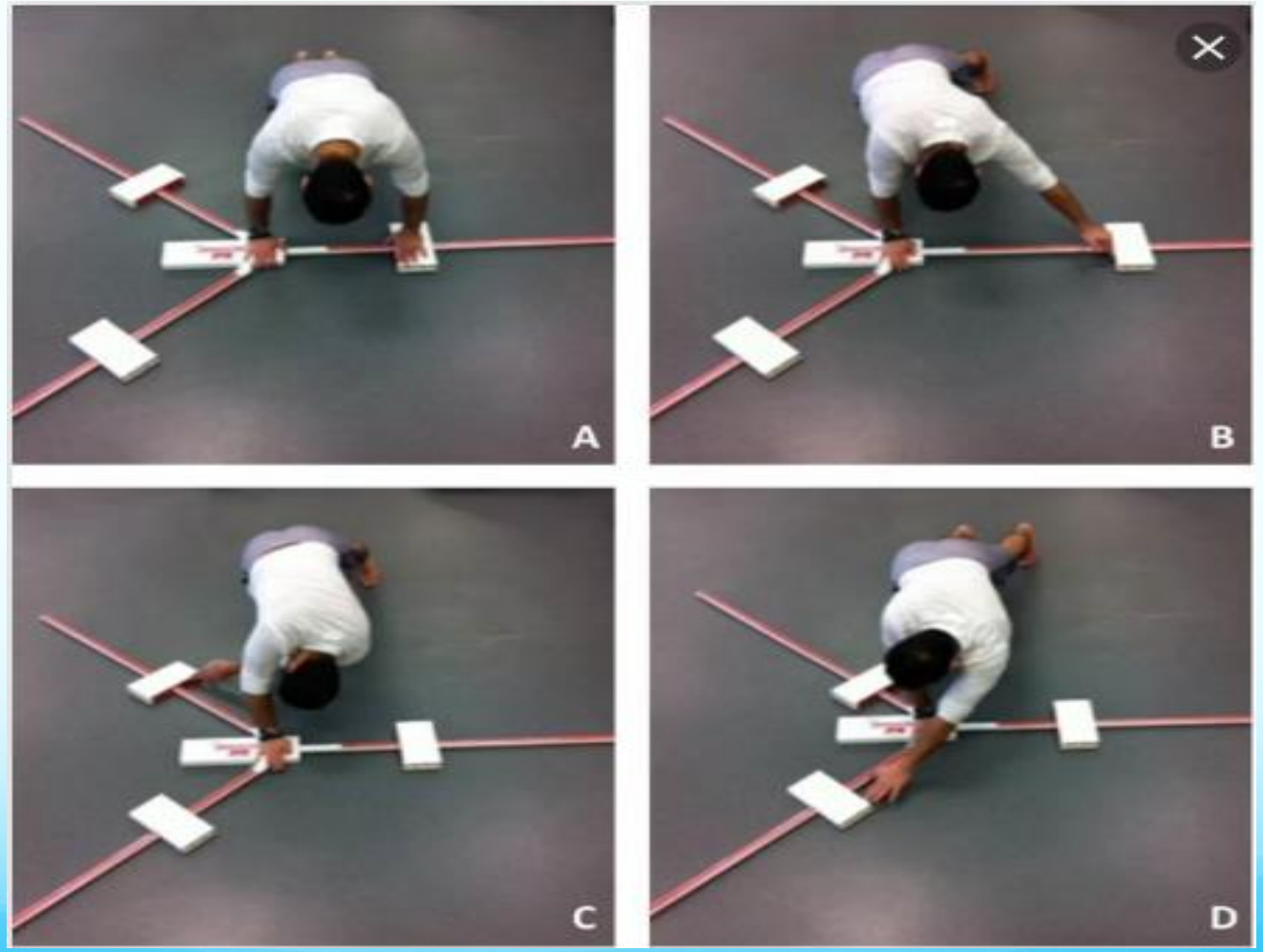
Upper Extremity Y-Balance Test

- Similar testing to the LE-YBT however much more difficult
- Scoring is the same as the LE-YBT

Medial+Inferolateral+Superolateral/Arm Length x3

- I prefer to have my athletes within 90% of the unaffected arm
- Research found there is a significant difference in positions however was found to be useful information for goals and functional discharge measure[25]

Upper Extremity Y-Balance Test



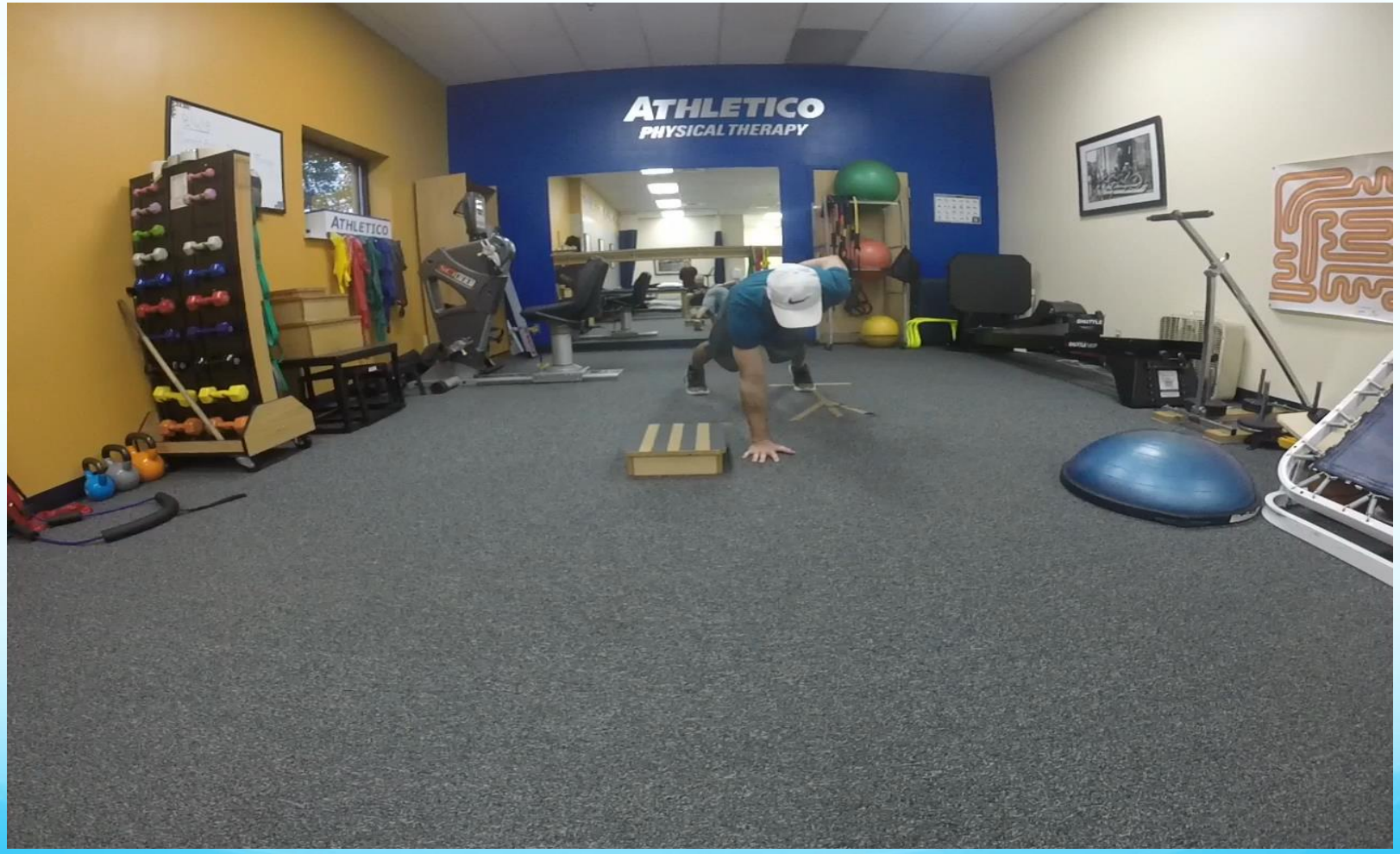
Upper Extremity Y-Balance Test

One Arm Hop Test

- Good functional performance test to compare right arm vs. left arm
- Athlete begin in a single arm push up position next to a 10.2 cm box and perform 5 single arm hops from box to floor for time.
- Research on collegiate football players and wrestlers found this test was a reliable functional performance test to assess injured arm vs. unaffected contralateral arm[26]

One Arm Hop Test

One Arm Hop Test



Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST)[25]

- Athlete is in a plank position with the hands on pieces of tape that are 36 inches apart
- Athlete is then instructed to reach to the opposite side with one hand and repeat with the other
- Number of touches in 15 seconds is counted and then is given 45 seconds of rest for 3 trials
- In a study no significant difference was found in collegiate baseball players however was found to be a good measure of strength for goals

Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST)[25]

Final Remarks

- In my opinion, it is best practice to look at the athlete through the entire kinetic chain which can be performed by having the patient begin with functional movements
- Based on what the movement screen shows, the best treatment plan can be developed
- Once the athlete is demonstrating competence with exercises and progression, functional testing can be performed in order to assess readiness for return to sport.
- Don’t forget – athletes do not live in a 3x10 world, switch it up, add holds, rhythmic stabilization and place them in challenging positions

THANK YOU!!

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