Elbow Valgus Instability Affect Stress Distribution Pattern in Baseball Players Assessed by Computed Tomography Osteoabsorptiometry

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Disclosures:

INTRODUCTION:
A delicate balance of elbow mobility and stability is required for throwing. Repetitive hyperangulation leads to tensile stressing of the ulnar collateral ligament. Little attention has been given to perform biomechanical studies on the stress distribution across the elbow joint, because of difficulties in direct measurement and in determining loading conditions. Previous study showed pitching activities increase actual stress on the elbow or shoulder joint assessed by computed tomography osteoabsorptiometry\(^1\)\(^-\)\(^3\). We hypothesized that mineral density in the subchondral bone of the elbow joint in baseball players with would be affected by elbow valgus instability during the pitching action. The aims of the current study were to evaluate the distribution of subchondral bone density across the elbow joint surface in asymptomatic non-throwing volunteers, asymptomatic baseball pitchers and symptomatic players with elbow valgus instability, and to clarify any alterations in the distribution of subchondral bone density associated with elbow valgus instability.

METHODS:
Computed tomography (CT) image data from the throwing side shoulder of 5 non-throwing volunteers, 10 college baseball players were collected for the current analysis (all men aged 19-21, mean 20.8 years). No subject had experienced any operations in either elbow within 3 years before the study commenced or had any history of elbow trauma. The baseball players were divided into 2 groups; the asymptomatic group and the symptomatic elbow valgus instability group.

A 3-dimensional (3D) bone model was created from the transferred axial image data, and then sagittal views at 1 mm intervals were reconstructed from the 3D model. The sagittal images were transferred to a personal computer, and newly developed software (OsteoDens 4.0) was used for further measurements. The subchondral bone region of the articular surface of the distal humerus—the target region for measurement—was identified automatically using the software. In each slice, bone density of the identified subchondral bone region was measured in Hounsfield units (HU; a unit of X-ray attenuation) at each coordinate point with 1 mm intervals. For each subject, the range between the maximum and minimum HU values was divided into 9 equal grades to generate a surface-mapping image depicted by a color scale (Figure 1).

Quantitative analysis of the mapping data focused on the location of high-density regions around the glenoid cavity. The percentage of high-density region (%HDR) in each articular segment of the distal humerus was calculated and compared statistically between groups. The high-density region was defined as regions where HU values were higher than 1200 HU (grades 7, 8 and 9 on the color scale). The distal humerus was divided into 6 regions (Figure 2).

All statistical analyses were performed using JMP 8.0 (SAS Institute, Cary, NC, USA). Statistical comparisons between groups and in each region were conducted using analysis of variance (ANOVA). The multiplicity of comparisons was adjusted by Turkey’s method; \(P < .05\) was assumed to be statistically significant.

RESULTS:
The %HDR values in the total articular surface in the instability groups were significantly greater than in the asymptomatics and the controls (\(P = .0002\) and = .0451, respectively; Figure 3, 4). In the instability group, the %HDR values in the AC segments were also significantly higher than in the control group (\(P = .0008\) Figure 3, 4).

DISCUSSION:
This study revealed that the high-density region of the distal humerus in the baseball players was significantly increased in the compared with the control group. Moreover, elbow valgus instability affected the anterolateral and anterocentral region in the articular surface of the distal humerus. These results indicate that elbow valgus instability is a risk factor of osteochondritis dissecans of the capitellum. This stress distribution pattern of the elbow in throwers may support theoretical background of throwing injury.

Our study had several limitations. We could not measure stress acting on the shoulder joint directly. Second, we have no data on age-dependent differences in subchondral bone mineral density patterns in the same subject.

SIGNIFICANCE:
Throwing motion affects stress concentration of the distal humerus. The analysis of stress distribution patterns help to clarify the mechanism of the throwing injury.
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Figure 1. The subchondral bone region of the elbow joint was identified automatically using customized software.

Figure 2. Segments used for quantitative analysis of the bone density mapping data for the articular surface of the distal humerus: anterolateral part (AL), anterocentral part (AC), anteromedial part (AM), posterolateral part (PL), posterocentral part (PC), posteromedial part (PM).

Figure 3. Distribution of the subchondral bone density across the distal humerus. A, Control group; B, Asymptomatic group; C, Instability group

Figure 4. Comparisons of the percentages of high-density regions (%HDR) between groups.
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