



Original research

The relationship between clinically measured hip rotational motion and shoulder biomechanics during the pitching motion



Kevin Laudner^{a,b,*}, Regan Wong^b, Takashi Onuki^b, Robert Lynall^c, Keith Meister^b

^a Illinois State University, United States

^b Texas Metroplex Institute for Sports Medicine and Orthopedics, United States

^c University of North Carolina at Chapel Hill, United States

ARTICLE INFO

Article history:

Received 3 March 2014

Received in revised form 17 July 2014

Accepted 19 July 2014

Available online 30 July 2014

Keywords:

Throwing athlete

Kinetic chain

Upper extremity

Lower extremity

ABSTRACT

Objectives: To examine how clinically measured hip motion is related to shoulder biomechanics during the pitching motion.

Design: Cross-sectional.

Methods: Bilateral hip rotational range of motion was measured clinically among 34 collegiate baseball pitchers. External rotation torque and maximum horizontal adduction range of motion of the throwing shoulder were measured using a three-dimensional, high speed video capture system.

Results: Separate standard multiple regression analyses showed that the total hip rotational range of motion of the lead leg had a significant relationship with shoulder external rotation torque during the throwing motion ($r=0.56$, $P=0.003$). Both lead leg hip external rotation range of motion ($r=-0.39$, $P=0.02$) and internal rotation range of motion ($r=0.42$, $P=0.009$) made significant contributions to this dependent variable. Lead leg external rotation range of motion also had a significant negative relationship with shoulder horizontal adduction range of motion ($r=-0.36$, $P=0.04$). The total rotational range of motion of the trail leg had a significant relationship with shoulder horizontal adduction range of motion ($r=0.43$, $P=0.04$). However, trail leg external rotation range of motion was the only significant contributor to this relationship ($r=-0.35$, $P=0.04$). No other significant relationships were noted ($r<0.37$, $P>0.11$).

Conclusions: Our results demonstrate that altered hip rotational range of motion, measured clinically, has a direct effect on the amount of external rotation torque and horizontal adduction range of motion of the shoulder during the throwing motion.

© 2014 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Described as one of the most highly dynamic skills in all sports,¹ baseball pitching requires contributions from the entire kinetic chain.^{2,3} The lower extremity provides vital energy, which must be transferred through the trunk to the shoulder, arm, hand, and finally to the ball during every pitch. The large muscles in the legs, hip, and trunk act as force generators while the smaller musculature of the shoulder funnel these forces to the arm and ball.⁴ Thus, when the kinetic chain is disrupted, pitchers may accommodate by placing a greater role on upper extremity force generation. Therefore, in order to optimize performance and reduce the risk of injury, especially in the upper extremity, all segments of the kinetic chain must effectively work together.

To maximize the energy transfer from the lower to the upper extremity, the lead leg (leg on opposite side of throwing arm) must be positioned correctly during the acceleration phase of the throwing motion, allowing for proper rotation of the pelvis, hips, and trunk.^{1,5} The appropriate location of the lead leg foot as it contacts the ground has been described as being in front of the trail leg (leg on same side of throwing arm) foot with a slight toe-in orientation.^{1,5} Because of the large amounts of torque transmitted to the upper extremity, improper sequencing of motion between the lower and upper extremity has been cited as a potential risk factor for shoulder pathology among these athletes.^{6–9}

Because clinical measurements during the actual throwing motion are difficult to conduct without the use of sophisticated and expensive laboratory equipment, it is important to understand the relationships between clinical examination and throwing biomechanics. It is also critical to understand the effect specific lower extremity characteristics have on shoulder motion and forces generated during the throwing motion. Thus, the purpose of this study was to determine the relationship between clinical measurements

* Corresponding author.

E-mail address: klaudner@ilstu.edu (K. Laudner).

of hip rotational range of motion (ROM) and the amount of torque and motion developed in the shoulder during the throwing motion. We hypothesized that clinical measurements of hip rotational ROM would have a direct relationship with dominant shoulder torque and horizontal adduction ROM during the throwing motion. Being able to recognize lower extremity deficits clinically may be beneficial in the proper recognition and treatment of various upper extremity disorders that are the result of the accumulation of forces sustained during the throwing motion.

2. Methods

Thirty-four NCAA, Division I baseball pitchers (age = 20 ± 1.3 years; height = 187.2 ± 5.8 cm; mass = 86.9 ± 6.8 kg) voluntarily participated in this study. All participants had no recent history of upper or lower extremity injury (past 3 months) and no history of upper or lower extremity surgery.

Each participant attended one testing session in a motion analysis laboratory and provided informed consent as approved by the university's ethics review committee (IRB# 2011-0010). Height, mass, radius length, humerus length, and past medical history were obtained. The lead leg was defined as the leg on the opposite side of the throwing arm and has been previously described as the leg that contacts the ground at the initiation of the cocking phase.⁴ The trail leg was defined as the leg on the same side as the throwing arm, which remains in contact with the ground during the stride phase of the throwing motion.¹⁰

Prior to any warm up, stretching, or throwing, bilateral hip rotational ROM were taken with the participant lying in a prone position and the knee flexed to 90° . The shank was passively rotated by one examiner until reaching the end ROM while the same examiner applied a stabilizing force to the posterior pelvis to limit pelvic rotation. The end ROM was defined as the point of first resistance without applying any overpressure. In this position, a second examiner aligned the Pro 3600 Digital Inclinometer (SPI-Tronic, Garden Grove, CA) with the tibial tuberosity and the midpoint between the medial and lateral malleoli. This digital inclinometer was modified with a reference line positioned along the midline of the device, which was used for proper alignment of anatomic landmarks. This alignment created an angle between the shank and a vertical reference line determined by the inclinometer. To determine the reliability of this measurement 22 participants (different individuals than those used for primary purpose of this study) completed pretest and posttest sessions, which were a minimum of 24 h apart. Our intraclass correlation coefficients for these internal and external hip rotation measurements were 0.95 and 0.92, respectively. Furthermore, the standard error of measurement values for assessing hip internal and external rotation ROM were 2.8° and 3.3° , respectively.

Prior to pitching data collection, all participants were instructed to proceed through their preferred warm-up routine (e.g. static and dynamic stretching, throwing exercises, and pitching specific exercises). Upon completion of the warm-up, 26 spherical 1.27 cm diameter reflective markers (Motion Analysis Corporation, Santa Rosa, CA) were placed on each participant using a standard setup and secured with electrode collars and tape.^{11–13} Markers were placed on the throwing arm side radial and ulnar styloids and third metacarpal. Bilateral markers were placed at the superior lateral acromions, lateral humeral epicondyles, anterior and posterior hips, medial and lateral femoral epicondyles, medial and lateral malleoli, between the second and third metatarsal heads, and on the calcaneus. Markers were also placed on the right side, left side, and top of the head (markers were attached to a hat worn by each pitcher). Participants wore spandex shorts and no shirt to limit movements of the markers from the anatomical landmarks during the pitching motion.

Table 1

Descriptive statistics for hip range of motion measured clinically.^a

Hip motion	Lead leg ($^\circ$)	Trail leg ($^\circ$)
Internal rotation	27.7 ± 5.9	28.9 ± 7.2
External rotation	35.8 ± 3.4	35.4 ± 6.2
Total arc of motion	63.4 ± 7.0	64.2 ± 8.4

^a Values are presented as mean \pm standard deviation.

Once this set-up was complete each participant acclimated himself to a collegiate regulation indoor pitching mound (Osborne Innovative Products, Inc., Jasper, IN) and threw to a strike zone target positioned 18.4 m away. Five representative fastball trials were gathered for each pitcher with typical throwing mechanics by what felt natural for each respective participant. Wild pitches and those pitches excluded by the athlete were not part of the subsequent data collection. All pitches were charted for location from behind the athlete and pitch velocity was assessed using a radar gun (Stalker Sport, Plano, TX) at a point directly behind the target zone for accuracy and consistency of readings. These pitches were recorded using 8 electronically synchronized high-speed (240 Hz) Eagle digital cameras (Motion Analysis Corporation, Santa Rosa, CA) that surrounded the pitching mound. The average of three fastballs, thrown for strikes, with the highest ball speeds was used for analysis.

The reflective markers were tracked using ExpertVision software (Eva 6.0, Motion Analysis Corporation) and three-dimensional coordinate data was determined using the direct linear transformation method. The joint centers of the throwing and non-throwing shoulder and elbow were estimated as previously described by Fleisig et al.⁸ Coordinate data were then filtered using a Butterworth fourth-order, zero-lag digital filter (cutoff = 10 Hz). In order to calculate shoulder torque the methods previously described by Feltner and Dapena¹⁴ were used. Shoulder horizontal adduction ROM was calculated using the methods described by Werner et al.^{11,12} To normalize data between participants, torque was expressed as percent body weight \times height.

Separate standard multiple regression analyses with Predictive Analytics Software (Version 18.0, International Business Machines Corp, Armonk, NY) were used to determine if relationships existed between hip external rotation ROM variables (independent variables) and external rotation torque produced at the throwing shoulder, as well as maximum shoulder horizontal adduction ROM during the throwing motion (dependent variables). The alpha level was set at 0.05 prior to all analyses.

3. Results

The average and standard deviation for shoulder external rotation torque and shoulder horizontal adduction ROM while throwing were $5.1 \pm 1.0\%$ body weight \times height and $21.0 \pm 8.1^\circ$, respectively. The descriptive characteristics for clinical hip ROM measurements can be found in Table 1. Paired *t* tests showed that there were no bilateral differences in either hip external rotation ($P=0.64$) or internal rotation ($P=0.39$).

All relationships between lead leg hip characteristics and throwing biomechanics can be viewed in Table 2. A moderate relationship was found for total hip rotational ROM measured clinically of the lead leg and shoulder external rotation torque during the throwing motion ($r=0.56$, $P=0.003$). Both lead leg hip external rotation ROM ($r=-0.39$, $P=0.02$) and internal rotation ROM ($r=0.42$, $P=0.009$) made significant contributions to the dependent variable. Lead leg external rotation ROM also had a significant negative relationship with shoulder horizontal adduction ROM ($r=-0.36$, $P=0.04$).

All relationships between trail leg hip characteristics and throwing biomechanics can be viewed in Table 3. Total hip rotational ROM

Download English Version:

<https://daneshyari.com/en/article/5872853>

Download Persian Version:

<https://daneshyari.com/article/5872853>

[Daneshyari.com](https://daneshyari.com)