Shoulder and Scapular Kinematics during the Windmill Softball Pitch: The Effect of Fatigue

Poster # 46

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Disclosure: We DO NOT have a financial relationship with any commercial interest.
Background

Clinical problem
– The repetitive stress of pitching alters structural and functional mechanics of the shoulder complex.\(^1\)

Figure 1. Six phases of the windmill pitch.

from Maffet et al, 1997\(^2\)
Background

Pitch count

– Guidelines have been adopted by Little League for the young baseball pitcher.\textsuperscript{3}

– No guidelines available for the female windmill (underhand) throwing athlete.\textsuperscript{4}

Kinematics

– Humeral-thoracic kinematics of the windmill softball pitch have been reported.\textsuperscript{5}

– Glenohumeral (GH) and scapulo-thoracic (ST) motions have not been documented during the windmill pitch.

Fatigue during a game length simulation

– Impact of fatigue on performance (ball speed) as well as on GH and ST kinematics is unknown.
Background

Purpose

– To measure **pitching performance, GH and ST kinematics** in high school female windmill softball pitcher
– To identify the **changes in performance and kinematic adaptations due to fatigue** in a simulated game situation
Methods

Subjects
- N = 8 female high school athletes (age range = 14-18 yrs)
- No history of previous shoulder injury

Motion Data Collection
- Kinematics
  - All testing in a motion analysis laboratory
  - 12 camera 3D motion capture system
  - 250 frames/sec
  - Coordinate systems
    - Both passive reflective marker clusters and manual palpating digitizer
    - Hand, forearm, humerus, scapula and trunk segments
    - Marker placement and calibration of bony landmarks
    - Followed ISB recommendations and Kontaxis
    - Custom built scapular tracker, based on Karduna
Methods

Testing Set-up
– Artificial pitching mound, regulation distance (43’) from home plate
– Pitching target with a designated strike zone
– Radar gun for ball speed

Pitching Protocol
– Fastball pitches
– 105 pitches total: 15 pitches x 7 sets
– 5 minutes rest between sets

Outcome Measures
– Ball speed
  • Last 5 pitches from all 7 sets
– GH & ST kinematics
  • Last 5 pitches from first & last sets
Methods II

Kinematics
– Normalized across the throw from Initial-drive (wind-up) to ball release

Figure 1. Six phases of the windmill pitch.
Results: Pitching Performance

Ball Speed Across All Sets

No change within subjects across 105 pitches

Subject 01
Subject 02
Subject 03
Subject 04
Subject 05
Subject 06
Subject 07
Subject 08
Results: GH Kinematics - All Subjects

Kinematics

– Average across subjects:
  • GH kinematics were consistent between Set 1 and Set 7

<table>
<thead>
<tr>
<th>Angle (°)</th>
<th>Pitch from Initial-Drive to Release (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH FLEX/EXT</td>
<td>Set 1</td>
</tr>
<tr>
<td>GH IR/ER</td>
<td>Set 1</td>
</tr>
<tr>
<td>GH ABD/ADD</td>
<td>Set 1</td>
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</tbody>
</table>
Results: GH Kinematics – Representative Subject

GH FLEX/EXT

Set 1  Set 2  Set 3  Set 4  Set 5  Set 6  Set 7

Pitch from Initial Drive to Release (%)
Results: GH Kinematics – Representative Subject

GH ER/IR

No change across 105 pitches for GH kinematics
Results GH Kinematics - All Subjects, Sets 1 & 7

GH IR/ER

Pitch from Initial Drive to Release (%)

Angle (°)

Subj 1 Set 1
Subj 1 Set 7
Results GH Kinematics - All Subjects, Sets 1 & 7

GH IR/ER

Angle (°)

Pitch from Initial Drive to Release (%)

Subj 1 Set 1
Subj 1 Set 7
Subj 2 Set 1
Subj 2 Set 7
Results GH Kinematics- All Subjects, Sets 1 & 7

<table>
<thead>
<tr>
<th>Angle (°)</th>
<th>Pitch from Initial Drive to Release (%)</th>
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<tr>
<td>75</td>
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<tr>
<td>100</td>
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</tr>
</tbody>
</table>

GH IR/ER

- Subj 1 Set 1
- Subj 1 Set 7
- Subj 2 Set 1
- Subj 2 Set 7
- Subj 3 Set 1
- Subj 3 Set 7
Results GH Kinematics - All Subjects, Sets 1 & 7

GH IR/ER

Angle (°) vs. Pitch from Initial Drive to Release (%)

- Subj 1 Set 1
- Subj 1 Set 7
- Subj 2 Set 1
- Subj 2 Set 7
- Subj 3 Set 1
- Subj 3 Set 7
- Subj 4 Set 1
- Subj 4 Set 7
Results GH Kinematics- All Subjects, Sets 1 & 7

GH IR/ER

Pitch from Initial Drive to Release (%)

Angle (°)
Results GH Kinematics- All Subjects, Sets 1 & 7

GH IR/ER

Pitch from Initial Drive to Release (%) vs. Angle (°)

- Subj 1 Set 1
- Subj 1 Set 7
- Subj 2 Set 1
- Subj 2 Set 7
- Subj 3 Set 1
- Subj 3 Set 7
- Subj 4 Set 1
- Subj 4 Set 7
- Subj 5 Set 1
- Subj 5 Set 7
- Subj 6 Set 1
- Subj 6 Set 7
Results GH Kinematics - All Subjects, Sets 1 & 7

Large between- & small within-subject variation
Results: ST Kinematics - All Subjects

Kinematics

– Average across subjects:
  • ST kinematics were consistent between Set 1 and Set 7
Discussion

The study has demonstrated a protocol for the investigation of underhand softball pitching.

- To our knowledge, this is one of the first studies to analyze GH as well as ST kinematics during softball pitching.

For the windmill underhand pitcher, 105 pitches was not sufficient to induce changes in performance or GH and ST kinematics.

- May require more pitches to demonstrate changes with increasing fatigue

- More variation between subjects than within subjects
  - Normalization to specific phases rather than the entire throw may reduce the between pitcher variation for selected phases
Discussion

Ball Speed
- Ball speed was very consistent across subjects throughout the pitching protocol

Shoulder kinematics during the pitching motion demonstrate large and complex GH joint excursions
- Very consistent patterns were observed for all 3 GH rotations

This is an ongoing pilot study and more athlete recruitment is planned to build a database of normative shoulder and full-body kinematics.
References Cited


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Questions?
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