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The effect of age on elbow range of motion in pitchers

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ABSTRACT

Background: Alteration of elbow range of motion (ROM) has been observed in baseball pitchers. This study aims to compare dominant elbow ROM between early-puberty, late-puberty, and young–adult pitchers.

Methods: We recruited 62 pitchers, consisting of 17 early-puberty (mean age 13.1 years old), 22 late-puberty (mean age 17.7 years old), and 23 young–adult players (mean age 19.4 years old). Dominant elbow ROMs was measured. One-way ANOVA was used to compare the differences in elbow ROM variables between 3 groups.

Results: Late-puberty pitchers exhibited a significantly lower elbow hyperextension and flexion than early-puberty or young–adult pitchers ($P < .05$). Valgus angle was significantly lower in young–adult ($7.7° \pm 5.5°$) versus early-puberty ($12.1° \pm 2.3°$) and late-puberty pitchers ($13.0° \pm 4.1°$; $P < .05$). Young–adult pitchers had the largest forearm supination range ($101.2° \pm 18.1°$), followed by early-puberty ($82.5° \pm 6.5°$; $P < .05$) and late-puberty pitchers ($70.6° \pm 15.8°$). Elbow flexion-hyperextension total range was smallest in late-puberty pitchers ($130.3° \pm 7.4°$), followed by young–adult ($142.6° \pm 9.3°$) and early-puberty pitchers ($144.6° \pm 8.3°$; $P < .05$). Forearm pronation–supination total range was also smallest in late-puberty pitchers ($142.0° \pm 20.3°$), followed by early-puberty ($159.8° \pm 9.5°$) and young–adult pitchers ($177.2° \pm 20.8°$; $P < .05$).

Conclusions: These results indicate that careful monitoring of the elbow and forearm range of motion should be undertaken in adolescent baseball pitchers to prevent and or minimize injury risk.

1. Introduction

Elbow injury is commonly seen in baseball. Previous baseball injury data have reported a 20–26% elbow injury rate for teenage pitchers (Chang, Chen, Jong, Lin, & Wang, 2007; Harada, Takahara, Mura, Sasaki, Ito, & Ogino, 2010; Lyman et al., 2001), and another study found an 18–56% injury rate among high school players in Taiwan (Chang, Chang, & Jong, 2010; Chang et al., 2007). In addition, the injury surveillance system of the NCAA revealed that the total incidence of elbow injury from 1988 to 2004 was approximately 3.2% at the collegiate level, and during training the injury rate increased to 7.8%, of which 8.1% were severe elbow injuries where players were absent from training and competitions for over 10 days (Dick et al., 2007). Recent studies have revealed that elbow injury in younger players is usually associated with muscle overuse, muscle fatigue (Rizio & Uribe, 2001), insufficient muscle endurance (Shanley, Rauh, Michener, Ellenbecker, Garrison, & Thigpen, 2011), excessive number of pitching innings (Harada et al., 2010), and curveball throwing (Olsen, Fleisig, Dun, Loftice, & Andrews, 2006; Nissen, Westwell, Ounpuu, Patel, Solomito, & Tate, 2009). These factors bring potential impact to elbow joint range of motion (ROM), raising the rate of elbow injury and altering throwing kinematics (Huang, Wu, Learman, & Tsai, 2010; Shanley et al., 2011). Therefore, evaluation of elbow ROM in younger baseball players is important.

Previous research has found that around 12% of Little League pitchers have a slight restriction in their active extension ROM of the elbow, and a slight increase in the valgus carrying angle of the

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elbow in their dominant arm (Gugenheim, Stanley, Woods, & Tullos, 1976). Chang et al. (2010) also found that adolescent baseball players showed significantly smaller angles of dominant elbow flexion, hyperextension, supination, pronation–supination total range, and non-dominant supination range than do normal adults, and pitchers showed a larger elbow valgus angle than fielders did. Reinold et al. (2008) assessed elbow ROM before, immediately after, and one day after pitching, and found that angles of elbow flexion and extension decreased, and these decreases were sustained one day after pitching (Reinold et al., 2008). Brown, Niehues, Harrah, Yavorsky, and Hirshman (1988) performed upper extremity ROM measurements on 41 professional baseball pitchers and found that the angle of forearm pronation increased, whereas the angles of elbow extension, flexion, and forearm supination decreased in pitchers' dominant compared to their non-dominant arm (Brown et al., 1988). Wright, Steger-May, Wasserlauf, O'Neal, Weinberg, and Paletta (2006) conducted elbow ROM measurements on 33 professional pitchers and found elbow extension, flexion and total flexion–extension arc angles decreased in the dominant vs. non-dominant arms (Wright et al., 2006).

Although alteration of elbow ROM has been observed in baseball pitchers at all age levels, no studies have been conducted comparing differences in elbow ROM as pitchers grow from adolescence to maturity. Bone maturity, age, player experience, and number of pitches may affect elbow ROM. These factors are important for clinicians to consider and understand how elbow ROM varies in relation to time. Therefore, this study had two aims: the first was to compare the differences in dominant elbow ROM for baseball pitchers in three age groups, while the second aim was to find the relationship between age, playing experience, and variables of elbow ROM.

2. Materials and methods

2.1. Participants

Sixty-two pitchers, consisting of 17 early-puberty players (mean age: 13.1 years), 22 late-puberty players (mean age: 17.7 years), and 23 young–adult players (mean age: 19.4 years), voluntarily underwent elbow ROM measurements. Participant demographic variables are summarized in Table 1. All subjects were asymptomatic for shoulder pain and elbow pain during the measurement period and had not undergone prior shoulder or elbow joint surgery. All measurements were performed before the beginning of daily training. Before the testing day, the subject cannot have excessive exercise training or competition. Moreover, all subjects agreed to receive the evaluations and signed informed consent forms before the assessments were performed. This study has obtained approval from the University Institutional Review Board.

2.2. Elbow range of motion assessment

A stainless steel goniometer (Sammons Preston Rolyan, A Patterson Medical Products, Inc., Bolingbrook, IL) was used to assess dominant elbow ROM, including elbow flexion, hyperextension, supination, pronation, and valgus angles. The order in which these factors were assessed was randomly selected.

When elbow flexion and hyperextension measurements were performed, the subjects were sitting and the fulcrum of the goniometer was placed on the lateral epicondyle of the humerus, parallel to the stationary arm, with the longitudinal axis made by the line between the humerus and acromion process. The movable arm was parallel to the longitudinal axis made by the line between the radius and radial styloid process. Elbow hyperextension was measured starting from full elbow extension (0°), and the terminal angle was recorded. Positive values indicated elbow hyperextension, while negative values indicated elbow flexion contracture. Elbow flexion was measured from full elbow extension to full flexion, and the terminal angle was recorded (Clarkson, 2000). The flexion angle and the hyperextension angle were summed to determine the flexion–hyperextension total range of the elbow. The forearm pronation and supination measurements were performed while subjects were sitting with the test elbow flexed at 90°. The forearm was placed in mid-position while the subject gripped a pen in their fist. The fulcrum of the goniometer was placed on the head of the third metacarpal and the movable arm was parallel to the pen while the stationary arm was perpendicular to the ground. The terminal angle of forearm rotation in the direction where the palm rotated to face the floor was recorded as forearm pronation; that of forearm rotation in the direction where the palm rotated to face the ceiling was recorded as forearm supination (Clarkson, 2000). The pronation and supination angles were summed to determine the pronation–supination total range of the forearm. The elbow valgus measurement was performed while subjects were sitting with arms fully extended and palms facing the ceiling. The fulcrum of the goniometer was placed on the antecubital crease of the elbow joint; the stationary arm was parallel to the centerline of the upper arm and the movable arm was parallel to the centerline of the forearm. The angle between the stationary arm and the movable arm was recorded (Clarkson, 2000; Magee, 1997).

2.3. Test–retest reliability of elbow range of motion measurement

The test–retest reliability of elbow ROM measurements has been previously established (Chang et al., 2010; Chunang et al., 2007). For our measurements, the intra-class correlation coefficient (ICC) for elbow flexion angle measurement was 0.800, while the ICC for assessment of the hyperextension angle was 0.655. The ICC values for assessment of the pronation and supination angles were 0.806 and 0.864, respectively. The ICC value for the assessment of elbow valgus angle was 0.661. All measurements in this study were performed by a senior physical therapist (H.Y.C.).

2.4. Statistical analysis

SPSS 17.0 for Windows (Chicago, IL) was used to perform all statistical analysis. One-way ANOVAs were used to compare the

Table 1
Demography data of the baseball pitchers.

	Early-puberty players	Later-puberty players	Youth adult players
N	17	22	23
Age, years	13.1 ± 0.6	17.7 ± 0.9	19.4 ± 1.9
Height, cm	156.9 ± 10.3	176.4 ± 6.4	176.4 ± 5.3
Weight, kg	50.8 ± 11.1	72.9 ± 8.8	74.9 ± 9.6
Body mass index (BMI)	20.5 ± 3.0	23.4 ± 2.1	24.0 ± 2.8
Playing experience, years	3.8 ± 1.5	7.0 ± 1.8	9.8 ± 1.9