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ORIGINAL ARTICLE

Radiographic comparison of adolescent athletes with elbow osteochondritis dissecans to ulnar collateral ligament injuries and controls

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Background: There are excellent data supporting recommendations to prevent elbow injuries (osteochondritis dissecans [OCD] and ulnar collateral ligament [UCL] injuries), such as pitch count and pitch type in baseball, but anatomic risk factors have not been thoroughly examined. This study aimed to evaluate radiographic measurements in adolescents with elbow OCD lesions or UCL injuries and controls.

Methods: We retrospectively identified adolescent patients between 2011 and 2016 with isolated capitellum OCD, UCL tear, or normal elbows based on magnetic resonance imaging. Nineteen patients (mean age, 13.5 years) had isolated OCD defects of the capitellum, 8 patients (mean age, 16.9 years) had isolated UCL complete tear, and the remaining 16 patients (mean age, 14.6 years) were normal controls. Radiographic measurements from corresponding anterior-posterior elbow radiographs were taken, including carrying angle, distal humeral articular surface angle, and radial neck-shaft angle. On the lateral radiograph, anterior angulation of the articular surface of distal humerus was measured.

Results: Significant differences were observed in carrying angle between controls (15.7°) and OCD patients (11.6°; $P = .03$) as well as between controls and UCL patients (10.3°, $P = .02$), with the OCD and UCL patients tending to be in more varus. Significant differences were also found between controls (88.5°) and OCD patients (93.6°; $P = .01$) and between controls and UCL patients (93.3°; $P = .03$) in distal humeral articular surface angle, with OCD and UCL patients with increased valgus at the distal humerus articular surface. There were no significant differences between groups in radial neck-shaft angle or anterior angulation of articular surface of distal humerus.

Conclusions: Patients with OCD and UCL injuries have anatomic differences compared with normal controls that can be measured radiographically.

Level of evidence: Basic Science Study; Anatomy; Imaging

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Keywords: Elbow; radiographic; alignment; adolescent; OCD; UCL

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Single-sport specialization and year-round athletic activity have led to a rapid increase in the number of youth sporting injuries.^{4,21} This is particularly prevalent in upper extremity athletes, such as baseball pitchers and gymnasts, who may be prone to injuries about the elbow, including

osteochondritis dissecans (OCD) lesions of the capitellum and ulnar collateral ligament (UCL) injuries.

OCD of the elbow is a sports-related injury found in overhead athletes.^{2,26,31} The cause is thought to be related to repetitive compression and shear forces to an immature capitellum that is vulnerable to vascular changes.^{5,16,26} Severe OCD leads to damaged articular surfaces and radiocapitellar incongruity, which is a risk factor for subsequent degenerative changes.^{28,29}

Diagnosis and outcomes depend on clinical suspicion and early diagnosis. Risk factors for elbow OCD include repetitive overhead activity including baseball, gymnastics, tennis, volleyball, and weightlifting in adolescent athletes. Despite its association with baseball, particularly pitchers, studies demonstrate only a 3.4% incidence among adolescent baseball players.¹⁴ Moreover, OCD is not always associated with symptoms or pain.¹⁴ The question remains how to identify the small percentage of overhead athletes that may develop an OCD lesion, particularly because early diagnosis while younger leads to better outcomes.²⁸

Currently, early diagnosis in at-risk populations is often done by a combination of history, physical examination findings, and radiographic imaging. Because a large majority of young pitchers will present with arm pain while in season,¹⁹ it can be difficult for the clinician to be able to determine which patients who present to the clinic warrant further investigation, whether it is plain radiography or advanced imaging. Radiographic signs of OCD include flattening of the capitellum, a focal defect of the articular surface, and loose bodies. These signs are based on subjective interpretation, which may contribute to the poor sensitivity of routine radiographs in identifying OCD of the capitellum, with nearly half demonstrating normal radiographic findings.¹⁵ In addition, extrinsic factors such as pitch count and pitch type along with the patient's age are associated with greater risk of injury.^{9,18,23} The "gold standard" in the diagnosis of OCD lesions has become magnetic resonance imaging (MRI), which also directs treatment by identifying stable or unstable lesions.²⁷ Yet, it is unclear if there are pre-existing alignment or radiographic indices that may indicate an athlete who is at risk for development of these lesions.

UCL tears are also associated with overhead sports, particularly baseball.⁸ A recent study by Erickson et al evaluated trends in UCL tears and reconstructions and found that adolescents (15 to 19 years old) had an incidence of 22 per 100,000 but accounted for 56.8% of reconstructions.⁸ Radiographs may demonstrate an avulsion lesion or an osteophyte along the posteromedial aspect of the medial epicondyle, and stress radiographs of bilateral elbows with valgus force on the elbow or live fluoroscopy may highlight gapping along the medial side of the affected side. MRI has also become the gold standard in diagnosis of a UCL injury. Although multiple risk factors for the development of these injuries have been noted in the literature, particularly in relation to workload (pitch count, months/year of pitching) and elbow/shoulder motion, there has been minimal attention paid to alignment and radiographic indices.^{7,25} We believe that OCD

lesions and UCL injuries represent a spectrum of injuries in the adolescent athlete from younger (OCD) to older (UCL injury) patients.

An article by Goldfarb et al described normal radiographic anatomy of the elbow in 178 pediatric and adolescent patients with objective measurements.¹⁰ The study found that several measurements were reliable on the anterior-posterior radiograph, including carrying angle, distal humeral articular surface angle, and articular surface measurement (trochlear sulcus depth, lateral sulcus depth, and lateral ridge height). They also demonstrated measurements on the lateral radiograph including the anterior angulation of articular surface of distal humerus, olecranon-coronoid angle, and greater sigmoid notch circle. The study demonstrated measurement techniques and defined normal values for these measurements in the adolescent population.¹⁰ To our knowledge, no studies have evaluated these radiographic measurements in patients with elbow OCD lesions or UCL tears. This is particularly important as lower extremity alignment has been shown to be a risk factor for the development of OCD lesions of the knee as well as anterior cruciate ligament tears.^{1,11} Elbow alignment may be a critical factor in determining why some young athletes (given the same volume and intensity of upper extremity activity) may develop elbow disease as opposed to others.

The purpose of this study was to investigate objective radiographic measurements in an adolescent population with confirmed isolated OCD lesions of the capitellum or UCL tears in comparison to a normal cohort. We hypothesized that patients with OCD and UCL injuries will vary from a normal population in regard to overall joint alignment.

Materials and methods

Patients

This was a retrospective review of adolescent patients at a single institution from 2011 to 2016 who had symptomatic elbow pain and obtained an elbow MRI examination. A review of our imaging archive was performed, and 3 groups of patients were identified: isolated OCD of the capitellum; isolated complete UCL tears of the elbow; and normal elbows. The diagnoses of capitellum OCD, UCL tears, and normal elbows were based on MRI interpretation. Normal elbows on MRI did not demonstrate structural damage but had symptomatic elbow pain. Patients were included in the study if they were between the ages of 10 and 18 years, had both anterior-posterior and lateral radiographs of the affected elbow, and had an elbow MRI study. Patients were excluded if they had neuromuscular disease, prior elbow surgery, or connective tissue disorders. Patients did not have clinically appreciable extension or flexion deficits. A total of 43 patients were identified: 19 patients with OCD, 8 patients with UCL injuries, and 16 normal controls.

Radiographic evaluation

All radiographs were performed at an individual institution. Radiographic measurements were based on descriptions by Goldfarb

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