

Differences in Clinical Presentation of Osteochondritis Dissecans of the Capitellum in Males and Females

ABSTRACT

BACKGROUND Capitellar osteochondritis dissecans (OCD) has primarily been described in male, adolescent baseball players. The aim of this study was to describe the presentation of OCD in males versus females at one tertiary children's hospital.

METHODS 88 patients who presented to a tertiary children's hospital with capitellar OCD between March 2014 and July 2016 were enrolled in a prospective registry, including 45 males with 48 affected elbows and 43 females with 45 affected elbows. Historical and clinical features as well as operative rates were compared between groups. Pre-operative imaging was used to analyze Nelson grades and Sauvegrain bone ages. Functional status was assessed using the QUICKDash questionnaire and Timmerman-Andrews Elbow Score.

RESULTS Mean age at presentation was 15.1 years for males and 13.6 years for females ($p < 0.001$). Mean skeletal age was 14.2 years for boys and 11.6 years for girls ($p < 0.001$). OCD affected the non-dominant elbow in 20% of males versus 43% of females ($p = 0.036$). Fifty-eight percent of males played baseball, of which 74% were pitchers. Seventy-three percent of females were competitive gymnasts. More males (70%) were multisport athletes, compared to females (37%) ($p = 0.003$).

CONCLUSION Elbow OCD presented with equal frequency in male and female adolescent athletes. While the majority of affected males were baseball players, affected females tended to be competitive gymnasts who presented at younger ages with more non-dominant elbow involvement.

LEVEL OF EVIDENCE Prognostic Level II

KEYWORDS Osteochondritis Dissecans, capitellum, adolescent athlete, gymnastics, baseball

Osteochondritis dissecans (OCD) is a characteristic condition of the adolescent athlete, typically affecting the distal femur, talus, and capitellum (**Figure 1**). While the exact etiology of capitellar OCD remains unclear, it is thought that repetitive loading of the vulnerable, ischemic distal humeral chondroepiphysis leads to subchondral bone and articular cartilage failure.¹⁻⁵ OCD of the capitellum can lead to pain, effusion, decreased range of motion, and mechanical symptoms (locking, catching, and crepitus) of the elbow.

Historically, capitellar OCD has been well characterized in throwing athletes. In particular, many studies have explored the presentation and treatment of OCD in male baseball players.^{3,6-9} However, OCD has also become a greater concern for female athletes with increasing female participation in sports.¹⁰ Gymnastics, a predominantly female sport involving repetitive loading of the elbow, is an example of an activity in which there may be increased risk for capitellar OCD.

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FIGURE 1 Sagittal DESS MRI image depicting an OCD lesion of the capitellum

Courtesy of Children's Orthopaedic Surgery Foundation

Few studies have described the presentation of capitellar OCD in young, female athletes.^{2,11,12} The purpose of this investigation was to compare the historical and clinical features of capitellar OCD in males versus females. We hypothesized that capitellar OCD would present at similar rates, with similar clinical features in male and female athletes, but with a difference in primary sports participation.

METHODS

Between March 2014 and July 2016, 88 patients who presented to a tertiary children's hospital with capitellar OCD were enrolled in a prospective registry. Patients were diagnosed based on physical exam, plain radiographs, and/or magnetic resonance imaging (MRI). Patients were queried for history of prior elbow pathology, OCD in other joints, family members with OCD, and sports participation. Tenderness over the capitellum, range of motion, pain, and mechanical symptoms such as locking, catching and crepitus were assessed during the initial clinic visit. Elbow flexion and extension was assessed by experienced attending surgeons with the shoulder abducted 90 degrees and forearm in supination; by convention, full elbow extension was defined as 0 degrees.¹³ Patients completed the QUICKDash questionnaire, used to assess upper-extremity disability and symptoms, and the Timmerman-Andrews Elbow Score, used to assess elbow pain and stiffness.^{14,15} (Table 1) While the QUICKDash has been validated in adult populations, it has also been used in multiple studies examining adolescent populations.¹⁶⁻¹⁸

TABLE 1 Timmerman-Andrews Elbow Score. The total score is calculated as the sum of the four question's scores. Scores may range from 20 to 100 with a score of 100 indicating normal elbow function.¹¹

Question	Possible Responses	Numerical Score
Do you experience pain in your elbow?	Never	25
	Occasionally	20
	With moderate physical activity	10
	With activity of daily living	5
Is there any swelling in your elbow?	Never	25
	Occasionally with heavy activity	20
	With moderate activity	10
	With any activity	5
Does your elbow lock or catch?	Never	25
	Rarely	20
	Occasionally	10
	Frequently	5
Do problems with the elbow limit your activities?	Never	25
	Occasionally	20
	Partial activities only	10
	Unable to work/ difficulties with activities of daily living	5
Total Score:		

Coronal and sagittal MRI scans were used to confirm diagnoses, determine the Nelson grade of the OCD, and identify loose bodies.¹⁹ DESS and T2 sequences were used to determine Nelson grades.²⁰ (Table 2) Forty-one percent of patients had MRIs with DESS sequences. T2 sequences were used to grade OCD lesions in the remaining patients.²¹ Plain radiographs were assessed to calculate Sauvegrain bone age.²²

Descriptive statistics included frequency counts and percentages for categorical variables, and means and standard deviations for continuous variables. Independent sample t-tests were used to analyze differences in chronological and skeletal age in males and females. Wilcoxon rank sum tests were performed to analyze all other continuous variables. Fisher's Exact Tests were performed on all categorical variables such as multi-sport participation, Nelson grades of lesions and numbers, and types of surgeries between males and females. A p-value < 0.05 was considered statistically significant. SAS (version 9.4, SAS Institute, Cary, NC) and SPSS (IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY: IBM Corp) software were used.

RESULTS





There were 45 males with 48 affected elbows, and 43 females with 45 affected elbows enrolled in the prospective registry. The mean chronological and skeletal ages were statistically different between males and females presenting with capitellar OCD lesions. The mean chronological age at presentation was 15.1 years (sd = 1.9) for males and 13.6 years (sd = 2.6) for females (p < 0.001). The mean skeletal age at presentation was 14.2 years (sd = 0.8) for males and 11.6 years (sd = 0.9, p < 0.001) for females. Males and females presented with statistically different body mass indexes

(BMIs); the mean BMI of males was 21.7 (sd = 3.4) and the mean BMI of females was 19.7 (sd = 3.7, p = 0.004). The mean period between the onset of symptoms and first clinical evaluation was 8.94 months for males and 4.71 months for females (p = 0.122).

Females in this study presented with more non-dominant elbow OCD involvement than males, as OCD affected the non-dominant elbow in 20% of males versus 43% of females (p = 0.036). More males (70%) were multisport athletes compared to females (37%) (p = 0.003). The majority of males (58%) played baseball and 74% of baseball players were pitchers. Seventy-three percent of females were competitive gymnasts. The mean Junior Olympic gymnastics level was level 7 (range 3 -10).

There was no significant difference between males and females in elbow extension (p = 0.982) or flexion (p = 0.933) at time of initial presentation. Mean elbow flexion for females was 130° (sd = 7) and for males was 129° (sd = 11°, p = 0.933). Mean elbow extension for females was 5° (sd = 8) and for males was 6° (sd = 13, p = 0.982). There was no statistical difference in average Timmerman-Andrews Elbow Scores between patients that had OCD in their dominant arms (68.8, sd=21.7) and patients that had OCD in their non-dominant arms (47.3, sd=15.1) (p = 0.136). There was also no statistical difference in average Timmerman-Andrews Elbow Scores between males (60.0, sd = 28.3) and females (51.9, sd = 18.5, p = 0.73). Sixty-seven percent of males had unstable OCD lesions (Nelson grade 3 or 4) compared to 54% of females (p = 0.272). There was no statistical difference in contained or uncontained lesion presentation between males and females; 83% of males and 80% of females had contained lesions (p = 0.779).²³ There was also no statistical difference in the number or types of surgeries performed on males versus females; 71% of males and

TABLE 2 Dipaola, Nelson and Colville's staging system for characterizing osteochondral lesions¹⁴

			
Thickening of articular cartilage and low signal changes.	Articular cartilage breached, low signal rim behind fragment indicating fibrous attachment.	Articular cartilage breached, high signal changes behind fragment indicating synovial fluid between fragment and underlying subchondral bone.	Loose body.
Stage 1	Stage 2	Stage 3	Stage 4

81% of females underwent surgery, consisting of debridement, microfracture, internal fixation, and/or osteochondral grafting ($p=0.328$). (Table 3)

DISCUSSION

The 2008 National Council of Youth Sports Survey found that 27 million youths between 6-18 years of age participate in team sports, and 60 million children and adolescents participate in some form of organized sport.²⁴ It has also been reported that an increasing number of children are participating in organized sports at an earlier age.^{24,25} With this rise in sports participation, recent reports have described high rates of acute and overuse injuries in youth athletes.^{10,26,27}

One factor contributing to increasing overuse injuries in young athletes may be the rise of early sports specialization.²⁸ Early specialization may lead to greater cumulative microtrauma, as well as greater repetitive loading to the immature skeleton.²⁹ In the current investigation, 73% of females with capitellar OCD were year-round competitive gymnasts, and only 37% of females were multisport athletes, raising the concern regarding a potential relationship between specialization and injury.

The benefits of multi-sport participation at young ages have been well documented. Snyder surveyed athletes from the 1984 - 2012 Olympic Games, and 88 percent of those athletes felt that multisport participation was either “valuable” or “very valuable” to their development as an athlete.³⁰ Multi-sport participation before puberty may be beneficial to developing athletes in multiple ways. For example, young, multisport athletes may benefit from greater motor skill development and fewer injury risk factors.²⁸ Consequently, even in sports such as gymnastics, where early specialization may be important to achieving elite/Olympic status, there have been efforts made to reevaluate competitive standards so that early specialization may become unnecessary.²⁵

Capitellar OCD is one overuse injury characteristic of adolescent athletes. However, capitellar OCD has been primarily described in males. With growing sport participation among all children, it is important to understand the clinical presentation of this relatively common overuse injury in both males and females.

In our cohort of patients, the sports associated with elbow OCD were baseball and gymnastics in males and females, respectively. Our findings are consistent with prior published information, highlighting the prevalence of elbow OCD in adolescent male baseball players, and pitchers in particular.^{3,6-9} More notably, our results identify a number of female gymnasts with capitellar OCD.^{2,11,12} It is interesting to note that there was a trend for females to present with earlier Nelson grades than their male counterparts. While the reasons for these differences in clinical presentation and treatment are unclear, it is possible that earlier grade OCD lesions may result in greater functional limitations given the demands of gymnastics. The similarity in Timmerman-Andrews Elbow Scores between male and female cohorts – despite the fact that females had earlier stage OCD – supports this hypothesis.

Additionally, female athletes with OCD of the capitellum were

TABLE 3 Numbers of surgeries for males and females by type of surgery performed		
	Males (n=45)	Females (n=43)
Simple Debridement	1	5
Microfracture	2	1
Drilling	12	16
Fixation	9	4
Osteochondral Grafting	14	17

more likely to have non-dominant arm involvement than their male counterparts. While additional investigation is needed to characterize the relationship between gymnastics and capitellar OCD, it is possible that the difference in non-dominant elbow involvement seen between male and female athletes is due to the fact that the majority of the female athletes were gymnasts and used both arms to perform, while the majority of the male athletes played baseball and had a dominant throwing arm. The lower BMI in females compared to males at presentation may also be attributable to the type of sport played, given that gymnasts have been shown to have a relatively low BMI.³¹

Repetitive microtrauma, a common cause of overuse injuries in sports, is thought to be the largest contributing factor to capitellar OCD. Valgus stress common in throwing athletes, such as baseball pitchers, and increased axial load common in gymnasts may both contribute to the microtrauma common with capitellar OCD.^{29,32-35} Our results support the relationship between repetitive valgus stress and/or axial loading and the development of capitellar OCD, as 58% of the male athletes were baseball players and 73% of females were competitive gymnasts.^{29,36}

Overuse injuries may be common in gymnastics because compression forces transmitted from the hands through the elbow, during upper extremity weight bearing activities such as tumbling, may cause trauma to the radiocapitellar joint.^{2,37-38} For example, Koh et al. have described how coached extension of the elbows during the double arm support phase of a back handspring may force the elbows to accept the full ground force generated by the maneuver, which may be upwards of 2.37 times body weight.³⁹ Without coaching, elbows would naturally bend during such an exercise, perhaps attenuating the compression forces generated. These compression forces, as well as the valgus moment imparted on the elbows during back handsprings, may increase gymnasts' risk of elbow injury and capitellar OCD in particular.³⁹⁻⁴¹

Intense training for female gymnasts at a young age may also contribute to the development of OCD.² Our findings that female gymnasts presented at younger skeletal ages may be explained by earlier specialization and higher intensity training at a younger age, as well as by the delayed skeletal maturation commonly seen in higher level gymnasts.⁴²⁻⁴³ Indeed, there may be an extended window of injury risk due to the longer periods of time when gymnasts are both training intensely and have vulnerable, predominantly cartilaginous distal humeral chondroepiphyses.

TABLE 4 Injury Prevention Strategies for Baseball and Gymnastics

Baseball
Emphasizing proper throwing mechanics ³⁹
Encouraging young players to play with lighter baseballs with smaller diameters ²⁹
Adding pitch counts and limits per game, season, and year ^{40,41}
Gymnastics
Increasing training for coaches ²³
Eliminating “no pain – no gain” mentalities ⁴²
Prompt and complete medical care for injuries ⁴³

Injury prevention strategies have been suggested for both gymnastics and baseball to reduce the risk of elbow injury.^{29,34,44-48} (Table 4) While prior studies have proposed measures to prevent injuries in baseball, less evidence-based data are available on injury prevention techniques in gymnastics.^{34,44-48} Therefore, many of the recent initiatives to reduce gymnastics injuries have been based on the personal experiences of gymnasts and coaches. For example, two recent tactics have been to place limits on activities that heavily impact the elbow during periods of rapid growth and to set limits on skill counts in gymnastics, similar to limiting pitch counts in baseball.

There were a number of limitations to the current investigation. While patients were enrolled and data collected in a prospective longitudinal fashion, there may be a sampling bias, as all patients were treated at a single tertiary care, referral center. Furthermore, as our OCD registry has only been in existence for two years, the current investigation consists of a small number of patients with limited longer-term functional outcomes data. Multicenter expansion is planned, and further longitudinal follow-up of a larger number of patients will allow for continued investigation of OCD in both male and female adolescent athletes.

Despite these limitations, our results indicate that OCD of the capitellum now presents with equal frequency in male and female adolescent athletes. While the majority of affected males were baseball players, affected females tended to be competitive gymnasts who presented at younger ages and with more non-dominant elbow involvement. Further efforts are needed to develop screening and prevention strategies in young female athletes and to identify differences in treatment outcomes, if any, between male and female patients.

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