Contained Versus Uncontained Lesions in Juvenile Elbow Osteochondritis Dissecans

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Background: Juvenile osteochondritis dissecans (OCD) of the elbow typically affects the capitellum and may be "contained" (surrounded by intact cartilage) or "uncontained" (extending beyond the lateral cartilaginous margin). The purpose of this investigation was to compare the clinical presentation, radiographic findings, and surgical results of patients with contained versus uncontained lesions.

Methods: Forty-three elbows in 42 patients who underwent surgery for OCD were followed for an average of 19.5 months. Average age at surgery was 14.2 years (range, 11.2 to 18.2 y); there were 16 female and 26 male patients. Preoperative magnetic resonance imaging was analyzed for location and size of the lesions, alignment and size of the radial head, presence of loose bodies, and lesion grades. Patients with contained and uncontained lesions were compared on the basis of preoperative characteristics, operative findings, and postoperative results.

Results: During surgeries of the 43 elbows, 22 elbows had loose bodies, which were removed, 32 underwent drilling, and 6 lesions had internal fixation of the OCD lesion. Twenty-nine of the 43 elbows (67%) had contained lesions, and 14 (33%) were uncontained. Preoperatively, uncontained lesions had greater, but not statistically significant, flexion contractures (24.8 vs. 14.3 degrees, $P = 0.088$), and more swelling (9/14, 64% vs. 7/29, 24%, $P = 0.007$). There was a trend toward significance for the uncontained lesions to be larger (155 vs. 125 mm^2, $P = 0.15$) and shallower (7.0 vs. 7.6 mm, $P = 0.07$). Postoperatively, uncontained lesions again had greater flexion contracture (13.4 vs. 3.3 degrees, $P = 0.025$).

Conclusions: At short-term follow-up, uncontained elbow OCD lesions have greater flexion contracture when compared with contained lesions. They also have higher rates of joint effusion and are broader and shallower than contained lesions.

Level of Evidence: Prognostic level IV.

Key Words: osteochondritis dissecans, containment, microfracture, loose body

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Osteochondritis dissecans (OCD) of the humeral capitellum is commonly seen in adolescent athletes, resulting from fragmentation of the subchondral bone followed by separation of the overlying articular cartilage.[1] This condition has high prevalence among throwers, gymnasts, cheerleaders, and athletes who excessively load the radiocapitellar joint. In baseball pitchers, for example, during the late cocking and early acceleration phase of throwing, the elbow joint undergoes valgus stress and capitellum is subjected to compression and shear forces.[2–4]

Patients with early-stage OCD are generally managed nonoperatively, and good results are usually achieved.[5,6] However, the spontaneous healing potential of advanced OCD lesions is low, and surgical treatments are usually recommended for patients with advanced OCD.[6,7]

Several radiographic and arthroscopic classification systems have been developed to help guide treatment, but they have all focused on the condition of the subchondral bone or articular cartilage.[8–10] We propose that the location of the lesion on the capitellum is an important variable that influences the natural history of this disease. We define an OCD lesion as "contained" if it is located in the central part of the capitellum, surrounded by intact cartilage; a lesion is "uncontained" if it is at the edge of the capitellum and extends beyond the lateral cartilaginous margin. The center and the edge of the capitellum may experience different magnitudes and directions of force; therefore, we hypothesize that contained and uncontained lesions behave differently and should be treated accordingly.

METHODS

After obtaining approval from our Institutional Review Board, we queried a computer database to identify all patients who underwent surgical treatment for OCD of the capitellum between 2000 and 2009. We found 42 patients (43 elbows) who had elbow arthroscopy, all of whom had preoperative magnetic resonance imaging (MRI) available for review. Among the cohort, there were 16 female and 26 male patients. Average age at time of surgery was 14.2 years (range, 11.2 to 18.2 y). Average time of follow-up was 19.5 months (range, 3.5 to 63.6 mo). Thirty-nine of 43 elbows affected the dominant limb. The causes of injury included baseball (17), trauma (11), basketball (3), gymnastics (3), and cheerleading (1); 4 patients had no identifiable cause.

Preoperative examination data were recorded, including elbow range of motion, presence of elbow effusion, and mechanical symptoms (locking, catching). MRIs were reviewed for presence of loose bodies and lesion containment. Two of the authors reviewed and graded the lesions as either "contained" or "uncontained." In cases where there were discrepant readings, a consensus grading was reached by joint evaluation. T1 coronal sequence of an MRI was appropriate for this grading system. Coronal reconstruction permits the evaluation of the lesion's relationship to the lateral margin. T1 sequence allows the best visualization of the subchondral bone and cartilage, without the confounding T2 fluid signal that is often present with edema. The OCD lesions were further classified according to Difelice et al[10] and Bradley and Petrie[8] (Table 1). Examples of contained and uncontained lesions are shown in Figures 1 and 2. The lesions' dimensions were measured in sagittal and coronal planes. To examine radial head enlargement, the diameter of the radial head was compared with the width of the capitellum on the sagittal reconstructions. To examine radial head subluxation, the percentage of radial head covered by the capitellum was measured on the coronal reconstructions.

Surgical indications included presence of a loose body or fragment instability as noted on the MRI, as well as persistent mechanical symptoms and pain after a trial of nonoperative therapy. All patients underwent elbow arthroscopy in supine position. Direct lateral soft spot was entered with an 18 gauge spinal needle to insufflate the joint with 15 ml of saline. The proximal anteromedial and anterolateral portals were used to examine the OCD lesion and the rest of the joint. Posterolateral portals were also used. The decision to make an arthrotomy was based on presence and retrievability of the loose bodies, feasibility of drilling, and surgeon preference. If an arthrotomy was performed, the surgical approach was made between the anconeus and extensor carpi ulnaris or the intramuscular plane through the anconeus.[6] Drilling the OCD lesion was done with 0.035 inch smooth K-wires to induce bleeding from the subchondral bone after lesion debridement. Soft dressing was applied, and gentle range of motion was initiated postoperatively.

In the study group, partial synovectomy and cartilage debridement were performed on majority of the patients. Thirty-two of the 43 elbows underwent drilling. In 6 elbows, osteochondral fragments were stabilized with bioabsorbable implants (SmartNail, ConMed Linvatec Corp., Largo, FL).

Patients' records were reviewed to gather data on surgical findings (presence of loose body, synovitis, additional procedures), postoperative ranges of motion and pain, and the need for revision surgery. Two sample *t* tests were performed to detect any statistical difference between continuous variables. Fisher exact tests were used on contingency tables of categorical variables.

TABLE 1. Radiographic Classification of Osteochondritis Dissecans (OCD) of the Capitellum[8,10]

Grades	Cartilage/Subchondral Bone	Description
Ia	Intact/stable	Intact articular cartilage; no loss of subchondral stability
Ib	Intact/unstable	Intact articular cartilage; unstable subchondral bone with impending collapse
II	Open/unstable	Cartilage fracture; collapse or partial displacement of subchondral bone
III	Detached	Loose cartilaginous fragments within joint

RESULTS

In the 43 elbows, the preoperative ranges of motion were 17.5 degrees extension, 125 degrees flexion, 84.5 degrees pronation, and 83.9 degrees supination. On the basis of the MRIs, there were 7 grade Ia, 13 grade Ib, 6 grade II, and 17 grade III lesions. The average coronal and sagittal dimensions and depth of the lesions were $11.1 \times 11.9 \times 7.0$ mm. Seventeen of 43 elbows had open

FIGURE 1. An example of contained capitellum osteochondritis dissecans lesion. T1 magnetic resonance image with coronal reconstruction.

FIGURE 2. An example of uncontained capitellum osteochondritis dissecans lesion. T1 magnetic resonance image with coronal reconstruction.

physes in the capitellum; the average age of patients with open physes was 13.2 versus 14.3 years for patients with closed physes ($P = 0.02$). In patients with open capitellum physes, the average distance between the physis and the deepest part of the lesion is 5.5 mm, as measured on the sagittal reconstructions.

In 17 elbows, MRIs indicated the presence of loose bodies. At the time of surgery, loose bodies were removed when identified. Additionally, in 6 elbows in which MRI did not show loose bodies preoperatively, loose bodies were found during surgery; therefore, 22 elbows had loose body removal. Postoperatively, patients' ranges of motion improved from what they were preoperatively, with extension, flexion, and supination being statistically significant: 6.8 degrees extension ($P = 0.003$), 136 degrees flexion ($P < 0.001$), 89 degrees pronation ($P = 0.13$), and 90 degrees supination ($P = 0.006$). At the time of the latest follow-up, 6 patients had mild pain, 35 patients had no pain, and 1 patient has no pain information available.

TABLE 2. Preoperative Physical Examination

	Contained	Uncontained	*P*
Preoperative extension (deg.)	14.3	24.8	0.088
Preoperative flexion (deg.)	126	123	0.61
Preoperative pronation (deg.)	84.5	82.5	0.69
Preoperative supination (deg.)	84.5	84.5	0.99
Presence of mechanical symptoms	8 of 29	3 of 14	0.73
Presence of effusion	7 of 29	9 of 14	**0.007**

Contained and uncontained lesions' ranges of motion, presence of mechanical symptoms, and effusion were compared. There was a trend for uncontained lesions to have greater loss of extension. Uncontained lesions had higher rate of effusion. The bold underlined *P* value indicates statistical significance.

Of the 43 elbows, 14 OCD lesions were classified as uncontained and 29 lesions were contained on the basis of preoperative MRIs (Figs. 1, 2). Table 2 lists the cohorts' preoperative examination findings. Extension was 14.3 and 24.8 degrees in elbows with contained and uncontained lesions, respectively ($P = 0.088$); flexion was 126 and 123 degrees ($P = 0.61$); pronation was 84.5 and 82.5 degrees ($P = 0.69$); supination was 84.5 and 84.5 degrees ($P = 0.99$). Eight (28%) of the 29 elbows with contained lesions and 3 (21%) of the 14 elbows with uncontained lesions exhibited mechanical symptoms ($P = 0.73$). Seven of 29 (24%) elbows in the uncontained lesion group, whereas 9 of 14 (64%) elbows in the uncontained lesion group showed presence of effusion ($P = 0.007$).

Grades of the lesions were not significantly affected by the location of the lesions ($P = 0.70$, Fisher exact test, Table 3). The area of the lesion was approximated by the product of its maximum dimensions in coronal and sagittal planes (Table 4); contained lesions had an average area of 125 mm^2, and uncontained lesions 155 mm^2 ($P = 0.15$). The contained lesions had an average depth of 7.6 mm, and uncontained lesions 7.0 mm ($P = 0.07$). Radial head enlargement was calculated by the ratio of radial head diameter to capitellum diameter on the sagittal reconstruction; for contained lesions, the average ratio was 0.99, and uncontained lesions' ratio was 0.98 ($P = 0.54$). Radial head subluxation was examined on the coronal reconstructions; the percentage of radial head covered by the capitellum was 77.8% and 77.5% for contained and uncontained lesions, respectively ($P = 0.85$). Nine elbows among the contained lesion cohort had open physes (9/29, 31%), and 8 elbows of the uncontained lesion cohort had open physes (8/14, 57%, $P = 0.10$). On the basis of preoperative MRI, loose bodies were found in 11of 29 (38%) elbows

TABLE 3. Preoperative Magnetic Resonance Imaging (MRI) Lesion Grades

Grades	Contained Lesions	Uncontained Lesions	*P*
Ia	5	2	—
Ib	10	3	—
II	3	3	—
III	11	6	0.70

Contained and uncontained lesions had similar distribution of lesion grades.

TABLE 4. Preoperative MRI Appearance of Capitellum and RH

	Contained	Uncontained	*P*
Area of lesion (= coronal dimension × sagittal dimension) (mm^2)	125	155	0.15
Depth – sagittal (mm)	7.6	7.00	0.07
RH enlargement (= radial head width/capitellum diameter, sagittal views)	0.99	0.98	0.54
RH subluxation (= % RH covered by capitellum, coronal views)	77.8%	77.5%	0.85
Presence of open physis	9 of 29	8 of 14	0.10
Presence of loose bodies on MRI	11 of 29	6 of 14	0.75

Contained and uncontained lesions' area and depth were compared, with a trend for uncontained lesions to be broader but shallower. There was no difference in the rate of RH enlargement and subluxation between the types of lesions. Presence of open physes and loose bodies was also no different.

MRI indicates magnetic resonance imaging; RH, radial head.

with contained lesions, and 6 of 14 (43%) elbows with uncontained lesions ($P = 0.75$). On the basis of intraoperative data, loose bodies were found in 14 of 29 (48%) elbows with contained lesions, and 8 of 14 (57%) elbows with uncontained lesions ($P = 0.58$).

Postoperative ranges of motion (Table 5), when stratified into contained and uncontained lesions, were: extension 3.3 and 13.4 degrees ($P = 0.025$); flexion 136.3 and 135.4 degrees ($P = 0.76$); pronation 89.9 and 90 degrees ($P = 0.49$); supination 90 and 86.5 degrees ($P = 0.15$).

Twenty of 43 elbows underwent arthrotomy. Rate of arthrotomy was no different between contained and uncontained lesions ($P = 0.19$). All postoperative motion parameters were similar between elbows requiring arthrotomy and those that did not: extension ($P = 0.39$), flexion ($P = 0.26$), supination ($P = 0.39$), and pronation ($P = 0.35$).

Seven patients (7 elbows) underwent revision surgery for pain or mechanical symptoms; all had loose bodies present—6 had loose bodies removed, and 1 had osteochondral fragment fixation. The average time lapse between first and second surgeries is 24.5 months (range, 6 to 60 mo). It is noteworthy that 5 of these 7 patients had interval symptom-free period with full return to sports after initial surgery, before recurrent pain and/or mechanical symptoms returned, necessitating revision. There were no significant predictors for revision, including patients' age, size of the OCD lesion, and preoperative physical examination findings (ranges of motion, swelling, mechanical symptoms). Revision rate also did not differ between patients with contained or uncontained lesions ($P = 1.00$). Among the 7 revision cases, 2 lesions were uncontained, and 5 were contained, of which 2 converted to uncontained on repeat prerevision MRIs. All 7 patients returned to full range of motion and function after revision surgery, and none had pain.

TABLE 5. Postoperative Examination and Need for Further Surgery

	Contained	Uncontained	*P*
Postoperative extension (deg.)	3.3	13.4	**0.025**
Postoperative flexion (deg.)	136.3	135.4	0.76
Postoperative pronation (deg.)	89.8	90	0.49
Postoperative supination (deg.)	90	86.5	0.15
Need for revision surgery	5 of 29	2 of 14	1.00

Contained and uncontained lesions' ranges of motion were compared. Uncontained lesions had greater loss of extension. Rate of needing revision surgery were no different between the 2 groups.

The bold underlined *P* value indicates statistical significance.

DISCUSSION

With increased youth sports participation, there has been a considerable rise in overuse injuries in children and adolescents. OCD of the elbow is thought to be caused by repetitive lateral compression and shear forces across the radiocapitellar joint, and it is characterized by the fragmentation of the subchondral bone and separation of the overlying articular cartilage.[5,7,12,16]

Long-term studies of patients with OCD show significant impairment of elbow function. Takahara et al[11] followed 53 patients with capitellum OCD for an average of 12.6 years, and this cohort had up to 50% poor outcome, with daily elbow symptoms. In a series of 31 patients followed for an average of 23 years, Bauer et al[12] reported that about half of the OCD elbows had impaired motion, pain, and radiographic evidence of arthrosis. They noted in two third of the patients the diameter of the radial head was enlarged in comparison with the contralateral elbow. These and other long-terms studies are all comprised of heterogeneous population of different grades of lesions undergoing both operative and nonoperative treatments. Despite this, they highlight the importance of maintaining articular congruity and joint stability in the treatment of elbow OCD lesions.

Several established radiographic and arthroscopic classification systems have focused on the conditions of the cartilage and subchondral bone.[8–10] Numerous prognostic and therapeutic studies have relied on these classification systems, which do not take into account the location of the lesion on the capitellum.[1,5–7,11–15] The central portion of the capitellum has the support of surrounding stable cartilage and subchondral bone and may experience compression forces imparted by the radial head, whereas the lateral edge of the capitellum lacks such support and may experience both compression and shear forces. This hypothesis is reinforced by recent findings by Mihara et al, who showed that patients undergoing OCD reconstruction with osteochondral autograft have poorer outcome if there is insufficient remodeling of the lateral margin of the capitellum.[14,16]

In our study, we proposed to classify OCD lesions as contained or uncontained on the basis of their location on the capitellum, and hypothesize that these 2 groups of lesions behave differently preoperatively and postoperatively. Our result showed that elbows with uncontained lesions tend to have greater flexion contractures preoperatively and postoperatively. Moreover, uncontained lesions were associated with higher rates of joint effusions. They were larger and shallower than contained lesions, although neither comparison reached statistical significance. Other range-of-motion parameters, presence of mechanical symptoms, and lesion grades were not statistically different between the contained and uncontained cohorts. Radial head enlargement and subluxation also were not different between the elbows with contained and uncontained lesions.

This study is limited by the relatively small number of patients and its inherent retrospective design. Although clinical follow-up was short, many of the clinical parameters of interest can be investigated at the time of presentation or shortly after the procedure. Future investigation of both surgical and nonoperative cases must be carried out to determine differential healing potential between contained and uncontained lesions. Longer clinical and radiographic follow-up is also needed to ascertain whether uncontained lesions are more likely to progress to fragment instability, joint subluxation, and/or arthrosis.

In conclusion, the concept of lesion "containment" is introduced. On the basis of the findings presented here, uncontained elbow OCD lesions are associated with greater loss of elbow motion and joint effusion at presentation and early follow-up. Future studies are needed to characterize longer-term differences in natural history and results of surgical treatment in contained versus uncontained lesions. Furthermore, consideration should be made for surgical strategies to reconstruct the lateral margin in uncontained lesions; conversion of uncontained to contained lesions may restore radiocapitellar stability and prevent irreversible joint changes.

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