Sport-Specific Rehabilitation Considerations for the Athletic Shoulder:

Tennis, Football, Softball, and Swimming

Friday, February 10, 2012

8:00-10:00 AM

SPORT SPECIFIC ISSUES FOR REHABILITATION OF THE SHOULDER: Tennis

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1) **Tennis Specific Demands**

75 % ALL STROKES IN MODERN HIGH LEVEL TENNIS – SERVE AND FOREHAND

CONCENTRIC IR FOR UE POWER GENERATION

LEADS TO UNILATERAL ANTERIOR UE STRENGTH DEVELOPMENT & SPORT SPECIFIC MUSCULAR IMBALANCES

2) **Classification of Tennis Injuries**

USTA SPORT SCIENCE COMMITTEE INJURY TRACKING STUDY

861 JUNIOR TENNIS PLAYERS

PRIMARILY OVERUSE INJURIES

41% OF ALL PLAYERS REPORTED AN INJURY

1/3 OF PLAYERS REPORTING ONE INJURY SUSTAINED A SECOND INJURY

KINEMATIC VARIABLES

GH ABD:	**93°**	**96 °**	**83 °**
MAX GH ER:	**173 °**	**164 °**	**154 °**
GH IR	**7550 °/s**	**4950 °/s**	**1514 °/s**
ELB FLXN	**22 °**	**36 °**	**35 °**
ELBOW EXT:	**2340 °/s**	**1760 °/s**	**1700 °/s**

3) **FLEISIG ET AL, 1996, SHAPIRO & STINE, 1992**

TECHNIQUE EFFECTS ON UPPER LIMB LOADING IN THE TENNIS SERVE, ELLIOTT ET AL, 2003,

AUSTRALIAN J MED SCI SPORTS

40 Professional Tennis Players (20 m / 20 f)

Effective Leg Drive (>10° front knee flexion @ MER)

Less Effective Leg Drive

(< 10° front knee flexion @ MER)

Peak IR Torque @ MER (55.6 Nm vs. 63.9 Nm)

Elbow Varus Torque @ MER: (62.7 vs. 73.9)

4) **PHASES AND STAGES OF THE TENNIS SERVE**

   COCKING PHASE

   HYPERANGULATION

   EMG ANALYSIS OF ELBOW FUNCTION IN TENNIS PLAYERS

      MORRIS ET AL, 1989, AM J SPORTS MED 17(2):241-247

5) **THE EFFECT OF AGE AND TOURNAMENT PLAY ON SHOULDER RANGE OF MOTION IN ELITE TENNIS PLAYERS**

CHANDLER, KIBLER ET AL, AJSM 24:525-532, 1996

SIGNIFICANT CORRELATION

   IR & YRS PLAYED

   TOTAL ROTATION ROM & YRS PLAYED

   IR AND # OF TOURNAMENTS PLAYED

6) **STRETCHING HAS NO EFFECT ON TENNIS SERVE PERFORMANCE**

KNUDSON ET AL, 2004, J STRENGTH CONDITIONING RESEARCH, 18(4):654-656, 2004

TRADITIONAL 5 MINUTE WARM-UP (T)

STATIC STRETCHIG PROGRAM (S)

MAXIMAL EFFORT SERVE SPEED

83 TENNIS PLAYERS

NO BENEFICIAL OR DETRIMENTAL EFFECT FROM STATIC STRETCHING AND SERVING PERFORMANCE

7) **SCAPULAR POSITIONING**

TENNIS SHOULDER

DOMINANT ARM

SCAPULAR DEPRESSION

SCAPULAR DOWNWARD ROTATION

SCAPULAR PROTRACTION

8) **ASYMMETRIC RESTING SCAPULAR POSTURE IN HEALTHY OVERHEAD ATHLETES**

OYAMA ET AL, J ATHLETIC TRAINING 2008;43(6):565-570

43 UNILATERALLY DOMINANT UE ATHLETES

TENNIS: MORE PROTRACTED DOMINANT SIDE

ALL ATHLETES: DOMINANT SIDE MORE SCAPULAR IR AND ANTERIOR TILT

9) COOLS ET AL, 35 ELITE JUNIOR TENNIS PLAYERS

DOMINANT SIDE GREATER SCAPULAR UR THAN ND

UT AND SERRATUS SIG STRONGER ON DOMINANT SIDE

MT AND LT = BILATERALLY

PEC MINOR SHORTER ON DOM SIDE COMPARED TO ND

10) MUSCULAR STRENGTH & ER/IR MUSCLE BALANCE

AGE SPECIFIC GLENOHUMERAL INTERNAL AND EXTERNAL ROTATION STRENGTH IN ELITE JUNIOR TENNIS PLAYERS. ELLENBECKER & ROETERT, J SCIENCE & MEDICINE IN SPORT 6(1):65-72, 2003

MUSCULAR STRENGTH ADAPTATIONS

CYBEX 6000

90° ABDUCTION

90, 210, 300 °/SEC

NORMATIVE DATA

147 ELITE JUNIOR PLAYERS

ER/IR RATIOS 66-72% DOM, 80% NDOM

ER PT/BW 10-15% (30-45% Nm/Kg)

IR PT/BW 15-20% (45-60% Nm/Kg)

MUSCULAR STRENGTH IN ELITE TENNIS PLAYERS

EXTERNAL ROTATION

DOM = NDOM

INTERNAL ROTATION

DOM >> NDOM

11) **NEED FOR SUPPLEMENTAL POSTERIOR ROTATOR CUFF STRENGTHENING**

ROTATOR CUFF STRENGTH – 4 MONTH SEASON

NCAA DIVISION I - FEMALE TENNIS PLAYERS

PRE & POST SEASON IR/ER ISOKINETIC STRENGTH TESTING AND ROM MEASUREMENT

90 DEGREES ABDUCTION

RESULTS:

NO SIGNIFICANT INCREASE IN INTERNAL OR EXTERNAL ROTATION STRENGTH OR ROM OVER THE COURSE OF THE 4 MONTH SEASON OF DAILY TENNIS PLAY AND COMPETITION

12) **TESTING ISOKINETIC MUSCULAR FATIGUE OF SHOULDER INTERNAL AND EXTERNAL ROTATION IN ELITE JUNIOR TENNIS PLAYERS**

ELLENBECKER & ROETERT,J ORTHOP SPORTS PHYS THER 29(5):275-281, 1999

RESULTS:

ENDURANCE RATIOS

ELITE JR TENNIS PLAYERS

SHOULDER IR & ER (300 DEG/SEC)

MALES:	DOM	NDOM
ER	67%	69%
IR	83%	84%

FEMALES:	DOM	NDOM
ER	62%	67%
IR	72%	80%

13) RETURN TO TENNIS:

INTERVAL TENNIS PROGRAM

BALL PROGRESSION

STROKE PROGRESSION

GROUNDSTROKES TO SERVE (SHOULDER)

SUPERVISION

USE OF BALL FEEDS VERSUS RALLIES

TECHNIQUE ANALYSIS CRITICAL

14) SUMMARY

ELITE TENNIS PLAYERS OFTEN PRESENT WITH SCAPULAR DYSFUNCTION AND ER/IR MUSCLE IMBALANCE, AS WELL AS GIRD AND ROM ALTERATIONS

KNOWLEDGE OF NORMAL FINDINGS AND MECHANICS CAN ASSIST CLINICIANS IN WORKING WITH ELITE TENNIS PLAYERS

BACKGROUND

USTA High Performance Profile

USTA Sports Science Committee (2003)

Elite Junior Testing

Compliment to USTA Fitness Testing Protocol, www.usta.com

<u>USTA HPP Tests (10)</u>

Scapular Stability (Dyskinesis)

Shoulder Rotation ROM

Shoulder Rotator Cuff Strength

Grip Strength

Core Stabilization / Strength

USTA HPP tests (10)

Hip Rotation ROM

One Leg Stability Test

Hip Flexor Flexibility

Hamstring Flexibility (SLR)

Quadriceps Flexibility

THANK YOU

Sport-Specific Rehabilitation Considerations for the Athletic Shoulder: Football

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Introduction

Epidemiology

- Shoulder injuries: 10-20% of all injuries at the collegiate and elite level
- Rotator cuff injuries and acromioclavicular joint separation most common

Differential Diagnosis

- Rotator cuff injuries
- Anterior instability with/without labral tear
- Posterior instability with/without labral tear
- Pectoralis major strain or tear
- Acromioclavicular joint separation
- Clavicular fracture
- Distal clavicle osteolysis

Position-Specific Rehabilitation Considerations

- Unique combination of closed chain, open chain, and non-throwing athletes
- Recognize the demands of each position!

Biomechanics of Positional Demands:

- -The long snap
- -The block
- -The tackle
- -The throw
    - -Defined phases: early cocking, late cocking, acceleration, and follow-through

Early Rehabilitation Phase

- -Pain modulation
- -Strengthening in non-provocative positions
- -Initiation of weight bearing through involved upper extremity
- -Total arm strength
- -Core and lower body strengthening, aerobic conditioning

Intermediate Rehabilitation Phase

- -Increased provocative positions
- -Increased weight bearing through involved upper extremity
- -Progress strength and conditioning

Advanced Rehabilitation Phase

- -Provocative positions
- -Plyometrics
- -Position-specific training

Return to Sport Considerations

-Return to practice

-Return to contact

-Return to weight lifting

Interval Throwing Program for Quarterbacks

Criteria for entry:

1. Clearance by physician
2. Pain-free range of motion
3. Adequate muscle power
4. Adequate muscle resistance to fatigue

Typical program:

-Intervals start at 10 yard throws, progress in steps up to deep route throws

-May include straight and cross throws, handoffs

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BIOMECHANICAL & REHABILITATION CONSIDERATIONS FOR THE SOFTBALL ATHLETE:

Current Concepts for Rehabilitation of the Female Athlete's Shoulder

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I. Introduction

- A. Sport overview
    1. Field description
        - a. Dirt infield
        - b. 200-225´ fence distance
        - c. 60´ between base distance
    2. Pitching distance
        - a. 12-17 years old: 40´
        - b. 18+: 43´
    3. Ball dimensions
        - a. Weight: 6.6 oz
        - b. 12 inch diameter
    4. Windmill pitching motion (video)
    5. Fun facts
        - a. Best pitchers

i. Pitching speed of 71 mph

0.413 reaction time roughly same as 100 mph fastball

ii. Throw 120+ pitches per game

iii. Pitch multiple games in a day, consecutive days

b. Best teams

i. 60+ games/season

ii. 3 pitchers per team, often play multiple positions

B. Anatomical and physiological differences between genders

1. Skeletal

a. Frame size

b. Growth plate closure

2. Muscular

a. Potential for strength gains

b. Potential for increased muscle mass

3. Connective tissue laxity

C. Presentation objectives

1. Review biomechanics of windmill pitching motion

2. Define shoulder injuries in fastpitch softball

3. Describe rehabilitation strategies for female softball athlete

4. Describe injury prevention strategies for female softball athlete

II. Biomechanics

A. Windmill pitching motion

1. Overview

a. Circumferential delivery motion

i. Wind up: Initial movement until lead foot toe-off

ii. Stride: Lead foot toe-off to lead foot ground contact

iii. Delivery: Foot contact to ball release

iv. Follow-through: Ball release until end of forward motion

b. Limitations with biomechanical studies

i. Only evaluated fastball pitching motion

Rise ball, curve, drop, screw ball, change up pitches more common among high-level pitchers

ii. Methodological limitations

2. Kinematics & kinetics (Barrentine 1998; Werner, 2005 & 2006)

Highest magnitudes during delivery phase, which is noted for arm acceleration

a. Shoulder

i. Full (±) sagittal/frontal plane arc of motion, with maximum during stride phase

ii. Magnitude of transverse plane motion not quantified

iii. Forward flexion velocity maximum of 5,000°/sec during first half of delivery phase

iv. Large internal rotation torque early in delivery phase

v. Superior force greatest near ball release (simultaneous with initiation of elbow flexion)

vi. Large anterior/posterior, and medial forces present to control translation of humeral head

b. Elbow

i. Extended throughout most of pitching motion, with flexion initiated during late delivery, maximum during follow-through, Release: 18°

ii. Sagittal plane velocity > 1,200°/sec, max near ball release

iii. Large superior force to resist distraction near ball release

iv. Valgus torque greatest during late delivery

*estimated greatest during rise ball (Werner, 2006)

3. Muscle activity (Maffet, 1997)

a. Supraspinatus

Functions to centralize humeral at lower elevation angles during early stride (78% MVC)

b. Posterior deltoid

Aides with humeral elevation and external rotation during late stride (102% MVC)

c. Infraspinatus

Maximum activity throughout stride phase (92-93% MVC), acting as primary external rotator at lower elevation angles

d. Teres minor

Maximum in late stride (87% MVC), with moderate activity during early delivery (57% MVC); more active as external rotator at higher elevation angles

e. Pectoralis major

Maximum activity during delivery (63-76% MVC) to accelerate arm into flexion/adduction/internal rotation; works in synchrony with serratus anterior

f. Serratus anterior

Greatest activity during delivery (45-61% MVC), muscle with most consistent activity throughout pitching motion; works to create stable scapula base

g. Subscapularis

Maximum during delivery phase (75-81% MVC) to internally rotate humerus

h. Biceps brachii (Rojas, 2009)

a. Maximum activity during 9 o'clock and follow through stages of windmill pitch, when muscle undergoes maximum eccentric activation
b. Maximum activity greater during windmill pitch than overhead throwing in softball

i. Triceps brachii (Oliver, 2011)

Active throughout pitching cycle (<150% MVIC)

j. Rhomboids (Oliver, 2011)

Most active from 6 to 3 o'clock phases of pitching motion at 170% MVIC; functioning as a scapula stabilizer

III. Injuries in fastpitch softball

A. Overview

1. Serious injuries are rare

2. Majority of lower extremity, hand injuries involve contact, trauma

3. Elbow and shoulder injuries most often secondary to overuse and may not be accurately captured with current injury surveillance techniques

a. Throwing-related arm pain likely more common than previously identified in this population, impacting sports and ADL levels

B. NCAA sport data

1. Injury rates (athlete/exposure)

a. 4.3 games, 2.7 practice

b. Ranks 15/15 for game injury rates; 13/15 for practice injury rates

2. Injury location

a. Games

i. Lower extremity: 43.3%

ii. Upper extremity: 33.1%

iii. Head/neck: 13.4%

b. Practices

i. Lower extremity: 40.8%

ii. Upper extremity: 33%

iii. Head/neck: 9.6%

3. Injury type

a. Games

i. Ankle sprain: 10.3%

ii. Knee: 13.5%

Internal derangement: 8.7%

Patella injury: 3.2%

Contusion: 1.6%

iii. Shoulder: 5.8%

Muscle-tendon strain: 2.8%

Tendinitis: 1.5%

Subluxation: 1.5%

b. Practice

i. Ankle sprain: 9.5%

ii. Knee: 7.9%

Internal derangement: 5.4%

Patella injury: 2.2%

iii. Shoulder: 12.9%

Muscle-tendon strain: 2.8%

Tendinitis: 8.5%

4. Mechanism of injury

a. Games

i. Contact: 71%

ii. Non-contact: 29%

b. Practice

i. Contact: 45%

ii. Non-contact: 55%

5. Injury by position (game data)

    a. Base runner: 28.8%

    b. Batter: 13.4%

    c. Pitcher: 10.8%

    d. Catcher: 9.3%

C. Collegiate fastpitch softball pitching injuries

1. Survey of 24 pitchers from 8/15 top teams of NCAA tourney

2. 26 episodes of complaints/injuries over course of season

    a. 9 involved the shoulder

    b. Almost half incurred a time-loss injury during season

D. High school softball injuries: 2 year assessment of varsity sports injury patterns

1. Injury rate: 16.7 (per 100 players)

2. Injury location

    a. Shoulder/upper arm: 16.3%

    b. Forearm/wrist/hand: 22.9%

3. 28.1% of injuries related to throwing

IV. Clinical presentation of the female athlete's shoulder

A. Overview

"Tendonitis +/- anterior compression of the long head of the biceps secondary to incompetence of dynamic stabilizers in presence of glenohumeral hypermobility"

1. Anterior pain more common, in contrast to posterior shoulder pain complaints in male overhead athletes

2. Clinical experience: glenohumeral instability is component of etiology in majority of cases
3. Need for more evidence to guide practice

B. Pain complaints

1. Vague anterior pain, tenderness
2. Consequence of anatomy (hypermobility) and biomechanical (extreme range of motion and muscle activity) sport demands
3. Difficult to differentiate between biceps, subscapularis, pectoralis major

   Clinical experience: long head of the biceps

C. Glenohumeral range of motion/joint mobility

1. Often limited. Side-to-side differences in shoulder motion not as predictive of injury in softball athlete compared to baseball athlete
2. Critical to identify what are limiting factors

   Clinical experience: Pain & guarding more common than capsular restrictions
3. Unclear pattern regarding which plane is most limited
   a. Largely because population norms have not been established
   b. IR and ER loss both likely to be present
4. Global hypermobility common, with greatest degree of hypermobility anteriorly

D. Rotator cuff weakness

1. May present as weakness of both internal and external rotators

   Question: weakness or activation deficits?

   Clinical experience: Both—with majority a result of activation deficits; limitation is how to objectively assess
2. Implications for dynamic humeral head stability

E. Poor scapula-thoracic base

1. Abducted/protracted scapula with rounded shoulders posture
2. Associated with muscle imbalance, including weak scapula stabilizers and tight pectoralis major/minor

Clinical experience: notable contributing factor to anterior compression and rotator cuff activation deficits

F. Neural symptoms

1. Usually ulnar nerve distribution, secondary to anterior humeral head translation
2. Rule out thoracic outlet component

F. Functional limitations

1. Often continue to pitch despite pain

   Pressure to continue because there are no other pitchers on team

2. Pain after pitching, during ADL's in mild/ moderate cases

   Includes sitting at rest, reaching forward

3. Pain during pitching with more severe cases

V. Rehabilitation concepts for the female softball athlete

Multi-phased, criteria based advancement (Wilk, 2002)

A. Acute

Often extended phase as pain/inflammation are slow to resolve; advancing too quickly is most frequent rehabilitation error that often leads to unsuccessful return to sports. Key is often limiting activity as much as rehabilitation intervention

1. Control pain, tissue inflammation

   a. Relative rest

b. Modalities

"Noxious Stimulation" (University of Delaware Protocol)

2500 Hz

50 Bursts/second

12 on / 8 off

2 second ramp

10-15 minutes

2. Restore baseline gleno-humeral, scapulo-thoracic stability

Softball athletes more likely to exhibit ER proprioceptive limitations than baseball athletes; side-to-side differences in proprioception not as pronounced in softball athlete

a. Manual neuromuscular drills

Glenohumeral joint—sagittal and transverse planes

Scapulo-thoracic joint

b. Modified scapular taping

3. Normalize ROM

a. What is normal?

b. What is source of motion limitation?

4. Selective UE strengthening

**Key is to not exacerbate soft tissue (primarily long head of biceps) irritation

Emphasize scapular strengthening

a. May need to void ER motion (passive and active) to prevent biceps subluxation out of groove

b. Active elevation only if pain free and able to dynamically stabilize humeral head

c. Scapular stabilization: limit arm motion to mid-line of trunk

d. Complement rotator cuff strengthening with NMES while performing multi-angle isometrics to address activation deficits

d. Include LE, trunk, and CV conditioning if symptoms not exacerbated

B. Sub-acute

Re-assess patient status to identify presence of joint hypermobility, muscle weakness now that pain and guarding are resolved

1. Restore “thrower’s motion”

2. Advance neuromuscular control

   Patterns progressed from static to dynamic

3. Active isotonic strengthening

   i. Assess for humeral head and scapulo-thoracic stability during active motions

   ii. Implement total arm strengthening concept

   iii. Emphasize strengthening of posterior musculature

   iv. Progressing towards full arc of motion

4. Initiate endurance training

C. Advanced

Progress patient to sport specific positions for exercise; mimic sport demands; add training for large muscle groups

1. Dynamic neuromuscular stabilization

   i. Combination of tubing/manual drills

   ii. Different positions on clock face for windmill pitcher

   iii. 90-90 position for other positions

2. Plyometric training

   Elbow and shoulder

3. Advance strengthening, include training of large muscle groups

   Females more likely to have weakness of larger muscle groups (upper and lower body) if not experienced in weight lifting; assess form during push ups, weight lifting—may necessitate technique instruction. Large muscle group weakness potential to impact throwing technique

4. Eccentric biceps training to replicate stresses of pitching

5. Train for total body strength, endurance, and power

D. Return to sports

1. Return to sport criteria?

2. Interval throwing program

University of Delaware interval throwing programs (Axe, 2002)

VI. Injury prevention

Challenge is to get teams on board with injury prevention programs secondary to limited practice time.

Selling point: injury prevention equals performance enhancement.

A. Pre-season preparation

1. Strength and conditioning consistent with periodization formula (taper in this phase)

2. Interval throwing program

B. Year-round strengthening

1. Thrower’s 10 program

2. Large muscle group training

C. Control training volume

1. Train more pitchers

2. Studies to identify appropriate pitch count

D. Biomechanical assessment of throwing motion

1. Personalized assessment
2. Sport assessment to better understand stresses of different pitches

VII. Conclusions

A. Presentation of the female athlete's shoulder a consequence of female anatomy/physiology in and sport demands

B. Biomechanics of windmill pitching motion impose unique demands to female athlete's shoulder

C. Instability a component of majority of shoulder injuries to the female softball athlete

D. Strict adherence to criteria based progression and minimizing painful activities key to early phases of treatment

E. Re-assessment and gradual exposure to sport demands key to progression in later phases of treatment

F. Performance enhancement equals injury prevention

G. Need for continued research to support evidence based practice

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Prevention and Treatment of Swimmer's Shoulder

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OUTLINE

I. Introduction

A. Achieving balance of stability and mobility

B. Relationship between tissue pathology and impairments

C. Microtrauma vs. Macrotrauma

D. Algorithim of shoulder injuries

II. Swimmer's Shoulder Background

A. General Biomechanics

B. Stroke Mechanics: Freestyle, Butterfly, Backstroke, Breastsroke

III. Etiology of Swimmer's Shoulder

A. Primary Impingement

B. Secondary Impingement

C. Internal Factors

D. External Factors

E. Effect on stroke mechanics

IV. Clinical Assessment

A. Common Findings

V. Principles of Treatment

VI. Keys to Success and Prevention

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