Evaluation & Conservative Rehabilitation of the Windmill Softball Pitcher

Herm Hundley, MS, AT, ATC, CSCS, FMSC
Michael Macatangay, MS, AT, ATC, FMSC

BEST CHILDREN'S HOSPITALS U.S.News & WORLD REPORT HONOR ROLL 2014-15

MAGNET RECOGNIZED AMERICAN NURSES CREDENTIALING CENTER

2013 Parents 10 BEST CHILDREN'S HOSPITALS

NATIONWIDE CHILDREN'S
When your child needs a hospital, everything matters.

Presenter Conflict

- The views expressed in these slides and the today's discussion are ours.
- Our views may not be the same as the views of our company's clients or our colleagues.
- Participants must use discretion when using the information contained in this presentation.

Objectives

- Compare baseball and softball pitching: Culture, rules, field and ball, injury incidence, injury types, rehabilitation considerations, and biomechanical differences.
- Review common subjective and objective findings during initial evaluation of softball pitchers and the types of corrective exercises to introduce initially.
- Identify when and how to perform biomechanical video analysis of softball pitching and how to interpret the analysis.
- Develop effective evaluation, initial conservative rehabilitation, and injury prevention strategies for windmill softball pitchers recovering from injury.
- Analyze windmill softball mechanics and common errors which contribute to musculoskeletal injuries.
- Develop appropriate home exercise program based on biomechanical video analysis of windmill softball pitcher.

Introduction

- Over 2.5 million female adolescents participate in fast-pitch softball [13],
    - Yet in spite of its popularity, there remains very little sports medicine research on the windmill softball pitch compared to its baseball counterpart.
- As a result, a clinical practice gap has formed:
    - Many athletic trainers lack the knowledge and skills to properly return a windmill pitcher to game play following an injury
    - Furthermore they lack the ability to properly identify or correct windmill pitching mechanics errors.
- Much like the baseball pitch, the windmill softball pitch is a very dynamic human movement and is dependent on many areas of the body working together in a fluid motion to generate power on the ball.
    - Therefore, it is vitally important that we have a solid understanding of the biomechanics of the windmill pitch and possess the ability to address errors with corrective exercises.

Common Softball Pathologies[18]

Upper Extremity:

- Anterior and Posterior Arthralgia
- Inflammation
- Bursitis
- Instability
- Labrum Tears
- Weakness due to overuse
- Strains: Trapezius, Biceps, Pectoralis, & Rotator Cuff
- Impingement: glenohumeral & subacromial
- Tendonopathies: Biceps & Rotator Cuff
- Acromioclavicular joint disorders
- Somatic Dysfunction: Thoracic Spine / Rib Derangements
- Apophysitis
- Triceps Fibrosis
- Compression, Neuritis, Rupture of periphery nerves

Back & Lower Extremity

- Arthralgia
- Inflammation
- Bursitis
- Tendonitis
- Strains
- Sprains (usually MCL associated with excessive reaction forces and overuse)
- Compression & Neuritis of periphery nerves
- Apophysitis
- Somatic Dysfunction / Sacral Dysfunction

Incidence of Pathology in Softball

- Nearly 52% of all injuries in softball are considered major disabling injuries requiring 3+ weeks of treatment [18]
  - 6-12% of these injuries are associated with pitching [18]

- It is estimated that 45% of all softball pitchers will miss time during a single season due to an injury [13, 16]
  - 70% of those injuries will be chronic overuse injuries [13, 16]
  - 2% required surgical interventions [18]
  - 23-47% of all injuries were associated with the upper extremity.
    - 38% shoulder [18]
    - 32% arm, elbow, & wrist [18]
    - 27% hand and fingers [18]

Common Softball Pathologies[9,16]

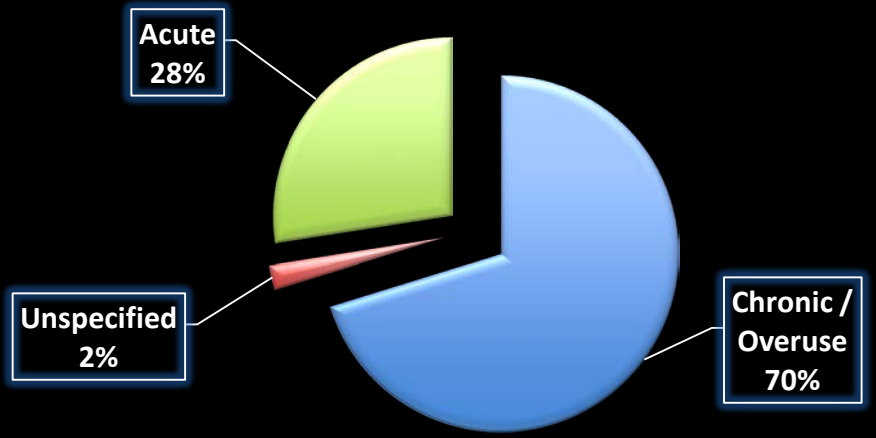
For our purposes we will focus on pitchers…

- NCAA Injury Surveillance data from 1988-2004 Injuries to pitchers account for 6.3% of all softball injuries.

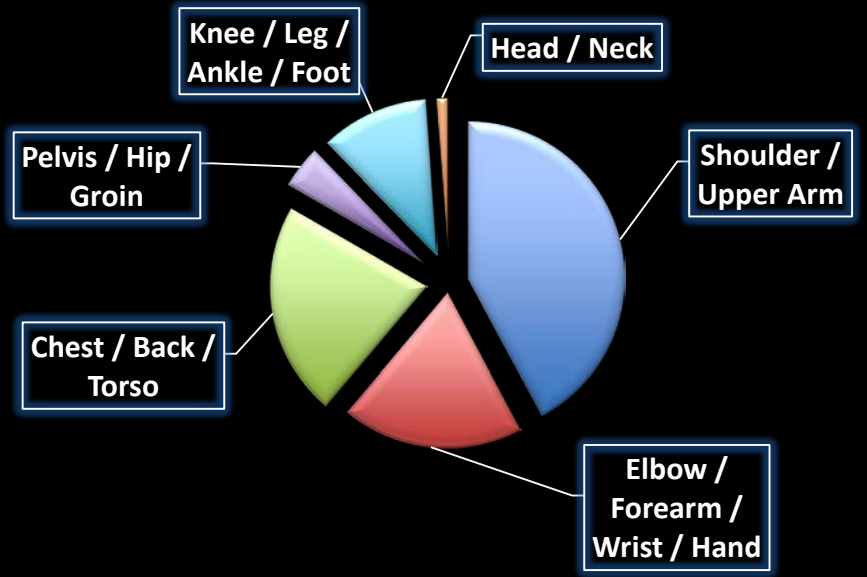
- Of 181 pitchers surveyed across 16 years, 131 reported injuries related to pitching
  - 92 (70%) of those injuries reported were chronic/overuse injuries
  - 25% of pitching injuries were chronic/overuse shoulder injuries

Softball Pitching Injury Incidence[9]

By Injury Type



By Injury Location



Softball vs. Baseball: Differences in the Game

- Softball is larger and heavier
- Softball pitchers gain no mechanical advantage from elevated mound.
- While baseball pitch counts are strictly scrutinized and routinely addressed, softball pitch counts seem to garner far less concern.
- Most governing bodies for softball don't have rules in place regarding pitch counts or required rest.
- Softball pitching staffs are often much smaller (2-3 primary pitchers vs 5+ in baseball)
  - Softball pitchers may pitch up to 6 full games in a weekend tournament (Hundreds of pitches or more)
    - Meaning potentially more pitches & innings pitched by a pitcher in softball.

But why?

There are numerous common theories, myths, and misconceptions:

- The windmill pitch is a "more natural motion", so it puts less stress on the shoulder than the overhead pitch.
- Softball games are shorter in length (7 innings vs. 7-9) meaning less pitches thrown.
- Lower ball velocities in softball.

Softball vs. Baseball – Pitch Counts

- Little League Baseball has standardized pitch counts for all athletes.

League Age	Daily Pitch Limit
7-8 years old	50 pitches
9-10 years old	75 pitches
11-12 years old	85 pitches
13-16 years old	95 pitches

- LL Baseball also has required rest days for baseball pitchers, based on number of pitches thrown:

Pitchers age 14 and under must adhere to the following rest requirements:	
1-20 pitches in a day	0 days rest
21-35 pitches in a day	1 days rest
36-50 pitches in a day	2 days rest
51-65 pitches in a day	3 days rest
66+ pitches in a day	4 days rest

Pitchers age 15-18 and under must adhere to the following rest requirements:	
1-30 pitches in a day	0 days rest
31-45 pitches in a day	1 days rest
46-60 pitches in a day	2 days rest
61-75 pitches in a day	3 days rest
76+ pitches in a day	4 days rest

http://www.littleleague.org/learn/rules/pitch-count.htm

Softball vs. Baseball – Pitch Counts

- Little League places far less restrictions on softball pitching:

LIMITED REQUIRED REST

NO LIMITS ON PITCHES THROWN

Player Age	Innings Restrictions	Required Rest
Minor/Little League Ages 7-12	12 Innings	7 or more innings requires 1 day rest
Junior/Senior League Ages 12-18	NO RESTRICTIONS	

The American Orthopaedic Society for Sports Medicine

AOSSM Recommendation for Fastpitch softball pitchers			
Age	Pitches/gm	Pitches/day (Days 1&2)	Pitches / day (Day 3)
8-10	50	80	0
10-12	65	95	0
13-14	80	115	80
15+	100	140	100

No other governing bodies for softball have rules regarding pitch counts.

http://www.littleleague.org/learn/rules/pitch-count.htm

Outlining the Importance of the Kinetic Chain

- A majority of the power generated during the windmill pitch is generated at the lower extremity and is translated through the trunk musculature and into the upper extremities and is ultimately projected onto the ball [1,11,20-22].
  - It has been estimated that 50-55% of the total energy output of the upper extremity is generated in the lower extremities[10]

- Actions at the proximal segments of the kinetic chain, including the feet, hips, and torso will create alterations at the more distal segments such as the shoulder, elbow, wrist, and hand [1, 20-22]

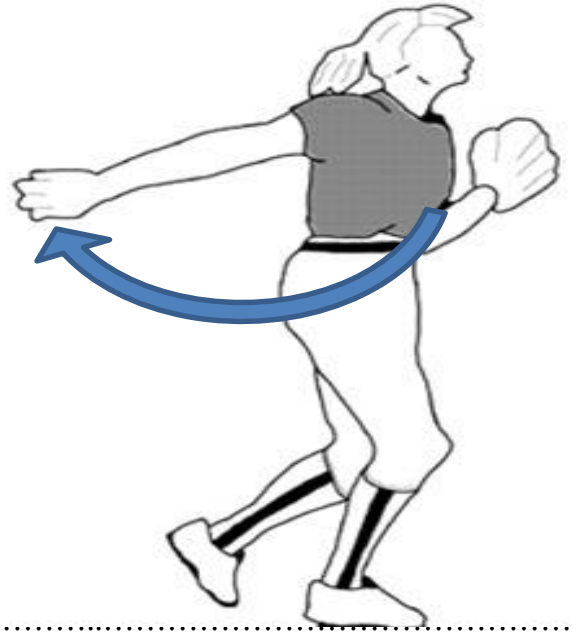
Outlining the Importance of the Kinetic Chain

- The windmill softball pitch is dependent on rotational movement of the lower extremities and core in the generation of power[8], and requires special consideration of the interactions between the lower extremities, the lumbopelvic region, and the upper extremities [19]

- Numerous studies have revealed that increases in lower extremity (predominately glute) activation generates longer stride lengths and more efficient transfer of energy to the upper extremity.
  - Greater power output from the drive leg = Greater ball velocities[8, 19].

Mechanics of the Windmill Pitch

Phase I: Windup [24]

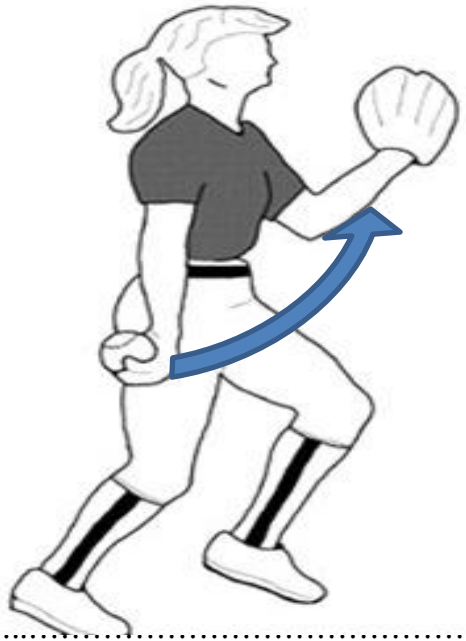


Motion is initiated with arm extension ranging from 0° to 90° :

- Pelvis is stabilized: Increased gluteus maximus activity
- Scapulothoracic region: Rhomboid activation
- Weight loaded onto dominant leg, arm extension

*Variances exist from player to player at this phase

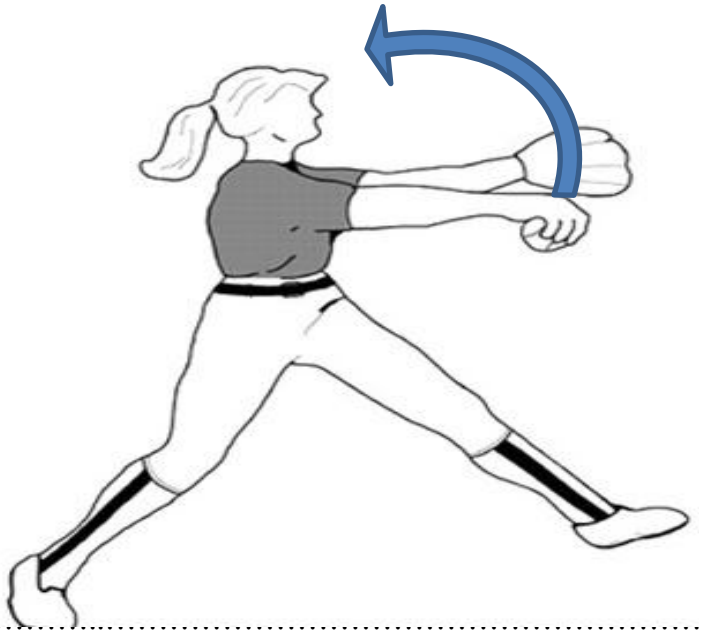
Mechanics of the Windmill Pitch
Phase II: 6 o'clock to 3 o'clock [24]



Arm proceeds from windup, forward to 3 o'clock:

- Body weight placed on ipsilateral leg, trunk faced forward, arm internally rotated and elevated to 90°.
- Rhomboids continue to stabilize the scapula
- Infraspinatus and supraspinatus activation increases.
- Glute medius stabilizes and begins to create torque at the pelvis.

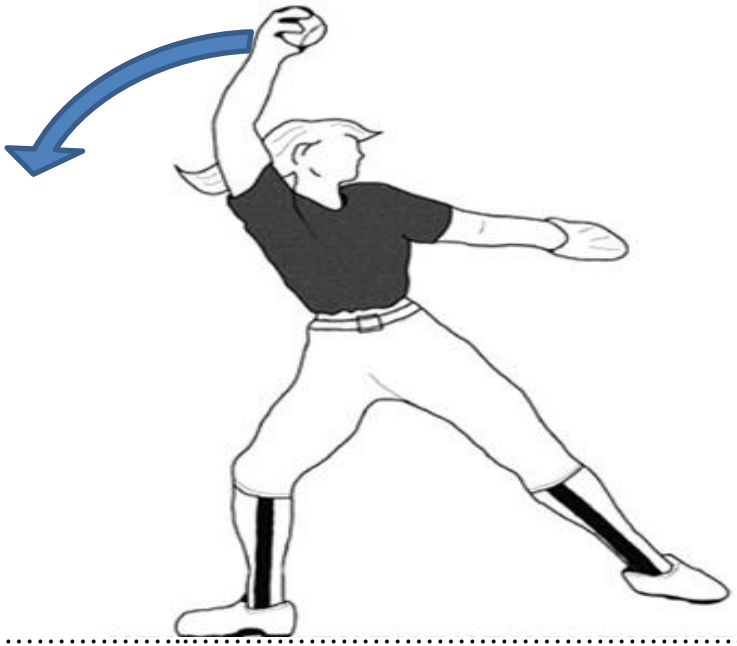
Mechanics of the Windmill Pitch
Phase III: 3 o'clock to 12 o'clock [24]



Arm position moves from 3 to 12 o'clock:

- Muscle activity begins to increase
- Bodyweight transferred forward and rotates toward throwing arm.
- Glute medius stabilizing pelvis.
- Arm elevates from 90 to 180°, with humeral ER.
- Posterior Deltoid, Infraspinatus, teres minor, rhomboids
- Humeral elevation and external rotation occurs

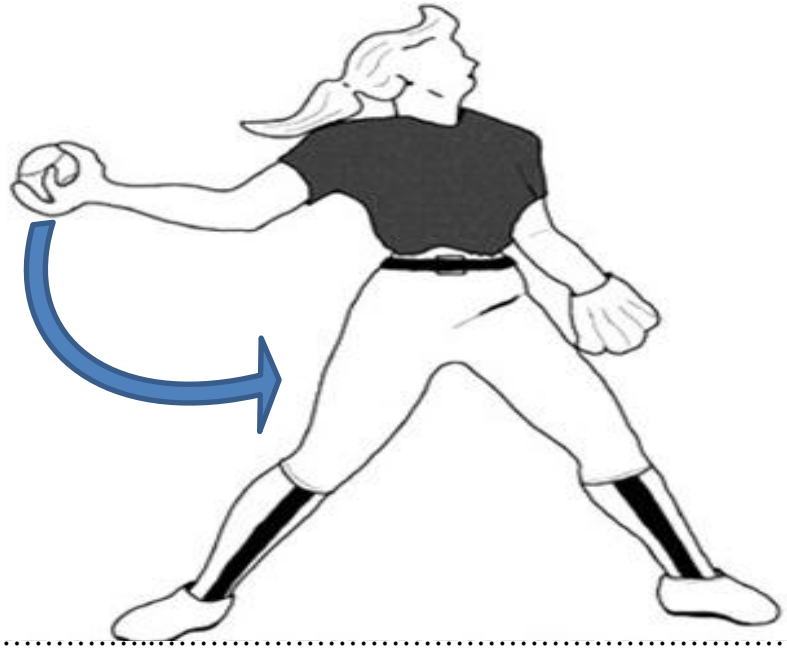
Mechanics of the Windmill Pitch
Phase IV: 12 o'clock to 9 o'clock[24]



Arm moves from 12 o'clock down to 9 o'clock

- Arm is adducted toward 9 o'clock position.
- Body remains rotated toward pitching arm.
- Glute medius continue to stabilize
- Body weight lands on the contralateral foot.
  - "Posting" of plant leg occurs
- Highest biceps activity
- Serratus anterior activity increases
- Pectoralis major and subscapularis assist in IR as arm begins to accelerate

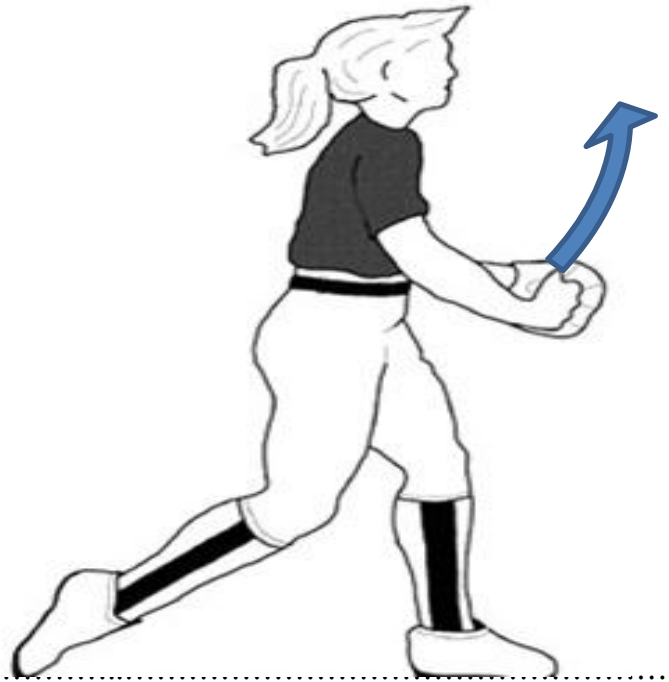
Mechanics of the Windmill Pitch
Phase V: 9 o'clock to Ball release[24]



Arm moves from 9 o'clock to ball release

- Momentum is transferred to adducted arm
- Hips/Torso is rotated back to forward position
- Momentum/Power is transferred to adducted arm just before release.
  - Pectoralis major, subscapularis, serratus anterior muscle activity remains high
  - Biceps brachii activity remains high
  - Biceps eccentric contraction occurs with highest shoulder distraction stress and elbow extension torque

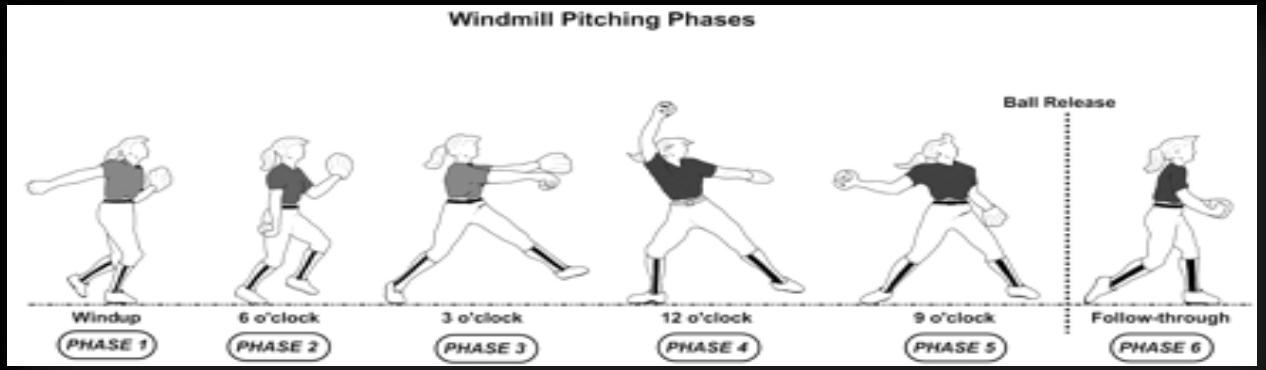
Mechanics of the Windmill Pitch
Phase VI: Follow-Through[24]

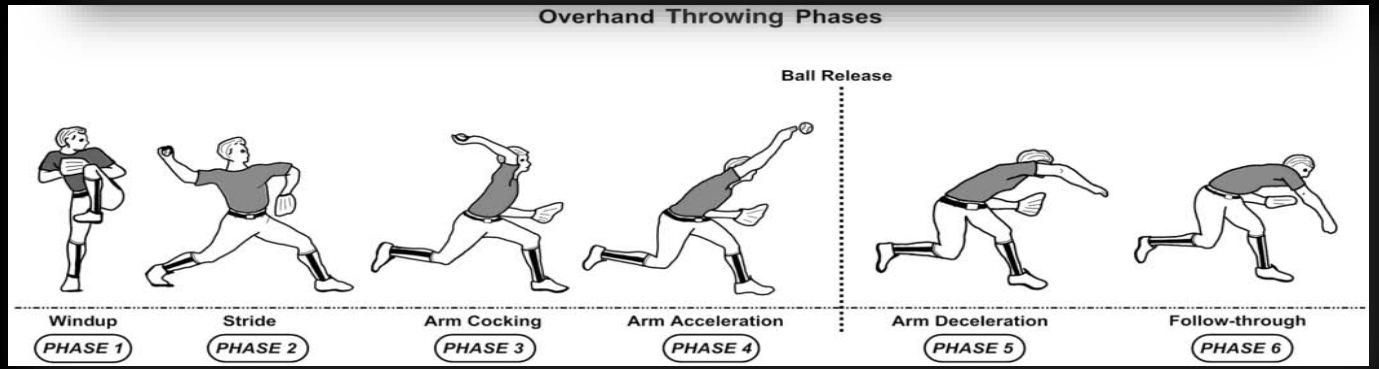


Final stage of the windmill motion

- Forward progress of the humerus is stopped as arm contacts lateral hip and thigh.
- Elbow flexion occurs
- Trail leg drives through back of stride leg.

Softball vs. Baseball: Mechanics of the Windmill Pitch[24]





Softball vs. Baseball: Similarities & Differences in the Motion

Similarities

- Pectoralis Major / Minor involved in power generation of the shoulder.
- Stabilization against anterior forces by anterior wall muscles.
- Serratus anterior involved in scapulohumeral rhythm.
- LE and core strength / mechanics are key for performance and injury prevention.

Differences

- Humerus remains within plane of the body as opposed to abducted.
- Adduction across the body contributes to power of the pitch instead of internal rotation.
- Deceleration of arm by contact with hip instead of eccentric muscle contraction.

Softball vs. Baseball: Outlining the Mechanical Differences

- Windmill pitch has highest levels of shoulder distraction stress and elbow extension torque (9o'clock to release) leading to **higher levels of eccentric biceps contraction than the overhand pitch**. [24]

- Overall shoulder motion is higher in windmill softball pitch.
  - 156 degrees abduction compared to 108 degrees in baseball may result in increased tendon excursion through bicipital groove. [24]

- **Joint loads at the shoulder are similar** to those reported in baseball pitching, however softball has a much smaller moment of ground reaction forces compared to baseball.

Softball vs. Baseball: Outlining the Mechanical Differences

- **Ground reaction forces are equal and sometimes higher in softball pitchers**, indicating increased stress placed on the lower extremity, hips, and core during pitching.

- Deceleration of arm by contact with hip instead of eccentric muscle contraction.
  - Scapular stabilizers most active during arm elevation of windmill pithing (6-3 o'clock) as compared to deceleration phase of baseball.
    - Would indicate **lower levels of stress on scapular stabilizers.**
      - **Chronic Overuse vs. Acute Injury**

What seems to be the problem?

- 9 positions on the field
  - Pitching is KING!
- 7 inning games
- 3-5 games in one weekend
- AAU, Travel ball, playing for 2 leagues (year-round pitching)
- Weekday games, then pitching multiple games each day, over the course of a weekend tournament.
- Is it faulty mechanics or overuse?
- **There are no rules regarding pitch counts in many leagues.**
  - If there are it's up to individual leagues to create/enforce them.
- **Strength training same as position players**
  - Unique mechanics demands unique training!
- **EARLY SPECIALIZATION!**

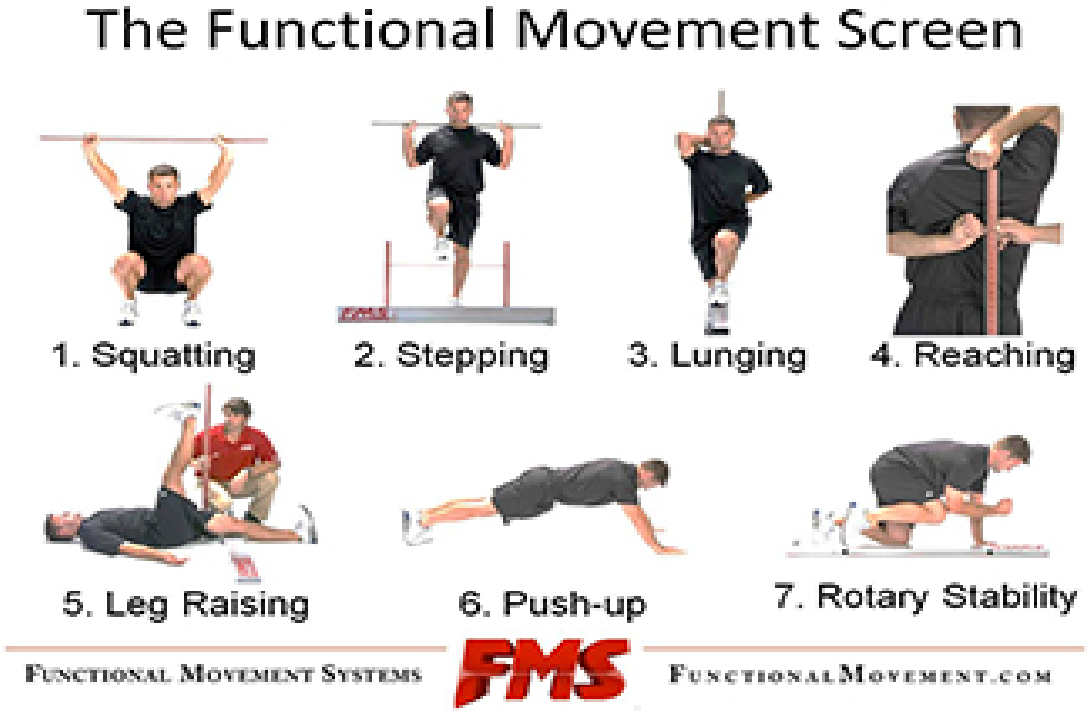
Subjective History

- Past injury history
- Childhood growth plate injuries
- Ankle, Knee, Hip, or Back injuries (kinetic chain)
- Significant muscular pathology – fascial restrictions
- Sites of normal/abnormal soft tissue post-performance
- Positions they play outside of pitcher
- # of teams / do the seasons overlap
- How many months a year do they play or train?
- Volume progression - pitch counts, innings pitched
- **Types of pitches thrown…Too many too soon?**
  - **Fastball > Changeup > Drop ball > Curve > Riseball**
- Parents & Coaches?

Objective Assessment

- Postural Assessment
  - Dysfunctional patters
    - Hyperthroracic v. Hyperlordotic v. Hypolordotic
- Scapular Assessment (Static & Dynamic)
  - Scapular Dysfunction
  - Scapulohumeral Rhythm
  - Scapular Stability/Endurance
- Range of Motion
  - TROM (Diff >5deg)
  - GIRD (>20deg)
- Strength

Functional Assessment



- Series of 7 movement tests that screen for movement quality.
- Each test is scored on a 3-point scale (21 Points Total)
  - 0= Unable to perform movement or movement is painful
  - 1=Movement performed but requires significant compensation
  - 2=Movement requires very little compensatory movement
  - 3= Sound Movement without compensation
- Score of <14 / 21 points indicates potential increased risk of injury.

Common Deficits At Initial Evaluation

- Posture- Head forward and rounded shoulders
- Scapular Anterior tilt and upward rotation
  - Thoracic Somatic Dysfunction
- UE ROM/Flexibility - GIRD, anterior / posterior shoulder tightness
- Shoulder strength deficits
- Poor eccentric scapular control with push, pull, overhead movements
- Poor GH control / stability
- LE Flexibility- tight hip flexors, tight hamstrings, low back
- Decreased hip strength (Glute max, med, min)
- Poor Core Stability/Strength- Anterior pelvic tilt
- Poor Core Rotary stability – rotational imbalances
- Poor balance – foot pronation, knee valgus, hip valgus, Trendelenberg sign

Initial Exercises

Attack the objective deficits:

- ROM exercises to improve pain-free ROM
- Stretching
  - Shoulder, Triceps, Biceps, Pec, Wrist, Lower Extremity
- Core Strength
- Scapular Stability
- GH Stability
- PNF Strengthening / Patterning
- RTC Strength

What else?

- Increase the velocity of the final 'arm-whip'.
- Wrist and hand strength
- Core Strength/Stability
- Balance
- Leg Strength, Control, and Power

Criteria for Throwing

- No TTP
- ROM WNL
  - TROM = Bilaterally
- Flexibility WNL & equal bilaterally
- 80% or more strength compared bilaterally
- Good core control
- Scapular stability = Humeral mobility!!!
  - No winging & Normal Rhythm

Mechanics of the Windmill Pitch

What are we looking for? (Lateral View)

Push-off and Stride
Athlete shifts weight back and onto the dominant side foot (heel) during windup and bends the knee.
Stride leg should be high off of the ground
Stride is aggressive and propels the athlete forward.
Proper opening and closing hip/trunk rotation
Pitchers hips open completely (toward 3rd for Righty) and then close halfway at release. (Shoulders fully close through release)
Rotation is smooth and not excessive
Closing hip rotation follows the arm after release
Fluid arm swing and Arm Whip
Arm goes overhead straight, elbow starts to bend beyond 12 o'clock.
Glove arm straight out in front of body pointing towards home plate
Head doesn't duck or tilt during motion.
Arm accelerates through release at the hip.
Ball position at various points of arm circle: (Ball down, ball out overhead, ball back at 9 o'clock, and ball forward at release point.)

Mechanics of the Windmill Pitch

What are we looking for? (Lateral View)

Stride landing and foot drag
Is Stride length appropriate percentage in relation to body height? (at least 75% height)
Upon landing, front knee remains slightly bent.
Front foot lands as the arm path approaches 9 o'clock position
Upon landing athlete's torso remains vertically stacked and doesn't fall forward, lean back, or to the sides.
Back foot remains on the ground through release.
Drive leg continues toward home plate and knees pinch together, allowing the athlete to stop forward momentum and finish in a defensive stance.
Release
Elbow is flexed 140-165 degrees at release
Pitching hand finishes through the release
Wrist snaps into full flexion and fingers flex at 1st MTP joints
Wrist snap is violent and deliberate
Wrist cocks (extension) during downswing in preparation for wrist snap
Follow-through
Wrist and arm both bend

Mechanics of the Windmill Pitch

What are we looking for? (Posterior View)

Push-off and Stride
Dominant (drive) foot remains facing forward and doesn't turn out during windup
Stride is close to the power line but not on it.
Rear foot remains in contact with the ground, NO crow hop or leaping.
Proper opening and closing hip/trunk rotation
No early rotation prior to pitch (as if coiling the body)
Stride landing and foot drag
Stride leg lands in a balanced position at roughly 30 degree angle. (1-2 o'clock) and creates a breaking force that stops momentum
Fluid arm swing and Arm Whip
Arm and hand travel in a circular path along the power line.
Arm remains adducted to the body without going behind the athlete's body (Biceps to ear overhead and arm against hip at release.)

Mechanics of the Windmill Pitch

What are we looking for? (Anterior View)

Stride landing and foot drag
Upon landing front knee flexes but doesn't dip into valgus
Release
Wrist travels into flexion and doesn't twist or pronate
Elbow remains adducted to athlete's body through release and into follow through
Follow-through
Arm is fluid and passive/relaxed following ball release
Arm travels upward with elbow and shoulder flexion

Throwing Analysis

Which errors often lead to injury:

- **Pitching 'Open':** Pitcher's hips remain facing third base throughout the pitch cycle
- Shoulders don't 'Open': Shoulders remain facing home plate throughout the pitch
- **Elbow locked during circle**
- Closing the hips too early: Hips turn toward home plate prior to ball release
- **Hyperextension of landing leg**
- Snap or No follow-through
- **'Chicken-Winging':** Elbow is abducted from body during acceleration from 9 o'clock to release.
- Improper stride foot landing: Most often foot is turned perpendicular to ball path
- Head/Neck/Upper Back jerk at ball release
- Failure to maintain front side resistance: Front leg bends too far into lunge or torso leans forward/back/to side.
- **Bending at the waist during release**
- 'Bowling' release

Athlete Injury History

- 14 year old female softball pitcher
- Presents with 3/10 chronic midline low back pain, thoracic spine pain, neck pain, decreased core strength/stability.
- Pain has been consistent and nothing really makes it worse except long pitching days.
- Following functional rehabilitation without relief, patient referred for MRI.
- Dx with Spondylolysis
- Returned to Functional Rehabilitation following rest ~12weeks.
- This time we started over with her rehabilitation.
    - Core activation & strength/stability
    - Hip stability and strength

Lateral View (Dominant Side)

Push-off and Stride	Yes/No	Comments
Athlete shifts weight back and onto the dominant side foot (heel) during windup and bends the knee.		***
Stride leg should be high off of the ground		
Stride is aggressive and propels the athlete forward.		***
Proper opening and closing hip/trunk rotation	**Yes/No**	**Comments**
Pitchers hips open completely (toward 3rd for Righty) and then close halfway at release. (Shoulders fully close through release)		***
Rotation is smooth and not excessive		
Closing hip rotation follows the arm after release		***
Stride landing and foot drag	**Yes/No**	**Comments**
Is Stride length appropriate percentage in relation to body height? (at least 75% height)		***
Upon landing, front knee remains slightly bent.		
Front foot lands as the ball path approaches 9 o'clock position		
Upon landing athlete's torso remains vertically stacked and doesn't fall forward, lean back, or to the sides.		***
Back foot remains on the ground through release.		
Drive leg continues toward home plate and knees pinch together, allowing the athlete to stop forward momentum and finish in a defensive stance.		
Fluid arm swing and Arm Whip	**Yes/No**	**Comments**
Arm goes overhead straight, elbow starts to bend beyond 12 o'clock.		
Glove arm straight out in front of body pointing towards home plate?		
Head doesn't duck or tilt during motion.		
Arm accelerates through release at the hip.		
Ball position at various points of arm circle: (Ball down, ball out overhead, ball back at 9 o'clock, and ball forward at release point.)		***
Release	**Yes/No**	**Comments**
Elbow is flexed 140-165 degrees at release		
Pitching hand finishes through the release		
Wrist snaps into full flexion and fingers flex at 1st MTP joints		
Wrist snap is violent and deliberate		
Wrist cocks (extension) during downswing in preparation for wrist snap		
Follow-through	**Yes/No**	**Comments**
Wrist and arm both bend		

Windmill Softball Pitching Rubric

Posterior View

Push-off and Stride	Yes/No	Comments
Dominant (drive) foot remains facing forward and doesn't turn out during windup		
Stride is close to the power line but not on it.		
Rear foot remains in contact with the ground, NO crow hop or leaping.		
Proper opening and closing hip/trunk rotation	**Yes/No**	**Comments**
No early rotation prior to pitch (as if coiling the body)		
Stride landing and foot drag	**Yes/No**	**Comments**
Stride leg lands in a balanced position at roughly 30 degree angle. (1-2 o'clock) and creates a breaking force that stops momentum		***
Fluid arm swing and Arm Whip	**Yes/No**	**Comments**
Arm and hand travel in a circular path along the power line.		
Arm remains adducted to the body without going behind the athlete's body (Biceps to ear overhead and arm against hip at release.)		

Anterior View

Stride landing and foot drag	Yes/No	Comments
Upon landing front knee doesn't dip into valgus		
Release	**Yes/No**	**Comments**
Wrist travels into flexion and doesn't twist or pronate		***
Elbow remains adducted to athlete's body through release and into follow through		
Follow-through	**Yes/No**	**Comments**
Arm is fluid and passive/relaxed following ball release		
Arm travels upward with elbow and shoulder flexion		

Impression:

Rehabilitation:

Taking a Ground Up Approach

- Rehabilitation of softball pitchers should focus initially on flexibility, balance, hip stabilization, and power generation of the glutes, hamstrings, and quadriceps as well as rotational stability and power within the core.

- Mechanical errors at the lower extremity during the windmill softball pitch will often lead to upper extremity changes that place undue stress on the pitching arm [7].

Rehabilitation:

Taking a Ground Up Approach

- Training should be developed in the core and lower extremities with a focus on rotational power and gluteal activation and should progress from the proximal segments to the distal segments of the windmill pitch[20,22].
  - Focus on strong foundations at the lower extremities, core, and shoulder is imperative for performance enhancement and injury prevention [20].

- Secondary to lower extremity and core rehabilitation concerns, we should also address any remaining flaws at the upper extremity to further which may not be associated with errors at the core and lower extremities.

Throwing Corrective Strategies

- To address mechanical errors:
  - Break the mechanics down into Lower Extremity Errors and Upper Extremity Errors
  - Decide which errors are most likely causing injury
    - Prioritize based on individual athlete
  - Address those concerns with exercises specific to that error.
    - Lower Extremity First
      - Addressing LE initially may lead to correcting errors identified in the UE as a result
    - Upper extremity
  - Keep it simple!!!

Lower Extremities & Torso Mechanics

Leg Drive, Hip Rotation, Landing, & Follow Through

Single Leg 9-6 Drill with Band

- Start standing on stride leg with trail leg in the air with knees squeezed together holding a pillow and trail leg bent at 90 degrees as shown.
- Begin with arms in the "T" position and band attached at chest height and held in both hands as shown.
- Bring both hands down through an arm circle motion until both hands hit your hips, making sure to maintain good single leg balance and positioning.
- Slowly reverse direction and return to starting position.

Perform _____ sets of _____ reps.

Pelvic Dissociations

- Stand with a ball between your knees and your arms relaxed at your sides.
- Using your core muscles rotate your torso to one side and then the other like a washing machine turbine. Leave arms relaxed during this motion, allowing them to swish back and forth.

Perform _____ sets of _____ reps.

Weighted Lunge with Torso Rotation



- Stand with a medicine ball/weight held outstretched in front of you as shown.
- Slowly outstretch one leg and move into a lunge position, getting your knee as close to the ground as possible.
- Slowly rotate your torso to one side and then the other.
- Lunge up and repeat on the other leg.

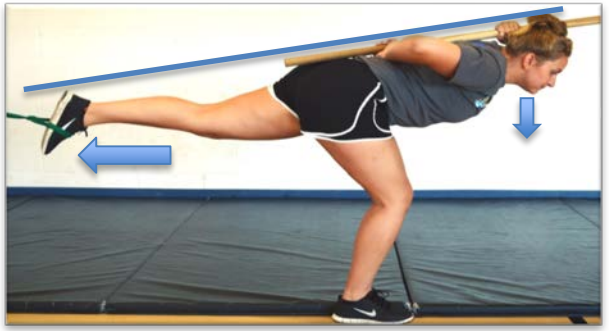
Perform _____ sets of _____ reps each leg.

Reverse Lunge Band Pull

- Start in a reverse lunge position holding band in front at chest height.
- Lunge up and drive rear knee up into 'high-knee' position while pulling bands backward, engaging core.
- Pause and reverse the movement.

Perform _____ sets of _____ reps each leg.

Band Assisted Single-leg Hip Hinge



- Begin standing on one leg with band secured behind you and around the push-off foot.
- Have stick on spine with head and low back touching stick
- Keep core tight and lean forward while also keeping leg straight to form a "T"
- Reverse direction driving knee of kick back leg into a 'high-knee' position as shown.

Perform ____ sets of ____ reps.

Band Resisted Single-leg Hip Hinge

- Begin standing on one leg with band secured in front and around the push-off foot.
- Have stick on spine with head and low back touching stick
- Keep core tight and lean forward while also keeping leg straight to form a "T"
- Reverse direction driving knee of kick back leg into a 'high-knee' position as shown.

Perform _____ sets of _____ reps.

Triple Extensions at wall

- Start with your hands on the wall and your stride leg extended behind you as shown. Be sure to have all of your weight on your push-off leg with the ankle, knee, and hip all flexed.
- Rapidly contract your glute, hamstring, and calf on your push-off leg and drive your stride leg into a high-knee position. If done correctly the movement should be explosive and force your momentum up the wall.

Perform ____ sets of ____ reps.

RNT Lunge & Stack Press



- Begin standing holding weights at your chest with the band around the outside of one knee.
- Move into a split stance, positioning leg without the band behind your body as shown
- Without moving your feet, drop back knee towards the ground and do not let front knee move forward or inward.
- From this position, slowly perform an overhead press with weights as shown.
- Reverse the movement and return to starting position.

Perform ____ sets of ___ reps on each leg.

Fall Catch & Push-off Lunge



- Start on your dominant leg with the other leg in the air (at 90 degrees hip/knee flexion)
- Fall forward into a lunge position catching yourself with the stride leg
  - Be sure that your knee does not go over your toe and that your chest does not lean forward.
- Once you have caught yourself in the lunge position press off the front foot and return to starting position.

Perform ____ sets of ____ reps on both legs.

Leap & Stick

- Start in a balanced position on your dominant foot (push/drag leg) with the opposite leg (stride leg) off the ground as shown.
- Leap out (not up!), from the push/drag foot, and land on the stride leg foot. The landing should be soft and on the ball of the foot. Hold for 5 sec.

Perform _____ sets of _____ reps.

Single Leg Rock & Power Leg Drive

- Begin standing on push/trail leg with stride leg in 'high-knee' position with arms up in front as shown.
- Slowly reach stride leg and throwing arm backward, bending at the waist and bending the push/trail leg knee slightly as shown.
- Powerfully rock back to the starting position.
- Repeat step 2, but this time accelerate out of the bent waist position and explode off of the push/trail leg into a full stride position.
  - Note: This drill can be performed without a ball or may be turned into a full pitch with release using a ball.

Perform ____ sets of ____ reps of the entire motion.

Balance Beam

Step 1

Step 2

- **Step 1**: Begin on trail/push-off foot on board. Reach stride leg back slightly then rapidly explode out into a 'Power-K' position with both feet on board, pause and maintain balance. Return to start position and repeat.
- **Step 2**: From 'Power-K' position with both feet on board, perform forearm fire with ball release with trail leg drive through into a 'high-knee' position, pause and maintain balance. Return to 'Power-K' position and repeat.
- **Full**: Perform steps 1 & 2 together fluidly to complete the entire pitching motion.

Perform ____ reps of each position.

Upper Extremity Mechanics:

Circle, Whip, Release, & Follow Through

Overhead Bar Press

Supine Press

- Begin laying on back, holding dowel rod at the chest, elbows tight to ribs, and back flat to the floor.
- Slowly press the bar over the head as shown keeping the bar close to your face and then the ground without touching until your arms are straight.
- Reverse direction slowly until you reach the start position.

Perform ____ sets of ____ reps.

Prone Press

- Begin laying face down, holding dowel rod at the upper back as shown.
- Slowly press the bar over the head as shown keeping the bar as high as possible from the ground until your arms are straight.
- Reverse direction slowly until you reach the start position.

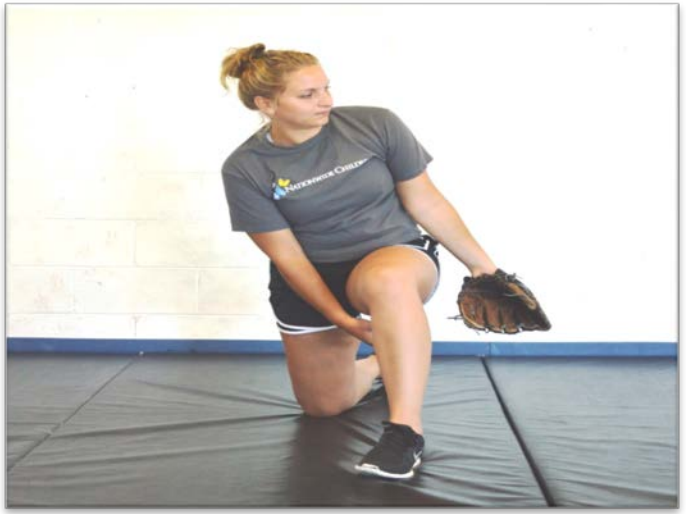
Perform ____ sets of ____ reps.

Band Resisted Wrist Snaps

- Attach resistance band at mid-thigh height, and loop the other end around the throwing hand.
- Facing in the opposite direction with the feet in a full stride position perform wrist snaps at the 6o'clock arm position.
  - Be sure to flex the fingers and the wrist to ensure proper wrist snap mechanics.

Perform ____ sets of ____ reps.

Kneeling Wrist Snaps Under Leg



- Kneeling with the stride leg in front of you, raise the arms up into the "Power K" position as shown.
- Relax the arms and drop the pitching arm down and through, releasing the ball with good wrist snap under the front knee as shown.

Perform ____ sets of ____ reps.

Wall Drills




- Stand facing the wall in an open stance position as close to wall as possible without touching it.
- Holding a ball, perform slow, deliberate arm circles.
  - **Phase 1:** Both arms come up to 3 o'clock position together, ball facing glove. Pause and return to starting position
  - **Phase 2:** Perform phase one and continue throwing hand into 12 o'clock position, ball facing out. Pause and return to starting position
  - **Phase 3:** Perform phases 1 & 2, continuing throwing hand into 9o'clock position with ball facing back. Pause and return to starting position.
  - **Phase 4:** Perform phases 1, 2, & 3 in a continuous motion allowing the arm to fire down from 9 o'clock through release, utilizing proper wrist snap mechanics. Simultaneously pull glove hand down to front hip.

Perform ____ reps of each phase.

Rewind & Fast Forward Arm Circle




- Begin with feet in an open stride position, glove against hip and ball held in front of you.
- Slowly rewind your arm circle and raise your glove to chest height, reversing your arm circle back until ball meets the glove.
- Reverse direction and accelerate through pitching arm circle using good mechanics through ball release. Pull glove hand down to hip through release and bring trail leg through as well.

Perform ____ sets of ____ reps.

References & Resources

1. Aguinaldo, A.L., J. Buttermore, and H. Chambers, *Effects of upper trunk rotation on shoulder joint torque among baseball pitchers of various levels.* J Appl Biomech, 2007. **23**(1): p. 42-51.

2. Borich, M.R., et al., *Scapular angular positioning at end range internal rotation in cases of glenohumeral internal rotation deficit.* J Orthop Sports Phys Ther, 2006. **36**(12): p. 926-34.

3. Burkhart, S.S., C.D. Morgan, and W.B. Kibler, *The disabled throwing shoulder: spectrum of pathology Part III: The SICK scapula, scapular dyskinesis, the kinetic chain, and rehabilitation.* Arthroscopy, 2003. **19**(6): p. 641-61.

4. Burkhart, S.S., C.D. Morgan, and W.B. Kibler, *The disabled throwing shoulder: spectrum of pathology. Part II: evaluation and treatment of SLAP lesions in throwers.* Arthroscopy, 2003. **19**(5): p. 531-9.

5. Burkhart, S.S., C.D. Morgan, and W.B. Kibler, *The disabled throwing shoulder: spectrum of pathology Part I: pathoanatomy and biomechanics.* Arthroscopy, 2003. **19**(4): p. 404-20.

6. Gilman, R. *Softball Pitching Tools Common Problems*. 2010 [cited 2016.

7. Greiwe, R.M., C. Saifi, and C.S. Ahmad, *Pediatric sports elbow injuries.* Clin Sports Med, 2010. **29**(4): p. 677-703.

8. Guido, J.A., Jr., S.L. Werner, and K. Meister, *Lower-extremity ground reaction forces in youth windmill softball pitchers.* J Strength Cond Res, 2009. **23**(6): p. 1873-6.

9. Hill, J.L., et al., *Female collegiate windmill pitchers: influences to injury incidence.* J Strength Cond Res, 2004. **18**(3): p. 426-31.

10. Kibler, W.B., *Biomechanical analysis of the shoulder during tennis activities.* Clin Sports Med, 1995. **14**(1): p. 79-85.

References & Resources

11. Kibler, W.B. and J. McMullen, *Scapular dyskinesis and its relation to shoulder pain.* J Am Acad Orthop Surg, 2003. **11**(2): p. 142-51.

12. Lintner, D., T.J. Noonan, and W.B. Kibler, *Injury patterns and biomechanics of the athlete's shoulder.* Clin Sports Med, 2008. **27**(4): p. 527-51.

13. Loosli, A.R., et al., *Injuries to pitchers in women's collegiate fast-pitch softball.* Am J Sports Med, 1992. **20**(1): p. 35-7.

14. Lukasiewicz, A.C., et al., *Comparison of 3-dimensional scapular position and orientation between subjects with and without shoulder impingement.* J Orthop Sports Phys Ther, 1999. **29**(10): p. 574-83; discussion 584-6.

15. Maffet, M.W., et al., *Shoulder muscle firing patterns during the windmill softball pitch.* Am J Sports Med, 1997. **25**(3): p. 369-74.

16. Marshall, S.W., et al., *Descriptive epidemiology of collegiate women's softball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004.* J Athl Train, 2007. **42**(2): p. 286-94.

17. McMullen, J. and T.L. Uhl, *A kinetic chain approach for shoulder rehabilitation.* J Athl Train, 2000. **35**(3): p. 329-37.

18. Meyers, M.C., B.R. Brown, and J.A. Bloom, *Fast pitch softball injuries.* Sports Med, 2001. **31**(1): p. 61-73.

19. Oliver, G.D., *Relationship between gluteal muscle activation and upper extremity kinematics and kinetics in softball position players.* Med Biol Eng Comput, 2014. **52**(3): p. 265-70.

20. Oliver, G.D., P.M. Dwelly, and Y.H. Kwon, *Kinematic motion of the windmill softball pitch in prepubescent and pubescent girls.* J Strength Cond Res, 2010. **24**(9): p. 2400-7.

References & Resources

21. Oliver, G.D. and H. Plummer, *Ground reaction forces, kinematics, and muscle activations during the windmill softball pitch.* J Sports Sci, 2011. **29**(10): p. 1071-7.

22. Oliver, G.D., H.A. Plummer, and D.W. Keeley, *Muscle activation patterns of the upper and lower extremity during the windmill softball pitch.* J Strength Cond Res, 2011. **25**(6): p. 1653-8.

23. Pluim, B., et al., *Science and medicine in tennis: an integeral part of player development.* Journal of Science and Medicine in Sport, 2003. **6**(1): p. 1-1.

24. Rojas, I.L., et al., *Biceps activity during windmill softball pitching: injury implications and comparison with overhand throwing.* Am J Sports Med, 2009. **37**(3): p. 558-65.

25. Amanda Scarborough (2014) *Softball Power Drive: Fastpitch Pitching Mechanics in Slow Motion*: https://www.youtube.com/watch?v=avcEmdxuc30

26. Schonberg et al. http://www.Fastpitchpower.com.

27. Werner, S.L., et al., *Biomechanics of youth windmill softball pitching.* Am J Sports Med, 2005. **33**(4): p. 552-60.

28. Werner, S.L., et al., *Kinematics and kinetics of elite windmill softball pitching.* Am J Sports Med, 2006. **34**(4): p. 597-603.