Introduction

Lateral condyle fractures are the second most common pediatric elbow fracture and the most common growth plate fracture about the immature elbow. They amount to displaced intra-articular fractures with commensurate need to reestablish articular congruency, but in addition to this, they carry other concerns such as delayed union, nonunion, and growth disturbance. Minimally displaced fractures are amenable to indirect reduction and internal fixation techniques, whereas the standard of care for substantially displaced fractures is formal open reduction and internal fixation (usually through the vertical limb of a Kocher lateral approach). Follow-up well beyond fracture healing is considered a normal part of caring for these injuries. The purpose of this article is to share some evidence-based and experience-based pearls and pitfalls that the authors have learned through many years of caring for young patients with lateral condyle fractures.

Summary: Lateral condyle fractures are second only to supracondylar humeral fractures when it comes to pediatric elbow fractures. Whether minimally displaced or substantially displaced, these growth plate fractures may present significant treatment challenges. These include nonunion, malunion, avascular necrosis, and growth disturbance. It must be remembered that lateral condyle fractures often represent significantly displaced intra-articular fractures involving the epiphysis that demand anatomic reduction and stable internal fixation. This article focuses on some of the pertinent pearls and pitfalls regarding these common elbow injuries using ample clinical examples.

Key Words: lateral humeral condyle, fracture, elbow, growth plate

Evaluation of the Patient with a Lateral Condyle Fractures

Children with a lateral condyle fracture have a clear-cut history of antecedent trauma followed by immediate pain localized to the elbow and decreased range of motion. Three radiographic views of the elbow, AP, lateral, and internal oblique views, are necessary, as minimally displaced fractures may not be visible on the AP view but will show maximum displacement on the internal oblique view. Impressive radiographic or clinical soft tissue swelling can also assist in the diagnosis in these patients and signifies a potentially unstable fracture (Figs. 1A, B). A posterolateral Thurston Holland fragment can often be identified. When severely displaced, the relationship between the radial head and the capitellum is lost, with the capitellum displaced laterally. Although some lateral condyle fractures are obvious, the diagnosis of a minimally to nondisplaced lateral condyle humerus fracture may be surprisingly difficult and oftentimes requires early follow-up examination and radiographs to make the diagnosis.

The traditional Milch radiographic classification has been mostly abandoned in clinical use, as the classification does not aid in decision making or have prognostic features. Although the Jakob and Song classification systems offer more guidance, they do not guide the surgeon in determining whether the lateral condyle fragment is merely hinged with the cartilaginous surface intact or if the fracture is complete through the intra-articular cartilage, without obtaining further studies such as MRI or arthrography. Currently, the Weiss classification offers the most clinically useful tool for assessment and decision making, although the findings have not been replicated by another center. In their study, articular congruity of all 65 patients with a Weiss type II fracture was confirmed with an intraoperative arthrogram. The authors found that all hinged Weiss type II fractures had 2–4 mm of displacement and were treated successfully with closed reduction and pinning. Those with >4 mm of lateral displacement had complete loss of articular congruity and required open reduction and pinning (Fig. 2).

Treatment of Lateral Condyle Fractures

Weiss Type 1

For truly nondisplaced fractures (Weiss type 1), simple immobilization in an above elbow cast or splint in 90 degrees of flexion is needed for 4–6 weeks. Families should be counseled that fracture displacement may occur and that surgery may be required, as 15% of patients with <2 mm of initial fracture displacement demonstrated further displacement.
FIGURE 1. Four-year-six-month-old boy with lateral condyle fracture initially considered Weiss II, whereas further follow-up revealed Weiss III. A, AP radiograph shows subtly displaced capitellar ossification center and marked lateral soft tissue swelling (large arrows) on AP radiographs (should alert surgeon potentially for instability). B, Lateral radiograph reveals nondisplaced lateral condyle fracture with posterolateral Thurstan Holland fragment. C, One-week postinjury AP and lateral radiographs. Note that fiberglass obscures bony detail. Capitellar center has displaced further (dotted line shows tilt). D, One week lateral radiograph also shows displacement. Treating surgeon did not repeat radiographs out of the cast nor obtain internal oblique view. E, Three-week post-injury AP out of cast showing further lateral displacement. F, Internal oblique radiograph illustrates maximal displacement. At this late presentation, open reduction and fixation is warranted to restore articular congruity. Percutaneous pinning with confirmatory arthrogram would likely have been successful if surgical intervention had been chosen at the 1-week follow-up.

within the first week of injury in a recent review article. Patients should be brought back for weekly radiographs (to include internal oblique views) out of the cast or splint for the first 2 weeks after treatment is initiated, and any signs of displacement warrant abandonment of nonoperative treatment (Figs. 1C–G). Unlike supracondylar humerus fractures, lateral condyle fractures are bathed in synovial fluid and prone to delayed or even nonunion (this has been estimated to be at least in the 15% range). If union is suspect at 4 weeks, the authors do not hesitate to continue immobilization for another 2 weeks, until there is radiographic union and the child is nontender to palpation. An early indicator of proper healing is posterior subperiosteal new bone noted on the lateral elbow radiograph. A final range of motion check is often needed at 4–6 weeks after cast removal.

Weiss Type 2

Management of the minimally displaced (2- to 4-mm displacement at the lateral metaphysis) lateral condyle is controversial and surgeon dependent. Although cast immobilization for these fractures has been reported as historically successful, close follow-up is mandatory to evaluate for subsequent displacement that will necessitate surgical treatment. The authors have a low threshold to surgically intervene when displacement occurs. Current accepted surgical treatment includes both closed reduction and percutaneous pinning (CRPP) with an arthrogram to confirm acceptable intra-articular alignment and open reduction with fixation. A recent report compared both approaches and found that although both had good outcomes, CRPP had statistically less surgical time and fewer complications (although the rate of complications did not reach statistical significance). The authors agree with the study conclusions, which is that CRPP is preferred if articular congruity is confirmed post reduction (Fig. 3).

An arthrogram may be performed either after closed reduction and fixation to confirm articular congruity or before fixation if there is uncertainty as to whether fracture displacement allows a closed reduction. It is the authors’ preference to perform the arthrogram posteriorly through the olecranon fossa. An 18-gauge needle is introduced through the triceps into the olecranon fossa with the shoulder externally rotated and the elbow in a lateral position. Once position of the needle is confirmed under fluoroscopy, a combination of 50% normal saline and 50% Hypaque sodium solution (Amersham Health, Princeton, NJ) is injected under live fluoroscopy as the articular surface is visualized (Fig. 3).

Weiss Type 3

There is consensus that surgery is warranted for displaced lateral condyle with malrotation or articular incongruity. Although there is one report of percutaneous reduction and fixation, the majority of surgeons perform open reduction with either pin or lag screw fixation. Although lag screw fixation is biomechanically superior, has higher union rates, and has lower infection rates, a second surgery is necessary for implant removal due to growth concerns. When choosing screw fixation, the screw entry point is at the metaphyseal Thurstan Holland fragment, thus avoiding the capitellar physis, which can lead to physeal closure and a future valgus deformity. In addition, this partially threaded cancellous screw does not need bicortical fixation, and a washer can help disperse the compressive force of the screw across a greater surface area. Divergence of smooth pins has been shown to be more stable than parallel pins, and 3 pins confer even more stability (Fig. 4).

Regardless of method of fixation, there should be minimal dissection of the posterior tissues during the lateral surgical approach, as the blood supply enters the lateral condyle posteriorly. The origin of the extensor tendons should be sharply dissected off the distal fragment and...
proximal metaphysis to allow adequate visualization of the articular surface, with a cuff left intact for repair. After the fracture hematoma is completely evacuated, the fragment can be reduced via manual palpation or manipulated with a towel clip or dental pick under direct visualization. Adequacy of reduction should be judged solely on the articular surface, as there is often plastic deformation of the distal metaphyseal fragment that precludes anatomic realignment.

**FIGURE 2.** Weiss classification of lateral humeral condyle fractures in children. A, Type I fractures have less than 2 mm of displacement at the lateral metaphysis. B, Type II fractures have ≥2 mm displacement at the lateral metaphysis but are hinged with an intact articular surface. C and D, Type III fractures no longer have an intact articular surface whether minimally or substantially displaced.

**FIGURE 3.** Example of arthrogram technique. A, AP radiograph Weiss II. B, Lateral radiograph Weiss II. C, Arthrogram confirms articular congruency post percutaneous pin fixation. D, Placement of 18-gauge needle in the olecranon fossa allows for a live arthrogram to clearly visualize the articular surfaces of the elbow.

**FIGURE 4.** Lateral condyle fracture fixed with 3 smooth pins. A, AP radiograph illustrating divergent pins conferring maximum stability. B, Lateral radiograph demonstrates pins predominantly entering in lower portion of hourglass.
Complications

Nonunion/Delayed Union

Due to the intra-articular nature, tenuous posterior blood supply, and strong distal pull of the extrinsic extensors on lateral condyle fractures, delayed union is the most frequent complication. Delayed union may occur with both nonsurgical and surgical treatments. For conservatively treated fractures, if there is no progression of healing or if displacement occurs in the first 6–8 weeks, surgical treatment is recommended. In situ fixation with a lag screw and without disturbing the articular surface and without bone graft can reliably promote union even in fractures presenting within 3–4 months of injury.\textsuperscript{15–17}

For late presenting fractures, treatment is often dictated by the symptoms. Patients with pain respond to in situ fixation, often with bone graft (Fig. 5). Those with unacceptable valgus deformity should be treated with corrective osteotomy, with or without an attempt to repair the nonunion. Patients who present with valgus deformity and tardy ulnar nerve symptoms should also have a concomitant ulnar nerve transposition.

Lateral Bump

Although not functionally disabling, the common prominent lateral bump overgrowth after lateral condyle fracture healing is often cosmetically displeasing to the family (Fig. 6). Lateral overgrowth may occur regardless of age and the type of treatment (cast vs. surgery), and the amount of initial fracture displacement is associated with both increased development and size lateral overgrowth.\textsuperscript{18} Lateral overgrowth has not been demonstrated to cause a decrease in elbow motion or function. Although removing part of the lateral metaphysis and periosteum at the time of surgical treatment has been proposed as a way of decreasing the risk of occurrence, this is not widely adopted. The authors strongly suggest that surgeons warn the family of a possible lateral bump when treatment is initiated, rather than try to explain the lateral bump after it has developed and caused parental anxiety.

Growth Arrest

Lateral humeral physeal arrest is rare despite the fact that lateral condyle fractures are Salter-Harris IV injuries, with only 7 patients reported in the literature.\textsuperscript{19} Asymmetric


FIGURE 6. Nine-year-8-months girl who had undergone ORIF Weiss III lateral condyle fracture 1 year 9 months earlier. A, AP radiograph demonstrating large lateral bump (spike). B, Lateral radiograph reveals no significant anterior or posterior extension of the bump. C, Clinical photograph of patient pointing to the lateral bump. D, Close-up clinical photograph of surgeon pointing to the lateral bump. This bump was observed and never required surgical intervention.
cubitus varus most commonly results. Progressive angular deformity can be treated with epiphysiodesis, depending on patient age. If deemed appropriate, osteotomy can correct problematic coronal deformity.

**Avascular Necrosis**

The etiology of avascular necrosis (AVN) is unclear, especially given that AVN has been reported after simple cast immobilization. There is currently no treatment to reverse the progression of AVN. Arthroscopic debridement reliably improves symptoms but does not improve long-term elbow motion or address joint subluxation and radiocapitellar or ulnohumeral impingement.

**CONCLUSIONS**

Lateral condyle fractures are common in children, and they carry with them their own particular treatment challenges. Among pediatric fractures (where nonunion risk is exceedingly low), minimally displaced lateral condyle fractures have a particularly high risk of nonunion (estimated at 15%). Surgical treatment is the rule rather than the exception for fractures displaced 2 or more millimeters. When surgical treatment is undertaken, the posteriorly derived blood supply to the lateral condyle must be respected. Lateral condyle fractures are the most common growth plate fracture about the elbow, and they merit radiographic follow-up to screen for growth disturbance.

**Pearls**

1. If treating nonoperatively, weekly radiographs out of the cast are needed to evaluate maintenance of reduction.
2. Internal oblique radiographs are mandatory to evaluate maximum displacement.
3. Do not disturb the posterior blood supply to the capitellum during the surgical approach.
4. Warn family of potential of lateral bump overgrowth.
5. Lateral condyle fractures may take up to 6 weeks before demonstrating radiographic and clinical union—do not be afraid to prolong immobilization.

**Pitfalls**

1. Surgical intervention for lateral bumps should virtually never be necessary.
2. Failure to intervene early when a fracture demonstrates displacement may lead to a nonunion.
3. Pulling pins too soon (before adequate healing noted) can be problematic (look for new bone on lateral image).
4. Failing to screen with elbow radiographs at 1 year (or more) may miss growth disturbance.
5. Pins that pass through the joint space and develop pin tract infection are at high risk of creating septic arthritis.

**REFERENCES**