Lateral Condyle Fractures

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Lateral condyle fractures are common in the pediatric population but continue to have controversy regarding treatment. Typically, treatment of these fractures is operative with recent literature debating treatment options. New diagnostic modalities, novel treatment approaches, and complications are discussed based on the most current studies available. A new classification system evolved to classify lateral condyle fractures based on the degree of displacement rather than the traditional classification based on fracture line location. New research has described the utility of internal oblique radiographs to accurately diagnose fracture displacement. The main indication for operative treatment includes displacement of the fracture greater than 2 mm or articular incongruity. For nonoperative management, weekly follow-up radiographs are necessary with displacement typically occurring within the first week. For fracture displacement greater than 2 mm, operative treatment should be performed using either percutaneous or open reduction with either K-wire or lag screw fixation. Lag screw fixation has been found to have a lower risk of infection and increased rate of fracture union. For reductions performed percutaneously, an elbow joint arthrogram is performed to ensure an anatomic articular surface after reduction and fixation. The 2 main complications of lateral condyle fractures noted in recent studies include delayed union and infection with K-wire fixation.
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Introduction

Lateral condyle fractures have proved to be somewhat of a conundrum for clinicians in the past. Multiple complicating features have defined the treatment of these fractures including missed diagnosis, malunions, nonunions, and avascular necrosis.[1,2] Currently the treatment of these fractures is typically operative, though indications for operative treatment are still controversial. In this review of what's new in lateral condyle fractures, we will describe some new diagnostic modalities, novel treatment articles, and discuss some literature regarding complications recently published about this difficult fracture pattern.

Classification

The Milch Classification has classically been used clinically to describe lateral condyle fractures but does not correctly indicate treatment. This was described originally in 1964 and classifies the fractures based on their involvement or location within the trochlear groove.[3] Type 1 involves the fracture line lateral to the trochlear groove whereas type 2 involves the fracture line extending medially into the trochlear groove (Fig. 1).[3] The Jakob Classification system provides both clinically useful information as well as treatment guidance.[4] According to the Jakob Classification, there are 3 lateral condyle fracture types. Type 1 is a nondisplaced (<2 mm) fracture. Type 2 is a >2 mm displaced fracture with an intact cartilaginous hinge. Type 3 fractures are displaced with the capitellum rotated from the joint (Fig. 2).[4,5]

More recently, as published by Weiss et al, classification schemes should be based on the displacement and articular surface congruity based on arthrogram findings rather than the location of the fracture line. These have been proven to better predict the risk of complications which occurred 3 times more likely in their high-grade fractures as their

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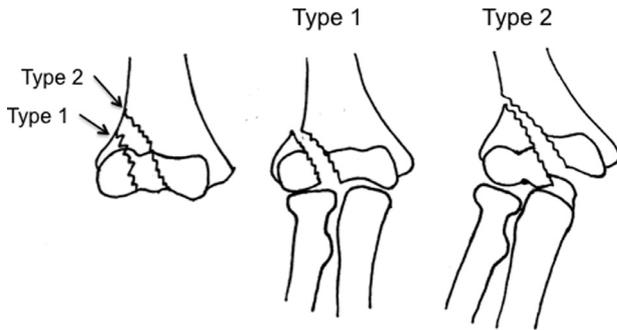
Figure 1 Milch Lateral Condyle Fracture Classification. Type 1 fracture line is lateral to the trochlear groove. Type 2 fracture line extends medially into the trochlear groove.

lower grade fractures. They divide their classification strategy into 3 types: less than 2 mm of displacement indicating intact cartilaginous hinge, greater than 2 mm but less than 4 mm of displacement with intact articular cartilage, and greater than 4 mm of displacement with disruption of the articular cartilage surface. The articular cartilage surface is investigated and defined by performing an elbow joint arthrogram. The authors utilized the largest series of lateral condyle fractures reported in the literature to define this classification scheme.[6] Figure 3 illustrates their findings.

Diagnosis

In terms of the diagnosis of these fractures, different modalities have been researched including XR, CT, and MRI. Recently, a 2007 paper described the utility for internal oblique radiographs to diagnose nondisplaced or minimally displaced lateral condyle fractures. The displacement patterns were noted to be unpredictable in a large percentage of fractures on the AP/Lateral displacement.[7] The internal oblique radiograph is the most accurate display of displacement based on the common posterolateral anatomical position of the fracture fragment (Fig. 4).[5,9,12]

Stress radiographs of the elbow are not recommended as they commonly provide no useful information and can be
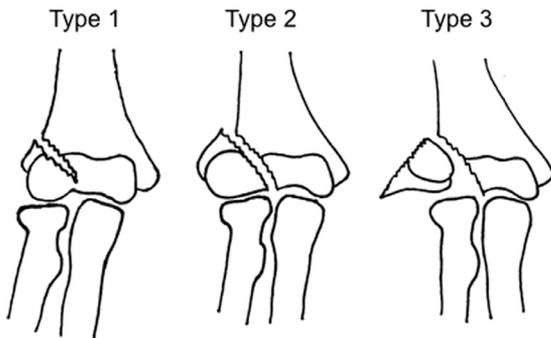

Figure 2 Jakob Lateral Condyle Fracture Classification. Type 1 is a non-displaced (<2 mm) fracture. Type 2 is a >2 mm displaced fracture with an intact cartilaginous hinge. Type 3 fractures are displaced with the capitellum rotated from the joint
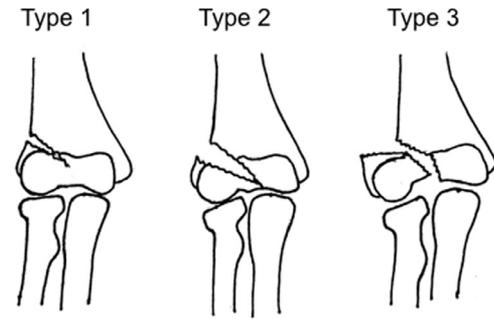

Figure 3 Weiss et al Lateral Condyle Fracture Classification. Type 1: less than 2 mm of displacement. Type 2: >2 mm and <4 mm of displacement with intact articular cartilage. Type 3: >4 mm of displacement with disruption of the articular cartilage surface

quite painful for the pediatric patient. If elbow ossification is not complete and a question remains about the existence or displacement of a fracture, a contralateral elbow radiograph can be obtained for comparison.

An elbow arthrogram performed by injecting radiopaque dye into the elbow joint space can be an adjunct procedure for diagnosis. An arthrogram is indicated for minimally displaced fractures to assess the cartilage surface when epiphyseal ossification is incomplete or absent, and allows for dynamic assessment of the joint.[6] Intraoperatively it is most commonly used to assess the articular surface and joint after fracture reduction.

Additional imaging modalities include MRI and CT. CT is rarely indicated due to the dose of radiation. MRI can be used to accurately identify minimally displaced or nondisplaced fractures to confirm conservative treatment options.[8] Park et al used 29 prospective fractures with 3D-CT reconstruction images of a posterolateral fracture fragment to assess their pin positioning following fixation of lateral condyle fractures. They developed a reference tool based on CT imaging to aid in accurate pin trajectories and configurations used during percutaneous pinning.[8] However, MRI is expensive and may require sedation in the pediatric population.
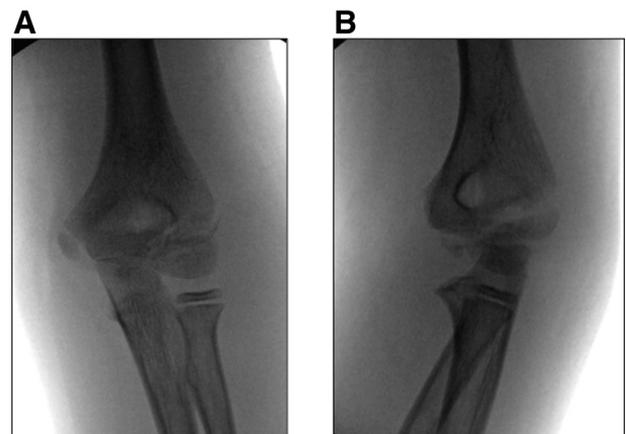

Figure 4 Internal Oblique Radiograph. Anteroposterior (AP) radiograph (A). Internal oblique radiograph that demonstrates increased widening at the fracture site as compared to the standard AP (B).

Figure 5 Lag Screw Fixation. Injury radiographs showing >2 mm displacement lateral condyle fracture with possible intact cartilage hinge (A). Intraoperative single percutaneous lag screw fixation with elbow joint arthrogram showing intact articular cartilage (B). One-week postoperative visit, no signs of healing (C). Four-week postoperative visit with evidence of callus formation and small lateral spur (D)

Indications for Operative Treatment

Traditionally, literature has been sparse but has favored operative intervention when fracture displacement is greater than 2 mm, as noted on the previously described classification scheme. Nonoperative treatment is generally indicated for stable, Jakob type I fractures in the form of a long arm cast.[4,6,9] Zale et al retrospectively reviewed 59 nondisplaced (Jakob type 1) lateral condyle fractures between 2002 and 2015. All fractures were initially treated in a long arm cast; however, 5 displaced requiring operative intervention consisting of closed reduction and pinning. A conversion rate of 8.5% was found with a mean of 13.2 days between casting treatment and closed pinning. Nondisplaced (Jakob type 1) lateral condyle fractures can be treated in a long arm cast with weekly follow up for the first 3 weeks, preferably using internal oblique radiographs.[9]

Conservative treatment can be successful for these fracture patterns if proper assessment of stability is performed. Knapik et al suggest that close, weekly radiographic follow-up is completely necessary if conservative treatment is performed. Their findings indicate that subsequent displacement was 15% of nonoperatively treated fractures and it would typically occur within the first week of follow-up. Overall in their review though, over 85% of those treated conservatively went on to uneventful union.[10] Minimally displaced lateral condyle fractures have a late displacement (>2 mm) rate of

12% and Lee et al developed a tool to predict lateral displacement using the lateral elbow soft tissue swelling to humerus shaft diameter ratio (LES-H). A LES-H ratio of ≥ 1.9 increases the risk of late displacement and patients should be monitored closely with a consideration of possible early surgical fixation.[11] Additionally, fracture displacement greater than 1.15 mm on a patient's original internal oblique radiograph can predict almost a 60% rate of further displacement, found by Bland et al.[12]

Operative Management: Open vs Closed Reduction

Song and Waters[13] suggest, all Jakob type II and III displaced fractures need an anatomic reduction and internal fixation to restore the anatomic alignment of the articular surface with adequate stabilization. Two primary operative techniques are described to treat lateral condyle fractures. Closed reduction and percutaneous pinning are performed with either 2 or 3 divergently oriented smooth K wires perpendicular to the fracture line or parallel to the joint, depending on the fracture orientation. To perform the fracture reduction, a varus stress is placed on the elbow joint with the forearm in a supinated position. In addition, an arthrogram can be undertaken to ensure an anatomic articular reduction by injecting radiopaque dye into the joint space. One study suggests
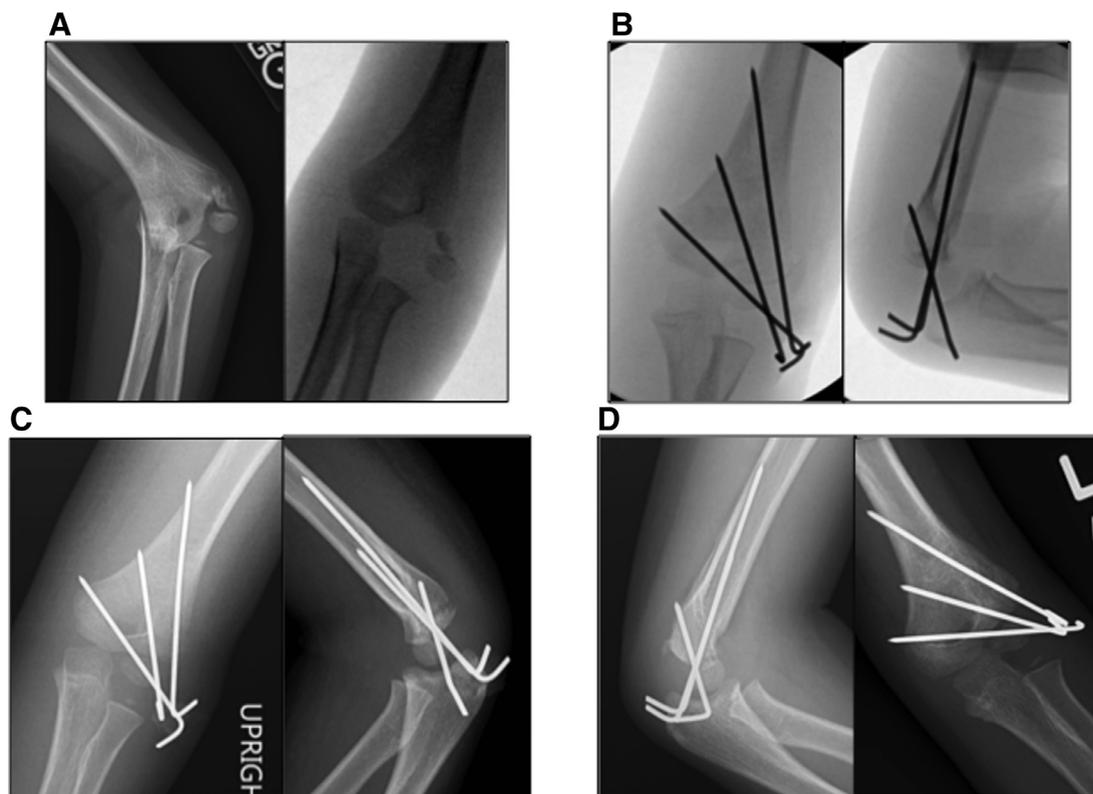
Figure 6 K wire Fixation. Injury radiographs showing markedly displaced (Jakob and Weiss et al. type 3 classification) lateral condyle fracture (A). Intraoperative K wire fixation (B). One-week postoperative visit, no signs of healing (C). Four-week postoperative visit prior to pin removal, with evidence of callus formation (D).

though that it is unlikely to alter the surgical plan and it is not associated with a better postoperatively radiographic alignment.[14] Alternatively, open reduction can be performed for fractures with a rotational profile that is difficult to anatomically align via closed reduction. This is typically performed via the direct lateral approach with care used in posterior dissection given the risk of avascular necrosis if the blood supply is disrupted.[14]

Several studies have addressed the topic of reduction. Song et al described a series of 18 closed reductions, which demonstrated good functional and clinical outcomes and suggest closed reduction as a new treatment alternative to open reduction in completely displaced lateral condyle fractures.[15] Pennock et al performed a retrospective review of 74 patients to evaluate closed vs open reduction and found that closed reduction with K wires decreased surgical time by nearly 30 minutes without increasing any complications. The outcomes in both of their groups were similar; however, they propose avoiding any incisions when closed reduction is possible.[16] Leonidou et al presented equivalent results in a case series of 105 open reductions with K wire fixation. They report 96% of the patients demonstrated evidence of radiographic union with excellent functional outcomes.[17] Further, in situ fixation has been advocated for lateral condyle nonunions in a series of 16 patients presented by Park et al. They were able to achieve bone union and improve elbow motion when treating lateral condyle nonunions with in situ lag screw fixation and minimal curettage of fracture gapping.[18]

Operative Management: Osteosynthesis With Screws vs. K Wires

Stein et al evaluated a retrospective cohort of 48 patients with lateral condyle fractures treated via either closed or open reduction. They found that closed reduction and percutaneous single 4.5 mm lag screw fixation resulted in a lower infection rate and a higher rate of closed reduction treatment than traditional pin fixation (Figs. 5 and 6). The screw fixation subset mobilized earlier as well.[19] In a biomechanical study, Schlitz et al noted that screw fixation in a Milch II model provided increased stability in stiffness and tension compared with 2 divergent K wires.[20] Also, screw fixation has been associated with a low risk of complications with early follow-up as demonstrated by Shirley et al. They discuss a retrospective review of 96 patients, 42 with closed reduction and 54 with open reduction. Their complication rate was 19% overall, but only 5% complication rate with screw fixation when lateral overgrowth of the condyle was excluded.[21] Li and Xu presented a retrospective review comparing K wires to cannulated screws that demonstrated that both are effective for treatment. However, when taking into account fixation strategies, K wire fixation requires skin care and a longer period of immobilization and screws may demonstrate hardware prominence and necessitate an additional procedure for removal.[22] Ganeshalingham et al found similar results with their 336 patient series evaluating K wire vs screw

fixation with no difference in Baumann angle, carrying angle, or additional major complications. There was also no benefit to immobilizing more than 4 weeks.[23]

Finally, in exploring K wire fixation, 1 study notes that there are no significant differences between buried or unburied K wires in terms of infections, total complications, fracture union, or reoperations.[24] A second study also notes that there is no significant difference in superficial or deep infections between buried or exposed K wires; however, exposed K wires are preferred as they are easier to remove.[25]

Complications

Very few studies have addressed the complications of lateral condyle fractures in the adolescent population. Silva et al reported that open reduction internal fixation could be performed up to 14 days after the original injury without adversely affecting the radiographic or functional outcomes.[26] Risks for delayed healing have also been documented in the literature based on a series of 210 patients with mean follow-up time of 25 weeks. Delayed union seemed to increase based on the amount of displacement postoperatively and difficulty obtaining an adequate reduction based on time of fluoroscopy.[27] Lastly, Tosti et al reported on their experience with K wire infections in pediatric orthopedic surgery. Their retrospective institutional review showed evidence that infections usually occurred following missed visits, pin-site drainage, and failed oral antibiotic therapy. The most common organisms in the study causing osteomyelitis were MSSA and pseudomonas. Additionally, they suggest that K wires may be maintained if superficial infection is suspected until the bone has united.[28]

Ultimately, operative management of lateral condyle fractures within pediatric orthopedic literature has demonstrated satisfactory functional outcomes as well as radiographic follow-up. Nazareth et al evaluated delayed unions and functional outcomes and concluded that short and long-term follow-up in their patient population demonstrated excellent outcomes regardless of age, weight, fracture classification, or treatment. They did notice a higher, nonstatistically significant delayed union rate with K wires and suggested the use of screws.[29] Additionally, Ganeshalingham et al suggested a higher rate of lateral condyle fracture nonunions using K wire fixation and recommended confirming their findings with prospective randomized controlled trials.[23]

More historic literature has discussed complications of lateral condyle humerus fractures to consist of elbow stiffness, possibility of a fishtail deformity, cubitus varus with or without tardy ulnar nerve palsy, lateral spurring, and growth arrest.[30,31] Pribaz et al were the first to publish on the common phenomenon of lateral spurring or overgrowth after lateral condyle fractures. Of 212 consecutive fractures, 73% developed a lateral spur. Spur development was found to be associated with initial fracture displacement and surgical treatment but neither the presence nor size influenced functional outcome.[32]

Conclusion

The newly proposed Weiss classification scheme improves the classification of these fractures as related to location of the fracture line and displacement. New diagnostic tools may help confirm the existence of a nondisplaced fracture or help with measuring or monitoring displacement. Internal oblique radiographs most accurately evaluate and measure displacement of lateral condyle fractures and are important to obtain. Minimally displaced fractures require close follow-up to avoid late displacement and delayed union. In terms of treatment, no definitive strategies for surgery of lateral condyle fractures have arisen in terms of open vs closed reduction; however, closed reduction with percutaneous fixation should be attempted if feasible with adjunctive elbow arthrogram to evaluate the articular surface. No studies have been able to definitely state an optimal type of fixation, K wires vs lag screw, for lateral condyle fractures. More recently however, literature suggests that lag screw fixation has decreased risk of nonunion. Both K wire and screw fixation achieve satisfactory clinical outcomes and treatment should be individualized to each patient treated until higher power, statistically significant studies definitively demonstrate superiority of treatment.

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