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ORIGINAL ARTICLE

Differences in humeral retroversion in dominant and nondominant sides of young baseball players

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Background: The relationship between the disabled throwing shoulder and humeral retroversion has recently attracted a great deal of attention. However, none of the previous studies clarified when the side-to-side difference of humeral retroversion in young baseball players would start. This study aimed to clarify when the difference of humeral retroversion in the dominant and nondominant sides appeared in baseball players.

Methods: The bicipital-forearm angle in bilateral shoulders of 172 elementary school baseball players was measured by ultrasound. The bicipital-forearm angle was defined as an angle between the perpendicular line to the bicipital groove and the ulnar long axis with the elbow flexed at 90°. The correlation between the bicipital-forearm angle and the grade and the difference of the bicipital-forearm angle between the dominant and nondominant sides were analyzed.

Results: In the nondominant shoulders, the bicipital-forearm angle increased with the grade in school ($r = 0.32$, $P < .0001$), but this was not observed in the dominant shoulders. In the fourth to sixth graders, the bicipital-forearm angles were significantly smaller in the dominant shoulders than in the nondominant shoulders.

Conclusion: Our findings indicated that humeral retroversion decreased with age in the nonthrowing side but not in the throwing side and that the side-to-side difference of humeral retroversion in the baseball players became obvious from the fourth grade. We assume that the repetitive throwing motion restricts the physiologic humeral derotation process and the difference became apparent from the fourth grade when the growth spurt begins in boys.

The Tohoku University School of Medicine Ethics Committee approved the protocol of the present study (2013-1-139, 2013-1-153).

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During baseball pitching, the lower extremities and trunk generate the large forces for producing exceeding linear and angular velocities at ball release.[8] Performing this throwing motion repetitively produces torque and distraction forces at the shoulder, which may cause soft tissue and osseous changes.[27,28] An increase in the external rotation angle and decrease in the internal rotation angle with the arm at 90° of abduction in the dominant shoulders of overhead throwing athletes are well known.[1,3,5,7,16,25,26] The shift of rotation in throwing shoulders is partially explained by humeral retroversion of the dominant arm. Humeral retroversion is also known to be greater in the dominant arm than in the nondominant arm in collegiate and professional baseball players.[5,21,25]

Polster et al[23] reported a trend that pitchers with smaller differences of humeral retroversion in the dominant and nondominant shoulders with lower degrees of retroversion of the dominant shoulder have more severe throwing injuries. Some studies have recently investigated the relationship between the risk of throwing injury and humeral retroversion.[20,23,31]

Several tools, such as radiographs, magnetic resonance imaging, computed tomography, and ultrasonography, have been reported for measuring humeral retroversion angle.[2,4,12,15,19-22,25,29,30,32-34] The reproducibility of measurement by ultrasound was recently investigated.[18,35] Myers et al[18] performed a validation study of the ultrasound measurement compared with the computed tomography measurement. Ultrasound measurement has been used widely because it is not invasive to the players and the device is simple and easy to operate.

The greater humeral torsion in the dominant shoulder was thought to be caused by adaptive changes in response to the repetitive stress of throwing.[5] Although Yamamoto et al[34] reported that the side-to-side difference of humeral retroversion has already occurred in the fifth grade of elementary school, players before the fourth grade have not been sufficiently investigated. The aim of this study was to clarify when the difference of humeral retroversion in the dominant and nondominant shoulders would start by examining the elementary school baseball players.

Materials and methods

Participants

This retrospective case-control study recruited 172 male elementary school baseball players. Their mean grade was 3 (9 years old). Their mean height and weight were 133.0 ± 10.5 cm and 30.3 ± 8.2 kg, respectively. There were 41 first graders, 33 second graders, 26 third graders, 33 fourth graders, 29 fifth graders, and 10 sixth graders. Their mean frequency of playing baseball per week was 1.4 times in first graders, 1.3 times in second graders, 1.3 times in third graders, 2.0 times in fourth graders, 2.2 times in fifth graders, and 2.8 times in sixth graders. The mean term of overhead throwing experience was 1.9 ± 1.2 years. All of the children were healthy and had no shoulder and elbow pain at the time of examination. Participants with a history of upper extremity fracture were excluded.

Procedures

All subjects attended medical check-up for baseball. Before examination, all subjects and their parents read and signed the informed consent forms approved by the Tohoku University Institutional Review Board.

Humeral torsion was assessed using the ultrasound measurement method described by Yamamoto et al[34] and others.[15,18,30] Humeral retroversion was measured for the dominant and nondominant sides, without the examiners being informed of the dominant side. The detailed measurement procedure conducted was as follows (Fig. 1): the bicipital-forearm angle (BFA) was measured with a digital inclinometer and a SonoSite M-turbo (SonoSite Inc., Bothell, WA, USA) portable ultrasound device. Subjects lay supine on an examination table with 90° of shoulder abduction and elbow flexion. The examiner rotated the subject's humerus so that the entrance of the bicipital groove appeared in the center of the ultrasound image, with the line connecting the apexes of the greater and lesser tuberosities being parallel to the horizontal plane. Another examiner then placed a digital inclinometer along the ulnar border with the forearm kept in neutral rotation and recorded the ulnar inclination angle with respect to the horizontal line.

Validation of our ultrasound measurement

Before starting this study, we used embalmed cadavers to investigate the accuracy of our measurement method. The BFA and humeral retroversion angle were not equal, so the relationship between humeral retroversion and BFA was assessed. First, the BFAs of 10 cadaveric shoulders were assessed using the ultrasound technique described by Yamamoto et al.[34] Next, after removing the soft tissue from the humeral bone, we used a digital camera to photograph the humeral bones along the long axis from the proximal and distal side. These photographs were imported into our personal computer, and humeral retroversion angle was measured as the angle between the proximal and the distal humeral axes. The relationship between the difference of the bilateral BFAs and that of humeral retroversion was examined by the Spearman rank correlation coefficient. The results of validation study are reported in Table I. The correlation coefficient between the difference of bilateral BFA and the difference of humeral retroversion was $r = -0.9277$ ($P = .023$).