Clinical Case Report

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Osteochondral flap fracture of the coronoid in pediatric humeral lateral condyle

A report of 3 cases

Jinkui Wang, MD[a,b], ZhongLiang Wang, MD[a,*]

Abstract

Rationale: Osteochondral flap fractures of the elbow are rare in children. To the best of our knowledge, only 12 cases are reported in the literature. Only 1 case was accompanied with lateral condyle fracture classified as Milch I, which was nondisplaced. The mechanism of these injuries is not explained in detail, and the treatment methods are not discussed. Here, we present 3 cases of osteochondral flap fracture of the ulnar coronoid process with accompanying obvious displacement of the lateral condyle fracture.

Patient concerns: All patients fell into one of their outstretched arms, which caused elbow pain and functional limitation.

Diagnosis: All 3 patients were diagnosed with lateral condyle fracture of the humerus and osteochondral flap fracture of the ulnar coronoid process.

Interventions: All patients underwent open reduction and internal fixation.

Outcomes: At 3 months after the operation, they regained full range of motion of the limb and had no elbow instability.

Lessons: Osteochondral flap fracture should be considered when there is a bone mass in the elbow space with accompanying displacement of the humeral lateral condyle fracture.

Abbreviations: CT = computed tomography, MEPS = Mayo elbow performance score, MRI = magnetic resonance imaging.

Keywords: case report, coronoid fracture, humeral lateral condyle, osteochondral flap fracture, pediatric, spontaneously reduced elbow dislocation

1. Introduction

Osteochondral flap injury of the elbow joint is rare in children. This injury was first mentioned by Grant et al in 1975,[1] and there are only 11 case reports that have been published, thus far; of these, 3 cases are osteochondral flap fractures of the ulnar coronoid process,[2–4] whereas the remaining cases are osteochondral flap fractures of the olecranon or others.[5–9] Its diagnosis is often delayed because of the radiolucency of the cartilage. The coronoid process is the important constituent part of the greater sigmoid notch of the ulna; thus, the injury of the coronoid process will severely affect the movement of the elbow joint.[10] The osteochondral flap of the coronoid is the articular cartilage, and its injury will affect the function of the elbow joint.[3] In our cases, the osteochondral flap remained in the elbow joint space. Its misdiagnosis could greatly affect the recovery of elbow function.

Lateral condyle fracture of the humerus is common in children, accounting for 12% to 20% of elbow joint fracture cases.[11] It is the second most common fracture in children with elbow joint injury, and second only to supracondylar fracture of the humerus. The lateral condyle fracture of these patients is divided into 3 types according to Milch classification.[12] Elbow joint dislocations are rarely seen in children, because the ligaments around the elbow in children are very strong.[13] Dislocation of the elbow joint associated with fracture of lateral condyle of the humerus in children is one of the serious injuries of the elbow.[14] Occult fractures often exist after a spontaneously reduced elbow dislocation, making it difficult to diagnose these injuries correctly.

Osteochondral flap fractures of the ulnar coronoid process were reported to be usually caused by posterior elbow dislocation.[7] However, there is only 1 case with combined lateral condyle fracture classified as Milch I, which was nondisplaced.[4] There has been no report on osteochondral flap fracture of the ulnar coronoid process with accompanying obvious displacement of the lateral condyle fracture. We herein report 3 cases of osteochondral flap fracture of the ulnar coronoid process with accompanying lateral condyle fracture

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[a] Department of Orthopedics, Children's Hospital of ChongQing Medical University, [b] Graduate Department, ChongQing Medical University, ChongQing, ChongQing Province, China.

[*] Correspondence: ZhongLiang Wang, Department of Orthopedics, Children's Hospital of Chongqing Medical University, ChongQing, ChongQing Province, China (e-mail: 4829855@163.com).

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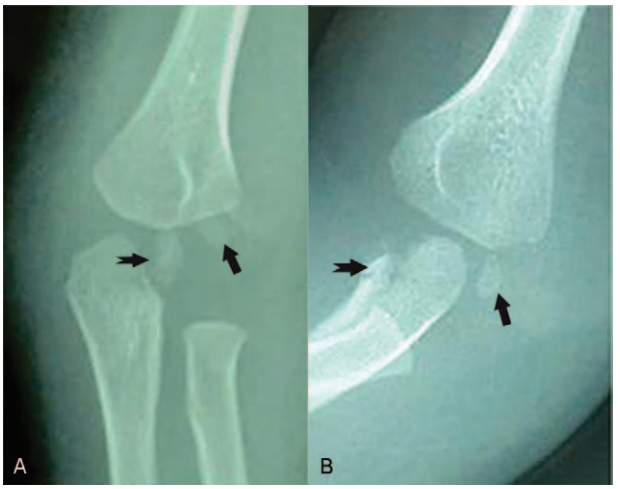

Figure 1. The preoperative radiographs. (A) The anteroposterior view shows the rotated lateral condyle of the humerus (flat tail arrow) and the unusual bone mass in the articular space (dovetail arrow). (B) Lateral view shows the rotated lateral condyle of the humerus (flat tail arrow) and the unusual bone mass in the articular space (dovetail arrow).

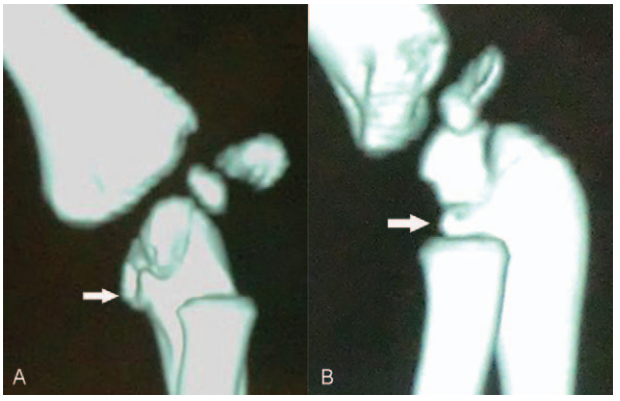

Figure 2. Three-dimensional computed tomography scan showing the fracture of the lateral condyle and fragment of the osteochondral flap, but the defect in the coronoid (white arrow) was neglected.

classified as Milch 3. Moreover, we present their treatment methods and follow-up evaluations and discuss the mechanism of these injuries.

2. Case report

2.1. Case 1

A 2-year-old boy fell from a bed, approximately 1.5 m high, on his outstretched left arm into the ground. On examination, his elbow was swollen and painful, and he was reluctant to move, but there was no obvious deformation and neurovascular injury. His past medical history was not significant and he had no history of elbow injuries. X-ray images (Fig. 1A and B) illustrated a well-aligned ulnohumeral joint, but the lateral condyle of the humerus (the capitellum had an accompanying epiphyseal triangular bone mass) avulsed away from the humerus and rotated laterally nearly 90°. Noticeably, there was an unusual bone mass found in the joint space, which was judged by the radiologist as the ulna olecranon fragment. Further evaluation using computed tomography (CT) (Fig. 2A and B) revealed fractures of the lateral condyle of the humerus and ulna olecranon, while the dubious defect in the coronoid was neglected. Given that the child was too young and open reduction was unavoidable (the fracture of the lateral condyle of the humerus was classified as Milch III), magnetic resonance imaging (MRI) was not performed. Under anesthesia, an exploratory and open reduction surgery was performed through a lateral approach. After the elbow joint capsule was opened and the hematocele was cleaned, it was found that the lateral condyle was overturned and displaced inferolaterally (Fig. 3A), and the anteromedial coronoid osteochondral flap was overturned outwardly and stuck on the medial surface of the lateral condyle fracture (Fig. 3B). The lateral condyle could not be reduced correctly owing to the obstruction of the osteochondral flap at the outset. After the coronoid osteochondral flap was reduced by pushing the flap medially under the traction of the elbow, the articular cartilage of the ulnar remained intact (Fig. 3C) and was fixed with a cartilage nail. Then, the lateral condyle was reduced anatomically with ease and fixed with an absorbable screw; further fixation was conducted with an absorbable suture. After operation, the X-ray images

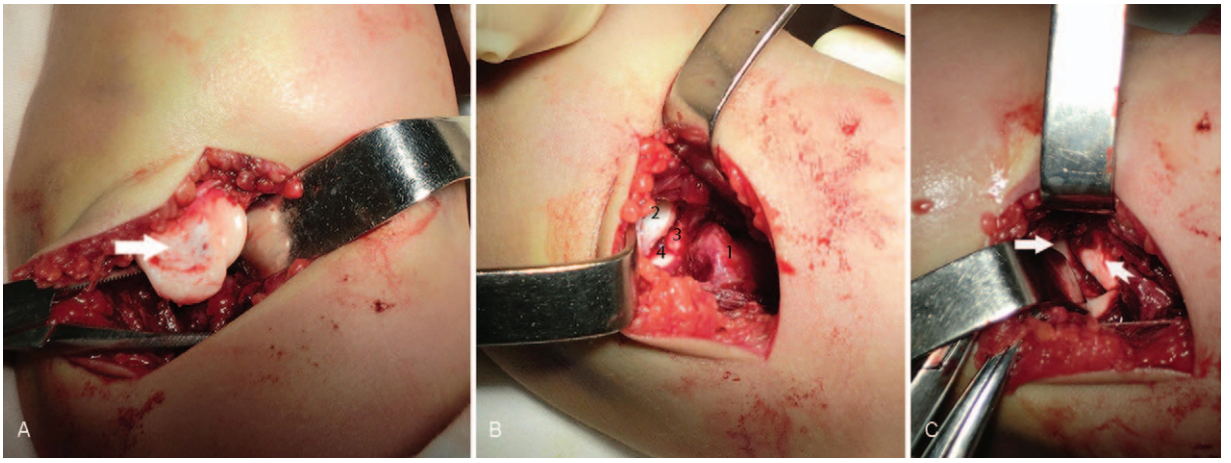

Figure 3. Operative photographs. (A) The fragment of the lateral condyle (white arrow) overturned in the lateral and lower direction. (B) The distal metaphysis of the humerus (1), the osteochondral flap (2) overturned and stuck on the medial surface of lateral condyle fracture section (3), the normal articular cartilage of olecranon (4). (C) After reduction of the osteochondral flap, the articular cartilage surface of the proximal end of the ulna (white arrow) recovered, and the medial surface of lateral condyle fracture section (dovetail arrow) was exposed completely.

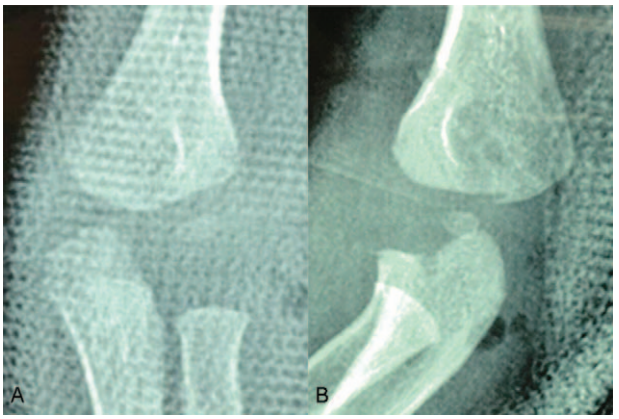

Figure 4. Postoperative radiographs. (A) Anteroposterior view. (B) Lateral view.

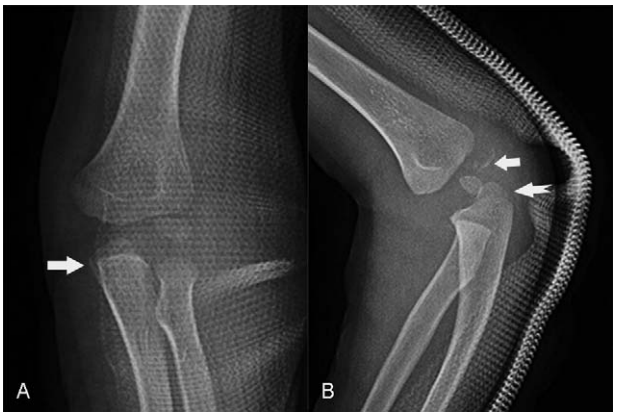

Figure 7. First radiographs. (A) Anteroposterior view shows a dubious defect (flat tail arrow) in the medial of the coronoid, but the bone mass cannot be seen clearly because of the plaster cast. (B) Lateral view shows the Milch 2 lateral condyle fracture of the humerus (flat tail arrow) and a bone flap (dovetail arrow) at the ulna olecranon.

indicated that the fracture was properly aligned (Fig. 4A and B). The elbow was immobilized in 90° flexion by plaster cast for 4 weeks, then active range of motion exercises was started. At 3 months after the operation, he had regained full range of motion of the limb and had no elbow instability. Moreover, at 8 years postoperatively, he has normal elbow function without apprehension or any complaints (Fig. 5A–C), and the Mayo elbow performance score (MEPS)[15] is 100. Radiographs revealed the articular surface at the ulnohumeral joint similar to the right arm, except for the hyperplastic bone formation of the lateral condyle (Fig. 6A–D).

2.2. Case 2

A 3-year-old boy fell from a height of approximately 1.5 m into his outstretched left arm. He felt pain immediately in the left arm. He was diagnosed with fracture of the humeral lateral condyle by radiographic findings in his local hospital. A plaster cast was applied by the local hospital, and the boy was transferred to our hospital. He had no significant history of past illness. On examination, his left elbow was swollen and he had movement limitations, but no neurovascular deficits were observed. X-ray images (Fig. 7A and B) illustrated the lateral condyle fracture of the humerus and ulnar

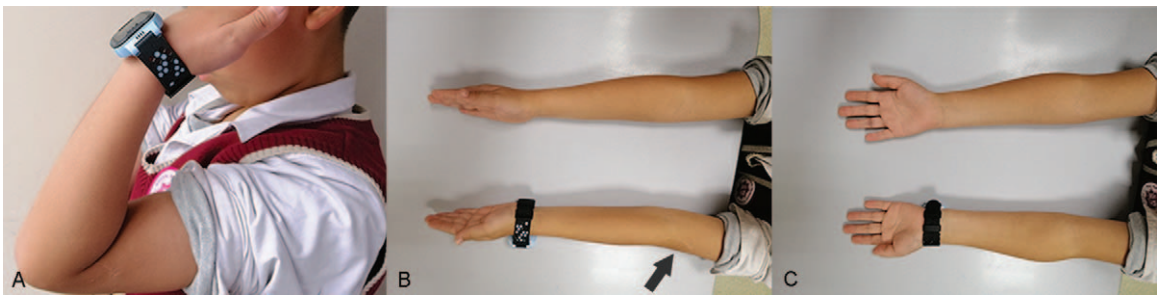

Figure 5. Clinical pictures at 8 years postoperatively. (A) Flexion of both arms. (B and C) Extension of both arms and surgical wound (black arrow).

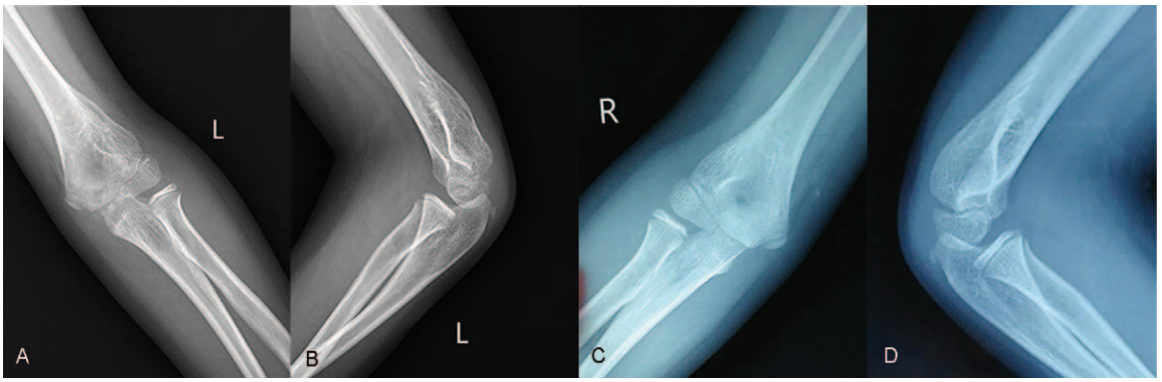

Figure 6. Postoperative 8-year follow-up radiographs. (A) Left arm anteroposterior view. (B) Left arm lateral view. (C) Right arm anteroposterior view. (D) Right arm lateral view.

Figure 8. Intraoperative image showing the osteochondral flap (virtual tail arrow) that was overturned and stuck on the medial surface of lateral condyle fracture section (dovetail arrow). The metaphysis of the humerus is marked by the flat tail arrow.

proximal end fracture, and the radial axis was aligned to the posterior of the humerus capitellum. The fracture of the osteochondral flap was neglected. CT and MRI examinations were not performed. Under anesthesia, the patient underwent close reduction with fixation of the ulnar olecranon using 2 K-wires. Then, a lateral approach was performed, and the elbow joint capsule was opened. It was found that the lateral condyle was overturned and displaced inferolaterally, and the anteromedial coronoid osteochondral flap was overturned outwardly and stuck on the medial surface of the lateral condyle fracture (Fig. 8). The coronoid osteochondral flap was reduced and was not fixed, because it was stable. Then, the lateral condyle was reduced anatomically and fixed with 2 K-wires; further fixation was conducted with an absorbable suture. After the operation, the X-ray images indicated that the fractures were well aligned (Fig. 9A and B). The wires were removed 6 weeks postoperatively, and 4 months after the operation, he had regained full range of movement of the limb. At 2 years postoperatively, he had normal elbow function, and the MEPS was 100 (Fig. 10A–C). Radiographs confirmed complete healing of the left elbow (Fig. 11A–D).

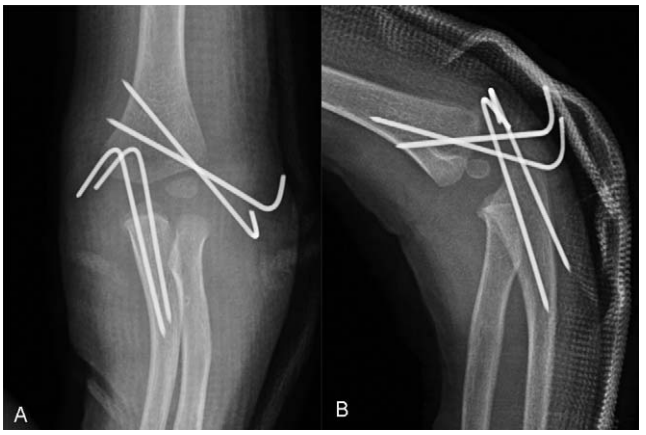

Figure 9. Postoperative radiographs. (A) Anteroposterior view. (B) Lateral view.

2.3. Case 3

A 4-year-old girl fell from a height of approximately 1.5 m into her outstretched right arm, injuring her elbow. On examination, her elbow was swollen but without deformities and neurovascular deficits. She had not significant history of past illness. X-ray images illustrated a Milch 3 lateral condyle fracture of the humerus associated with an ulna olecranon fracture. However, the coronoid osteochondral flap fracture was neglected by the radiologist. CT and MRI examinations were not performed. Under anesthesia, a lateral approach was performed. It was found that the lateral condyle was overturned and displaced inferolaterally, and the anteromedial coronoid osteochondral flap was overturned outwardly and stuck on the medial surface of the lateral condyle fracture. An olecranon fracture fragment was separated toward the proximal end and rotated medially. First, the coronoid osteochondral flap was reduced and not fixed, because it was stable. Then, the lateral condyle was reduced anatomically and fixed with an absorbable screw; further fixation was performed with an absorbable suture. Subsequently, an arc incision at the olecranon was made and a posterior approach was performed. The olecranon was reduced and fixed with an absorbable screw, and further fixation was conducted with an absorbable suture. After the operation, the X-ray images indicated that the fractures were well aligned. At 3 months after the operation, she had regained full range of motions of the limb and had no elbow instability. Unfortunately, we lost her radiographs, photos, and follow-up data.

Figure 10. Clinical images at 2 years postoperatively. (A) Flexion of both arms. (B and C) Extension of both arms and surgical wound (white arrow).

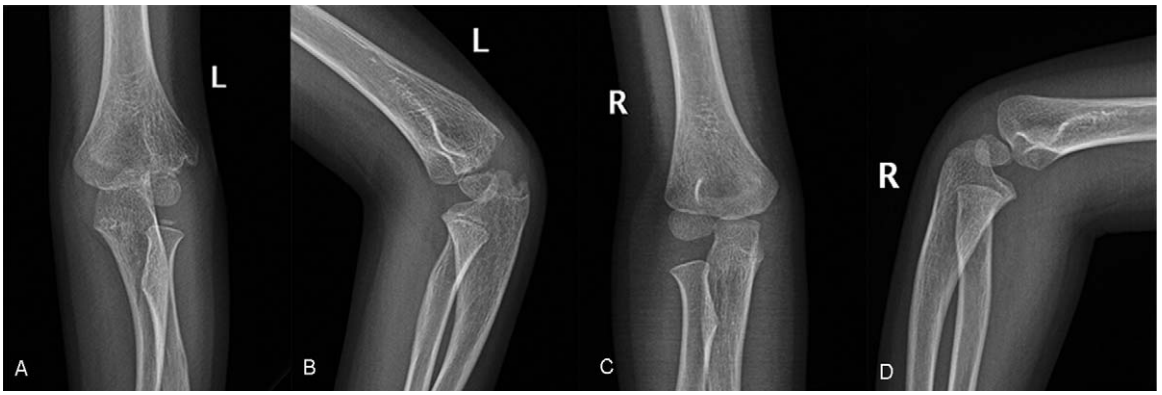

Figure 11. Postoperative 2-year follow-up radiographs. (A) Left arm anteroposterior view. (B) Left arm lateral view. (C) Right arm anteroposterior view. (D) Right arm lateral view.

3. Discussion

Osteochondral flap fractures of the ulnar coronoid process are rare in children; to the best our knowledge, only 12 cases were reported in the literature. These cases were reported to be usually accompanied with elbow dislocation, with majority of the cases having spontaneously reduced dislocation; only 1 case was accompanied with nondisplaced lateral condyle fracture.[4] The mechanism of these injuries is indeterminate, and 2 possible mechanisms are mentioned.[4,9] First, these injuries may occur during spontaneously reduced elbow dislocation.[5] During spontaneous reduction, the posterior aspect of the trochlea collides with the coronoid process and shears the osteochondral flap off and displaces into the ulnohumeral joint. Second, these injuries may occur during the initial trauma. With elbow extension and forearm pronation, the coronoid process impinges on the anterior aspect of the trochlea.[2,7]

In our cases, all 3 children suffered from lateral condyle fracture with severe displacement, which may have different mechanisms. Given that all of the osteochondral flaps were stuck to the medial fracture surface, we speculate that the injuries may occur in a progressive process, which is as follows: when the children fell into the floor, the lateral condyle was avulsed because the extensor muscles contracted suddenly, thereby causing the overturn displacement.[16] Then, the radial head lost its bony support, and posterolateral dislocation of the elbow occurred. At this moment, there would be no ligament rupture for the highly elastic ligaments and muscles in children, and the ulnar coronoid process moved to the position of left lateral condyle and was stuck on the medial surface of lateral condyle fracture. Then, the elbow joint was reduced under the effect of flexor contraction and medial collateral ligament traction. When the ulnar coronoid process returns back, the medial edge of the joint surface was

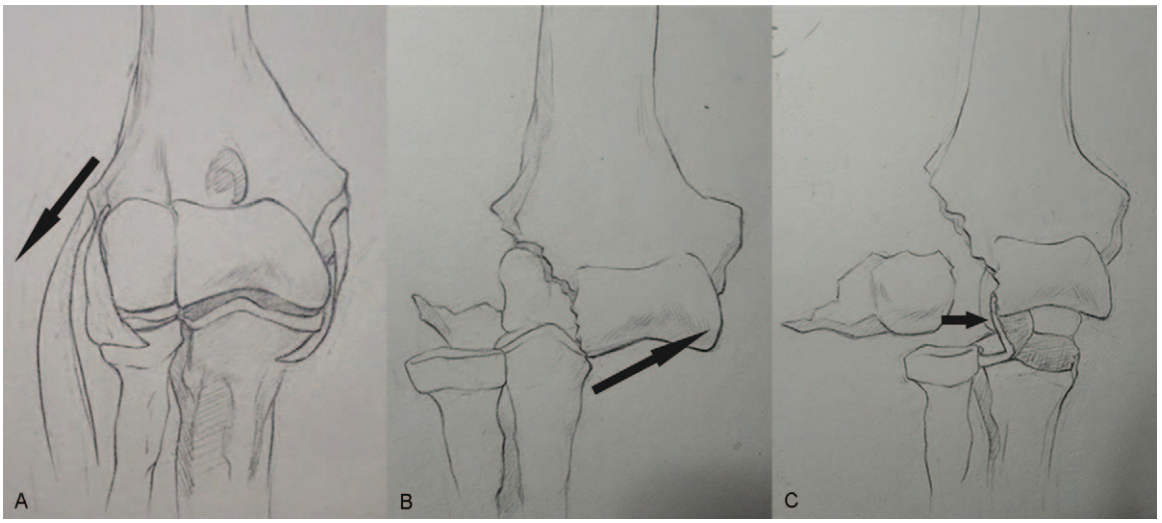

Figure 12. The speculated mechanism of the osteochondral flap fracture in combination with the lateral condyle fracture of the humerus. (A) First, the lateral condyle was avulsed because the extensor muscles and ligaments contracted suddenly, which caused the overturn displacement (the black arrow indicates the direction of the contraction of the extensor muscle and ligaments). (B) The radial head lost its bony support and posterolateral dislocation of the elbow occurred. The ulnar coronoid process moved to the position of left lateral condyle and was stuck on the medial surface of lateral condyle fracture. The elbow joint was reduced under the effect of flexor contraction and medial collateral ligament traction (the black arrow indicates the direction of the contraction of the flexor). (C) When the ulnar coronoid process return back, the medial edge of the joint surface was stuck on the medial surface of the lateral condyle fracture. The osteochondral flap fracture occurred under the shearing force produced by spontaneous reduction. With the reduction of the ulnar body, the osteochondral flap fracture extended further to the lateral side and was stuck on the medial-lateral condyle fracture section (black arrow).

blocked by the medial surface of the lateral condyle fracture. The osteochondral flap fracture occurred under the shearing force produced by spontaneous reduction, because the junction point of the cartilage and subchondral bone was more fragile than the ligaments in children. With the reduction of the ulnar body, the osteochondral flap fracture extended further to the lateral side and was stuck on the medial section of lateral condyle fracture. The mechanism was illustrated in Figure 12A–C.

These injuries are rare in children and may not be correctly recognized in surgery. It may be neglected during X-ray examinations, because the osteochondral flap contains less subchondral bone. When the fracture of the lateral condyle of the humerus was seriously displaced on the X-ray images and there was a suspicious bone mass in the joint space, it should be considered that the fracture of the osteochondral flap of the coronoid process occurred. Further CT scan and MRI examinations will help diagnose these injuries. Given that the articular cartilage is thick and has good elasticity, no rupture occurred even when folding the elbow more than 90°. Therefore, by gently pushing toward the ulnar side during the operation, the overturned osteochondral flap could be reduced by itself after the release. Given that there was no fracture in the radial part of the articular surface cartilage, the fracture was stable and required no fixation. This was confirmed because our children regained normal elbow function after the operation.

Besides, the radiograph may illustrate injuries incorrectly. In the first case, the osteochondral flap fracture was mistakenly regarded as olecranon fracture in the plain radiograph and CT scan. Moreover, in the latter 2 cases, osteochondral flap fractures were neglected on the X-ray images. Given that the cartilages are difficult to be interpreted in the radiographs, the osteochondral flap may be considered as an olecranon fragment. Thus, the diagnosis of complex elbow injuries is challenging in children.

4. Conclusion

The complicated injury of pediatric elbow is difficult to diagnose because of the radiolucency of cartilage. X-ray examinations may not detect the fracture of the osteochondral flap; thus, CT and MRI examinations should be considered if necessary. Our cases illustrate that spontaneously reduced dislocation and osteochondral flap fracture should be considered when there is a bone mass in the elbow space with accompanying displaced humeral lateral condyle fracture.

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Author contributions

Conceptualization: JinKui Wang, ZhongLiang Wang.
Data curation: JinKui Wang, ZhongLiang Wang.
Formal analysis: JinKui Wang.
Investigation: JinKui Wang, ZhongLiang Wang.
Methodology: JinKui Wang, ZhongLiang Wang.
Project administration: JinKui Wang, ZhongLiang Wang.
Resources: JinKui Wang.
Software: JinKui Wang.
Supervision: ZhongLiang Wang.
Visualization: JinKui Wang, ZhongLiang Wang.
Writing – original draft: JinKui Wang.
Writing – review and editing: JinKui Wang, ZhongLiang Wang.
JinKui Wang orcid: 0000-0002-9719-0757.

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