Rotator Cuff Tendinopathy in Athletes

Introductions

Dr. Daniel G. Stewart

PT, DPT

dr.danielstewartdpt

Dr. Jonathan C. Sum

PT, DPT, FASSET

- Doctor of Physical Therapy
- Board Certified Orthopedic Clinical Specialist
- Board Certified Sports Clinical Specialist
- Fellow, American Society of Shoulder & Elbow Therapists

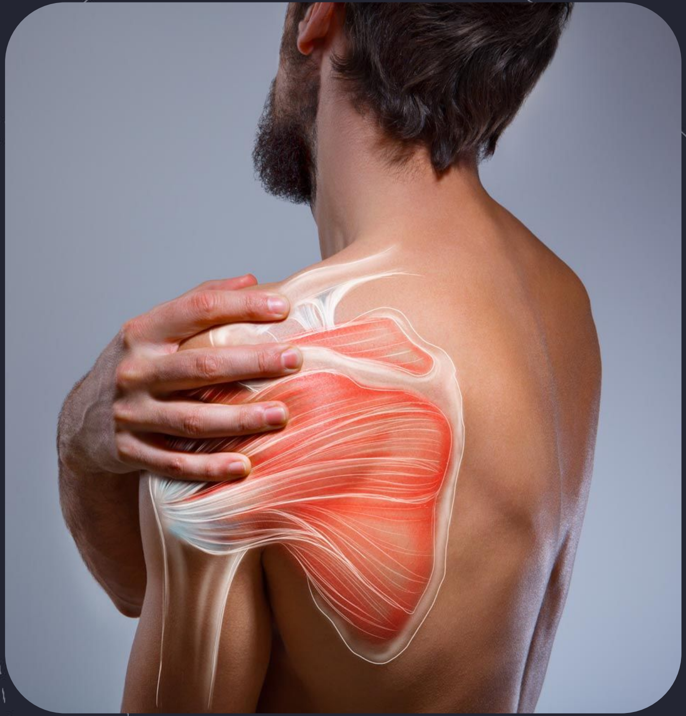
Learning Outcomes

- Understand the pathophysiology, risk factors, and clinical presentations of rotator cuff tendinopathy in athletes, with emphasis on tensile overload and subacromial impingement mechanisms.
- Execute an integrated shoulder assessment — including targeted ROM, scapular evaluation, and ActivForce2 dynamometry setups for abduction, flexion, and internal and external rotation.
- Interpret ActivForce2 dashboard data — force outputs and rotator cuff strength ratios — to build a criterion-based rehab protocol progressing from isolated RC loading to overhead and sport-specific strengthening.

Agenda

- Introduction: Rotator Cuff Tendinopathy in Athletes
- Clinical Presentations of Rotator Cuff Tendinopathy in Athletes
- Anatomical Structures Affected
  - Primary: Supraspinatus tendon, Infraspinatus tendon, Subscapularis tendon
  - Secondary / Contributing: Subacromial bursa, Long head of biceps tendon, Coracoacromial arch
- Mechanisms of Injury: Tensile Overload and Subacromial Impingement
  - Primary drivers: Supraspinatus tendon (critical zone / watershed region), Subacromial bursa (compressive loading), Coracoacromial arch (structural narrowing)
- Common Causes and Risk Factors
- Clinical Assessment
  - ROM: Shoulder Flexion, Shoulder Abduction, Shoulder External Rotation, Shoulder Internal Rotation, Horizontal Adduction (cross-body), Cervical Spine Screening
  - Muscle Testing: Shoulder Abductors (Supraspinatus), Shoulder External Rotators (Infraspinatus & Teres Minor), Shoulder Internal Rotators (Subscapularis), Scapular Stabilizers (Middle & Lower Trapezius, Serratus Anterior)
- Case Study: Data Review and Analysis (Guest Speaker)
- Treatment and Rehabilitation Strategies (Guest Speaker)
- Q&A

Rotator Cuff Tendinopathy in Athletes



Understanding Tendinopathy

****Clarifying a commonly confused spectrum of tendon pathology:*

Tendinitis
Acute / Inflammatory

- Active inflammatory cell infiltration
- Short-duration, acute onset
- Usually resolves with rest & anti-inflammatories
- Less common than previously assumed

Tendinosis
Chronic / Degenerative

- Collagen disarray & failed healing response
- Hypervascular but avascular in critical zone
- No significant inflammation on biopsy
- Often precedes partial/full thickness tear

Tendinopathy
Umbrella / Clinical Term

- Encompasses the full pathological spectrum
- Pain + loss of function as defining features
- Preferred clinical label in current evidence
- Guides load-based rehab, not just rest

Rotator Cuff Tendinopathy in Athletes

#1	Most common cause of shoulder pain in overhead athletes
36-51%	Prevalence in competitive swimmers
Up to 20%	Of acute sporting presentations involved the rotator cuff

- Persistent anterolateral shoulder pain, typically reproduced between 60–120° of shoulder elevation (painful arc).
- Driven by tensile overload of tendon collagen and/or compressive loading within the subacromial space.
- Primarily involves the supraspinatus; infraspinatus and subscapularis may co-present depending on sport and mechanism.
- Key distinction from tear: pain on resisted testing, but strength generally preserved unless significant structural change has occurred.

Clinical Presentation

Pain Behavior

Anterolateral shoulder ache during and after overhead activity; painful arc at 60–120° elevation; worsens with loading.

Location & Referral

Localized to the anterolateral acromion and deltoid insertion; may radiate to the mid-arm - typically no radiation below the elbow.

Aggravating Factors

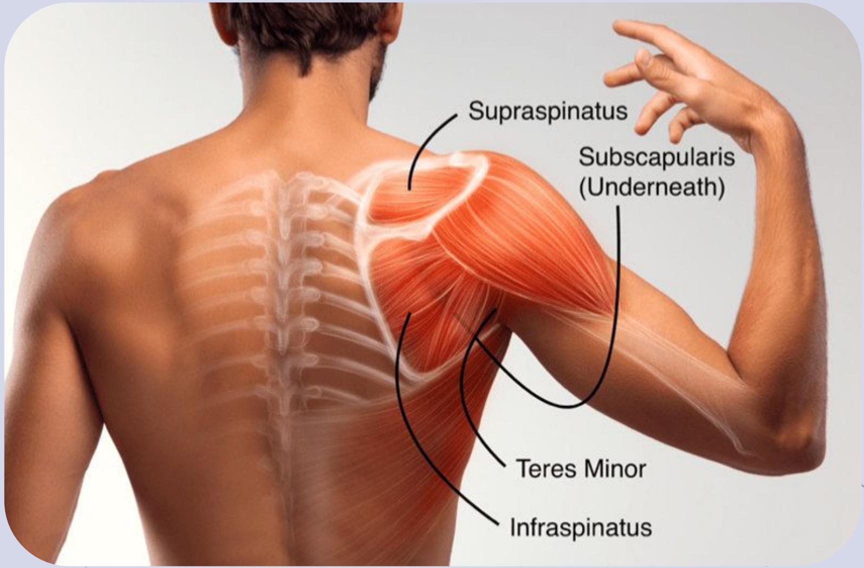
Overhead reaching, serving, throwing, swimming; lying on the affected shoulder at night; loaded elevation above 90°.

Functional & Special Signs

Positive Painful arc test; Hawkins-Kennedy (rules out); painful resisted abduction and external rotation; scapular dyskinesis on observation.

Primary Structures Involved

The four rotator cuff tendons —
each with a distinct role and injury profile



Supraspinatus Tendon

Most commonly involved. Inserts on the superior greater tuberosity. The 'critical zone' (avascular watershed ~1 cm from insertion) is the primary site of degeneration and partial tears.

Infraspinatus Tendon

Inserts on the middle facet of the greater tuberosity. Primary external rotator. Vulnerable to tensile overload during deceleration of overhead throws and serves.

Teres Minor Tendon

Inserts on the inferior facet of the greater tuberosity. Assists in external rotation and humeral head depression. Less frequently involved but contributes to posterior RC integrity.

Subscapularis Tendon

Inserts on the lesser tuberosity; the only anterior RC tendon. Primary internal rotator. Involved in anterior instability-related tendinopathy and the follow-through phase of throwing.

Secondary & Contributing Structures

****Structures that amplify or sustain tendon loading — not always the primary pain source*

Subacromial Bursa

A fluid-filled sac between the supraspinatus tendon and the acromion. Becomes inflamed and thickened under repeated compressive loading, further reducing the effective subacromial space and increasing tendon friction.

Long Head of Biceps Tendon

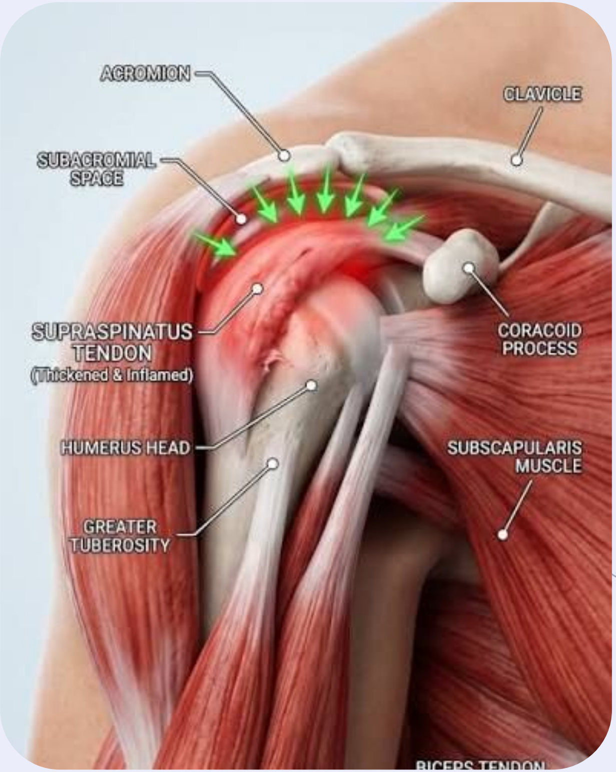
Passes through the bicipital groove and attaches to the supraglenoid tubercle; an intra-articular structure. Frequently co-irritated alongside RC tendinopathy — contributes to anterior shoulder pain and may be a secondary pain generator.

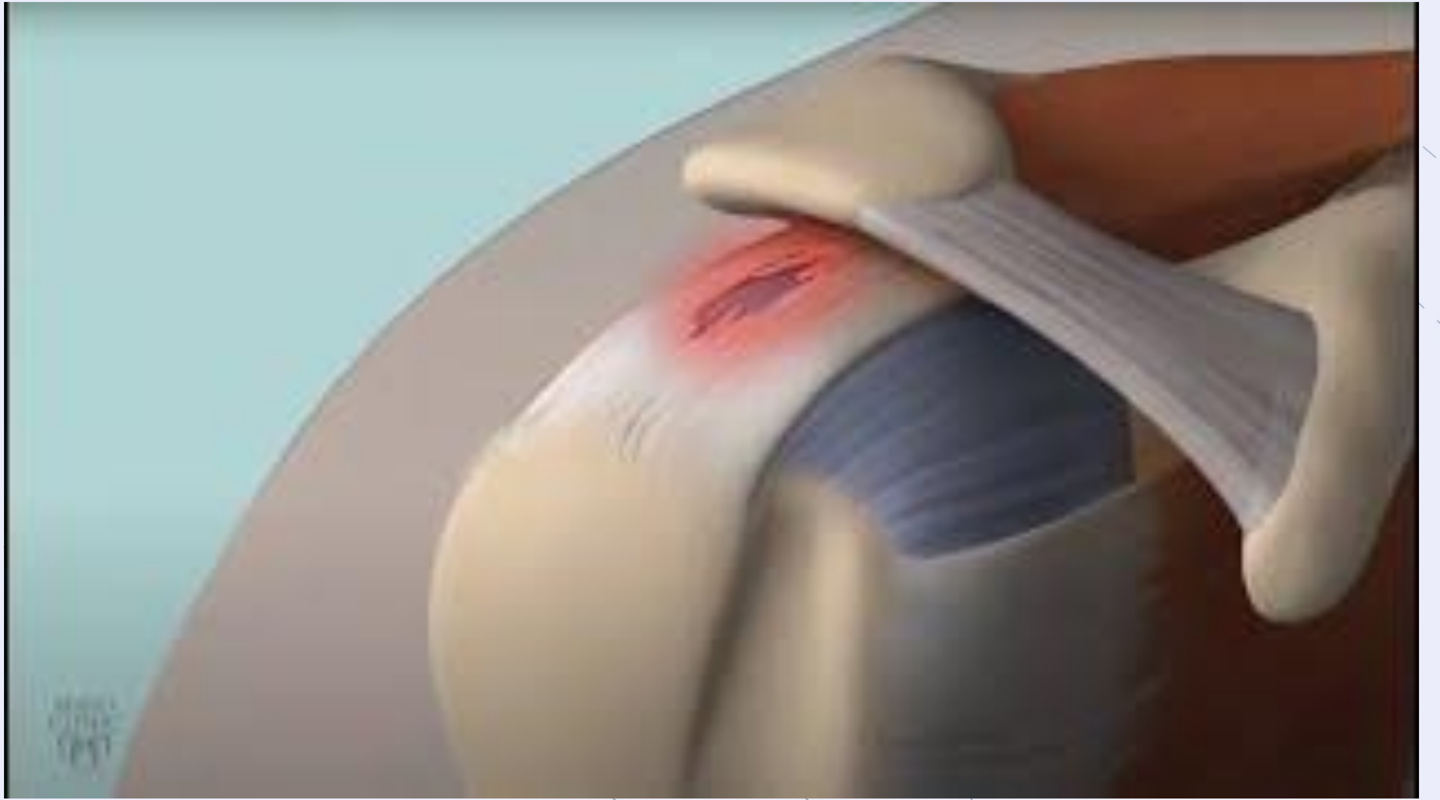
Coracoacromial Arch

Formed by the acromion, acromioclavicular joint, coracoid process, and coracoacromial ligament. Its shape (flat, curved, or hooked acromion — Bigliani Types I–III) and orientation determine the available subacromial space.

Clinical note: these structures often co-present with RC tendinopathy — treating the tendon in isolation without addressing the contributing architecture limits outcomes.

Secondary & Contributing Structures





Mechanism of Injury: Tensile Overload & Subacromial Impingement

Two intersecting pathways — often co-existing in the athletic shoulder

Pathway 1: Tensile Overload

- Repetitive overhead loading exceeds tendon's capacity to remodel
- Collagen fiber micro-failure accumulates faster than repair
- Failed healing → disorganized matrix → tendinopathic tissue
- Most pronounced at the supraspinatus critical zone (avascular watershed region)
- Sport examples: baseball pitching, swimming freestyle/butterfly, volleyball spike

Pathway 2: Subacromial Compressive Loading

- Humeral head migrates superiorly → narrows subacromial space
- Tendon compressed between humeral head and coracoacromial arch
- Subacromial bursa thickens, further reducing space
- Functional impingement: driven by RC weakness allowing superior migration
- Structural impingement: driven by acromial morphology (Type II/III) or OA changes at AC joint

Mechanism of Injury:
Primary Structural Drivers of RC Tendinopathy

Supraspinatus Critical Zone

Hypovascular watershed region (~1 cm from insertion) bears highest tensile load with every elevation. First to accumulate microtrauma; first to show pathological matrix change on MRI/ultrasound.

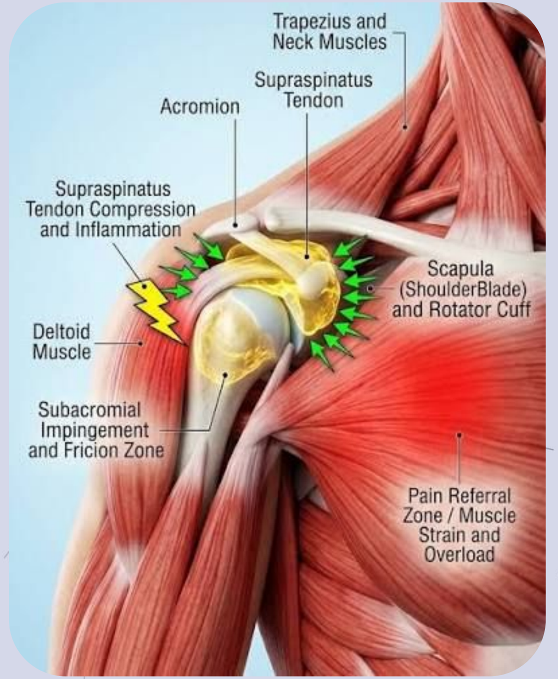
Subacromial Bursa

Mechanical irritation → bursal thickening → further subacromial space narrowing → increased compressive load on the overlying tendon. A secondary pain generator and a cycle amplifier.

Coracoacromial Arch

Hooked (Type III) or curved (Type II) acromion physically reduces the subacromial outlet during elevation. Combined with functional factors (RC weakness, scapular dyskinesis), this creates the 'structural + functional' impingement overlap.

These three drivers rarely act alone — functional deficits (RC weakness, scapular dyskinesis, reduced GH IR) amplify structural vulnerability.


Trapezius and Neck Muscles
Supraspinatus Tendon
Acromion
Supraspinatus Tendon Compression and Inflammation
Scapula (ShoulderBlade) and Rotator Cuff
Deltoid Muscle
Subacromial Impingement and Fricion Zone
Pain Referral Zone / Muscle Strain and Overload


Subacromial Impingement
AC joint osteophyte
Supraspinatus

Common Causes & Risk Factors

Sport & Extrinsic Factors

- Overhead and throwing sports: baseball, volleyball, swimming, tennis, water polo
- Rapid increases in training volume or intensity without adequate adaptation time
- Unilateral sport dominance leading to cumulative load asymmetry
- Poor technique or faulty throwing/serving mechanics
- Insufficient recovery between high-volume sessions

Biomechanical & Intrinsic Factors

- RC strength deficit — particularly ER weakness allowing superior humeral head migration
- Reduced glenohumeral internal rotation deficit (GIRD) — associated with posterior capsule tightness in throwers
- Scapular dyskinesis — compromised upward rotation reducing subacromial clearance
- Reduced shoulder flexion and horizontal adduction ROM (posterior capsule stiffness)
- Prior shoulder injury or RC pathology history; acromial morphology (Type II/III)

Clinical Assessment:
Range of Motion

ROM: Shoulder Flexion

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing

ROM: Shoulder Abduction

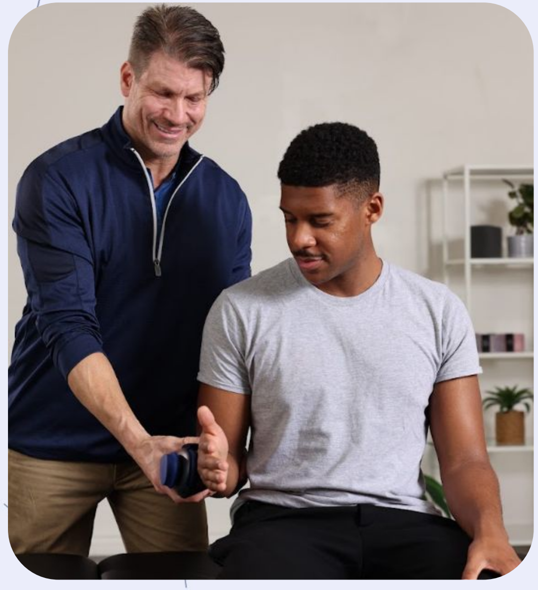
- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing

ROM: Shoulder External Rotation

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing

ROM: Shoulder Internal Rotation

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing



ROM: Shoulder Horizontal Abduction

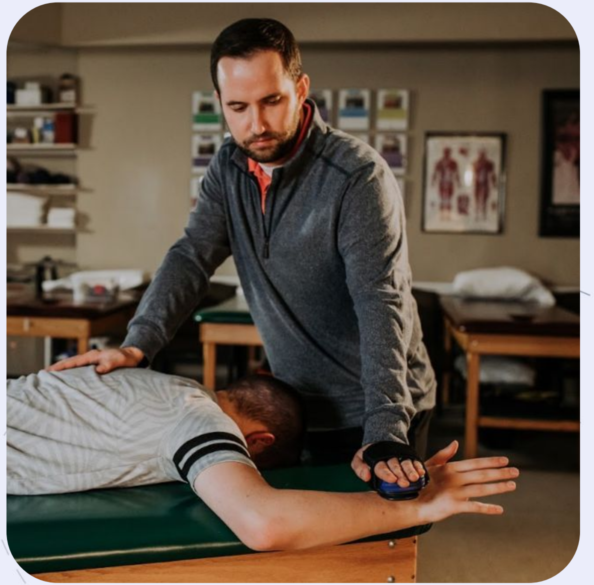
- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing

Clinical Assessment:

Muscle Strength Testing

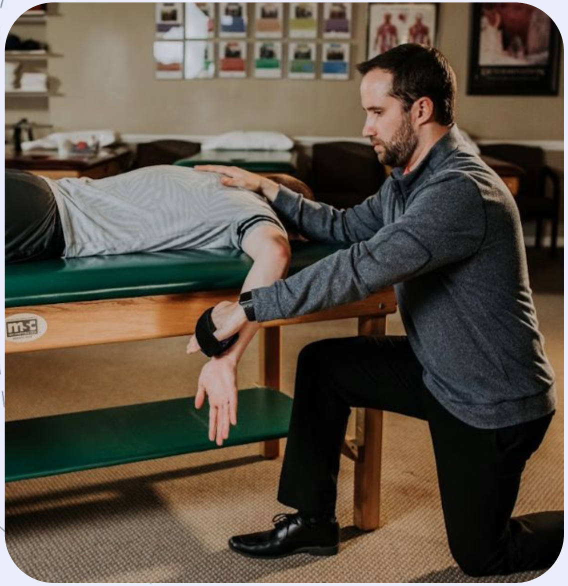
MT: Shoulder External Rotators

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing



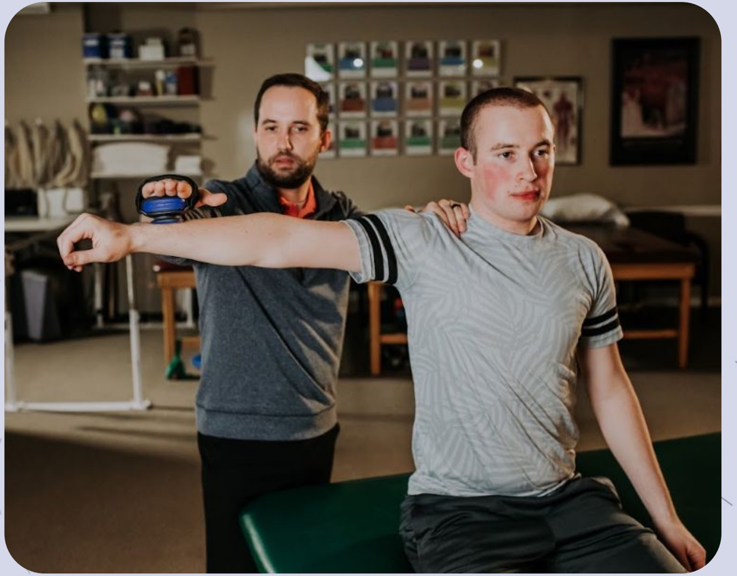
MT: Shoulder Internal Rotators

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing



MT: Shoulder Abductors

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing



MT: Scapular Stabilizers

- Best tested with the device strapped on the patient's arm or wrist.
- Can be done in supine, sidelying, seated, or standing

Case Study

20 year old junior college center fielder

- ***Throws R, Bats L***

Chief Issue

- Gradual onset of right lateral shoulder pain
- Pain during long throws from the outfield
- Pain following games and throwing practice
- Decreased throwing velocity and accuracy
- *Considerations: throwing shoulder AND lead batting shoulder*

Onset

- Insidious onset over 6 weeks
- No traumatic mechanism

Aggravating Activities

- Long toss
- Crow-hop throws
- Throws from the warning track
- Overhead lifting
- Bench press

Athlete Goals

- Return to unrestricted baseball participation
- Restore throwing velocity
- No soreness with batting
- Return for conference play

Easing Factors

- Rest
- Reduced throwing volume
- Skipping lifts

Initial Evaluation: Physical Exam

Observation

- Static Posture
- Mild rounded shoulder posture
- Slight scapular protraction

Dynamic Scapular Dyskinesis Test

- Mild scapular dyskinesis during elevation
- Reduced scapular upward rotation during throwing simulation

IE: Range of Motion and Humeral Torsion

Measure	Right Shoulder (Throwing/Injured)	Left Shoulder (Non-Throwing)
Flexion	175°	180°
Abduction	170°	180°
External Rotation @ 90° Abd	125°	105°
Internal Rotation @ 90° Abd	45°	65°
Total Arc of Motion	**170°**	**170°**
External Rotation @ Side (0° Abd)	70°	75°
Horizontal Abduction	45°	30°
Horizontal Adduction	25°	40°
Humeral Retrotorsion	31°	15°
Painful Arc	Present (90°-120°)	None

IE: Strength Assessment **Body Weight: 90.72 kg**

Muscle Group	Right (Involved)	Left (Uninvolved)	LSI (%)	BW Ratio (Right)	BW Ratio (Left)
External Rotation @ Side	13.0 kg	18.0 kg	72%	0.143	0.198
External Rotation @ 90/90	8.5 kg	13.0 kg	65%	0.094	0.143
Internal Rotation @ Side	22.0 kg	23.0 kg	96%	0.243	0.254
Internal Rotation @ 90/90	16.0 kg	17.0 kg	94%	0.176	0.187
Abduction (Scaption)	14.0 kg	20.0 kg	70%	0.154	0.220
ER:IR Ratio @ Side	0.59	0.78	N/A	N/A	N/A
ER:IR Ratio @ 90/90	0.53	0.76	N/A	N/A	N/A

Treatment & Rehab Strategies

Return to Throwing Strength Criteria

Criterion	Goal
ER @ 90/90 LSI	**≥ 90-95%**
ER:IR Ratio	≥72-76%
ER/Body Weight Ratio	≥ 18-23%
IR/Body Weight Ratio	≥ 26-32%
Pain During Testing	0-1/10
ROM	Full, pain-free
Plyometric Program	Completed symptom-free

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Rehab: Phase 1

Goals

- Reduce pain/tissue irritability
- Maintain ROM
- Prevent general deconditioning
- Initiate tendon loading

Activity

- Catch Play: limit long toss to less than 90 ft, reduc number and intensity of throws (workload guided, using wearable)
- Continue LE/core strengthening

Tendon Loading

- ER isos, arm at side, arm at 90/90
- ER/IR step aways
- Adduction and scaption isos
- 3-5 sets, 30-45 sec

Mobility/Kinetic Chain

- T/S mobility
- Post shoulder stretching/ mobility
- Scap work: serratus wall slides, rows, scap retraction, low push pulls

Rehab: Phase 2

Goals

- Improve cuff force production
- Restore ER/IR ratio
- Dynamic stability>progress to high positions/ ranges
- Introduce neurocognitive re-training
    - Blaze Pods, Cognitive Dual Task, etc

Rotator Cuff Strengthening

- Low ER/IR: free wts, band, cable, side plank w/ER
- Progress towards 90/90
    - 90/90 iso>step aways, cable ER/IR, half kneeling or split lunge ER 90/90
- Abduction/Scaption: Full can/Scaptions conc/ecc

Scapular Strengthening

- Push-up plus, Plank, Side Planks
- Prone Y/T
- Wall Slide progressions
- *manual perturbations

Use of HHD

- ER @ Side: 13.0 → 16.0 kg
- ER @ 90/90: 8.5 → 11.0 kg
- ER @ 90/90 LSI: 65% → 85%

Rehab: Preparation for Return to Throw

Goals

- Maximize RFP
- Improve dynamic, multi-position stability
- Integrate kinetic chain
- Meet RTS objective criteria

Dynamic Stability

- Rhythmic stabilization and perturbation training
  - BodyBlade, WaterBags, ShoulderSphere, AXIO

Plyometric Progression

- Med Ball Chest Pass (2 arm -> 1 arm)
- Side Toss, Reverse Flips, Decel Catches

Kinetic Chain Progression

- Rotations med ball throws; med ball slams
- Single leg loading and control
- Core power and control

Use of HHD

- Week 8 Outcomes
  - ER @ 90/90 LSI = 96%
  - ER:IR Ratio @ Side = 0.80
  - ER:IR Ratio @ 90/90 = 0.74
  - ER/BW Ratio = 20.4%

Rotator Cuff Strength Progression

Time Point	ER @ Side (kg)	ER @ Side LSI	ER @ 90/90 (kg)	ER @ 90/90 LSI	IR @ Side (kg)	IR @ Side LSI	IR @ 90/90 (kg)	IR @ 90/90 LSI
Initial Evaluation	13.0	***72%***	8.5	***65%***	22.0	***96%***	16.0	***94%***
Week 4	16.0	***89%***	11.0	***85%***	22.5	***98%***	16.5	***97%***
Week 8	18.5	***103%***	12.5	***96%***	23.0	***100%***	17.0	***100%***

Rotator Cuff Strength Ratio and BW Normalization

Time Point	ER:IR Ratio (Side)	ER @ Side /BW Ratio	IR @ Side /BW Ratio
Initial Evaluation	***0.59***	***0.143***	***0.243***
Week 4	***0.71***	***0.176***	***0.248***
Week 8	***0.80***	***0.204***	***0.254***

Return to Throwing Strength Criteria
(Did we meet the goals?)

Criterion	Goal
ER @ 90/90 LSI	≥ 90-95%
ER:IR Ratio	≥72-76%
ER/Body Weight Ratio	≥ 18-23%
IR/Body Weight Ratio	≥ 26-32%
Pain During Testing	0-1/10
ROM	Full, pain-free
Plyometric Program	Completed symptom-free

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Rotator Cuff Strength Progression

Time Point	ER @ Side (kg)	ER @ Side LSI	ER @ 90/90 (kg)	ER @ 90/90 LSI	IR @ Side (kg)	IR @ Side LSI	IR @ 90/90 (kg)	IR @ 90/90 LSI
Initial Evaluation	13.0	**72%**	8.5	**65%**	22.0	**96%**	16.0	**94%**
Week 4	16.0	**89%**	11.0	**85%**	22.5	**98%**	16.5	**97%**
Week 8	18.5	**103%**	12.5	**96%**	23.0	**100%**	17.0	**100%**
Return-to-Throwing Clearance	***18.5***	***>95%***	***12.5***	***>95%***	***23.0***	***>95%***	***17.0***	***>95%***

Rotator Cuff Strength Ratio and BW Normalization

Time Point	ER:IR Ratio (Side)	ER @ Side /BW Ratio	IR @ Side /BW Ratio
Initial Evaluation	**0.59**	**0.143**	**0.243**
Week 4	**0.71**	**0.176**	**0.248**
Week 8	**0.80**	**0.204**	**0.254**
Return-to-Throwing Clearance	***>72-76%***	***> 18-23%***	***> 26-32%***

Rotator Cuff Strength Ratio and BW Normalization

Measure	Initial Evaluation	Week 8	Goal/Criterion	Met?
ER @ 90/90 LSI	65%	96%	≥ 95%	✅ Yes
ER:IR Ratio @ Side	0.59	0.80	≥ 0.75	✅ Yes
ER:IR Ratio @ 90/90	0.53	0.74	≥ 0.70	✅ Yes
ER @ Side / Body Weight Ratio	0.143 (14.3%)	0.204 (20.4%)	0.18-0.23 (18-23%)	✅ Yes
IR @ Side / Body Weight	0.243 (24.3%)	0.254 (25.4%)	0.26-0.32 (26-32%)	⚠️ Slightly Below

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Additional Return to Throw Criteria

Criterion	Outcome	Status
Pain-Free ADLs	Achieved	✅
Pain-Free Strength Testing	Achieved	✅
Full Shoulder ROM	Achieved	✅
Total Arc Symmetry	170° Bilaterally	✅
Completion of Plyometric Progression	Achieved	✅
Completion of Long Toss Progression	Achieved	✅
Position-Specific Outfield Throwing	Tolerated	✅
Return to Full Practice	Achieved	✅

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Case Study Take Home Message

How Hand Held Dynamometry Influenced Clinical Decision Making and Management

Assessment

- Identified significant external rotation weakness not fully captured by MMT
- Revealed greatest impairment in the throwing-specific 90/90 position (65% LSI)
- Distinguished force-production deficits despite relatively normal ROM

Exercise Progression

- Guided advancement of loading and strengthening exercises
- Quantified response to rehabilitation over time
- Supported progression from isometrics → strengthening → plyometrics → throwing

Case Study Take Home Message

How Hand Held Dynamometry Influenced Clinical Decision Making and Management

Return to Throw Factors

- ER @ 90/90 LSI improved from 65% to 96%, exceeding the clinic return-to-throw criterion of ≥95%
- ER:IR ratios normalized (0.59 → 0.80 at side; 0.53 → 0.74 at 90/90), indicating restoration of rotator cuff balance
- ER/BW Ratios improved substantially, reflecting increased shoulder force-generating capacity and improved tolerance for throwing demands
- IR/BW Ratios remained symmetrical and stable, suggesting preservation of internal rotator strength throughout rehabilitation

Additional Return to Throw Factors

- Full pain-free ROM achieved while maintaining total arc of motion
- Unremarkable physical exam
- Plyometric and interval throwing progressions completed without symptom reproduction or loss of performance

Research Spotlight:

Vila-Dieguez et al. (2023).
Exercise for Rotator Cuff Tendinopathy: Proposed Mechanisms of Recovery.
Shoulder & Elbow, 15(3), 233–249.

- "Subacromial impingement" is no longer a recommended primary diagnosis — biomechanical evidence does not support tendon compression as the main driver
- Surgical decompression does not consistently outperform exercise or placebo surgery — the structural model alone is insufficient
- RC tendinopathy is now understood as a multi-system condition spanning four domains: tendon structure, neuromuscular function, psychosocial factors, and central pain processing
- 40–50% of patients develop recurrent or chronic symptoms — current exercise-only approaches leave too many unresolved

The 4 Domains at a Glance

- Tendon Structure — reduced stiffness, thickening, and collagen disorganization; exercise promotes remodeling but RC-specific evidence is still limited
- Neuromuscular — lower trapezius activation delay, altered kinematics, and deficits in rate of force development (RFD) — not just peak strength — are the most clinically relevant findings
- Psychosocial — kinesiophobia, pain catastrophizing, and low self-efficacy predict poor outcomes and must be actively screened
- Central Pain Processing — bilateral reduced pain thresholds and altered cortical excitability indicate central sensitization in a significant subset of patients

Clinical Implications:

- RFD during resisted isometric external rotation — not peak force — showed the strongest association with improved outcomes; ActivForce2 force-over-time curves directly capture this
- Non-responders to standard exercise should be "stepped" to matched care — psychologically-informed treatment, pain education, or modified loading strategies
- Scapular retraining (lower trapezius and serratus anterior) and sensorimotor work are consistent evidence-based targets alongside RC strengthening

Bottom line: objective data from ActivForce2 (strength ratios, RFD, bilateral asymmetry) addresses the structural and neuromuscular domains — but complete management requires screening all four

Questions?

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