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SHOULDER KINEMATICS OF MALE AND FEMALE HIGH SCHOOL PITCHERS

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SUMMARY

This work investigated of scapular kinematics during a pitching protocol in male and female high school pitchers.

INTRODUCTION

Pitching in sports such as American baseball and softball requires highly coordinated effort between the upper and lower extremity segments. Shoulder injury is a primary concern for these overhead athletes. Investigations into windmill softball mechanics are limited and, in general, full 3D scapular motion has not been reported for male or female pitching athletes.

The objective of this abstract is to quantify the kinematic differences of the shoulder between overhand and underhand pitchers. This project received institution IRB approval.

METHODS

24 high school level pitchers (12 male, 12 female) were recruited by word-out-mouth to participate. Age was restricted to 15-18 years old with no history of injury or pain in the throwing shoulder.

Dynamic data collection was done indoors on a full-size simulated mound with a 12-camera optical motion capture system recording at 250Hz. Pitchers threw into a netted enclosure at a pitching target at high school regulation distance from the mound (male: 60.5 feet, female: 43 feet).

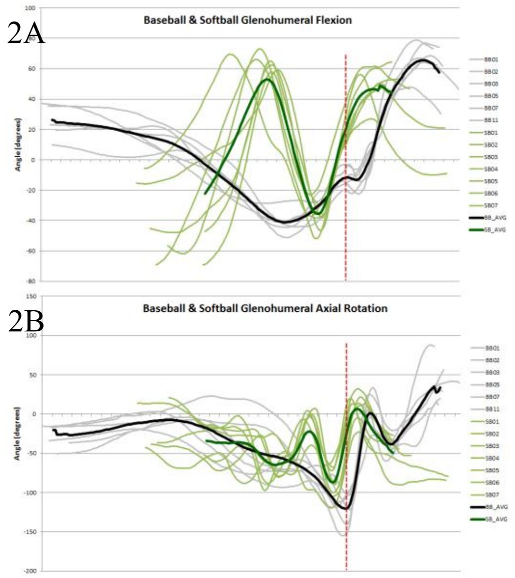
Figure 1. Upper extremity markerset with scapular

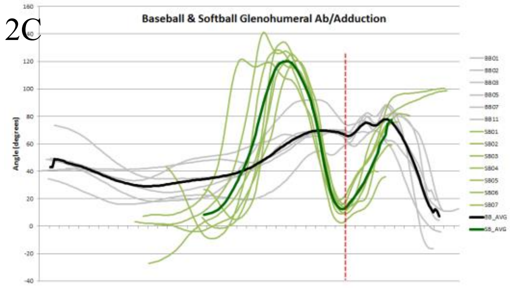
Upper body kinematics (head, thorax, scapula, humerus, forearm, hand) were recorded using a marker set that was designed based on recommendations of Kontaxis et al. [1] (see Figure 1). The scapula was tracked with a marker cluster design based on Karduna et al. [2]. The humerus was tracked with proximal and distal technical frames in order not to underestimate humeral internal/external rotation during the dynamic motion of throwing [3]. Glenohumeral (GH) angular kinematics (humerus in scapula frame) were calculated for both male and female pitchers using a Z-X-Y (Abduction-Flexion-Rotation) Euler rotation decomposition, and scapulothoracic (ST) kinematics (scapula in thorax frame) were calculated using a Y-Z-X (Protraction-Elevation-Tilt) decomposition.

All pitchers were instructed to throw only fastballs; males threw 90 total pitches and females threw 105. Throws were done in 15 pitch bouts to mimic a normal game inning sequence. Five minutes rest was taken in between bouts for recovery. Kinematics were calculated and plotted between the following start and stop events: Knee-Up (baseball, maximum height of the leading knee) and Initial Drive (softball) to follow-through (post ball release forearm velocity minimum). All plots were aligned to a common event – release of the ball.

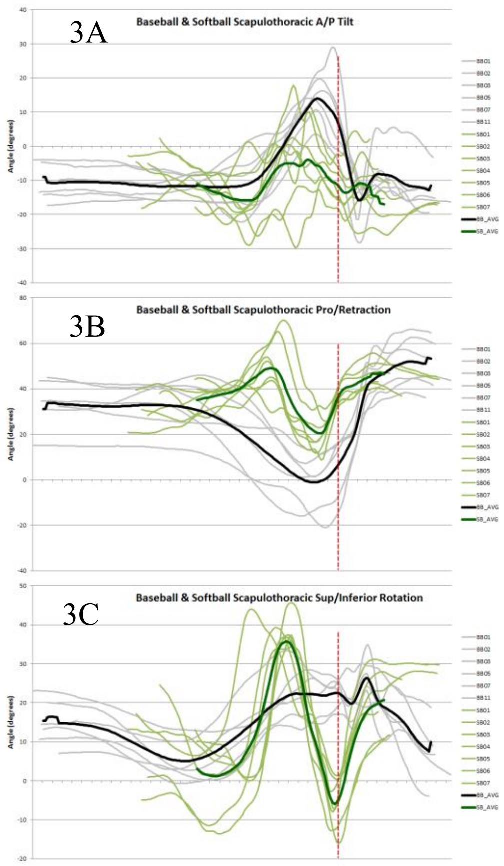
RESULTS AND DISCUSSION

This is an ongoing investigation where seven softball and six baseball pitchers' data have been processed at the time of abstract submission. Glenohumeral (Figure 2) and scapulothoracic (Figure 3) kinematics are reported both as average per subject of last five pitches in the first set. The average of all male and female participants is also shown.





Figures 2A-C. Glenohumeral kinematics comparing overhand baseball and windmill softball pitching; light grayscale and green curves denote individual baseball and softball subject averages, respectively; thick lines are overall baseball and softball means. Ball release is shown as a vertical dashed red line.



Figures 3A-C. Scapulothoracic kinematics comparing overhand baseball and windmill softball pitching.

As expected the male overhand pitching motion is very different from the female windmill motion with the males having larger ext/internal GH ROM and the female athletes having a larger Ab/Adduction ROM. For scapula ROM the retraction/protraction and A/P tilt values of the baseball pitchers was larger than in the windmill athletes (Table 1).

All reported kinematic curves were aligned to the release of the ball because of the wide temporal variation seen between subjects.

Overall scapular rhythm was observed to be similar between male (slope = 0.285) and female (slope = 0.291) pitching (Figure 4), however this data is presented over the entire pitching motion and analysis of specific within-pitch phases may yield different conclusions.

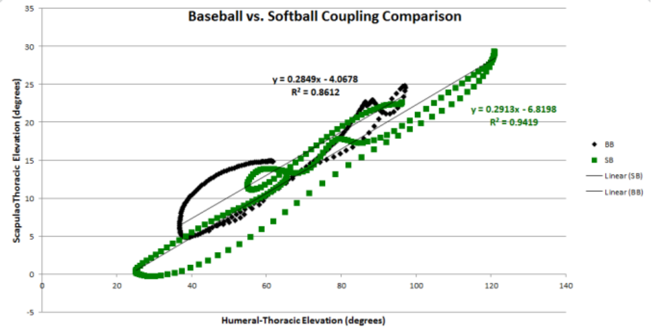


Figure 4. Angle-angle coupling plot of scapula rhythm kinematics for overall average overhand (black) and windmill (green) pitching.

Shoulder Joint Parameters	Baseball (6)	Softball (7)
GH Flexion ROM(°)	113.1 ± 11.4	125.8 ± 13.1
GH Abduction(°)	83.7 ± 17.4	130.7 ± 12.3
GH Rotation(°)	188.1 ± 21.2	133.0 ± 14.0
ST Tilt(°)	39.9 ± 8.4	26.2 ± 3.0
ST Protraction(°)	56.6 ± 6.6	41.4 ± 6.0
ST Sup/Inf Rot(°)	27.8 ± 7.4	49.7 ± 5.5
Scapular Rhythm	0.285	0.291

Table 1. Shoulder ROM (Mean ± 1.0 SD) comparison between baseball and softball pitching motions for glenohumeral (GH) and scapulothoracic (ST) joints.

CONCLUSIONS

To the authors' knowledge the results presented are new and provide evidence to show that the overhand and windmill pitching motions are different at the level of the shoulder. Qualitatively, marked differences are seen between baseball and softball pitching in all rotational planes at the glenohumeral and scapulothoracic joint. This work provides a normative dataset for shoulder kinematics in the male overhead and female windmill pitching athlete.

This work is part of a larger study investigating the pitching motion and fatigue across a large number of throws. Future work will analyze shoulder kinematic patterns in relation to pitching performance as well as possible compensatory lower body motion. Practically, this information will contribute to the knowledge of those interested in preventing musculoskeletal injury in the throwing athlete.

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ACKNOWLEDGEMENTS

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