Physical functions, to be or not to be a risk factor for osteochondritis dissecans of the humeral capitellum?

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Background: Physical risk factors for osteochondritis dissecans (OCD) of the humeral capitellum in young baseball players have not been fully elucidated. We aimed to identify the risk factors for capitellar OCD in baseball players aged 8-14 years.

Methods: Between December 2018 and December 2019, young baseball players were recruited from 8 regional baseball leagues. Ultrasonography and physical assessments were performed preseason and at the end of the study period. Bilateral passive ranges of motion (ROM) of the shoulders, internal rotation (IR) of the hips, and the thoracic kyphosis angle were measured. 1-year follow-ups were scheduled to determine the occurrence of OCD. Players with OCD were categorized into the OCD group; those without OCD and any elbow pain for one year were categorized into the non-injured group. The players’ baseline data (age, sex, position in baseball, and Rohrer’s Index) were analyzed using univariate analyses. Their physical parameters were analyzed using two-way analysis of variance with repeated measures to investigate OCD-related risk factors.

Results: In total, 3651 baseball players attended the 1-year follow-up. Of these, 71 (1.9%) players had OCD of the humeral capitellum. In the OCD group, a significant association was found at baseline and at the end of the study period between a higher Rohrer index at the baseline and a smaller hip IR ROM on the nondominant side.

Conclusions: Loss of hip IR ROM on the nondominant side is a newly discovered risk factor related to physical function in the development of OCD.
Osteochondritis dissecans (OCD) of the humeral capitellum is a critical and relatively rare injury in young baseball players. Nonoperative treatment of capitellar OCD involves long-term rest from throwing, surgical treatments recommended for young baseball players with advanced stage capitellar OCD,2,20 Previous cross-sectional studies have reported the prevalence of capitellar OCD to range from 1.3% to 3.4%.3,5,17 The incidence of capitellar OCD has been reported in a limited number of prospective cohort studies. Matsuura et al11 showed that the incidence of capitellar OCD within a 1-year period in young baseball players was 1.8%.

In athletic overhead throwing, the elbow is subjected to valgus overload.16 Valgus stress increases contact pressure in the radio-capitellar joint.11 The cause of OCD of the humeral capitellum might be due to repetitive compression forces on the humeroradial joint, and this microtrauma may lead to articular cartilage changes and stress reactions to subchondral bone (humeral capitellum). However, one previous study found no association between the player position, age at starting to play baseball, and years of play, and capitellar OCD.11 Some studies have reported that the risk factors for capitellar OCD include ischemia of the humeral capitellum4,24 and genetic factors.22 However, no definitive study of the risk factors associated with capitellar OCD has been published.

Two prospective studies have identified some physical risk factors for throwing elbow injury in adolescent and youth baseball players.18,21 With respect to height and weight, Lyman et al18 reported that much taller or heavier players were at an increased risk of elbow pain occurrence. Shanley et al21 reported that posterior shoulder tightness conferred a greater risk for throwing injuries in adolescent baseball players. Sakata et al18 reported that the risk of medial elbow injury increased in young players with excessive thoracic kyphosis and in those with a silent elbow extension deficit. They also reported a significant relationship between medial elbow injury and decreased hip flexibility.18 However, no previous studies have investigated the physical functions associated with lateral elbow injury in young baseball players because of the low prevalence of capitellar OCD. Therefore, this prospective study aimed to identify the physical risk factors for capitellar OCD in young baseball players. We hypothesized that players with shoulder tightness and hip rotational ROM deficits would be at greater risk of OCD than those without.

Materials and methods

This multicenter, prospective, cohort study across 8 regions covered a baseball season (December 2018 to December 2019). Ethical approval was obtained from the appropriate institutional review board. We recruited young baseball players (age, 8-14 years) who played for baseball leagues from each region, and informed consents were obtained from all participants and their guardians prior to the study enrollment. Exclusion criteria comprised players (i) who were injured at the initial examination, (ii) unable to undergo the physical assessments, and (iii) with a diagnosis of OCD at the initial examination.

Baseline data including age, sex, and the position in baseball (a pitcher or other) were collated for analysis. Players’ height and weight were measured. Normal body mass index (BMI) values in children and adolescents vary as they gain in height and weight15; therefore, Rohrer’s Index (weight (kg)/height (m)\(^3\) \times 10) was used to evaluate the players’ physique.
repeated measures (two groups, non-injured and OCD, and two
time points, baseline and end of study period) were also performed
to determine the physical risk factors for OCD. When no significant
interaction effect was observed on the two-way analysis of var-
ance, only single main effects were analyzed. Single main effects
were evaluated for significant differences between the groups us-
ing a Bonferroni correction for alpha. All data were analyzed using
PASW Statistics 18 (IBM Japan, Tokyo, Japan) software. Statistical
significance was set at a P value < .05.

Results

At the time of the initial examination, 3978 players had agreed
to participate in this study. Of these, 81 players presented with
capitellar OCD at the initial examination and 246 players dropped
out of the study. In total, 3651 players completed the follow-up
during one season period (Fig. 2).

A total of 1859 (50.9%) players reported having had elbow and/
or shoulder pain in the throwing arm during the 1-year follow-up
period without the occurrence of OCD. Seventy-one (1.9%) players
had been diagnosed with capitellar OCD. Of these, 44 reported
elbow pain. The incidence of OCD did not differ between male
(2.0%) and female (0%) participants (P = .055), and between pitchers
(1.0%) and those in other positions (2.0%) (P = .087). The average
ages of the players in the two groups did not differ significantly
(non-injured group, 10.5 ± 1.1 years; OCD group, 10.5 ± 0.8 years,
P = .715). The incidence of OCD remained almost the same (range,
approximately from 1% to 3%) throughout each age group, except
for a slight decrease at age 14 years at the initial examination
(Fig. 3). Univariate analysis showed that the OCD group was
significantly associated with a higher Rohrer index (non-injured
group, 123.7 ± 16.2; OCD group, 131.7 ± 19.7, P = .001).

There were no significant interaction effects among the follow-
ing variables (Fig. 4): shoulder HA ROM of the throwing side
(F = 0.056, P = .813), deficit in shoulder HA ROM (F = 0.483,
P = .487), hip IR ROM on the dominant side (F = 0.387, P = .534), hip
IR ROM on the nondominant side (F = 0.0001, P = .984), and
thoracic kyphosis angle (F = 0.593, P = .492). The simple main effects
in the OCD and non-injured groups at baseline were identified as
significantly different, hip IR ROM on the nondominant side (non-
injured group, 37.5 ± 12.7; OCD group, 34.1 ± 12.1; P = .05). The
difference in hip IR ROM at baseline was 3.4° (95% confidence in-
terval [CI] 0.005-6.946). IR ROM on the nondominant hip at the end
of the study period was also found to be significant for simple main
effects in the OCD and non-injured groups (non-injured group,
35.0 ± 12.4; OCD group, 31.5 ± 11.5; P = .041). The difference in hip
IR ROM at the end of study was 3.5° (95% confidence interval 0.136-
6.889).

Discussion

This study aimed to identify the physical risk factors for cap-
tillar OCD in young baseball players. This is the first prospective
cohort study to investigate the physical risk factors for OCD of the
humeral capitellum. Matsuura et al13 reported an incidence rate of
1.8% concerning capitellar OCD within one year in preadolescent
baseball players, and players aged 10–11 years had a significantly
greater risk of developing OCD than those aged 6–9 years. In this
study, the incidence of OCD was similar (1.9%). In addition, our
results showed that the occurrence of OCD was similar in partici-
ants aged 8–13 years, with a peak age at 10–11 years. Otoshi et al17
found that the prevalence of capitellar OCD remained the same for
all ages in players in the later years of elementary school. Our re-
results were consistent with these findings, and capitellar OCD onset
appears to occur more commonly in players in the later years of
elementary school, between the ages of 9 and 12 years, who have
immature elbows.

The Rohrer index has been used to assess obesity in children. In
this study, OCD was associated with a higher Rohrer index. The
Rohrer index of the OCD group was 131.7 ± 19.7, which did not
reflect obesity in this age group. Komiya et al6 reported that, as
children grow, their Rohrer index decreases. Therefore, it may be
that the higher Rohrer index in the OCD group was affected by their
growth phase. One risk factor for OCD might be immaturity in
development. Takahara et al23 showed that separation of the
immature epiphyseal cartilage is an early event in OCD. Our study
suggests that OCD begins at an age at which the epiphyseal car-
tilages are immature.

As in previous studies concerning the risk of medial elbow
injury, we found that a reduced hip IR ROM on the nondominant
side was a risk factor for capitellar OCD. A preventive intervention
study also found that an improvement in IR ROM on the
nondominant side after intervention was related to a reduced
incidence of medial elbow injury.10 A difference in hip IR of only
3.4° between the injured and non-injured groups at baseline has
been associated with an increased risk of OCD, and hip flexibility

Figure 1 Ultrasonographic images of the humeral capitellum. Irregularity (arrow) is seen on the capitellum (A: anterior long-axis view and a: anterior short-axis view). A break in the continuity (arrow) is seen on the capitellum (B: anterior long-axis view and b: posterior short-axis view). Double floor line (arrows) is observed on the capitellum (C: anterior long-axis view and c: anterior short-axis view).
has been shown to be modifiable using a prevention program. However, Bullock reported that the minimum clinically important difference in the hip IR in the youth baseball players was 5.1°. While our results were statistically significant, they were not clinically significant. Milewski et al. evaluated the biomechanics of the lower extremities during the pitching cycle in adolescent pitchers. They found that the hip IR angle was 7° ± 11° at foot contact and 15° ± 13° at ball release. Hip IR is considered to be important at ball release; however, our results indicated that the hip IR angle at ball release was within the passive hip IR ROM in the OCD group. Further studies are needed to clarify the relationship between hip flexibility and pitching biomechanics.

In contrast, the thoracic kyphosis angle was not found to be associated with capitellar OCD. The thoracic kyphosis angle has been reported to be associated with medial elbow injuries in young players; an excessive kyphosis angle may decrease the scapular contribution to the maximum shoulder external rotation during throwing, resulting in an increased stress on the elbow joint. This might suggest dissimilarity with the mechanism of medial elbow injury and OCD of the humeral capitellum. As noted, there was no association found between shoulder HA ROM and OCD. One study reported that adolescents (aged 13-18 years) with HA ROM deficits were at a greater risk of arm injury than younger individuals aged 8-12 years. These results suggest that shoulder tightness may not be a risk factor for throwing injuries in young baseball players.

This study had some limitations. First, reporting of elbow and/or shoulder pain was based on questionnaires completed only at initial and final examinations. For young players, it may have been difficult to recall elbow or shoulder injuries over the course of one year. Second, we did not analyze other potential risk factors such as total years played, the number of throws, and pitching mechanics. Third, OCD was defined using ultrasonography only and not radiography, whereas previous studies have used both these examination methods. Finally, all tests were performed by multiple examiners at 8 different regions. The same examiners participated throughout the study; however, players’ preseason measurements and their final measurements were taken by different examiners. Although we sought to ensure data consistency, it is possible that not all examiners performed ultrasonography of the elbow and physical assessments to the same quality level.

Conclusions

Although some risk factors for medial elbow injury in young and adolescent baseball throwers have been reported, including joint ROM, muscle flexibility, and muscle strength, no previous studies have examined the physical risk factors for lateral elbow injury in young baseball players. We found that reduced hip IR on the nondominant side correlated with OCD of the humeral capitellum. Increasing hip flexibility might be a key factor in preventing capitellar OCD.

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Figure 4 The annual change in variables of physical function. Thick lines show the group’s mean values for the non-injured group at baseline and at the study endpoint. Dotted lines show the mean values for the OCD group. *Significant simple main effect at each of baseline and endpoint of follow-up (P < .05) | HA, horizontal adduction; IR, internal rotation; ROM, range of motion; OCD, osteochondritis dissecans.

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