ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 09, Issue, 07, pp. 28975-28988, July, 2019

RESEARCH ARTICLE OPEN ACCESS

OUTCOME OF OPERATIVE TREATMENT OF DISPLACED LATERAL CONDYLE FRACTURES OF THE HUMERUS IN CHILDREN IN RELATION TO TIME OF PRESENTATION

[1]Dr. Mustafa Jlood Hamza, [2]Dr. Jafer N. Hussein and [3]Dr. Midhat Mohammad Mahdi

Thyqar Health Directorate, Iraq

ARTICLE INFO

Article History:

Received 19th April, 2019
Received in revised form
26th May, 2019
Accepted 03rd June, 2019
Published online 31st July, 2019

Key Words:

Reduction, Internal,
Fixation.

ABSTRACT

Background: Lateral condyle fractures in children are the second most common fracture around the elbow. The problem arises in those cases which are difficult to treat by cast or by close reduction with percutaneous pin fixation. Late presentation is another challenge. We were select surgical treatment for such cases up to 12 weeks to evaluate our results. **Aim:** The short term outcome of usefulness of open reduction and k –wire fixation of displaced, unstable with or with rotation of lateral condyle fractures of humerus in children presenting up to 12 weeks post injury. Late presentations of lateral humeral condylar fractures, between 4-12 weeks, are candidate to open reduction and internal fixation? Can be included or not? **Method:** In this prospective study a series of eighteen patients were treated using technique of open reduction and internal fixation by k- wire and casting of displaced lateral humeral condyle fracture (Jakob II and III) from January 2016 upto January 2017.The results were assessed by criteria of Hardacre et al after follow-up between three and eighteen month. The patients were dividing into three groups according to time of surgery from date of injury; less than 1 week, between 1-4 weeks and 5-12 weeks. **Results:** Excellent results were observed in six (60%) and good in three (30%) of ten patients presenting at less than one week post injury with poor result of one (10%) patient. In four patients presenting between one week to four weeks, the results were excellent in three (75%), and poor in one (25%) patient. In four patients presenting at more than four weeks the result was good in two (50%) and excellent in two (50%) patients. **Conclusions:** Open reduction and internal fixation is an effective treatment in all cases of displaced fractures of the lateral condyle of the humerus presenting up to 12 weeks post injury on the basis of high union and low surgical complications rate.

Citation: Dr. Mustafa Jlood Hamza, Dr. Jafer N. Hussein and Dr. Midhat Mohammad Mahdi. 2019. "Outcome of operative treatment of displaced lateral condyle fractures of the humerus in children in relation to time of presentation", *International Journal of Development Research*, 09, (07), 28975-28988.

INTRODUCTION

In 1883, Stimson first described the fracture patterns in lateral condyle fracture in his book Treatise on fracture .He described the fracture at beginning in the lateral metaphysis proximal to the condyle, coursing distally, and exiting through the articular surface through the medial trochlear notch or through the capitellotrochlear groove .In 1955, Milch recognized the significance of these patterns as they related to elbow stability (http://emedicine.medscape.com/article/1231199-overview). Pediatric elbow fractures are different from many other pediatric injuries. They are associated with a relatively high rate of complications, and the results of nonoperative management are not always good. The child's elbow is well vascularized, and therefore fracture healing takes place very quickly. Such a narrow window of opportunity makes it imperative that the fracture be properly managed very quickly (Bülent Erol, 2004). Acute trauma to the pediatric elbow creates injuries that are among the most concerning for orthopedic surgeons to encounter. The unique anatomy and the intimate location of neurovascular structures often result in a spectrum of injury with associated complications and potential long-term disability. Most elbow injuries in children are obvious in their presentation. *Swelling, tenderness, limited range of motion,* or gross deformity after a traumatic event will often lead the family to seek medical attention. High-quality radiographs are

***Corresponding author: Dr. Mustafa Jlood Hamza,**
Thyqar Health Directorate, Iraq

diagnostic in most cases. Yet the presentation of nondisplaced, or occult, elbow fractures can be subtle. The posterior fat pad sign on a radiograph has recently been shown to be 76% effective in picking up an occult fracture around the elbow (http://emedicine.medscape.com/article/1231199-overview).
This finding should therefore prompt the treating physician to immobilize the elbow as if a fracture were present.In the presence of a clearly identified fracture, it is imperative to perform a complete neurologic and vascular examination at the time of initial presentation to document the level of function before treatment. This is because of the moderate rate of neurovascular complications in children with elbow injuries related to the injury itself, the treatment provided, or both (Todd, 2004). Most children who have sustained elbow trauma can be expected to have a full functional recovery if they are treated promptly with appropriate intervention and currently accepted techniques (Todd, 2004). Lateral condyle mass fractures (LCM) constitute 12% to20% of all paediatric distal humerus fractures and are the second most common injury around the elbow in paediatric population, after supracondylar fractures. LCM fractures occur most commonly between five and ten years of age. Cases have been reported in patients as young as2 years and as old as 14 years (http://emedicine. medscape.com/article/1231199-overview). usually as an isolated injury .These fractures are easily missed and when not managed appropriately can displace. Missed fracture is a common cause of non-union and deformity; thus, a high index of suspicion and adequate clinical and radiographic evaluation are required (Bülent Erol, 2004; Todd, 2004; Noor Akbar Sial, 2011 Kasser, 2001 and Kyoung Hwan Koh, 2010).

Relevant anatomy: The pertinent anatomic considerations in lateral condyle fractures include the capitellum, the lateral epicondyle, and the soft tissues attached to it, namely, the extensors and supinator. The capitellum is the first secondary ossification centre of the elbow to appear, usually around 2 years of age. The lateral epicondyle is the last, often not appearing until 12 or 13 years of age. The two ossification centres fuse at skeletal maturity (John, 2010). Though all the epiphyses are in some part cartilaginous, the secondary ossific centres can be seen on x-ray; they should not be mistaken for fracture fragments! (Andrew Cole, 2010). There are 6 ossification centres around the elbow joint .They appear and fuse to the adjacent bones at different ages. It is important to know the sequence of the appearance since the ossification centres always appear in a strict order .This order of appearance is specified in the mnemonic C-R-I-T-O-E(Capitellum –Radius – Internal or medial epicondyle – Trochlea-Olecranon –External or lateral epicondyle).The ages at which these ossification centres appear are highly variable and differ between individuals. It is not important to know these ages, but as a general guide you could remember 1-3-5-7-9-11 years (Robin Smithuis, 2012). There is another different age which appear are easily remembered by the mnemonic CRITOE: Capitellum – 2 years. Radial head – 4 years. Internal (medial) epicondyle – 6 years. Trochlea – 8 years. Olecranon – 10 years. External (lateral) epicondyle – 12 years (Andrew Cole, 2010). As shown in Figure (1). Obviously epiphyseal displacements will not be detectable on x-ray before these ages (Andrew Cole, 2010). Ossification centre of lateral condyle appears between eighteen month and two years. It extends medially to form main part of lower articular end of humerus; it ossifies at age 13 and fused with capitellum at age 16; radial collateral ligament, supinator and forearm extensors are attached (Kasser, 2001).

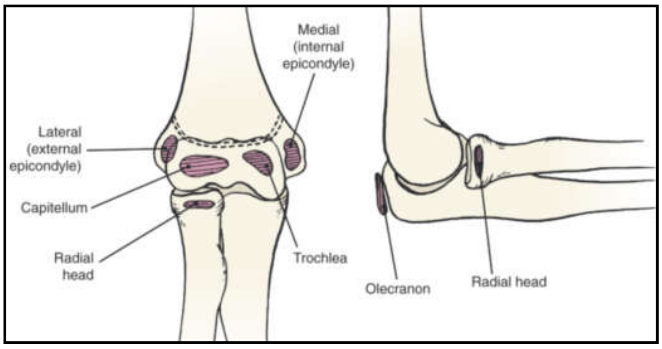

Figure 1. Secondary ossification centres about the elbow. These landmarks may appear at a younger age in girls and an older age in boys; however, the sequence remains constant (John, 2010)

Fractures of the lateral humeral condyle originate proximally at the posterior aspect of the distal humeral metaphysis and extend distally and anteriorly across the physis and epiphysis into the elbow joint. The fracture line may extend through the ossification centre of the capitellum or may continue more medially and enter the joint medial to the trochlear groove. If the fracture extends medially to the trochlear groove, the elbow may be unstable and dislocate (John, 2010).

Extraosseous

There is a rich arterial network around the elbow .The major arterial trunk, the brachial artery, lies anteriorly in the antecubital fossa, Figure (2). Most of the intraosseous blood supply of the distal humerus comes from the anastomotic vessels that course posteriorly (Kasser, 2005 and James, 2010).

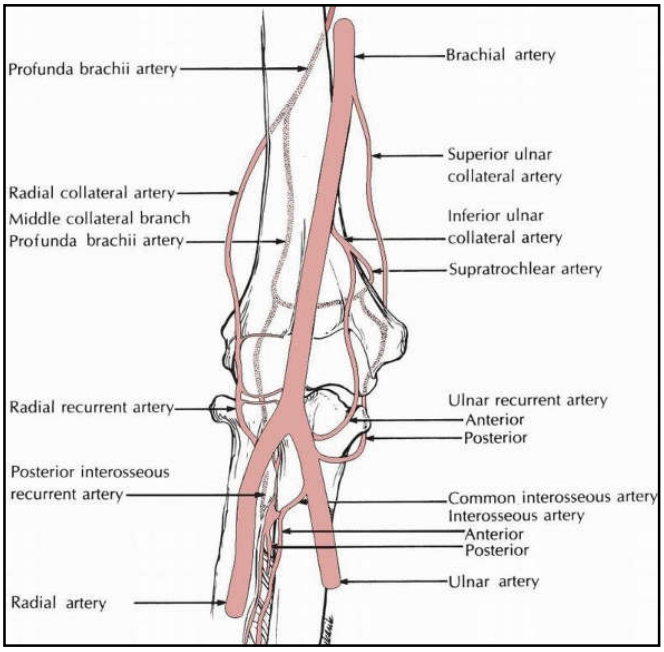

Figure 2. The major arteries about the anterior elbow (James, 2010)

Three structural components govern the location of the entrance of the vessels into the developing epiphysis. First, there is no communication between the intraosseous metaphyseal vasculature and the ossification centers. Second, vessels do not penetrate the articular surfaces. The lateral condyle is nonarticular only at the origin of the muscles and collateral ligaments. Third, the vessels do not penetrate the

articular capsule except at the interface with the surface of the bone. Thus, only a small portion of the lateral condyle posteriorly is both nonarticular and extra capsular Figure (3).

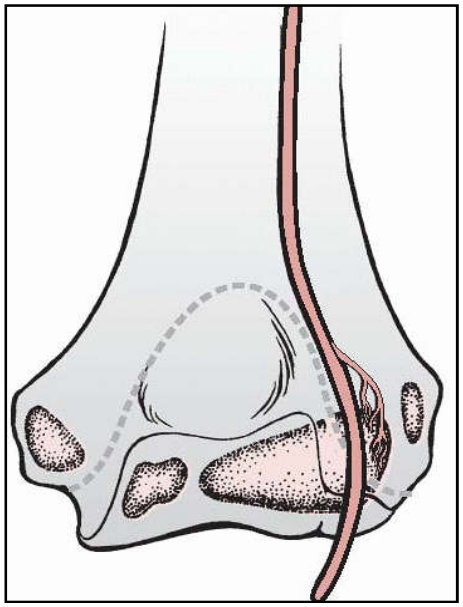

Figure 3. The vessels supplying the lateral condylar epiphysis enter the posterior aspect of the condyle, which is extra articular (James, 2010).

Posterior End Vessels: Two types of vessels exist in the developing lateral condyle. These vessels enter the posterior portion of the condyle just lateral to the origin of the capsule and proximal to the articular cartilage near the origin of the anconeus muscle. They penetrate the non-ossified cartilage and traverse it to the developing ossific nucleus. In the young child, this is a relatively long course. These vessels communicate with one another within the ossific nucleus but do not communicate with vessels in either the metaphysis or nonossified chondroepiphysis. Thus, for practical purposes, they are end vessels. As shown in Figure (4).

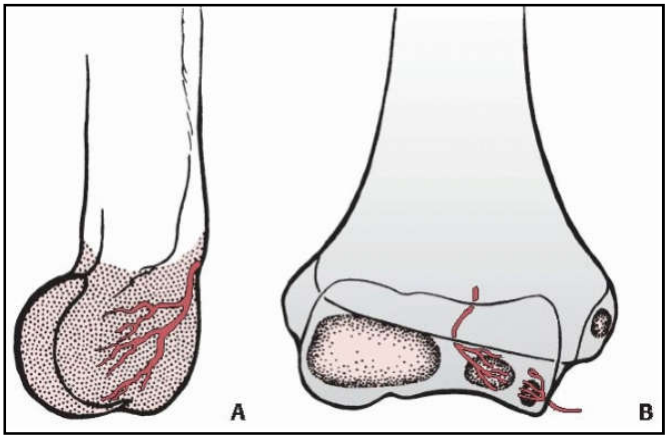

Figure 4. Intraosseous blood supply of the distal humerus

The vessels supplying the lateral condylar epiphysis enter on the posterior aspect and course for a considerable distance before reaching the ossific nucleus. Two definite vessels supply the ossification center of the medial crista of the trochlea. The lateral vessel enters by crossing the physis. The medial one enters by way of the nonarticular edge of the medial crista (James, 2010).

Lateral Crista Is Part of Lateral Condyle : The ossification center of the lateral condyle extends into the lateral portion of the trochlea. Thus, the lateral crista or ridge of the trochlea derives its blood supply from these condylar vessels. The medial ridge or crista remains unossified for a longer period of time.

Final Anastomosis: When growth is complete, metaphyseal and epiphyseal vessels anastomose freely. The blood supply from the central nutrient vessel of the shaft reaches the epicondylar regions in the skeletally mature distal humerus (Kasser, 2001 and James, 2010).

Important relation to the elbow joint

- **Anteriorly:** The brachialis, the tendon of the biceps, the median nerve, and the brachial artery.
- **Posteriorly:** The triceps muscle, a small bursa intervening.
- **Medially:** The ulnar nerve passes behind the medial epicondyle and crosses the medial ligament of the joint.
- **Laterally:** The common extensor tendon and the supinator (Snell, 2008).

Mechanism of injury: Most commonly caused by a fall on the outstretched upper extremity, these injuries are thought to occur in response to either.

1. Compression generated across the radiocapitellar joint during valgus load (Todd, 2004) (The push –off theory)
2. From tension created by the lateral joint ligaments and capsule during varus load (Todd, 2004). This is thought to be the most common mechanism of the injury (the pull –off theory) [1]. Figure (5).

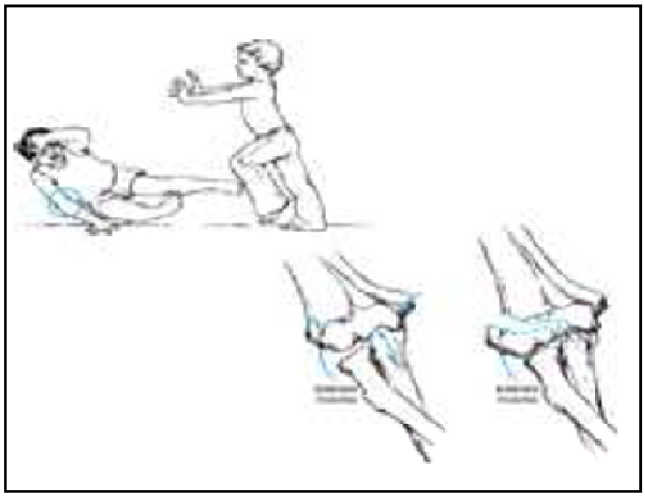

Figure 5. The most common mechanism of injury is believed to occur when the elbow is forced into varus (bottom left), which, along with the extensor muscles and lateral collateral ligaments, applies an avulsion force to the lateral condyle. When the fracture line extends to the trochlear notch (bottom right), the elbow becomes unstable (Kasser, 2001)

Classification: Lateral condyle fractures are classified by the location of the fracture line with respect to the lateral condyle and the amount of displacement of the fracture fragment.The most commonly used anatomic classification is that of Milch, which differentiates between type I and II. Figure (6).

Type 1, in which the fracture line traverses the secondary ossification center of the capitellum and falls lateral to the lateral crista of the (Todd, 2004). Salter-Harris IV fracture in which the fracture traverses the ossification center of the capitellum so that the lateral wall of the trochlea remains attached to the main portion of the humerus (Kasser, 2001).

Type 2, in which the fracture line extends further medially and potentially enters the joint medial to the lateral crista of the trochlea and essentially destabilizes the elbow joint (Todd, 2004). Fracture described as being a SH II physeal fracture (Kasser, 2001).

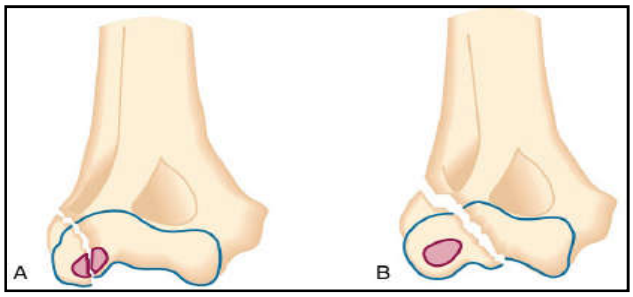

Figure (6): lateral condyle drawing – Milch classification. (A)Milch type I fracture .The fracture line is through the ossific center of the capitellum; (B) Milch type II fracture. The fracture line is medial to the ossific center of the capitellum (David, 2012).

Milch 2 fractures are far more common than Milch 1 fractures (approximately 15:1) (Todd, 2004). The classification of elbow fracture in children is on the degree of separation of the bone fragment (Jakob) which is more clinically useful (David, 2012) Figure (7).

- **Type 1:** are undisplaced or minimally displaced fractured are those with less than 2mm gap between the fractured bone part.
- **Type 2:** are displaced fractures with greater than 2mm gap, (2 mm–4mm).
- **Type 3:** are displaced fractures along with rotation of the bone fragment; more than 4mm (David, 2012 and lbow Fracture, 2012).

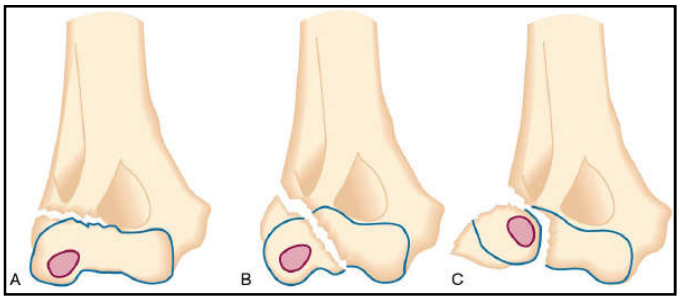

Figure 7. Lateral condyle drawing – Jacob classification (David, 2012).

Clinical presentation and diagnosis

Signs and Symptoms: Compared with the marked distortion of the elbow that occurs with displaced supracondylar fractures, little distortion of the elbow, other than that produced by the fracture hematoma, may be present with lateral condylar fractures. The key to the clinical evaluation of this fracture is the location of soft tissue swelling concentrated over the lateral aspect of the distal humerus (Major, 2002). The presence of localized lateral elbow ecchymosis in a young child is usually the sign of lateral condyle fracture of the humerus (Meyer, 2003). Children who present with nondisplaced fractures may initially have minimal swelling. A young child may present with vague pain which can confuse the diagnosis with nursemaid's elbow, other subtle fractures, or infection in the joint (www.pedortho.com/files/ PIPFxElbowLatCond.pdf) The elbow is swollen and deformed. There is tenderness over the lateral condyle (Andrew Cole, 2010). Stage I displacement may produce only local tenderness at the condylar fracture site, which may be increased by forcibly flexing the wrist or passive flexion of the wrist (pulling on the extensors) may be painful (Andrew Cole, 2010 and James, 2010). Children with displaced fractures may show obvious deformity and swelling (www.pedortho.com/files/ PIPFxElbowLatCond.pdf) Stage II or III displacement may result in some local crepitus with motion of the lateral condylar fragment. The benign appearance of the elbow with some stage I and II displacements may account for the delay of parents seeking treatment for a child with a minimally displaced fracture (James, 2010).

Radiological findings: X-rays are usually diagnostic. A non-displaced fracture may not show a fracture line, but blood inside the joint will expand the joint capsule and displace the anterior and posterior fat pads on the lateral x-ray (www.pedortho.com/files/PIPFxElbowLatCond.pdf)A fat pad sign may alert the physician to the presence of an effusion within the elbow. The anterior fat pad is a triangular radiolucency anterior to the distal humeral diaphysis; it is seen clearly, and in the presence of elbow effusion, it is displaced anteriorly. The posterior fat pad is not normally visible when the elbow is flexed at right angles; however, if an effusion is present, it will also be visible posteriorly. Figure (8).

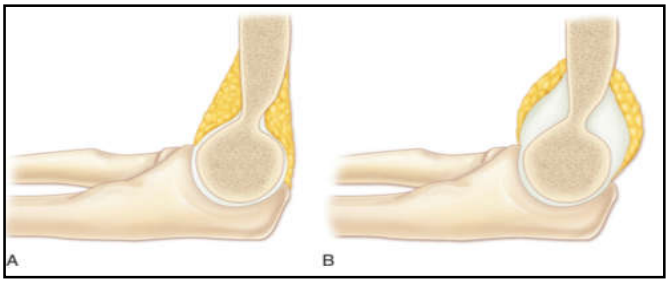

Figure 8. Fat pad sign. A, There is normally both an anterior and a posterior fat pad. These structures may be seen as radiolucencies adjacent to their respective cortices. B, In the presence of an effusion, the fat pad will be elevated, thereby creating a radiolucent "sail" (John, 2010)

The radiographic appearance varies according to the fracture line's anatomic location and the displacement stage. In the AP view, the metaphyseal flake may be small and seemingly minimally displaced. The degree of displacement can often be better appreciated on the true lateral view. Figure (9). In determining whether the articular hinge is intact (i.e., stage I vs. stage II), the relationship of the proximal ulna to the distal humerus is evaluated for the presence of lateral translocation. Oblique views are especially helpful in patients in whom a stage I displacement is suspected (Shyam, 2011).

Treatment

Background: The treatment goal in lateral condylar fracture is union without residual deformity. However, growth

disturbance may occur despite initial anatomic reduction and secure fixation. The evaluations of the clinical and functional results, including complications, of lateral condylar fracture treatments in children are the another goal (Kyoung Hwan Koh, 2010).

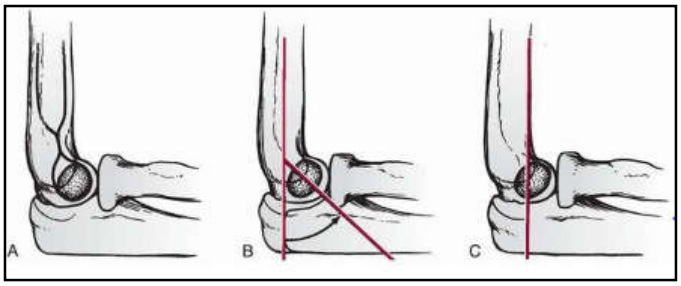

Figure 9. Lateral radiograph lines of the distal humerus .A. The tear drop of the distal humerus. B. The angulation of the lateral condyle with the shaft of the humerus. C. The anterior humeral line (James, 2010).

Conservative: Treatment decisions regarding lateral condyle fractures are influenced by the displacement and stability of the fracture (Todd, 2004). Non-displaced fractures are protected with a splint (www.pedortho.com/files/ PIPFxElbowLatCond.pdf) Only cast immobilization if the fracture is nondisplaced (Milch type I with inherent stability) and minimally displaced fractures of less than 2mm, when the fracture is stressed cast immobilization alone may be justified. The elbow flexed 90 degrees, the forearm neutral and the wrist extended (this position relaxes the extensor mechanism which attaches to the fragment). However, it is essential to repeat the x-ray after 5 days to make sure that the fracture has not displaced. The splint is removed after 2 weeks and exercises are encouraged (Andrew Cole, 2010). Ultrasound, MRI, and contrast arthrography have been used to demonstrate whether the cartilage hinge has been disrupted. Unfortunately, the drawbacks with each of these techniques, including expense, requirement for sedation, and technical experience performing and interpreting the results, limits their usefulness in most clinical practice settings (Horn, 2002 and Vocke, 2001).

Close reduction and percutaneous Pinning:- Techniques have also been described for minimal displaced fractures with closed reduction and percutaneous pin fixation (with two divergent pins) in order to maintain the alignment (Bülent Erol, 2004). Close reduction and percutaneous pinning with the aid of image intensification, eliminating the need for open reduction and internal fixation. It is recommended for lateral condylar fractures with less than 2 mm of displacement and congruent joint surfaces (Noor Akbar Sial, 2011).

Open reduction and internal fixation: Because of the high incidence of poor functional and cosmetic results with closed reduction methods, open reduction has become the most widely advocated method for unstable fractures with stage II displacement and fractures with stage III displacement (James, 2010). Displaced and rotated fractures require open reduction and pinning (Todd, 2004). So, it is recommend open reduction and pinning of all fractures displaced >2 mm (Noor Akbar Sial, 2001). Displaced fractures will require surgery, which typically involves open reduction and internal fixation (www.pedortho.com/files/PIPFxElbowLatCond.pdf) If open reduction is necessary, use a lateral approach routinely, replacing the fragment without significant dissection and fixing it internally with pins or screws. Different authors have suggested various forms of fixation, including:

- Suture fixation, which is inadequate;
- Smooth pin fixation, preferably with two pins, through the epiphysis or through the metaphyseal spike .Two 0.0625-in.K wire are placed either parallel or divergent to avoid crossing of the pins at the fractures site which would decrease stability, The most distal pin is directed toward the medial epicondyle and should engage bone rather than the trochlear cartilage (Todd, 2004). The anterior tissue is lifted and protected by a retractor to protect the radial nerve during drilling when using a lateral approach;
- Screw fixation, preferably through the metaphyseal area (Noor Akbar Sial, 2011 and Canale and Beaty, 2008). As shown in Figure (10).

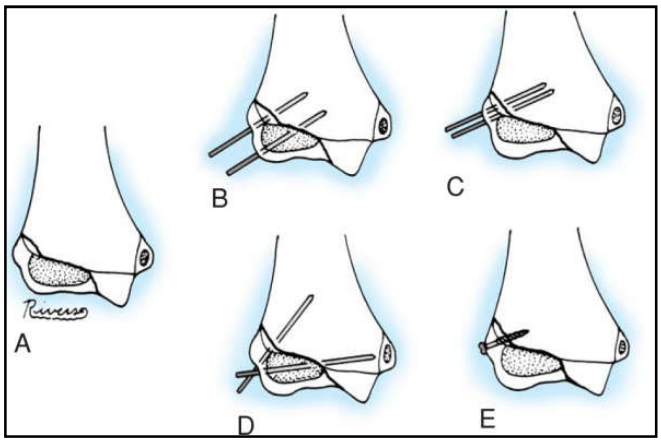

Figure 10. Different methods of fixation of lateral condylar fractures. A, Fracture pattern. B, Parallel pins. C, Parallel pins through metaphysis only. D, Cross pin fixation. E, Cancellous screw fixation (Canale and Beaty, 2008)

Operative management is essential for all displaced fractures and demonstrating joint instability or delayed instability, unsatisfactory reduction, completely dislocated, rotated fragments and in long-standing untreated cases hence it is fracture of necessity means that reduction can seldom be achieved by closed means because the fragment is frequently rotated by the pull of the wrist extensor muscles attached to it and cannot be replaced by manipulation, nor can it be held in the reduced position simply by a plaster cast (http://emedicine. medscape.com/article/1231199-overview) and (Major, 2002).

Post-Operative Care: A temporary cast is also applied to hold the fracture. After 5-7 days, an x-ray is obtained to confirm that the fracture is still properly aligned. The temporary cast is then converted into a solid cast. After 4 weeks, the cast and pins are removed so that motion exercises can be started. Use of the arm is limited by wearing a sling during the day. After 6 weeks, the fracture is well healed and activities can be gradually increased (www.pedortho.com/files/ PIPFxElbowLatCond.pdf) Controversy exists as to the recommended duration for leaving pins in place for the treatment of lateral condyle fractures .Late displacement after reduction and pinning has led to recommendations for leaving pins in place for as long as 6 six weeks, if necessary .Serial radiographic evaluation using anteroposterior, lateral, and internal oblique radiographs may be obtained 3 to 6 weeks postoperatively to determine the appropriate time for pin

removal. The removing of the pins at 4 weeks allows adequate time for healing and is often necessary to avoid pin site infections and prevent joint stiffness (Todd, 2004).

Pain management:Fractures hurt and appropriate pain management is important. With good pain management, children will eat better, sleep better, heal better, and have less apprehension when they have the cast removed and start working on motion. Elements of pain management include treating the injury, resting the elbow, elevation to decrease swelling, pain medications, and other supplementary measures. Ibuprofen and lortab (mild narcotic), when give together, work well and provide good pain relief for most children. Ibuprofen every 8 hours for 5 days and on top of the ibuprofen, give the lortab every 4 hours, adjusting the dose based on the level of pain. Most kids are off the lortab within 2-3 days and off the ibuprofen by 5-7 days. Children usually do very well are usually pain free within 5-10 days (www.pedortho.com/files/ PIPFxElbowLatCond.pdf).

Evaluation of the results: To assess the outcome of results which included the functional (loss of motion) and the cosmetic (carrying angle), in addition to sign and symptom like pain, weakness and neuritis. The normal range of motion of the elbow (flexion –extension: 0 -140°) and the normal carrying angle is (5 -15°) (Andrew Cole, 2010). There are multiple criteria used: Dhillon et al scoring system (Kyoung Hwan Koh, 2010), which depend on the loss in carrying angle, motion restriction of the flexion and extension and pain or weakness. There are two other criteria, one as defined by Aggarwal *et al* (Shyam, 2011) and the other Hardacre et al (Song, 2010; Kwang Soon Song, 2008 and Marcheix, 2011) which is include three parameter range of motion, carrying angle and symptom, which is use in our research.

Complication: Lateral condyle fractures are associated with a concerning number of complications and consequences of improper treatment. Delayed union, nonunion, lateral condyle overgrowth or spur formation(30%), elbow deformity with progressive cubitus valgus, tardy ulnar nerve palsy, and loss of motion are among the problems seen with these injuries (Todd, 2004 and Janos, 2011). Vigilance and meticulous attention to detail are essential in managing these injuries to ensure a positive outcome. The complications that affect the outcome can be classified as either biologic or technical (Janos, 2011). Biologic problems occur as a result of the healing process, even if a perfect reduction is obtained. These problems include spur formation with pseudo–cubitus varus or a true cubitus varus and cause difficulty in patient with a small carrying angle. In general ,it should not cause a cosmetic or functional problem (Kasser, 2001 and Janos, 2011). The technical problems arise usually from errors in management and result in nonunion or malunion with or without valgus angulation, osteonecrosis, neurologic injuries and myositis ossificans (Kasser, 2001 and Janos, 2011).

Biologic problems

Lateral Spur Formationz Lateral condylar spur formation is one of the most common deformities after a fracture involving the lateral condylar physis caused by coronal rotation of the distal fragment, which tends to displace laterally the flap of periosteum associated with the distal fragment. This periosteum then produces new bone formation in the form of a spur. Cotton believed that this spur formation produces no functional that it was of no functional importance, and he also believed that the cosmetic effect is insignificant. The spur occurs after both nonoperative and operative treatment. After nonoperative treatment, it results from the minimal displacement of the metaphyseal fragment and usually has a smooth outline. In patients with no real change in carrying angle, the lateral prominence of the spur may produce an appearance of mild cubitus varus (pseudovarus). In patients in whom a true cubitus varus develops, the presence of the lateral spur accentuates the varus alignment. The spur that occurs after operative treatment has a more irregular outline and usually is the result of hypertrophic bone formation from extensive dissection at the time of open reduction and internal fixation. When performing an open reduction, care should be taken to limit the aggressiveness of the dissection and to carefully replace the lateral periosteal flap of the metaphyseal fragment. Before treatment, the parents should be warned that either lateral overgrowth with mild cubitus varus or lateral spur may develop, regardless of the method of treatment (Kasser, 2001 and Canale and Beaty, 2018). This overgrowth usually remodeling and disappears over time (Janos, 2011). See Figure (11 and 12). Transient stimulation resulting in lateral condylar overgrowth, radial prominence, and variation in the carrying angle of the elbow has been described (Noor Akbar Sial, 2011).

Figure 11. The overgrowth of lateral condyle fracture of boy 4 years age treated by open reduction and internal Fixation (photographed by the researcher)

Cubitus Varus: Reviews of lateral condylar fractures demonstrate that a surprising number heal with some residual cubitus varus angulation. In some series, the incidence of cubitus varus is as high as 40%, and the deformity seems to be as frequent after operative treatment as after no operative treatment. The exact cause is not completely understood. In some instances, it is Probably a combination of both an inadequate reduction and stimulation of growth of the lateral condylar physis from the fracture insult. Rarely is the cubitus

varus deformity severe enough to cause concern or require further treatment. This is probably because it is a pure coronal varus angulation and does not have the horizontal anterior rotation of the lateral condyle along with the sagittal extension that makes the cubitus varus that occurs after supracondylar fractures such an unacceptable deformity. Some investigators have noted that children with cubitus varus deformities have pain, decreased range of motion, epicondylitis, and problems with sports such as sidearm pitching, swimming, judo, and pushups (Kasser, 2001 and John, 2010).

Technical Problems

Nonunion/Delayed Union: The most common technical problem is nonunion, usually due to inadequate treatment; True nonunion with significant deformity is rare because it is usually the result of non-treatment of a displaced fracture of the lateral condylar physis (inadequate fixation or stabilization) or may be caused by the pull of the extensor musculature (Janos. 2011). Nonunion can occur with or without angular deformity. True nonunion occurs in patients with progressive displacement of the fragment. The mobile fragment can be palpated, or the patient has weakness or pain in the elbow. See Figure (12). If the fracture has not united by 12 weeks, it's classified as a nonunion (Noor Akbar Sial, 2011; Kasser, 2001 and Janos, 2011). If the condyle is left capsized, non-union is inevitable; with growth the elbow becomes increasingly valgus, and ulnar nerve palsy is then likely to develop. Stiffness and pain can result. Even minor displacements sometimes lead to nonunion (Andrew Cole, 2010).

Figure 12. Nonunion of lateral condylar fracture After 18 month follow up (photographed by researcher)

Speed and Boyd repeatedly noted that these fractures were notorious for complications, with the worst being that of nonunion with subsequent migration proximally of the nonunited fragment, an increase in the carrying angle (cubitus valgus), and tardy ulnar nerve palsy(20 years) (Noor Akbar Sial, 2011 and Rutherford, 1985). Speed, in reviewing his results, found them to be so unsatisfactory after closed treatment that open reduction and internal fixation were necessary—hence the term fracture of necessity (Canale and Beaty, 2008). Nonunion, when it occurs, creates the risk of gradual progressive valgus deformity of the elbow and the occurrence of tardy ulnar nerve palsy. When identified, nonunion should be treated with open debridement of the nonunion fibrous tissue and in situ fixation with bone graft to achieve union and prevent further deformity (Todd, 2004). It is often not possible to restore normal anatomy and not worth the risk of avascular necrosis to perform an overly aggressive debridement of the fracture site in an effort to improve the appearance of the reduction in fractures treated more than 3 weeks after injury with more than 1 cm of fracture displacement (Todd, 2004).

Fishtail Deformity: Two types of fishtail deformity of the distal humerus may occur. The first, a sharp-angled wedge, commonly occurs after fractures of the lateral condyle, this type is believed to be caused by persistence of a gap between the lateral condylar physis ossification center and the medial ossification of the trochlea, and this may represent a small "bony bar" in the distal humeral physis (Janos, 2011 and Song, 2007). Because of this gap, the lateral crista of the trochlea may be underdeveloped physis. The cause of fishtail deformity of the distal humerus is uncertain. Rutherford found that this type of deformity occurred only in fractures that were inadequately reduced (John, 2010). However, Morrissey and Wilkins noted it after a variety of fractures of the distal humerus and attributed it to AVN. In all likelihood, both causes occur (John, 2010). Despite some reports of loss of elbow motion with this type of fishtail deformity, most investigators have not found this type of radiographic deformity to produce any functional deficiency (Janos, 2011). The second type of fishtail deformity is a gentler smooth curve. It is usually believed to be associated with osteonecrosis of the lateral lip of the trochlea .This is also treated conservatively (Kasser, 2001 and Rutherford, 1985). Figure (13).

Figure 13. Eight months follow up, three years child presented with fish tail deformity due to avascular necrosis of lateral condyle fracture after open reduction and internal fixation. (Photographed by the researcher)

Cubitus Valgus:-Cubitus valgus is much less common after united lateral condylar fractures than cubitus varus. As with cubitus varus, it is usually minimal and rarely of clinical or functional significance. The more difficult type of cubitus valgus associated with nonunion , in this case ,treatment is complex and difficult address and stabilize the nonunion ,and perform a medial closing wedge osteotomy to correct the angular malalignment this may be performed simultaneously, or it may sequentially be staged . Care must be given to the amount of dissection performed to avoid avscular necrosis of the lateral fragment (Kasser, 2001 and Janos, 2011). Cubitus valgus secondary to physeal closure has rarely been reported .Treatment transposition with or without osteotomy with open

reduction and internal fixation, only if symptomatic or unstable (Rutherford, 1985). Malunion of a Milch type I fracture pattern can result in the development of a bifid lateral condyle .No reliable operative treatment has been described to reestablish the congruity of the articular surfaces in condylar malunion, and they probably are best left untreated (Rutherford, 1985).

Loss of the motion: If treated improperly, the patient may present with malunion .deformity at the site, instability of the elbow joint, stiffness and some loss of motion in the elbow (Major, 2002).

Neuro-vascular Complications: The neurologic complications can be divided into two categories: acute nerve problems at the time of the injury and delayed neuropathy involving the ulnar nerve (the so-called tardy ulnar nerve palsy) (Canale and Beaty, 2008).

Acute neurocirculatory compromise: The rate of neurovascular complication is much less. Acute compromises of the neural or circulatory status in the extremity are transient and lead to no permanent complication when adequate treatment is instituted immediately the most serious of all vascular complication is a Volkmann contracture which results in an ugly deformity that often renders the hand and forearm practically useless .Usually develop after tight bandages applied by bone setters in developing countries (Noor Akbar Sial, 2011). Smith and Joyce reported two patients with posterior interosseous nerve injury after open reductions of the lateral condylar fragment, both of whom recovered spontaneously (John, 2010).

Tardy Ulnar Nerve Palsy: Tardy ulnar nerve palsy as a late complication of fractures of the lateral condylar physis is well known. Forty-seven percent of his patients with tardy ulnar nerve palsy had fractures of the lateral condylar physis as a child. The onset of the symptoms varied from 30 to 40 years. Subsequently, reports by numerous other investigators confirmed the frequency of this complication after the development of cubitus valgus from malunion or nonunion of fractures of the lateral condylar physis (Noor Akbar Sial, 2011). The symptoms are usually gradual in onset. Motor loss occurs first, with sensory changes developing somewhat later. The average interval of onset was20- 22 years (Rutherford, 1985). Various methods of treatment have been advocated, ranging from anterior transposition of the ulnar nerve (originally the most commonly used procedure) to simple relief of the cubital tunnel (Kasser, 2001 and John, 2010).

Physeal Arrest: Although lateral condyle fractures cross the germinal layer of the physis and are classified as Salter-Harris type IV injuries, growth arrest is a rare complication (John, 2010). Physeal arrest may be manifest by no more than premature fusion of the various secondary ossification centers to each other, with little or no deformity (Kasser, 2001). It can be noted by measuring the width and tilt of the distal humerus and the depth of the trochlear groove with fishtail deformity (deepening of the trochlear groove) and premature closure of the epiphysis, resultant mild to moderate valgus deformity and rare varus deformity (Noor Akbar Sial, 2011). This phenomenon probably occurs because the fracture stimulates the ossification centers to grow more rapidly and thus they reach maturity sooner, or, rarely, it is caused by inadvertent dissection in the lateral condylar physis. Because of the limited growth of the distal humerus (20% of the entire humerus, or approximately 3 mm/year), physeal arrest rarely causes any significant angular or length deformities (John, 2010). Older patients are probably best treated with completion of the epiphysiodesis and osteotomy (Kasser, 2001).

Osteonecrosis: Osteonecrosis of the condylar fragment may be iatrogenic in origin and is most commonly associated with the extensive dissection necessary to effect a late reduction.Osteonecrosis is rare in fractures of the lateral condylar physis that receive little or no initial treatment and result in nonunion.Overly vigorous dissection of fresh fractures, in order to mobilize the condyle it may be necessary to divide part of this soft tissue attachment, thus endangering the blood supply of the fragment and causing avascular necrosis (Noor Akbar Sial, 2011). Result in osteonecrosis of either the lateral condylar ossification center or, rarely, the metaphyseal portion of the fragment, leading to nonunion. If the fracture unites; osteonecrosis of the lateral condyle reossifies over many years, much like Legg-Calvé-Perthes disease in the hip (Kasser, 2001).

Myositis Ossificans The only report of myositis ossificans after lateral condylar fracture when was associated with a dislocation. The myositis resolved with no functional residual. The myositis ossificans occurred after a delayed open reduction 1 week after injury. This may had some residual loss of elbow extension (Kasser, 2001).

Ipsilateral Injuries: Fractures of the lateral condyle have been associated with elbow dislocations, fracture of the ulnar shaft, and fracture of the medial epicondyle .Often an elbow dislocation is misdiagnosed in a patient with a lateral condylar fracture. Loss of the lateral crista can make the elbow unstable and allow the proximal radius or ulna to translocate laterally. This is a part of a normal pathologic condition associated with completely displaced lateral condylar fractures. In a true elbow dislocation, the proximal radius and ulna are displaced, not only medially or laterally but also proximally (Canale and Beaty, 2008).

Pin tract infections: The postoperative pin tract infection is common. Most of the pin site infections were mild which can be prevented by pin tract care, oral antibiotics and relatively early removal of the pins (Noor Akbar Sial, 2011).

Aims of study: To assess the short term results of usefulness of open reduction and k –wire fixation of displaced, unstable with or with rotation of lateral condyle fractures of humerus in children presenting up to 12 weeks post injury. Late presentations of lateral humeral condylar fractures, between 1-12 weeks, are candidate to open reduction and internal fixation? Can be included or not?

Patients and methods: A short prospective study was conducted from January 2016 to January 2017, at orthopaedic units of the general hospitals in al–Basra. Eighteen children with displaced lateral condylar fracture of humerus were qualified for operative treatment. Eighteen were treated by different surgeons in different hospitals during the same period.Ten patients presented within one week, four between 1-4 weeks and four between 5-12 weeks post injury. The mean age was years (range: 3 -11 years). Pain, swelling, ecchymosis over lateral epicondyle, local tenderness, limited range of motion, gross deformity and lateral prominence after

a traumatic event was usual clinical findings. Radiological examination include true antero–posterior and lateral views some time oblique for determined displacement and grading of injure side .Although not frequent used ,plain radiograph for normal side used for comparison. The fractures were classified using Milch and Jakob classification (Schalamon, 2007). The 18 patients with types II and III fractures underwent surgery and are the focus of this study. Jakob type II (n= 4) displacement between 2 -4mm (gap). Jakob type III (n=14) more than 4mm (flip).The cause of fractures was fall into ground (ladder, bed, car…) on an out stretch hand except three cases one after RTA , the other fall on flexed elbow and the 3rd one after sport injury . The indication of surgery was displacement of fractures more than 2mm (Jakob type II and III).The time interval from injury and surgery vary from few days to few weeks. Ten patients presented within first week, 4 patients after one week to 4 weeks and 4 patients more than 4 weeks.Ultrasound, MRI, and arthrography studies were not request for those patients.Inclusion Criteria included the following: all cases unilateral, displaced, and unstable with or without rotation, failure with conservative treatment and late cases (upto12 weeks) of unsatisfactory deformity with poor functional results, while the exclusion criteria include the following: cases with polytrauma, multiple bones fracture involving the same elbow, fractures managed by immobilizations alone which are stable (Jakob I,crack) and fractures with dislocation of elbow.The surgical procedure was performed with the patient in supine position and the involved limb held beside operating table .At time of induction of general anaesthesia, a third generation cephalosporin (ceftriaxone) antibiotic was administered intravenously and continued at 12 hour interval for next 24 hours. The dose was calculated according to body weight (150 mg /kg /day in divided dosage). An Esmarch tourniquet on well-padded cotton was applied proximally in the upper 3rd of the arm.

A lateral approach was performed through Kocher incision (Canale and Beaty, 2008), by all the surgeons. In the proximal angle of the wound, avoid the radial nerve where it enters the interval between the brachialis and brachioradialis muscles, the posterior aspect of fracture fragment is left undisturbed because it is the source of the blood supply to the capitellum. A gentle dissection of the fracture fragment was done, with minimum striping of soft tissue attachment on it.The fracture line was easily visualized after blood, fibrin, and loose articular debris were irrigated from the joint. In late cases multiple incisions over the fascia of the common extensor were done in an attempted to close the gap between the fragments , not use the force to bring fragments .Anatomical reduction was acheived in every case by applying traction and gentle varus force to elbow and direct compression anteromedially on the fragment .At least two plain k-wires from the lateral bone margin were applied in a way that two cortices (bicortical) should engaged near and far for firm fixation either parallel or divergent according to the fragment specification and also to avoid crossing of the pins at the fracture site which decrease stability. Bone graft not used. After that the wound closure without drain, Figure (15). As general the kirschner wires were not buried under the skin but some surgeon especially when decided to leave k –wire for long time especially in older patients, the k –wire buried under the skin. Postoperatively elbow was supported in plaster back slab for about 4 -6weeks, depending upon state of union.The patient was discharged home on the next 24-48 hour provided no complications were reported except one patient has an anesthetic complication and remains for 5 days. The follow up scheme of patients at one week interval for the first month, at the first week inspect the wound, sent the patient for checking x-ray after discarded the plaster and change of dressing was done. Removal of stitches was done provided that the wound is healed in the 2nd or 3rd week Immobilization for about 4-7 weeks depending upon the status of union. The wires were removed between 3-12weeks .The child sent for physiotherapy (elbow exercise) which started after removal of posterior slab. The physiotherapist advised not to do under any circumstances forced passive movement of the elbow .The children usually regain a good range of movement without any need for physiotherapy . Follow up every3 months or some time more than this period espacially for kids who live far away for more than a year. For assessment of the results, the patients were evaluated clinically for pain, range of motion, carrying angle, and deformity at local site (i.e., lateral prominence). Radiographic evidence of the bone healing, reduction, status of the growth plate (overgrowth), the avascular necrosis of the fractured fragment, state of union and the deformity. The results of treatment were ranked as excellent ,good or poor using the protocol of criteria suggested by Hardacre et al table (1) (Song, 2010).

Table 1. Evaluation of the results by Hardacre Et al

	Range of Motion	Carrying Angle	Symptom
Excellent	No limitation	No alteration	No symptom
Good	Functional range of motion (lacking no more than 15° of complete extension)	Inconspicuous alteration	No arthritis ,neurological symptom
Poor	Disabling loss of function	Conspicuous alteration	Arthritic symptom, ulnar neuritis, roentgen findings of non-union ,avascular necrosis

For data analysis, we depend on the Fisher′s exact tests which determine the p –value, as follow: $p<0.05$ is significant; $p<0$, 01 is highly significant and $p>0.05$ is not significant.

RESULTS

A total of 18 patients were finally evaluated .The average ages was7.4 year (range 3 year to 11 year). The average length of follow-up monitoring was 10 month (range, 3 to 18months). Of total eighteen patients were present during this duration, fifteen (83.3%) males and three (16.7%) females, Table (2).

Table 2. Gender distributions

Gender	No.of patients	Percent
Male	15	83.3%
Female	3	16.7%
Total	18	100%

Lateral condylar involvement in left side was thirteen fractures involved (72.2%) and right side in five involved (27.8%) patients and no bilateral cases reported, Table (3) The fractures were classified according to Jakob into three types but type one not included in this study Table (4). All patients were distributed into three groups base on time of surgical

interferance following injury, Table (5). The complications are mention according to surgical interval, Table (6). Patients have one complication and the other more than one Table (7). The carrying angle and range of movement of 18 patients with mechanism of injury Table (9).

Timing of removal of K-wire in compared with surgery interval as shown in table (10). The results are evaluated and assessment according to criteria defined by Hardacre et al [21].Table (11).

Table 3. Elbow involvement

Side	No.	Percent%
Left	13	72.2%
Right	5	27.8%
Total	18	100%

Table 4. Fracture displacement according to Jakob classification

Classification	No. of patients	Percent
Type II*	4	22.2%
Type III•	14	77.8%
Total	18	100%

*displacement between 2-4 mm.
•displacement more than 4mm.

Table 5. Distribution of patients according to surgery date from injury time

Time interval	No. of patient	Percent
Less than one week	10	55.6%
>1-4 week	4	22.2%
>4-12 week	4	22.2%
Total	18	100%

Table 6. Distribution according to the complication

Complications	Surgery interval							
	<1 wk. (10 pats.)		>1-4wk (4pats.)		>4-12wk (4 pats.)		Total (18 pats)	
	N0.	%	No.	%	No.	%	No.	%
Pats. with no complication	3	30	3	75	2	50	8	44.44
AVN			1	25			1	5.6
Over growth	3	30	1	25	1	25	5	27.7
Loss of full extension	4	40	1	25	2	50	7	38.8
Fish tail			1	25			1	5.6
Cubitus valgus	1	10					1	5.6
Non-union	1	10					1	5.6
superficial infection	2	20					2	11.1
Total Complications	11	61.12	4	22.22	3	16.66	18*	100

Note: no. of the complication exceeded the no. of the patient because of there is more than one complication in one patient.

Table 7. Distribution of combine complication

Interval of surgery	Patient No.	Combined complication						
		AVN	Over growth	Loss of extension	Fish tail	Infection	Cubitus valgus	Nonunion
Less than one week (10 pat.)	3			+			+	+
				+		+		
				+		+		
>1-4 week (4 pat.)	1	+	+	+	+			
More than 4 week (4 pat.)	1		+	+				
Total	5	5						

+ : means present

Table 8. Distribution of single complication

Interval of surgery	Single complication (Patient No.)	Over growth	Loss of extension
Less than one week (10 pat.)	4(40%)	3(30%)	1(10%)
>1-4 week (4 pat.)	0	0	0
> 4 -12week (4 pat.)	1(25%)	0	1(25%)
Total	5(27.7%)	3(16.6%)	2(11.0%)

Table 9. Demographic information and fracture description of 18 pediatric patients with lateral humeral condylar fracture

case	Mechanism of injury	Jakob classification	Duration of K wire maintenance	Carrying angle		Range of motion	
				Non- injured side	Injured side	Non- injured side	Injured side
1	FOOSH•	III	3 weeks	7	7	0-135	0-135
2	FOOSH	III	4 weeks	7	7	0-140	0-140
3	FOOSH	III	6 weeks	7	13	0-140	30-135
4	FOOSH	II	3 weeks	7	7	0-145	0-145
5	FOOSH	II	7 weeks	7	8	0-140	0-140
6	FOOSH	III	4 weeks	8	8	0-145	5-140
7	FOOSH	III	4 weeks	8	8	0-145	0-145
8	FOOSH	II	3 weeks	7	7	0-140	0-140
9	FOOSH	III	4 weeks	7	7	0-140	0-140
10	FOOSH	III	4 weeks	7	7	0-140	15-140
11	FOFE*	III	11 weeks	8	8	0-140	15-135
12	FOOSH	III	8 weeks	7	7	0-145	0-145
13	FOOSH	III	4 weeks	7	6	0-140	25-135
14	FOOSH	III	7 weeks	8	8	0-140	15-135
15	RTA°	III	13 weeks	7	7	0-140	15-135
16	Football	II	10 weeks	7	7	0-140	15-140
17	FOOSH	III	11 weeks	8	8	0-145	0-145
18	FOOSH	III	4 weeks	7	7	0-135	0-135

• FOOSH :fall on out stretch hand
* FOFE: fall on flexed elbow
° RTA: road traffic accident

Table 10. Time of removal of k-wire

Surgery interval	Time of removal of k –wire in weeks		Total
	Less than 4wk	More than 6 wk	
Less than 1 wk.	5(50%)	5(50%)	10
>1 -4 wk.	3(75%)	1(25%)	4
> 4 -12wk.	2(50%)	2(50%)	4
Total	10(55.6)	8(44.4%)	18

Table 11. Results according to a protocol from Hardacre Et al

Time of Surgery	Excellent (no. and %)		Good (no. and %)		Poor (no. and %)	
Less than one week (10 patient)	6	(60%)	3	(30 %)	1	(10%)
>1-4 week (4 patient)	3	(75%)	0		1	(25%)
> 4 -12 week (4 Patient)	2	(50%)	2	(50%)	0	
Total	11	(61.11%)	5	(27.78%)	2	(11.11%)

Complications A: Loss of extension, B: Overgrowth of lateral condyle, C: Cubitus Valgus as a result of non-union.

DISCUSSION

A prospective study is done for a means 6th months period follow up (from 3 months to one and half year) to evaluate the outcome of operative treatment of displaced lateral condyle fractures of humerus. Fractures of the lateral humeral condyle in children are relatively frequent, behind only the supracondylar fracture in occurrence (Kyoung Hwan Koh, 2010 and Flynn, 1986). They are the most common distal humeral epiphyseal fracture. They are more common than fractures of the medial epicondyle or the medial condyle or fracture-separation of the entire distal epiphysis (John, 2010 and Canale and Beaty, 2008). The age of patients in our series mostly range between 3 and 11 years with average 7.4 years; this is similar to a study done by Bulent Erol et al. (Bülent Erol, 2004), Canale and Beaty (Canale and Beaty, 2008), and Shyam K Saraf *et al.* (Shyam K Saraf and Ghanshyam N Khare, 2011). This series contain small number of cases because we included only those who need surgery and also some parents of kids refuse surgery due to lack awareness of complication.This small size comparable with other studies by Vocke Hell AK (Vocke, 2001), Song KS. (Song, 2011), P.S.Marcheix (Marcheix, 2011), and Ayubi N. (Ayubi, 2010). In this study used only anteroposterior (AP) view and lateral view for diagnosing displaced or minimally displaced fractures but sometime internal oblique view was used because all fractures were obvious not needed to more sophisticated investigation (arthrography, ultrasound or MRI). Recently, 20° tilt AP radiograph has been suggested to demonstrate fragment dislocation more precisely than a standard radiograph (Imada, 2010). The extent of the injury may not be appreciated radiographically because most of the distal humeral epiphysis is still cartilaginous in the young patient and cannot be seen on the radiograph (Canale and Beaty, 2008). A prospective cohort study showed that internal oblique radiographs are more sensitive than a plain anteroposterior (AP) view for diagnosing displaced or minimally displaced fractures (Song, 2007). High-resolution ultrasound, MRI, and contrast arthrography have been used to demonstrate the cartilage hinge and the displacement; however, these facilities may not be available in the rural and suburban areas in most developing countries. Unfortunately the drawbacks with each of these techniques, including expense, requirement for sedation, and technical experience for performing and interpreting the results, limits their usefulness in most clinical practice settings (Zhang, 2008 and Horn, 2002). A total of eighteen fractures were finally evaluated in 15 boys and 3 girls. The average age rate's was7.4 year (range 3year to 11 year) which are same finding of many authors like K young Hwan Koh et al. (Jakob, 1975). Thirteen fractures involved the left elbow and five involved the right elbow. This occur in the boys more than girls, because they are

most probably more active .the left more than right, this is for unknown reason, although all cases are right hand dominant, these finding similar to result of Song KS et al and P.S. Marcheix et al (Song, 2010 and Kwang Soon Song, 2008). All patients have similar mechanisms which are fall from height (wall, furniture, etc.) (Robin Smithuis, 2012) except three cases; road traffic accident, fall during sport injury and third case fall on flexed elbow. It's more difficult to decide the specific type of mechanism whether compression or pulling off in our locality because the parent are not well descriptive the sort and the detail of injury history, this Corresponds to a study done by Eksioglu et al (2008), Kirkos et al. (2003) and Pouliart & De Boeck (Pouliart, 2002 and Jakob, 1975). Open reduction and internal fixation is necessary in cases of unsatisfactory reduction, completely displaced, rotated fragments and in long-standing untreated cases hence it is fracture of necessity means that reduction can seldom be achieved by closed means because the fragment is frequently rotated by the pull of the wrist extensor muscles attached to it and cannot be replaced by manipulation, nor can it be held in the reduced position simply by a plaster cast (Johnm, 2010 ; Canale and Beaty, 2008 and Kwang Soon Song, 2008). These are identical to our series where the Jakob et al advocated open reduction and internal fixation for stage II and III (Jakob, 1975 and Launy, 2004). Jakob I (less than 2 mm) can be treated conservatively, also an undisplaced fracture treated by long cast for 4 weeks. Although this method is safe, but needed closed observation every 5 to 7 days. Good quality plain radiographs of the elbow (best taken with the cast off) are obtained to make sure that the reduction has been maintained. Techniques have also been described for minimally displaced fractures with closed reduction and percutaneous pin fixation (with two pins) in order to maintain the alignment (Bülent Erol, 2004 and Canale and Beaty, 2008 and Eksioglu, 2008 and Thomas, 2001). This is not included in the study but there are four cases present late due to failure of conservative treatment. Launey et al showed displacement in 5 of the 17 fractures treated by cast immobilization; four of them required surgery at a later date (Launy, 2004). Close reduction with percutaneous pin fixation is recommended for fractures with less than 2 mm of displacement and others that can be anatomically reduced with residual gap or step of less than 2mm. This may be performed in the operating room under fluoroscopic guidance by Intraoperative arthrogram or with the aid of image intensification only in fresh cases (Song, 2010 and Kwang Soon Song, 2008). This not present in our locality.The eighteen patients (all cases) with types II and III fractures underwent surgery and the focus of this study, because the open reduction has become the standard treatment (Rutherford, 1988 and Jakob, 1975). Those treated by different surgeons in different hospitals but used only one method of fixation which is k-wire (at least two wire if not more, either parallel or cross). In these series four patient present late after one month and this is might be related to many reasons mostly low education families ,failure of initial treatment or missed diagnosis have good to excellent after surgical treatment (two cases are excellent and two cases are good) although the later have short period of follow up (3 -4 month). In the series by Shen et al 13 patients with fracture of more than 4 weeks duration (56 days on average) were treated by open reduction and internal fixation; all had improvement in range of movements and good cosmetic outcome (Ayubi, 2010 and Shen, 2007). If left untreated, it can result in malunion or nonunion with proximal migration of the fragment leading to cubitus valgus and tardy ulnar nerve palsy .In our study there are four cases present between 4week and 10week and have good to excellent result. This outcome is similar to Shyam K Saraf (Shyam, 2011). Jakob and Fowles, about 35years ago ,reported that the results of lateral humeral condyle fractures treated more than three weeks after injury did no better than if they had no treatment at all , secondary to avascular necrosis. Results of recent series is much more favorable ,if surgery on such an injury is undertaken ,great care must be given to preserving the vascular supply of the fracture fragment (Jakob, 1984). Controversy exists as to whether elbow function can be improved by a late(>4 weeks) open reduction and internal fixation of the fracture fragment. Delayed open reduction has been complicated by osteonecrosis and further loss of elbow motion (James, 2010). Dhillon et al. (Dhillon, 1988), and Zionts and Stolz (Zionts, 1984) also reported that osteonecrosis was frequent after late open reduction and recommended no treatment for these fractures.A late presentation leads to difficulty in management due to displacement of the fragment as a result of the pull of the common extensors, new bone formation, and sclerosis and smoothening of the fracture line. With higher grades of displacement, it sometimes becomes impossible to bring the fragment into normal position without stripping the soft tissue attachments on the displaced fragment. As extensive soft tissue dissection may lead to avascular necrosis of the fragment, many recommend that these fractures should be left alone. Only one case present with avascular necrosis which operated after 23 dayes, we think not due to delayed in presentation but because of excessive dissection and manipulation. Most of surgeon preferred the lateral approach not used the posterior approach which is more liable to complication. This looks like the results of studies done by Shyam K Saraf et al, Skaksv et al (Vocke, 2001 and Shyam, 2011). Wattenbarger et al. (Wattenbarger, 2002) studied the effect of late open reduction of >3-week- old lateral condyle fractures in 11 children and did not find any case of avascular necrosis even though four of their cases had displacement of more than 10 mm . In comparison to similar study by Anil Agarwal et al. (Anil Agarwal, 2012) over all 4 patient present late are united. There is high rate of union and satisfactory elbow function in late presenting lateral condyle fractures in children following osteosynthesis attempt (Wattenbarger, 2002 and Anil Agarwal, 2012). Pin tract infection is a known complication of percutaneous K- wire fixation (Sharma, 2007 and Hargreaves, 2004). There are two cases of superficial pin infection of thirteen patients which are treated by oral antibiotic and change of dressing, the wires were removed at (48 &80 days) which might be related to prolong period of fixation, the wound healed completely without any serious complication (septic elbow, abscess,..) This looks like the results of studies done by Schalamon J et al (2004). The other five cases , the k- wire buried under the skin (5cases) Which is identical to study done by L Wilson; D Gibson et al. (2011), who said ,these k-wire should be bent and buried to remain in situ for three months. In comparison between exposed versus buried wires the results were nearly similar; this is supported by Lester Wai and Hua Ming who show good outcome for both methods (Lester Wai Mon and Hua Ming Siow, 2011). The maintenance of reduction by 2 K-wires is standard practice for most clinicians (Foster, 1985), but there is lack of consensus regarding the actual duration of fixation and casting that is appropriate for this type of fracture. Many clinicians depend on radiological findings to guide their decision on when to remove fixation and splint, meaning an average of six or more weeks but with such assessment is complicated by

overlying plaster if the cast is not removed for examination (Cardona, 2002), where in our small series there is about 10 cases healed in less than 4 weeks and remove the k-wire in that time, but k –wire stay in the remainder (8 cases) for long period not due to only delayed in the healing processes but there are many cases the k-wire is buried under the skin and needed for another surgery to remove the k –wires,in comparison to similar study by Lester Wai Mon and Hua Ming Siow (2011). In our study excellent to good results are in 9 out of 10 cases operated within first week and one have serious complication is nonunion with cubitus valgus with repeated physical examination no neuritis .This occur most probably due to non- perfect reduction. However in this series, we could found excellent to good results in the patient present early within first week since the serious complication such as nonunion, cubitus valgus and others are minimal. There is no statistical significant association between the results and surgical interval especially in late presentation, because we don't have large number of patients.

Conclusion

Open reduction and internal fixation by at least 2 k –wire for all displaced fractures are effective treatment of the lateral condyle fracture of humerus in the children based on high union rate and low complication rate which signified the good cosmetic and functional outcome among patient with Jakob type II and III fractures. The patients who presented late (up to 12 weeks) for any reason can be treated operatively with delicate dissection and manipulation.

Recommendations

- All patients were treated conservatively (meaning Jakob I) by cast should be followed strictly at least one week interval since considerable number will be displaced and present late.
- Although the time of surgery is important for lateral condyle fractures as early as possible but we recommend for majority of orthopedic surgeon to perform the open reduction and internal fixation for late presentation.
- We have to include patients with late presenting to evaluation the exact values of operation.
- A wide expectation of period, we developed to know which are true long outcomes, especially for those had complications such as nonunion and avascular necrosis.

REFERENCES

Andrew Cole, Paul Pavlou, David Warwick. Apley's System of Orthopaedics and Fractures: Fractures And Joint Injuries:Injuries of the shoulder, upper arm and elbow. Hodder Arnold,UK 9th ed2010;24:p.761-763.

Anil Agarwal, Nadeem Akhtar Qureshi, Neeraj Gupta, Indreshwar Verma, and Devreshi Kumar Pandey Management of neglected lateral condyle fractures of humerus in children: A retrospective study. *Indian J Orthop.* 2012 Nov-Dec; 46(6): 698–704.

Ayubi N., Mayr JM., Sesia S., et. al. Treatment of lateral humeral condyle fractures in children :Oper Orthop Traumatol;2010 Mar ;22(1):81 -91.

Bülent Erol, Murat Bezer, Gökhan Er,et,al . The Management of Elbow Fractures in Children: Introduction. Marmara Medical Journal 2004; 17(2):93-98.

Canale and Beaty .Campbell′[19]Operative Textbook: Fractures and dislocations in children: Lateral condyle fractures. Mosby 11th ed 2008; Ch.33:p.1569-1574.

Cardona JI, Riddle E, Kumar SJ.Displaced fractures of the lateral humeral condyle: criteria for implant removal. *J Pediatr Orthop*. 2002 Mar –Apr; 22(2):194-7.

David B.Weiss, Matthew D.Milewski,Stephen R. Thompson, et.al. Review of Orthopaedics: Lateral condyle drawing. Elsevier Saunders. 6th Edition. 2012; chp.12.P.795.

Dhillon KS, Sengupta S, Singh BJ. Delayed management of fracture of the lateral humeral condyle in children. *Acta Orthop Scand* 1988; 59:419-424.

Eksioglu B, Uslu M, Gudemez E, et al. Medial elbow dislocation associated with a fracture of the lateral humeral condyle in a child. Orthopedics 2008 ; 31: 93–7.

Elbow Fracture in Children: Types, Diagnosis and Treatment. http://www.joint-pain-expert.net/elbow-fracture-in-children.html. On 13/03/2012.

Flynn JC. Nonunion of slightly displaced fractures of the lateral humeral condyle in children: an update. Journal of Pediatric Orthopedics 1989; 9(6): 691-6.

Foster DE, Sullivan JA, Gross RH. Lateral humeral condylar fractures in children. *J Pediatr Orthop*. 1985 Jan-Feb; 5(1): 16-22.

Hargreaves DG, Drew SJ , Eckersley R .Kirschner wire pin tract infection rates :a randomized controlled trial between percutaneous and buried wires. *J Hand Surg*., Br .2004 Aug;29 (4):374-6.

Horn BD, Herman MJ, Crisci K, et. al. Fractures of the lateral humeral condyle: Role of cartilage hinge in fracture stability. J Pediatr Orthop 2002; 22:8-11.

Horn BD,Herman MJ,Crisci K,et al.Fractures of the lateral humeral condyle: role of the cartilage hinge in fracture stability .J Pediatr Orthop 2002,22:8-11.

Imada H, Tanaka R, Itoh Y, Kishi K. Twenty-degree-tilt radiography for evaluation of lateral humeral condylar fracture in children. Skeletal Radiol. 2010; 39:267–72.

Jakob R,Fowles JV,Rang M ,et al.Obesrvation concerning fractures of the lateral humeral condyle in children .J Bone Joint surg Br.1975 Nov ;57(4):430 -6.

James R. Kasser, James H. Beaty: Rockwood and Wilkins' Fractures in Children: General Concepts in the Pediatric Patient: the Elbow Region. Lippincott Williams & Wilkins.7th .2010; ch.15.

Janos P Ertl .Lateral Humeral Condyle Fracture:Treatment . http://emedicine.medscape.com/article/1231199-treatment. on 14/02/2011.

John A. Herring. Upper extremity injuries.In: Tachdjian's Pediatric Orthopaedics, 4th Edition.New York: Saunders; 2010.ch.42.

Kasser JR, Beaty JH. Rockwood and Wilkins' Fractures in Children: Supracondylar fractures of the distal humerus. Lippincott Williams and Wilkins 5th ed 2001; 15: 577-624.

Kirkos JM, Beslikas TA, Papavasiliou VA. Posteromedial dislocation of the elbow with lateral condyle fracture in children.Clin Orthop 2003;408: 232–6.

Kwang Soon Song ,Chul Hyung ,Byung Woo Min, et al. Closed reduction and internal fixation of displaced unstable lateral condylar fractures of the humerus in children. *The Journal of Bone and Joint Surgery* (American) ; 2008 ; 90:2673–2681.

Kyoung Hwan Koh, Sung Wook Seo, Kyung Mu Kim, et.al.Clinical and Radiographic Results of Lateral Condylar Fracture of Distal Humerus in Children. *J Pediatr Orthop.* Volume 30, Number 5, July/August 2010.

L Wilson, D Gibson, and AP Cosgrove: the treatment of lateral condyle fracture in children: *Journal of Bone and Joint Surgery –British* Volume , Vol 88-B,Issue SUPP –II, 284.

Launy F, Leet AI, Jacopin S et al. Lateral humeral condyle fractures in children: Acomparison of two approach to treatment. *J Pediatr Orthop*. 2004; 24:385 -91.

Lester Wai Mon and Hua Ming Siow. Exposed versus buried wires for fixation of lateral humeral condyle fractures in children: a comparison of safety and efficacy. *J Child Orthop.* 2011 October; 5(5):329 -333.

Major NM, Crawford ST. Elbow effusions in trauma in adults and children: is there an occult fracture?. *AJR Am J Roentgeno* l 2002; 178:413-418.

Meyer NJ, Lyon RM. Lateral elbow ecchymosis as a clinical sign of lateral humeral condylar fractures. *Am J Orthop (Belle Mead NJ).* 2003 May;32(5):260-1.

Noor Akbar Sial: Fracture Lateral Condyle Humerus in Children. Independent Review 2011 Jan to Mar; 108: 147-155.

Online article accessed on 14/2/2011 http://emedicine. medscape.com/ article/1231199-overview

Online article accessed on 14/2/2011 www.pedortho.com/ files/PIPFxElbowLatCond.pdf

P. S.Marcheix, V.Vacquerire, B.Longis ,et.al .Distal humeral condyle fracture in children :when is the conservative treatment a valid option ?.Orthopedic and Tramatology ;Surgery and Research Volume 97,2011;(3):P.304-307.

Pouliart N, De Boeck H. Posteromedial dislocation of the elbow with associated intraarticular entrapment of the lateral epicondyle. J Orthop Trauma 2002;16 : 53–6.

Robin Smithuis .Elbow Fractures in Children .update version; http://www.radiologyassistant.nl/en/p4214416a75d87/elbow-fractures-in-children.html. On 14/ 3 / 2012.

Rutherford A.Fractures of the lateral humeral condyle in children. *J Bone Joint Surg Am.* 1985 Jul; 67(6):851 -6.

Satoshi Toh , Kenji Tsubo ,Shinji Nishikawa , et. al. Long – standing nonunion of fractures of the lateral humeral condyle. *The Journal of bone and joint surgery (American)* 84: 593-598(2002).

Schalamon J, Petnehazy T, Ainoedhofer H, et. al. Pin tract infection with external fixation of pediatric fractures. *J Pediatr Surg.* 2007 Sep; 42(9): 1584-7.

Sharma H, Taylor GR, Clarke NM. A review of K-wire related complications in the emergency management of pediatric upper extremity trauma. *Ann R Coll Surg Engl.* 2007 Apr; 89(3): 252-8.

Shen P, Zhang J, Chen T. Treatment of old united lateral condyle fractures of humerus in children. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2007;21:266–8.

Shyam K Saraf and Ghanshyam N Khare: Late presentation of fractures of the lateral condyle of the humerus in children. *Indian J Orthop*. 2011 Jan–Mar; 45(1): 39–44.

Snell RS .Clinical anatomy by regions 8th Edition Lippincott Williams and Wilkins. (2008), Chapter 9.p 511.

Song KS , ShinYW ,Oh CW, et.al. Closed Reduction and Internal Fixation of Completely Displaced and Rotated Lateral Condyle Fractures of the Humerus in Children. *J Ortho Trauma.* 2010 Jul;Vol 24(7):434 -8.

Song KS, Kang CH, Min BW, et. al. Internal oblique radiographs for diagnosis of nondisplaced or minimally displaced lateral condylar fractures of the humerus in children. *J Bone Joint Surg Am.* 2007;89:58–63.

Thomas DP, Howard AW, Cole WG, et. al .Three weeks of Kirschner wire fixation for displaced lateral condylar fractures of the humerusin children. *J Pediatr Orthop* 2001; 21:565-569.

Todd A. Milbrandt and Lawson A.B. Copley: Common elbow injuries in children: evaluation, treatment, and clinical outcomes. Curr Opin Orthop 2004;15: 286–294.

Vocke –H ell AK, Schmid A: Sonographic differention of stable and unstable lateral condyle of the humerus in children. *J Pediatr Orthop* 2001, 10:138-141.

Zhang JD, Chen H. Ultrasonography for non-displaced and mini-displaced humeral lateral condyle fractures in children. *Chin J Traumatol.* 2008; 11: 297–300.

Zionts LE, Stolz MR. Late fracture of the lateral condyle of the humerus. Orthopedics ;1984;7:541-545. Wattenbarger JM, Gerardi J, Johnston CE. Late open reduction internal fixation of lateral condyle fractures. *J Pediatr Orthop.* 2002; 22:394–8.

****