UPPER EXTREMITY RETURN TO PLAY: PROGRESSIONS AND OBJECTIVE ASSESSMENTS FOR DECISION MAKING

Cassie Endsley PT, DPT, SCS, CSCS

APTA MN Spring Conference 2024

TODAY'S GOALS

- Review common upper extremity injuries
- Identify ways to bridge the gap between common rehab exercises and return to play
- Discuss objective tests and measures for the upper extremity
  - Make individualized decisions on which tests to include based upon the demands of the sport
- Apply the above information to case studies

COMMON SPORTS RELATED UPPER EXTREMITY INJURIES

POST-OPERATIVE

- Shoulder
  - Rotator Cuff Tear
  - SLAP/Labral Tear
  - Instability
- Elbow
  - UCL Reconstruction

NON-OPERATIVE

- Shoulder
  - Subacromial Pain
  - Instability
  - Posterior Impingement
  - Tendinopathy
    - RTC/Biceps

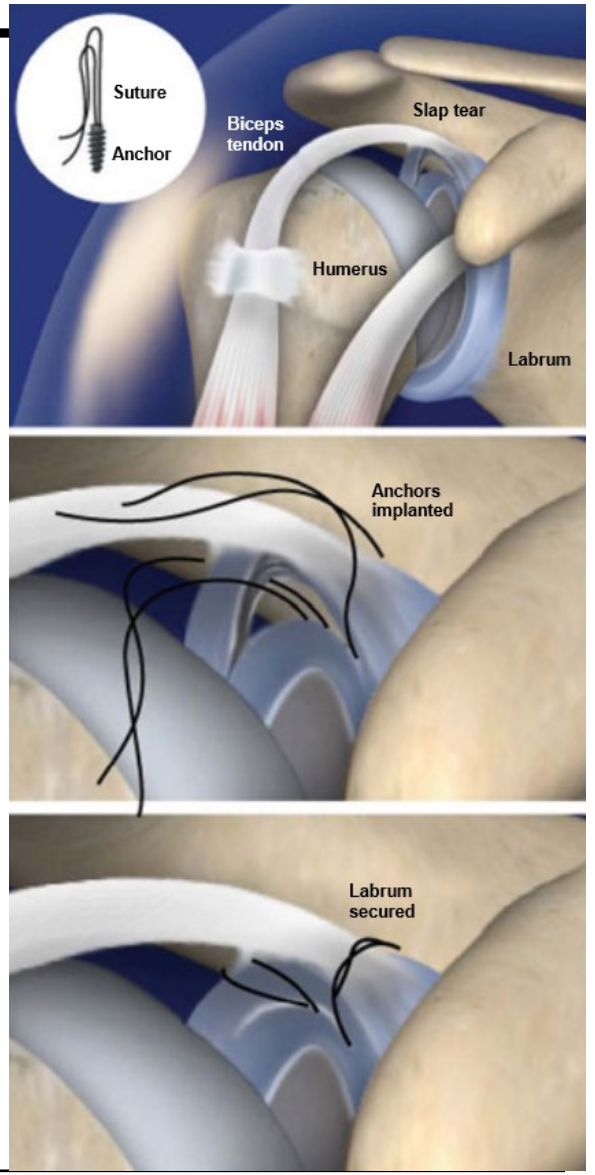
UCL RECONSTRUCTION

- Return to play:
  - MLB pitchers 80-97%
    - Avg 12 months
- Return to SAME Play
  - 67-87%
    - Avg 15 months
- Considerations:
  - Elbow Valgus Loads
  - ROM

Thomas SJ, Paul RW, Rosen AB, et al. Return-to-Play and Competitive Outcomes After Ulnar Collateral Ligament Reconstruction Among Baseball Players: A Systematic Review. *Orthop J Sports Med*. 2020;8(12):2325967120966310. Published 2020 Dec 28. doi:10.1177/2325967120966310 (UCL)

SLAP REPAIR

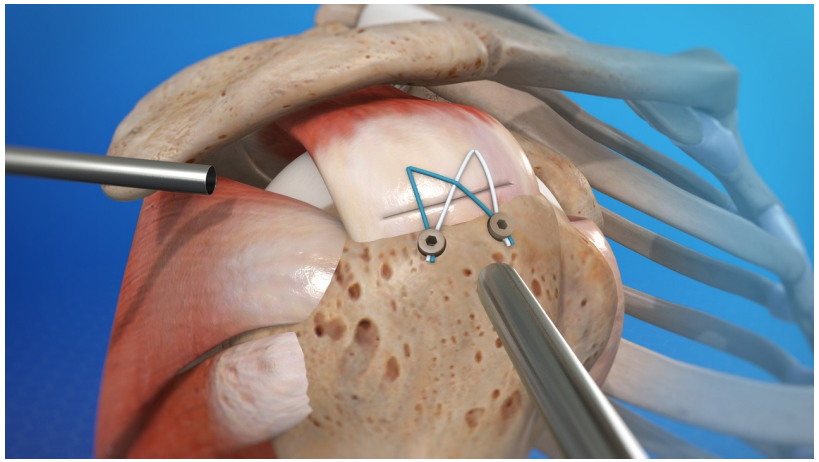
- Return to Play:
  - 69% Return
    - Avg 6 months
    - Pitchers 57%
    - Other Athletes 87%
- Considerations:
  - Biceps Involvement

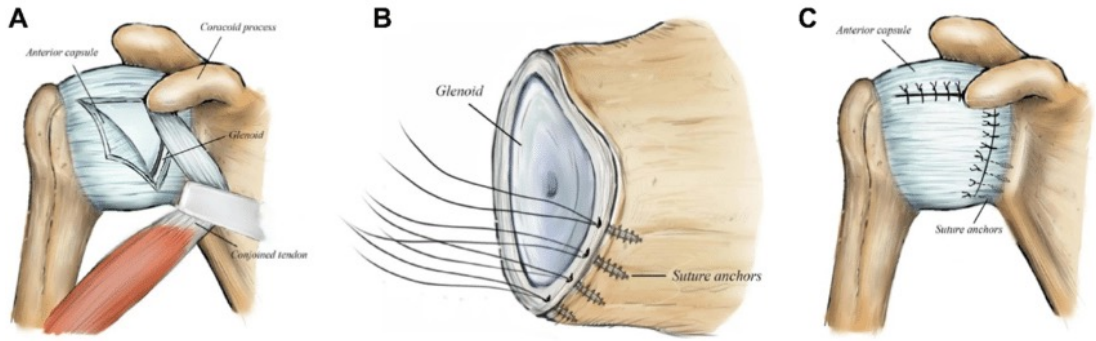


Thayaparan A, Yu J, Horner NS, Leroux T, Alolabi B, Khan M. Return to Sport After Arthroscopic Superior Labral Anterior-Posterior Repair: A Systematic Review. *Sports Health*. 2019;11(6):520-527. doi:10.1177/1941738119873892 (SLAP)

ROTATOR CUFF REPAIR & SHOULDER STABILIZATION

- Return to Sport
  - 67% Return
    - Avg 6 months
- Considerations:
  - Range of Motion
  - Loading repaired tendons





Griffith R, Fretes N, Bolia IK, et al. Return-to-Sport Criteria After Upper Extremity Surgery in Athletes-A Scoping Review, Part 1: Rotator Cuff and Shoulder Stabilization Procedures. *Orthop J Sports Med*. 2021;9(8):23259671211021827. Published 2021 Aug 6. doi:10.1177/23259671211021827 (RTC, SSS)

RISK FACTORS FOR UE INJURY

- Early Sport Specialization
- Load Management
- Non-Compliance with Injury Prevention Programs
- Hip ROM asymmetries (elbow)
- Decreased lower extremity balance/Neuromuscular control

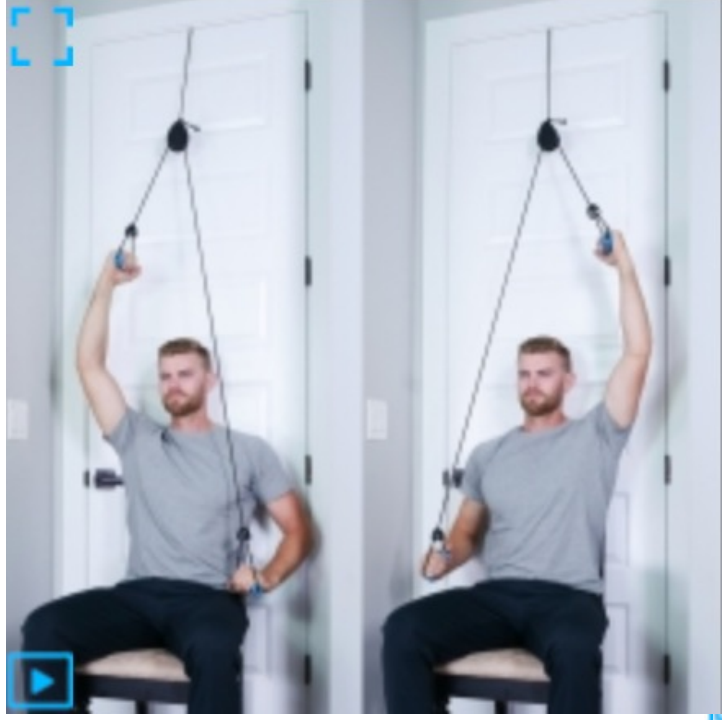
- Mixed evidence on Shoulder ROM
  - ER Gain
  - IR Loss
  - Total Arc of Motion

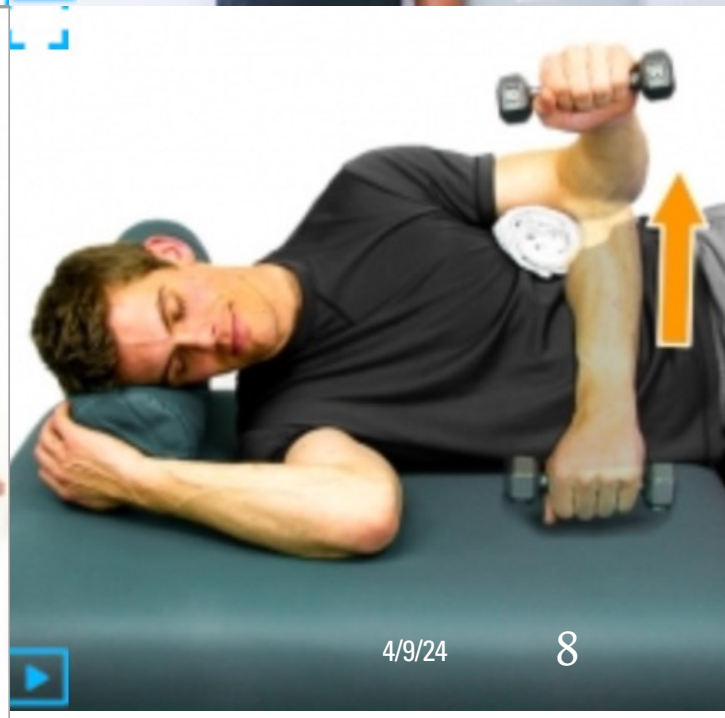
Deal MJ, Richey BP, Pumilia CA, et al. Regional Interdependence and the Role of the Lower Body in Elbow Injury in Baseball Players: A Systematic Review. *Am J Sports Med*. 2020;48(14):3652-3660.

EARLY REHAB

- Restore ROM
- Initiate & progress muscle performance
- Protect the surgical tissue

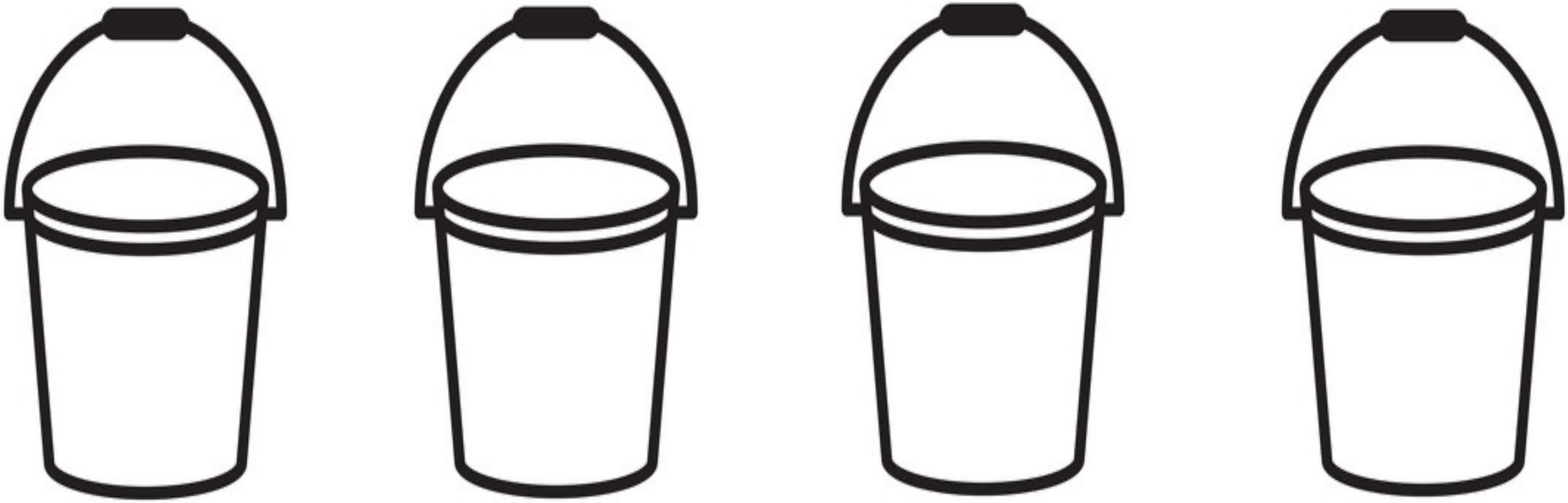
- Non-Operative
  - What can we do to decrease pain initially?





REHAB
PERFORMANCE , PRACTICE, PLAY

- Progressing along the blended continuum



Traditional Rehab

Performance

Practice

Play

PERFORMANCE (REHAB+)

- What will the patient need to be successful?
- What are the biomechanical demands?
- How can we train with respect to the healing tissue?
- What has their training looked like in the past?

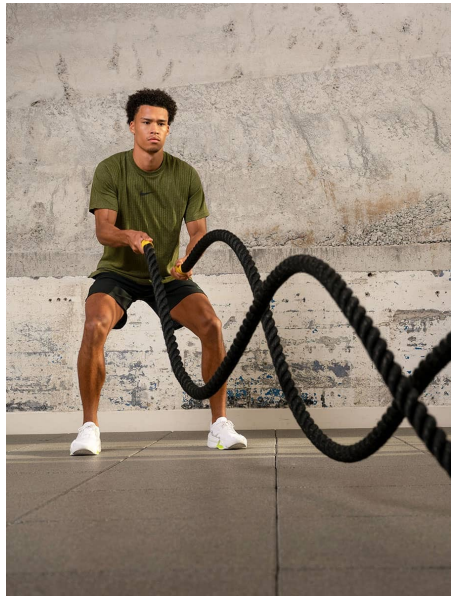
UE REHAB PROGRESSIONS –

- What do they need to do well?
  - Open Chain? Closed Chain? Both?
  - Stability, Endurance, Strength, Power?
  - In what ROM?

UE REHAB PROGRESSIONS – REGIONAL INTERDEPENDENCE

- Can we efficiently transmit forces from the ground through the UE?
- Can we absorb load through the kinetic chain?

PROGRESSIONS



PROGRESSION EXAMPLES

PROGRESSION EXAMPLES

PRACTICE


I'M TALKING ABOUT PRACTICE!
AND YOU CAN'T DO IT 'CAUSE
YOU'RE HURT.

PRACTICE CONSIDERATIONS

- What modifications can be made?
  - Volume counts
  - Predictive versus Reactionary
  - Drills versus Scrimmage

- Communication is Essential
  - Coaches, ATs
  - What is expected of them in specific drills?

INTERVAL THROWING PROGRAMS

Interval Throwing Program for Baseball Players: Phase I

45' Phase

Step 1:
A) Warm-up Throwing
B) 45' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 45' (25 Throws)

Step 2:
A) Warm-up Throwing
B) 45' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 45' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 45' (25 Throws)

60' Phase

Step 3:
A) Warm-up Throwing
B) 60'(25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 60' (25Throws)

Step 4:
A) Warm-up Throwing
B) 60' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 60' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 60' (25 Throws)

90' Phase

Step 5:
A) Warm-up Throwing
B) 90' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 90' (25 Throws)

Step 6:
A) Warm-up Throwing
B) 90' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 90' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 90' (25 Throws)

120' Phase

Step 7:
A) Warm-up Throwing
B) 120' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 120' (25 Throws)

Step 8:
A) Warm-up Throwing
B) 120' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 120' (25 Throws)
F) Rest 5-10 min.
G) Warm-up throwing
H) 120' (25 Throws)

150' Phase

Step 9:
A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 150' (25 Throws)

Step 10:
A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 150' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 150' (25 Throws)

180' Phase

Step 11:
A) Warm-up Throwing
B) 180' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)

Step 12:
A) Warm-up Throwing
B) 180' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 180' (25 Throws)

Step 13:
A) Warm-up Throwing
B) 180' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 180' (20 Throws)
I) Rest 5-10 min.
J) Warm-up Throwing
K) 15 throws progressing from 120 → 90'

Step 14: Return to respective position or progress to step 14 below.

All throws should be on an arc with a crow-hop

Warm-up throws consist of 10-20 throws at approximately 30 feet

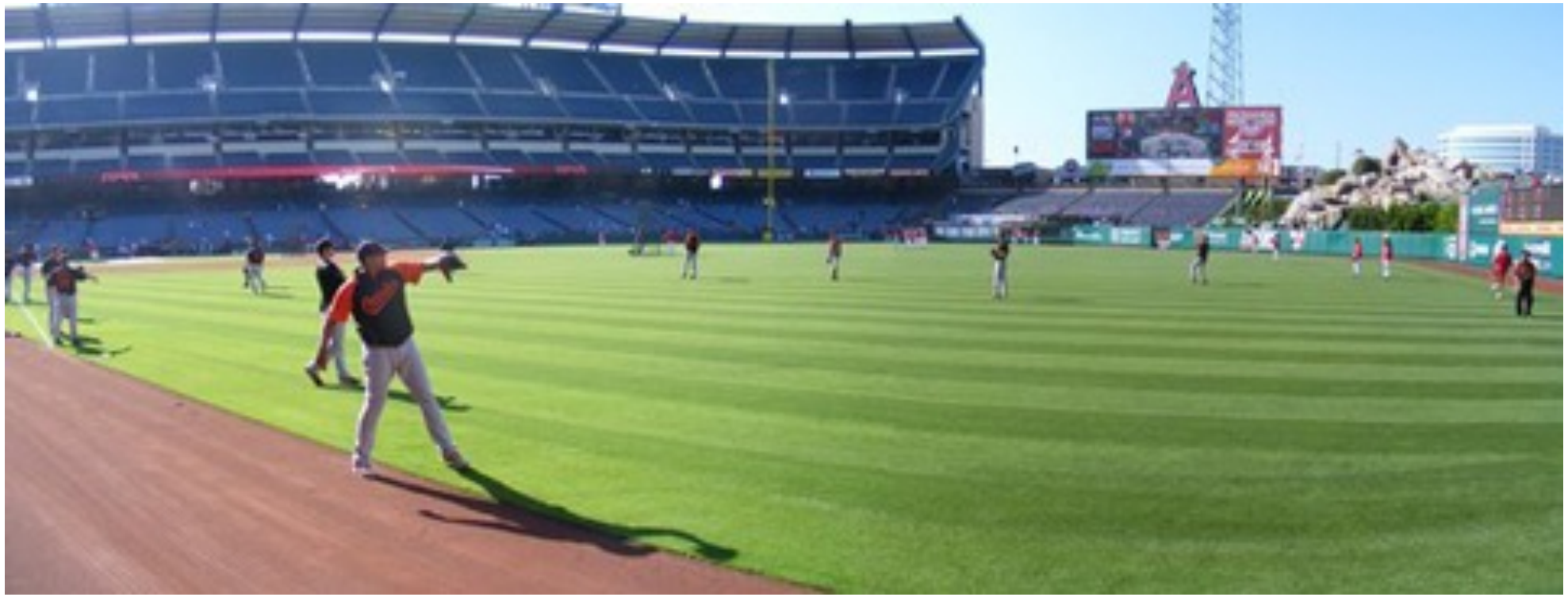
Throwing Program should be performed every other day, 3 times per week unless otherwise specified by your physician or rehabilitation specialist.

Perform each step _____ times before progressing to next step.

Flat Ground Throwing for Baseball Pitchers

Step 14:
A) Warm-up Throwing
B) Throw 60 ft. (10-15 throws)
C) Throw 90 ft. (10 throws)
D) Throw 120 ft. (10 throws)
E) Throw 60 ft. (flat ground) using pitching mechanics (20-30 throws)

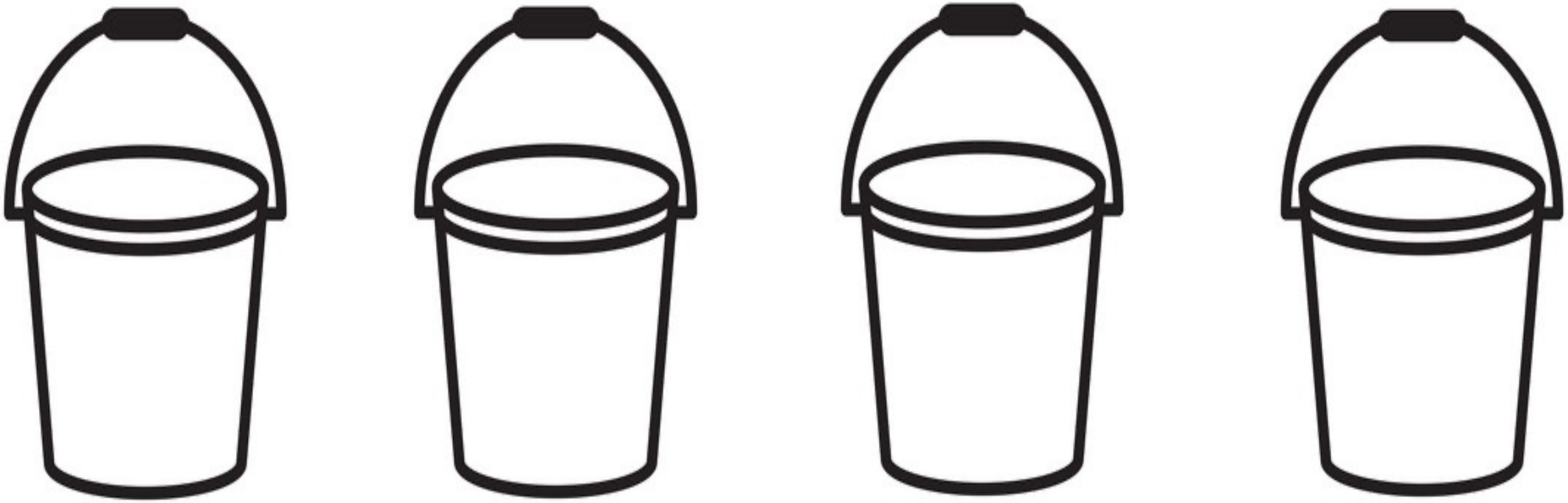
Step 15:
A) Warm-up Throwing
B) Throw 60 ft. (10-15 throws)
C) Throw 90 ft. (10 throws)
D) Throw 120 ft. (10 throws)
E) Throw 60 ft. (flat ground) using pitching mechanics (20-30 throws)
F) Throw 60-90 ft. (10-15 throws)
G) Throw 60 ft. (flat ground) using pitching mechanics (20 throws)



CONSIDERATIONS

- Very Black and White
- How do we monitor intensity?
- Can we make these more individualized?
  - Positional Demands
  - Previous Throwing Drills

RETURN TO PLAY



Traditional Rehab

Performance

Practice

Play

HOW DO WE KNOW IF SOMEONE IS READY?

DECISION MAKING - EVIDENCE BASED CHALLENGES

- Research is Very limited in the UE RTP Space
  - UE Biomechanical Demands Vary
  - LE Biomechanical Demands are more consistent across sporting activities

2023 DELPHI STUDY ON UE RTP

Background: Limited evidence for RTP Test Batteries

1 Case-Series & Clinical Commentaries

Purpose: Develop consensus among experts (52)

Consensus Reached:

Important to use a Functional Testing Algorithm

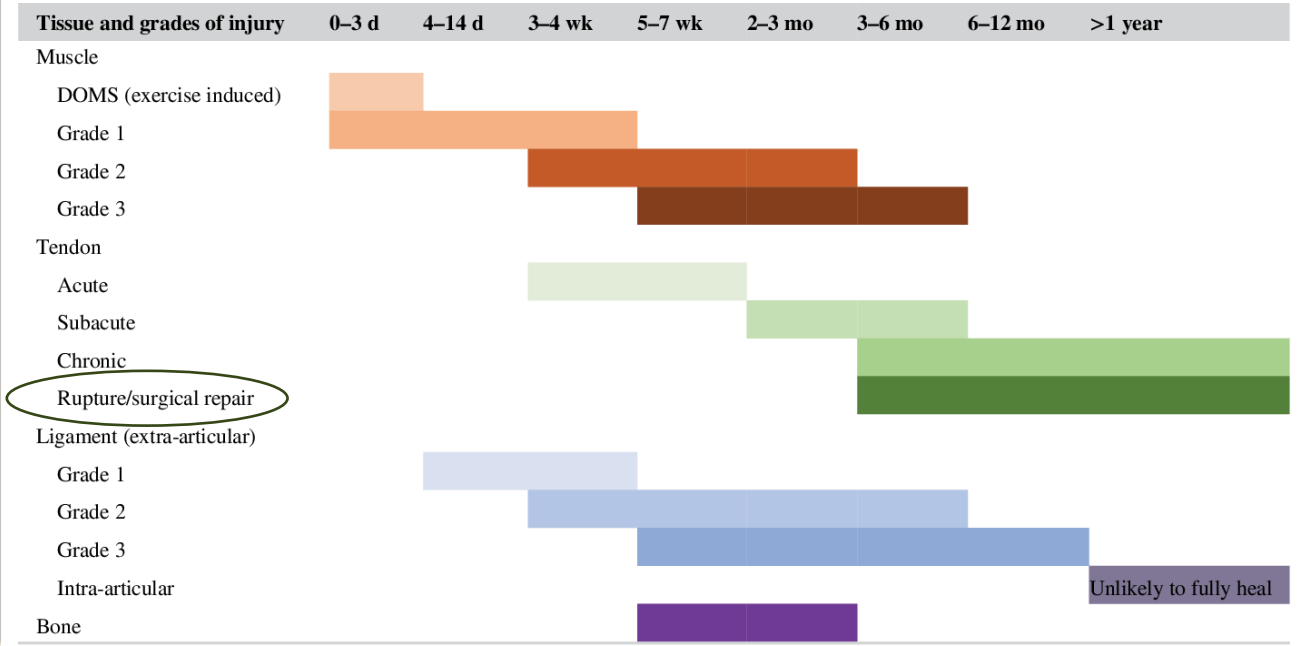
- Create Algorithm Based on Biomechanical Demands
- Tissue Healing Timeframes
- Pain Assessment
- Patient Reported Outcomes
- Strength Assessment
- Physical Performance Tests

Barber P, Pontillo M, Bellm E, Davies G. Objective and subjective measures to guide upper extremity return to sport testing: A modified Delphi survey. *Phys Ther Sport*. 2023;62:17-24.
Pontillo M, Sennett BJ, Bellm E. Use of an upper extremity functional testing algorithm to determine return to play readiness in collegiate football players: A case series. *Int J Sports Phys Ther*. 2020;15(6):1141-1150.

TISSUE HEALING TIMELINES

	0–3 days	4–14 days	3–4 wk	5–7 wk	2–3 mo	3–6 mo	6 mo–1 yr	2 yr
Tendon								
Tendinitis								
Rupture								
Muscle								
Exercise induced								
Grade I								
Grade II								
Grade III								
Ligament								
Grade I								
Grade II								
Grade III								
Lig. graft								
Bone								

FIGURE 3-1 Tissue-healing time line.

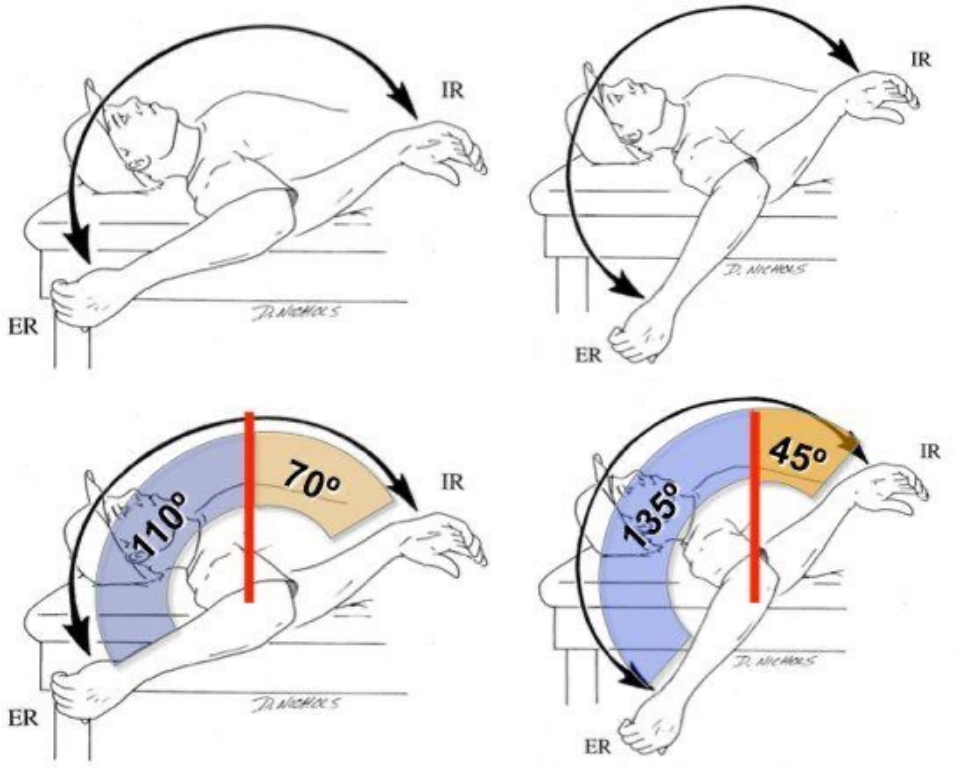


PATIENT REPORTED OUTCOME MEASURES

- Disabilities of Arm, Shoulder, and Hand (DASH)
  - Ceiling Effect
- Kerlan Jobe Orthopaedic Clinic Questionnaire
  - No reported ceiling

RANGE OF MOTION

- OKC Athletes
  - Total ROM (IR+ER) within 5 deg of contralateral side
- CKC Athletes
  - Determine based on sport specific demands, injury pathology/severity
- Shoulder stabilization procedures - considerations



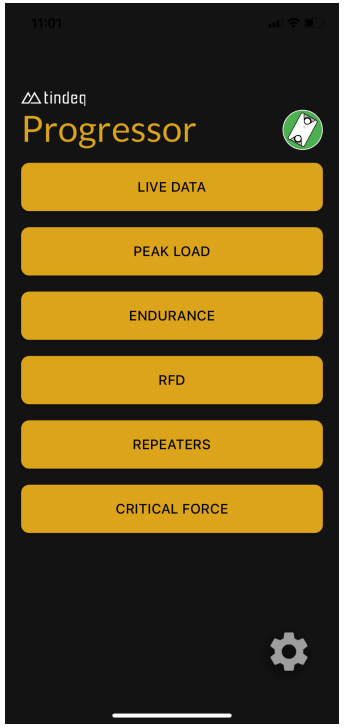
Wilk KE, Macrina LC, Arrigo C. Passive range of motion characteristics in the overhead baseball pitcher and their implications for rehabilitation. *Clin Orthop Rel Res*. 2012;470(6):1586–159

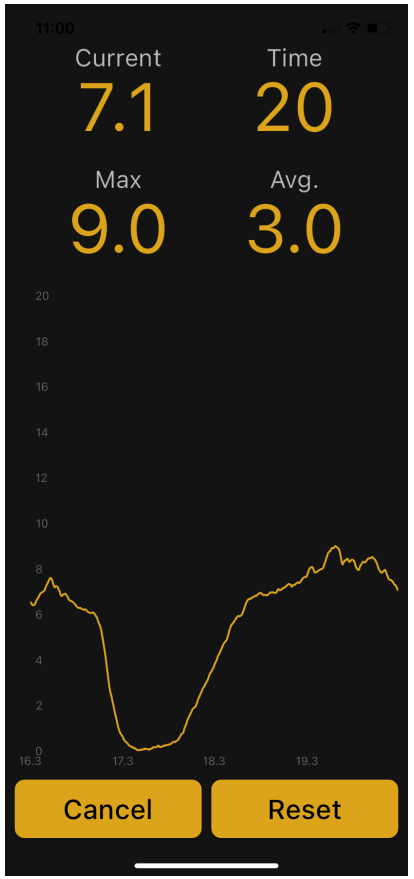
STRENGTH TESTING

- MMT?
- Hand-Held Dynamometer
  - Best if you can stabilize it against something!
- Inline Dynamometer
- Combination of
  - ER:IR Ratio (75%)
  - Absolute Strength Values – Compare to Available Norms
  - LSI (Dominant Arm 10% Stronger)

SIDE TRACK: IN-LINE DYNAMOMETER

- Crane Scale
- Tindeq




11:00
Current
7.1
Time
20
Max
9.0
Avg.
3.0
20
18
16
14
12
10
8
6
4
2
0
16.3
17.3
18.3
19.3
Cancel
Reset


VORCOOL

- Ankle Strap

HHD SET UPS – IR/ER

INLINE DYNAMOMETER SET UPS




PHYSICAL PERFORMANCE TESTS

No Consensus Reached

Top 3 Agreements: "_____ is an important test for readiness":
1. CKCUEST (82%), 2. LE/Core Tests (82%), 3. Seated Shot Put Test (71%)

OKC Top

1. Seated Shot-Put Test
2. Prone T Ball Drop Test
3. LE/Core Tests
4. CKCUEST
5. Push-Up Test
6. UQ Y-Balance Test

CKC Top

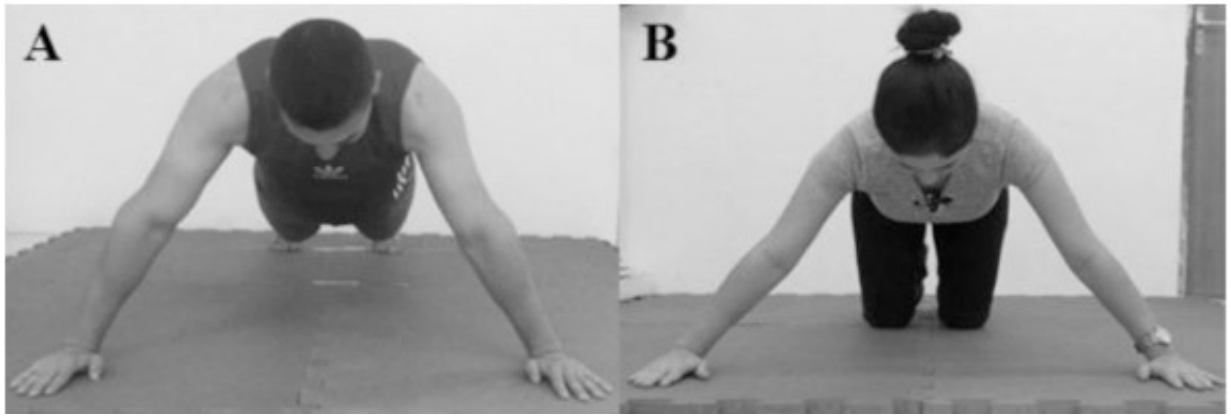
1. CKCUEST
2. Push-Up Test
3. UQ Y-Balance Test
4. LE/Core Tests
5. Seated Shot-Put Test
6. Prone T Ball Drop Test

CLOSED KINETIC CHAIN UPPER EXTREMITY STABILITY TEST

CKCUEST

- Correlates with high performance on strength assessments
- Hands placed 36 inches apart, Reach across and tap hand back and forth 15 seconds
- Test-Retest Reliability – Excellent (Tucci 2014)
- Normative Values Available for Populations
- Easy Set up, Short Testing duration

CKCUEST - BEEF



CKCUEST DEMO

SEATED SHOT-PUT TEST

- Upper extremity power
- In sitting with the back supported against a wall, 6# medicine ball is "thrown"
  - Measure where the ball first hits the ground
- Test-Retest Reliability = Excellent
- Normative values available from 1 study
  - Limb Symmetry Index was around 106% in favor of the dominant arm
- Standard Error = 7 inches
- MDC = 17 inches

Negrete RJ, Hanney WJ, Kolber MJ, et al. Reliability, minimal detectable change, and normative values for tests of upper extremity function and power. *J Strength Cond Res*. 2010;24(12):3318-3325. doi:10.1519/JSC.0b013e3181e7259c
Chmielewski TL, Martin C, Lentz TA, et al. Normalization considerations for using the unilateral seated shot put test in rehabilitation. J Orthop Sports Phys Ther. 2014; 44(7): 518–524.

PRONE-T BALL-DROP TEST

- Evaluate: Endurance & Dynamic Stability
- Prone with arm abducted to 90 degrees
- 2lb ball
- Patient drops & catches the ball repeatedly for 30 seconds
- Proposed LSI = 110% in favor of dominant arm

- No published research to support

Wilk K, Bagwell M, Davies, G, Arrigo C. (2020). Return to sport participation criteria following shoulder injury: a clinical commentary. *IJSPT*. 15. 624-642. 10.26603/ijspt20200624.

PRONE-T BALL DROP TEST VIDEO

PUSH-UP TEST

- Measures muscular endurance of the UE
- Test-Retest Reliability =0.96
- Participant lowers their body until the upper arm is parallel with the ground.
- Complete as many as you can in 15 seconds. 3 trials are taken.
- OR Complete as many as possible in 2 minutes

Negrete RJ, Hanney WJ, Davies GJ. Reliability,

minimal detectable change, and normative values for tests of upper extremity function and power. J Strength Cond Res. 2010; 24(12): 3318–3325.

UPPER QUARTER Y-BALANCE TEST

- Moderate correlation between UQYBT performance and core stability, CKCUEST performance, and push-ups.
- MDC = 8.1 cm
- Norms available – normalized to limb length

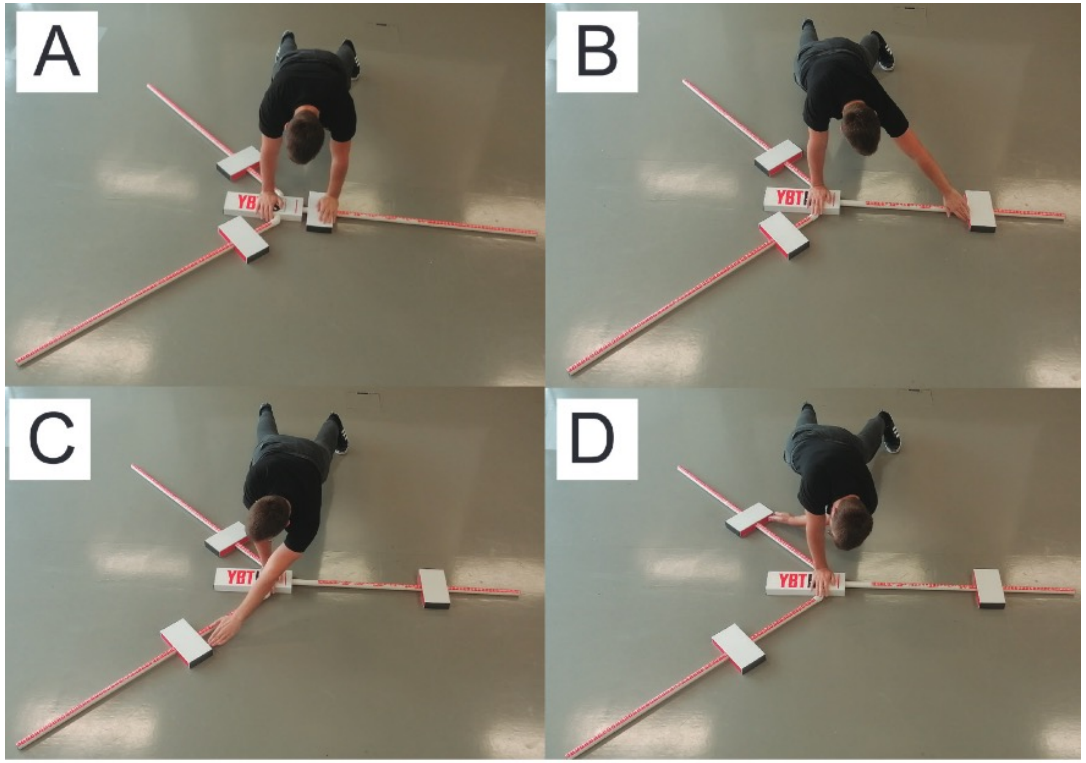


FIGURE 1. A display of performance of the UQYBT test. A – initial position; B – medial reach; C – superolateral reach; D – inferolateral reach.

Westrick RB, Miller JM, Carow SD, Gerber JP. Exploration of the y-balance test for assessment of upper quarter closed kinetic chain performance. *Int J Sports Phys Ther*. 2012;7(2):139-147.

BONUS – ATHLETIC SHOULDER TEST (ASH)

- Newer (2018)
  - Developed for rugby specific tackling positions
- Long lever isometric test
- Excellent reliability (0.94-0.98)

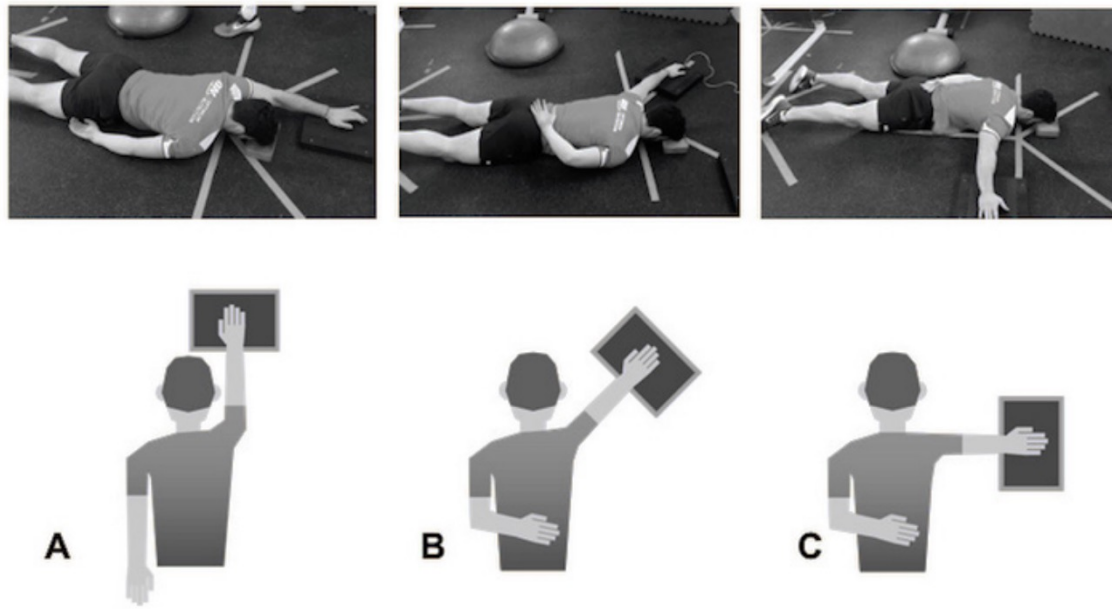


Figure 1 ASH test positions. (A) I-test (B) Y-test (C) T-test. ASH, Athletic Shoulder.

- Originally described with force plates
  - Could use HHD

LE/CORE TESTS

- What are we using?

PROPOSED LE/CORE TESTS

- Lower Extremity
  - Y-Balance Test
  - Single Leg Balance Assessments
  - Hip Abductor Strength Measurements
- Core
  - Side Planks – Time to Failure
  - Single Leg Bridge

DECISION MAKING

- Are they within tissue healing timelines?
- Do they have the full, expected ROM?
- Concerns with outcome measures?
- Can they participate in performance/practice without symptoms?
  - Post-activity as well
- Strength – Do they demonstrate deficits?
  - Are they progressing?

DECISION MAKING

- Physical Performance Tests
  - Do they demonstrate adequate symmetry?
    - Typically 110% performance on dominant arm?
  - Do they compare to available norms?
  - Do they perform the test without reported symptoms?

REINTRODUCING PLAY

- Build up to 100%
  - Play Counts
  - Pitch Counts
  - Hit Counts
  - Rep Counts

- Keep communication with the patient open

CASE APPLICATION

- Any current patients?

VOLLEYBALL PLAYER WITH SLAP REPAIR

- 6 months s/p R SLAP repair.
- Outside hitter (R handed)

- Demands of her activity?

- What tests might we want to look at?

DEMO

FINDINGS

- ROM – total arc within 5 degrees of L, no pain with overpressure
- Strength:
  - ER @ 90 - 100% LSI
  - IR @ 90 – 95% LSI
- CKCUEST: 24 touches
- Seated Shot Put: LSI = 90%
- UQYBT – 115% LSI
- Continues to report some anterior shoulder pain when hitting @ 90% intensity

REFERENCES

Ashworth B, Hogben P, Singh N, Tulloch L, Cohen DD. The Athletic Shoulder (ASH) test: reliability of a novel upper body isometric strength test in elite rugby players. *BMJ Open Sport Exerc Med*. 2018;4(1):e000365.

Barber P, Pontillo M, Bellm E, Davies G. Objective and subjective measures to guide upper extremity return to sport testing: A modified Delphi survey. *Phys Ther Sport*. 2023;62:17-24.

Borms D, Cools A. Upper-Extremity Functional Performance Tests: Reference Values for Overhead Athletes. *Int J Sports Med*. 2018;39(6):433-441.
Cools AM, Maenhout AG, Vanderstukken F, Declève P, Johansson FR, Borms D. The challenge of the sporting shoulder: From injury prevention through sport-specific rehabilitation toward return to play. *Ann Phys Rehabil Med*. 2021;64(4):101384.

Davies GJ, Riemann BL. Relationships between the seated single arm shot put test and Quick-DASH in patients being discharged from physical therapy. *Musculoskelet Sci Pract*. 2022;60:102568.

Deal MJ, Richey BP, Pumilia CA, et al. Regional Interdependence and the Role of the Lower Body in Elbow Injury in Baseball Players: A Systematic Review. *Am J Sports Med*. 2020;48(14):3652-3660.

Keller RA, De Giacomo AF, Neumann JA, Limpisvasti O, Tibone JE. Glenohumeral Internal Rotation Deficit and Risk of Upper Extremity Injury in Overhead Athletes: A Meta-Analysis and Systematic Review. *Sports Health*. 2018;10(2):125-132.

Kelley TD, Clegg S, Rodenhouse P, Hinz J, Busconi BD. Functional Rehabilitation and Return to Play After Arthroscopic Surgical Stabilization for Anterior Shoulder Instability. *Sports Health*. 2022;14(5):733-739

Laudner K, Wong R, Evans D, Meister K. Lumbopelvic Control and the Development of Upper Extremity Injury in Professional Baseball Pitchers. *Am J Sports Med*. 2021;49(4):1059-1064.

Lee DR, Kim LJ. Reliability and validity of the closed kinetic chain upper extremity stability test. *J Phys Therapy Sci*. 2015;27(4):1071-1073.

Lee YS, Jeong JY, Park CD, Kang SG, Yoo JC. Evaluation of the Risk Factors for a Rotator Cuff Retear After Repair Surgery. *Am J Sports Med*. 2017;45(8):1755-1761.

Popchak A, Poploski K, Patterson-Lynch B, Nigolian J, Lin A. Reliability and validity of a return to sports testing battery for the shoulder. *Phys Ther Sport*. 2021;48:1-11.

REFERENCES

Pontillo M, Sennett BJ, Bellm E. Use of an upper extremity functional testing algorithm to determine return to play readiness in collegiate football players: A case series. *Int J Sports Phys Ther*. 2020;15(6):1141-1150.

Pozzi F, Plummer HA, Shanley E, et al. Preseason shoulder range of motion screening and in-season risk of shoulder and elbow injuries in overhead athletes: systematic review and meta-analysis. *Br J Sports Med*. 2020;54(17):1019-1027.

Tagliarini GO, Junior JR de S, Barbosa GMP, Secchi LLB. Performance, Test-retest Reliability, and Measurement Error of the Upper Limb Seated Shot Put Test According to Different Positions of Execution. *Int J Sports Phys Ther*. 2023;V18(3):698-706

Tooth C, Gofflot A, Schwartz C, et al. Risk Factors of Overuse Shoulder Injuries in Overhead Athletes: A Systematic Review. *Sports Health*. 2020;12(5):478-487.

Watson S, Allen B, Grant JA. A Clinical Review of Return-to-Play Considerations After Anterior Shoulder Dislocation. *Sports Health*. 2016;8(4):336-341.

Westrick RB, Miller JM, Carow SD, Gerber JP. Exploration of the y-balance test for assessment of upper quarter closed kinetic chain performance. *Int J Sports Phys Ther*. 2012;7(2):139-147.

Wilk KE, Bagwell MS, Davies GJ, Arrigo CA. RETURN TO SPORT PARTICIPATION CRITERIA FOLLOWING SHOULDER INJURY: A CLINICAL COMMENTARY. *Int J Sports Phys Ther*. 2020;15(4):624-642.

Wilk KE, Thomas ZM, Mangine RE, Fuller P, Davies GJ. Neurocognitive and Reactive Return to Play Testing Protocol in Overhead Athletes Following Upper Extremity Injury. *Int J Sports Phys Ther*. 2023;18(6):1364-1375

Wright AA, Ness BM, Donaldson M, Hegedus EJ, Salamh P, Cleland JA. Effectiveness of shoulder injury prevention programs in an overhead athletic population: A systematic review. *Phys Ther Sport*. 2021;52:189-193.

Zaremski JL, Zeppieri G Jr, Tripp BL. Sport Specialization and Overuse Injuries in Adolescent Throwing Athletes: A Narrative Review. *J Athl Train*. 2019;54(10):1030-1039.