Management of Upper Extremity Injuries In Female Athletes
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The number of female athletes in the United States has reached over 3.2 million. Upper extremity injuries can be common, mostly often occurring in tennis, swimming, softball and gymnastics athletes. Female athletes may differ from male athletes in terms of biomechanical demands, posture, and training; all of these must be considered to optimize return to play in an injured athlete. Additionally, several risk factors have been identified, which should be integrated into injury prevention programs for these athletes.

This session will examine the incidence and prevalence of common shoulder, elbow and wrist injuries in female athletes, and the clinical presentation and differential diagnosis of these conditions. The biomechanical demands of gymnastics, tennis, swimming, and softball will be examined, and an evidence-based approach to rehabilitation for each sport will be presented. Return to play criteria and integration of interval sports programs (ISPs) will be discussed.

The attendee should leave this course with a greater understanding of the specific considerations for the female athlete who has sustained an upper extremity injury.

Objectives:

1. Synthesize upper extremity injury prevention programs for the female athlete.
2. Describe the incidence and prevalence of shoulder, elbow and wrist injuries, and distinguish between common upper extremity injuries in the female athlete.
3. Examine the biomechanical demands of swimming, diving, tennis, softball, and gymnastics.
4. Develop evidence-based, sport-specific rehabilitation programs, including integration of return to play criteria and interval sports programs, for female athletes after an upper extremity injury.
Management of Shoulder, Elbow and Wrist Injuries in the Female Gymnast

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I. Incidence and prevalence

II. Pathophysiology
   a. Overuse injuries
   b. Injury occurs when dynamic stability cannot accommodate for sheer and/or compressive forces sustained by the joint
   c. Adaptations:
      1. “The Gymnast Profile”
      2. Adequate versus excellent ROM/flexibility

III. Regional Concerns
   a. Shoulder
      1. Rotator cuff tendonopathy
         a. Supraspinatus
      ii. Instability
         1. Anterior
         2. Multidirectional instability
   b. Elbow
      i. Instability
         1. Dislocations
         2. Ulnar collateral ligament sprains/tears (caused by repetitive microtrauma)
   c. Wrist and Hand
      i. Scaphoid fractures
      ii. TFCC tears
         1. Triangular fibrocartilage complex tears
            a. Common in upper extremity closed kinetic chain athletes
            b. Traumatic or overuse
      iii. Upper Extremity Stress Fractures
         1. History: include last menstrual period and current nutritional status
         2. Symptoms: deep, focal pain, at midshaft of the bone

IV. Sport-Specific Demands
   i. Considerations:
      1. Start their sport at a young age
      2. Function largely in a closed kinetic chain manner (incorporation into rehabilitation)

IV. Biomechanical demands
   a. Vault
   b. Bars
   c. Beam
d. Floor

V. Exercise progressions
   a. Dynamic Stabilization
   b. Closed chain strengthening

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<th>Early Phase</th>
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<td>• Protraction/retraction or push up plus with ball on wall</td>
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<td>Advanced Phase</td>
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<td>• Push up with hands on floor or unstable surface</td>
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<td>Sport Specific</td>
<td>• Handstand activities</td>
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VI. Return to sport progressions
   a. Vault
      i. Handspring onto mat (flat body landing) >> handsprings into landing pit >> handsprings onto landing pad >> handsprings with twist, progression as above >> Yurchenko vault
   b. Bars
      i. Hanging from bar >> giants >> kips >> accelerate giants and dismounts >> casts/handstands >> endo circles >> release/re-grasps
   c. Beam/Floor
      i. Handstands >> walk overs >> handsprings on soft/elastic surfaces, pirouettes on floor >> handsprings on hard surface

VII. Return to Sport Evaluation
   a. Physical profile strength tests
   b. Upper extremity functional testing
      i. Upper quarter Y-Balance Test or Single Arm Shot Put: compare limb symmetry
      ii. CKCUEST: normative value for collegiate gymnast: 27 touches in 15 seconds

References
Rehabilitation Considerations for the Shoulder, Elbow and Wrist in Elite Female Tennis Players

Combined Sections Meeting 2016
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I. Incidence of Upper Extremity Injury in Elite Female Tennis Players
   a. Pluim et al, 2006 (Review of epidemiological studies in tennis)

II. Biomechanical Implications of Upper Extremity Injury in Elite Tennis Players
   a. Shoulder: Posterior Impingement / Rotator Cuff Injury
      i. Role of hyperangulation in the tennis serve (Mihata et al 2010)
      ii. Role of kinetic chain and use of the lower body (Elliott et al, 2003)
   b. Wrist injury patterns in elite tennis players
      i. Radial side causes – dominant extremity
      ii. Ulnar side causes – 2 handed backhand non-dominant extremity
   c. Elbow injury patterns
      i. Valgus extension overload
      ii. Flexor-prontator injury forehand and serve (Morris et al, 1989)

III. Musculoskeletal Adaptations in Elite Female Tennis Players
   a. Infraspinatus Atrophy (Young et al, 2015)
   b. ROM, RTC strength, Scapular Pathology, Elbow and Wrist ROM (Ellenbecker, 2014)

IV. Rehabilitation Considerations
   a. Shoulder
      i. Importance of evaluation of ROM and application of appropriate ROM interventions to normalize shoulder IR ROM
      ii. ER/IR Muscle balance – what does the research show ? (Byram et al, 2010 / Ellenbecker & Roetert 2003)
      iii. Scapular stabilization and rotator cuff strengthening techniques for tennis players
   b. Elbow / Wrist
      i. Tennis specific techniques to improve strength and endurance
      ii. Tyler twist for eccentric training for humeral epicondylitis (Tyler et al, 2010)
c. Return to Tennis
   i. Components of an interval tennis program (Ellenbecker 2012)
   ii. Manipulation of ball weight / compression
   iii. Stoke progression based on injury

References:


Swimmer’s Shoulder
Brian Tovin, PT, DPT, MMSc, SCS, ATC, FAAOMPT
The Sports Rehabilitation Center
Atlanta, GA

I. Introduction
   A. Balance of mobility and stability
   B. Demands on overhead athlete

II. Incidence of swimmer’s shoulder

III. General Biomechanics
   A. Swim Phases
      1. Pull through
      2. Recovery

IV. Stroke Mechanics
   A. Freestyle
   B. Butterfly
   C. Backstroke
   D. Breastroke

V. Etiology of swimmer’s shoulder
   A. Intrinsic factors
      1. Primary impingement
      2. Secondary impingement
   B. Extrinsic factors
      1. Misuse
      2. Abuse
      3. Disuse

VI. Preventative Programs

VII. Clinical Assessment
   A. History and presentation
   B. Common findings on physical examination

VIII. Principles of treatment
   A. Address pain/inflammation
   B. Joint mobility
   C. Neuromuscular control/scapular stabilization
   D. Strength/Endurance

IX. Keys to success
   A. Address the concerns of the individual
   B. Activity modification versus keeping swimmer out of the water

X. Summary
REHABILITATION OF THE FEMALE SOFTBALL ATHLETE

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I. Introduction
A. Participation
   1. NCAA
      a. 1981-82: 143 teams, 2,532 participants NCAA I; overall 416 teams
         7,465 participants
      b. 2011-2012: 285 DI teams with 5,770 participants; overall 976 teams
         with 18,505 participants
   2. Fifth most popular high school girl’s sport: 362,488 participants in 2012-2013 season
B. Pitch volume
   1. No pitch limits; limited number of pitchers/team
   2. Weekend tournament: 2-3 games/3-4 day period throwing 70-100 pitches
      (high school)
   3. Estimation of 1500-2000 pitches in a 3-day period
   4. Shanley et al 2012
      12 HS uninjured pitchers followed for 10 week season
      Average pitch count 61/game, 745/season (±506)
      Pitch count not different between injured/uninjured pitchers
C. Field and equipment
   1. Bases 60 feet apart
   2. Pitcher’s rubber to home plate, 43’
   3. Dirt infield
   4. Ball, 12 inches in circumference, 6 1/4 to 7 oz in weight
   5. Metal bats
   6. 8’ pitcher’s circle
   7. Outfield fence, 185-235’; college now has specific guidelines

II. Epidemiology
A. NCAA data
B. Hill et al, 2004
   181 collegiate pitchers self-reported data from previous year (72.8%) (2001-2002 season)
   131 reported injuries: 36 acute, 92 chronic, 3 unspecified
   All but 16 were upper extremity injuries
C. Smith et al 2015
   98 athletes including 48 pitchers between 9-18 years self-reported injuries for one year
   49 injuries total including 18 (38%) to pitchers; 11 (61%) involved the shoulder;
   the majority (78%) occurred in the first 6 weeks of the season
D. Shanley et al 2011
   10 high school softball teams (103 athletes) over a single season
   Injuries documented by athletic trainer; exposure documented by coach
   Injury rate of 5.6/1000 AE; not different between games and practice
   6/12 pitchers sustained an injury, with the six injuries accounting for 28.5% of all softball injuries
Rate of injury highest for first month of season

E. Rauh et al 2007
Evaluated subsequent injury in high school softball athletes using 1995-97 NATA surveillance data
N, 5435
678 injuries (12.5%) sustained initial injury; subsequent injury in 232 (34.2%) with 88 (13%) having injury to same body location
34% of re-injuries to shoulder, 10.2% to upper arm/elbow

F. Sauers et al 2011
Injury history, pain and HRQOL captured in 25 (HS, 10; Collegiate, 15) female softball pitchers with DASH, FAST, and self-reported arm injury history and pain rating
64% reported history of arm injury, 31% who had to cease activity > 10 days
Shoulder most common site for time-loss injury (81%)
60% reported mild-severe shoulder pain during competitive season
Correlation between pain and HRQOL

III. Windmill pitch biomechanics

A. Phases of pitching motion: Clock face
1. Windup: First ball motion forward to 6 o’clock, arm extension range from 0-90°
2. 6-3 o’clock: Body weight placed on ipsilateral leg, trunk faced forward, arm internally rotated and elevated at 90°
3. 3-12 o’clock: Body weight transferred forward, body begins to rotate toward pitching arm, arm is elevated to 180° and the humerus is externally rotated
4. 12-9 o’clock: Body remains toward pitching arm, the arm is adducted toward next position and the body weight lands on the contralateral foot
5. 9 o’clock to ball release: Momentum is transferred to adduct arm, body is rotated back to forward position and more power is transferred to arm just before ball release
6. Follow through: Arm contacts lateral hip and thigh, forward progression of humerus is halted and ball release to completion of pitch

B. Phases of pitching motion: movement description
1. Wind up: Initial movement until lead foot toe-off
2. Stride: Lead foot toe-off to lead foot ground contact
3. Delivery: Foot contact to ball release
4. Follow-through: Ball release until end of forward motion

C. Kinematics & kinetics (Barrentine 1998; Werner, 2005 & 2006)
Highest magnitudes during delivery phase, which is noted for arm acceleration
1. Shoulder
   a. Full (±) sagittal/frontal plane arc of motion, with maximum during stride phase
   b. Magnitude of transverse plane motion not quantified
   c. Forward flexion velocity maximum of 5,000°/sec during first half of delivery phase
   d. Large internal rotation torque early in delivery phase
   e. Superior force greatest near ball release (simultaneous with initiation of elbow flexion)
   f. Large anterior/posterior, and medial forces present to control translation of humeral head
2. Elbow
   a. Extended throughout most of pitching motion, with
      flexion initiated during late delivery, maximum during
      follow-through
      Release: 18°
   b. Sagittal plane velocity > 1,200°/sec, max near ball
      release
   c. Large superior force to resist distraction near ball
      release
   d. Valgus torque greatest during late delivery
      *estimated greatest during rise ball (Werner, 2006)

D. Muscle activity (Maffet, 1997)
   1. Supraspinatus
      Functions to centralize humeral at lower elevation angles during
      early stride (78% MVC)
   2. Posterior deltoid
      Aides with humeral elevation and external rotation during late
      stride (102% MVC)
   3. Infraspinatus
      Maximum activity throughout stride phase (92-93% MVC), acting
      as primary external rotator at lower elevation angles
   4. 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
   5. Pectoralis major
      Maximum activity during delivery (63-76% MVC) to accelerate
      arm into flexion/adduction/internal rotation; works in synchrony
      with serratus anterior
   6. Serratus anterior
      Greatest activity during delivery (45-61% MVC), muscle with
      most consistent activity throughout pitching motion; works to
      create stable scapula base
   7. Subscapularis
      Maximum during delivery phase (75-81% MVC) to internally
      rotate humerus
   8. Biceps brachii (Rojas, 2009)
      a. Maximum activity during 9 o’clock and follow through stages of
         windmill pitch, when muscle undergoes maximum eccentric activation
         *Oliver:  maximum activity 12-9 o’clock
      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
   9. Forearm musculature (Remaley 2015)
      a. sEMG collected from FCR, FDS, FCU and pronator teres in 10
         collegiate pitchers
b. 6 pitch types evaluated: fastball, changeup, riseball, curveball, screwball and dropball
c. Across all pitches greatest muscle activity in phases 5 & 6 (9 o’clock h)
d. FCU activity greater than other musculature
e. Riseball had highest peak activity
f. Curveball and dropball and highest average signal strength, correlating with increasing elbow distraction

IV. Normal presentation
   A. Range of motion
      1. Shanley et al 2012
         Preseason shoulder PROM of IR, ER, HA and total arc were documented
         ER: 119° (B)
         IR: D, 60°; ND, 63°
         Total Arc: D, 180°; ND, 182°
         HA: D, 30°; ND, 37°
      2. Shanley et al 2011
         103 HS softball athletes (Pitchers, 12; Catchers, 14; Position players, 77)
         Preseason shoulder PROM of IR, ER, HA and total arc were documented
         9 UE injuries
         Mean ER, 124°
         Mean IR, 60°
         Mean HA, 34°
         No side-to-side asymmetries
      3. Dover et al 2003
         50 collegiate softball athletes
         AROM of IR and ER measured with inclinometer
         ER: 105°; ND, 100°
         IR: D, 95°, ND, 102°

   B. Proprioception
      Dover et al 2003
      100 female collegiate athletes (50 softball, 50 nonthrowing)
      Target angle active repositioning using inclinometer
      Softball athletes with significantly poorer ER error than nonthrowing athletes

V. Clinical Presentation
   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
LHB classification
  a. Traumatic
  b. Instability
  c. Tendinopathies
  d. Biomechanical dysfunction
  e. Capsular involvement
  f. SLAP lesions

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

G. 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

VI. Rehabilitation considerations
Multi-phased, criteria based advancement (Wilk, 2015)

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
   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
   e. Include LE, trunk, and CV conditioning if symptoms not exacerbated
   f. Light biceps strengthening if not painful; emphasize short arc eccentrics

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
      a. Assess for humeral head and scapulo-thoracic stability during active motions
      b. Implement total arm strengthening concept (Advanced Thrower’s 10)
      c. Emphasize strengthening of posterior musculature
      d. Progressing towards full arc of motion
      e. Increase eccentric biceps demands
   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
      a. Combination of tubing/manual drills (GH + scapular)
      b. Different positions on clock face for windmill pitcher
      c. 90-90 position for position athletes
      d. Scapular stabilization
   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)

VII. Conclusions
A. Biomechanics of windmill pitching motion impose unique demands to female athlete’s shoulder
B. Multi-factoral etiology contributing to clinical presentation
C. Strict adherence to criteria based progression and minimizing painful activities key to early phases of treatment
D. Re-assessment and gradual exposure to sport demands key to progression in later phases of treatment
E. Need for continued research to support evidence based practice

VIII Acknowledgements
   University of Delaware (collaborators)
   Motion Analysis Laboratory (Mayo Clinic)
   Biomechanics Laboratory (Mayo Clinic)

IX. References


Appendix A. Softball Pitcher’s Program

Phase I. Early throwing

—All throws are to tolerance to a maximum of 50% effort.
—All long tosses begin with a crow-hop.

**Step 1.** Warm-up toss to 30 ft (9.14 m)
10 throws @ 30 ft (9.14 m)
Rest 8 min
10 throws @ 30 ft (9.14 m)
10 long tosses to 40 ft (12.19 m)

**Step 2.** Warm-up toss to 45 ft (13.72 m)
10 throws @ 45 ft (13.72 m)
Rest 8 min
10 throws @ 45 ft (13.72 m)
10 long tosses to 60 ft (18.29 m)

**Step 3.** Warm-up toss to 60 ft (18.29 m)
10 throws @ 60 ft (18.29 m)
Rest 8 min
10 throws @ 60 ft (18.29 m)
10 long tosses to 75 ft (22.86 m)

**Step 4.** Warm-up toss to 75 ft (22.86 m)
10 throws @ 75 ft (22.86 m)
Rest 8 min
10 throws @ 75 ft (22.86 m)
10 long tosses to 90 ft (27.43 m)

**Step 5.** Warm-up toss to 90 ft (27.43 m)
10 throws @ 90 ft (27.43 m)
Rest 8 min
10 throws @ 90 ft (27.43 m)
10 long tosses to 105 ft (32.00 m)

**Step 6.** Warm-up toss to 105 ft (32.00 m)
10 throws @ 105 ft (32.00 m)
Rest 8 min
10 throws @ 105 ft (32.00 m)
10 long tosses to 120 ft (36.58 m)

Phase II. Initiation of pitching

—All pitches are fast balls (no off-speed pitches).
—All pitches to tolerance or maximum effort level specified.
—All long tosses begin with a crow-hop.

**Step 7.** Warm-up toss to 120 ft (36.58 m)
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 20 ft (6.10 m) (50%)
Rest 8 min
10 throws @ 60 ft (18.29 m) (75%)
5 pitches @ 20 ft (6.10 m) (50%)
10 long tosses to 120 ft (36.58 m)

**Step 8.** Warm-up toss to 120 ft (36.58 m)
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 35 ft (10.67 m) (50%)
Rest 8 min
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 35 ft (10.67 m) (50%)
10 long tosses to 120 ft (36.58 m)

**Step 9.** Warm-up toss to 120 ft (36.58 m)
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 46 ft (14.02 m) (50%)
Rest 8 min
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 46 ft (14.02 m) (50%)
15 long tosses to 120 ft (36.58 m)

**Step 10.** Warm-up toss to 120 ft (36.58 m)
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 46 ft (14.02 m) (50%)
Rest 8 min
10 throws @ 60 ft (18.29 m) (75%)
10 pitches @ 46 ft (14.02 m) (50%)
15 long tosses to 120 ft (36.58 m)
**Phase III. Intensified pitching**

—Pitch sets 11–15 consist of 1 fastball to 1 off-speed pitch at the effort level specified.
—Pitch sets 16–21 consist of a percentage of pitches that match the preinjury pitch mix specific to the athlete at the effort level specified.
—Begin each step with warm-up toss to 120 ft (36.58 m).
—End each step with 20 long tosses to 120 ft (36.58 m).

**Step 11**
2 throws to each base (75%)

- 15 pitches (50%)*
- 15 pitches (50%)*
- 1 throw to each base (75%)
- 15 pitches (50%)*

**Step 16**
1 throw to each base

- 15 pitches (100%)*

**Step 12**
2 throws to each base (75%)

- 15 pitches (50%)*
- 15 pitches (50%)*
- 15 pitches (50%)*

**Step 17**
1 throw to each base

- 15 pitches (100%)*

**Step 13**
2 throws to each base (75%)

- 15 pitches (50%)*
- 15 pitches (75%)*
- 15 pitches (75%)*

**Step 18**
1 throw to each base

- 15 pitches (100%)*

**Step 14**
2 throws to each base (75%)

- 15 pitches (50%)*
- 15 pitches (75%)*
- 15 pitches (75%)*

**Step 19**
1 throw to each base (100%)

- 20 pitches (100%)*

**Step 15**
(100%)

- 15 pitches (75%)*
- 15 pitches (75%)*
- 15 pitches (75%)*

**Step 19**
1 throw to each base (100%)

- 20 pitches (100%)*

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<td>1 throw to each base (100%)</td>
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*Rest 8 min after these sets.*
Step 20  
Batting practice  
100–120 pitches  
1 throw to each base per 25 pitches

Step 21  
Simulated game  
7 innings  
18–20 pitches/inning  
8-min rest between innings  
preinjury pitch mix
Appendix B. Softball Pitcher’s Instructions

General rules
1. Break a sweat
2. Shoulder stretches
3. Throwing program
4. Rotator cuff strengthening
5. Shoulder stretches
6. Ice for 20 min

Warm-up
Begin at 20 ft (6.10 m) and advance 20 ft (6.10 m) at a time, throwing 3–5 times at each distance at 50% effort until reaching the warm-up distance for that workout. Begin all throws with a crowhop.

Soreness rules
If sore more than 1 hour after throwing or the next day, take 1 day off and repeat the most recent throwing program workout. If sore during warm-up but soreness is gone within the first 15 throws, repeat the previous workout. If shoulder becomes sore during this workout, stop and take 2 days off. Upon return to throwing, drop down 1 step. If no soreness, advance 1 step every throwing day.

A. Baseline/preseason
To establish a base for training and conditioning, begin with step 4 and advance 1 step daily to step 19, following soreness rules.

B. Nonthrowing arm injury
After medical clearance, begin step 4 and advance 1 step daily to step 21, following soreness rules.

C. Throwing arm: bruise or bone involvement
After medical clearance, begin with step 1 and advance program as soreness rules allow, throwing every other day.

D. Throwing arm: tendon/ligament injury (mild)
After medical clearance, begin with step 1 and advance program to step 6, throwing every other day as soreness rules allow. Throw every third day on steps 7–10 as soreness rules allow. Return to throwing every other day as soreness rules allow for steps 11–21.

E. Throwing arm: tendon/ligament injury (moderate, severe, or postoperative)
After medical clearance, begin throwing at step 1. For steps 1–6, advance no more than 1 step every 3 days, with 2 days’ active rest (warm-up and long tosses) following each workout. Steps 7–10 advance no more than 1 step every 3 days, with 2 days’ active rest (warm-up and long tosses) following each workout. Advance steps 11–21 daily as soreness rules allow.