OPEN REDUCTION AND K-WIRE FIXATION OF DISPLACED UNSTABLE LATERAL CONDYLE FRACTURES OF THE HUMERUS IN CHILDREN

ORIGINAL
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ABSTRACT... Background: Lateral condyle fractures in children are the second most common fracture about the elbow. The problem arises in those cases which are difficult to treat by pop cast or by close reduction with percutaneous pin fixation. Late presentation is another challenge. We selected surgical treatment for such cases up to 12 weeks to evaluate our results. **Objective:** To study the usefulness of open reduction and K-wire fixation of displaced, unstable with or without rotation of fractures lateral condyle of the humerus in children presenting up to 12 weeks post injury **Design:** Prospective. **Setting:** Three teaching orthopaedic units Independent Medical College / Punjab Medical College, and University Medical College Faisalabad. **Period:** From January 2008 to December 2010. **Method:** In this prospective study a series of 22 patients were treated using technique of open reduction and internal fixation with k-wires. The results were assessed by criteria of Agarwal et al with little modification after follow-up for 1 year. **Results:** Excellent to good results were observed in all the12 patients presenting at 1–4 weeks post injury. In 5 patients presenting at 5–8 weeks, the results were excellent in one, good in 2, fair in1 and poor in one patient. In 5 patients presenting at 9-12 weeks good in 1 fair in 2 and poor in 2 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 low surgical complications and high union rate.

Key words: Lateral condyle fracture, displacement, rotation, children, open reduction, internal fixation, Kirschner wires.

INTRODUCTION

Fractures of the lateral condyle of the humerus constitute around 10% of elbow injuries, with the peak occurring at the age of 6–7 years[1]. The fracture line runs from the region of the external epicondyle downward and inward into the joint close to the junction of the Capitellum and trochlea. The detached fragment consists of the capitular epiphysis and the lateral third of the trochlea with a fragment of the humeral metaphysis. The attached extensor muscles avulse the fragment from its bed, causing displacement which varies from a downward, lateral and usually also backwards with or without rotation of the fragment. The fractured surface in the typical case is turned outward so that it is subcutaneous, while the articular surface of the capitellum is directed toward the fractured surface of the shaft[2].

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. In this instance it is helpful to make radiographs of the normal elbow and compare the two sides, paying particular attention to the alignment of the humerus, the capitular osific nucleus and the radius[1]. The problem arises in those cases which are difficult to treat by pop cast or by close reduction with percutaneous pin fixation. Late presentation is another challenge. The displaced fracture requires open reduction. If this is delayed, anatomic reorientation of the fragment becomes difficult because the fracture surfaces are covered with fibrous tissue, and the ligamentous and muscular attachments of the fragment are shortened, thus preventing derotation and reduction; indeed, 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[3].

If these fractures are left untreated, treated improperly or too late, the patient may lose some motion in the elbow and complications like early closure of the epiphyseal growth plate, malunion, nonunion, cubitus valgus and tardy ulnar nerve palsy.

The treatment of establish cubitus valgus/varus at a later date is by corrective osteotomy with or without ulnar nerve transposition in case of tardy ulnar nerve palsy rather than to attempt a difficult reduction[1,2].

The appropriate treatment of this injury is immediate open reduction by the lateral approach and fixation with at least two fine Kirschner wires. We report our experience of treating a series of 22 cases using this technique.

PATIENTS AND METHODS

In this prospective study 26 patient with displaced, unstable with or without rotation of fractures of the lateral condyle of the humerus presenting upto12 weeks post injury qualified for this study. 2 patients declined surgical treatment in spite of severely displaced fractures.24 were treated by three surgeons working at their hospitals in the same city during the same period using technique of open reduction and internal fixation from January 2008 to December2010.2 patients lost for follow. Completed follow up of 22 cases.

12 patients presented between 1–4 weeks, 5 between 5-8 weeks and 5 between 9–12 weeks post injury. The mean age was 8 years (range: 4–14 years).

Pain, swelling, ecchymosis over the lateral epicondyle, local tenderness, limited range of motion, gross deformity and lateral prominence after a traumatic event were usual clinical findings.

Plain radiographs (anteroposterior and lateral) of both the elbows were obtained. The fractures were classified using the Milch classification [4]. Type I (n = 4) when the fracture line traversed the secondary ossification center of the capitellum lateral to the lateral crista of the trochlea, Type11(n=18) 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. The informed consent for surgery was obtained after the approval of study from our institutional review board. Immobilization was used for a period of four to six weeks, and the final outcome assessed at a mean of 12 months (6 to 24) after the operation.

Inclusion Criteria

- All cases unilateral
- Displaced, unstable with or without rotation.
- Failure of conservative treatment.
- Late cases of unsatisfactory deformity with poor functional results.

Exclusion Criteria

- Cases with polytrauma.
- Fractures manageable by immobilization alone which were stable
- Multiple bones fracture involving the same elbow.
- Fractures with dislocation of elbow

Surgical Technique

After taking all necessary preoperative measures we operated the patients in supine position with above elbow tourniquet under general anesthesia. A lateral approach was used. A gentle dissection of the fracture fragment was done with minimum stripping of the soft tissue attachments on it. The fracture line was easily visualized after blood, fibrin, and loose articular debris were irrigated from the joint. We avoided the use of sharp instruments to force the reduction. The fracture was reduced by using Bristow spike placed through the proximal anterolateral portal into the fracture. Under vision the distal fragment rotation and displacement was repositioned by applying traction and gentle varus force to elbow and direct compression anteromedially on the fragment or using Kirschner wires as joy sticks until there was no step in the articular cartilage joint surface along with reduction of metaphyseal portion of the fragment to the distal humerus then gradually taking the forearm in supination, elbow flexed and slight valgus force for maintaining reduction for fixation [Figure-1]. At least two Kirschner wires from the lateral bone margin were placed percutaneously in such a way that two cortices (bicortical) should be engaged near and far for firm fixation either parallel or divergent according to the fragment specification to avoid crossing of the pins at the fractures site which would decrease stability. The most distal pin was directed toward the medial epicondyle to engage bone rather than the trochlear cartilage.

The anterior tissue was lifted and protected by a retractor to protect the radial nerve during drilling. The stability of the fixation was checked by moving the elbow through its

Figure-1. Surgical steps

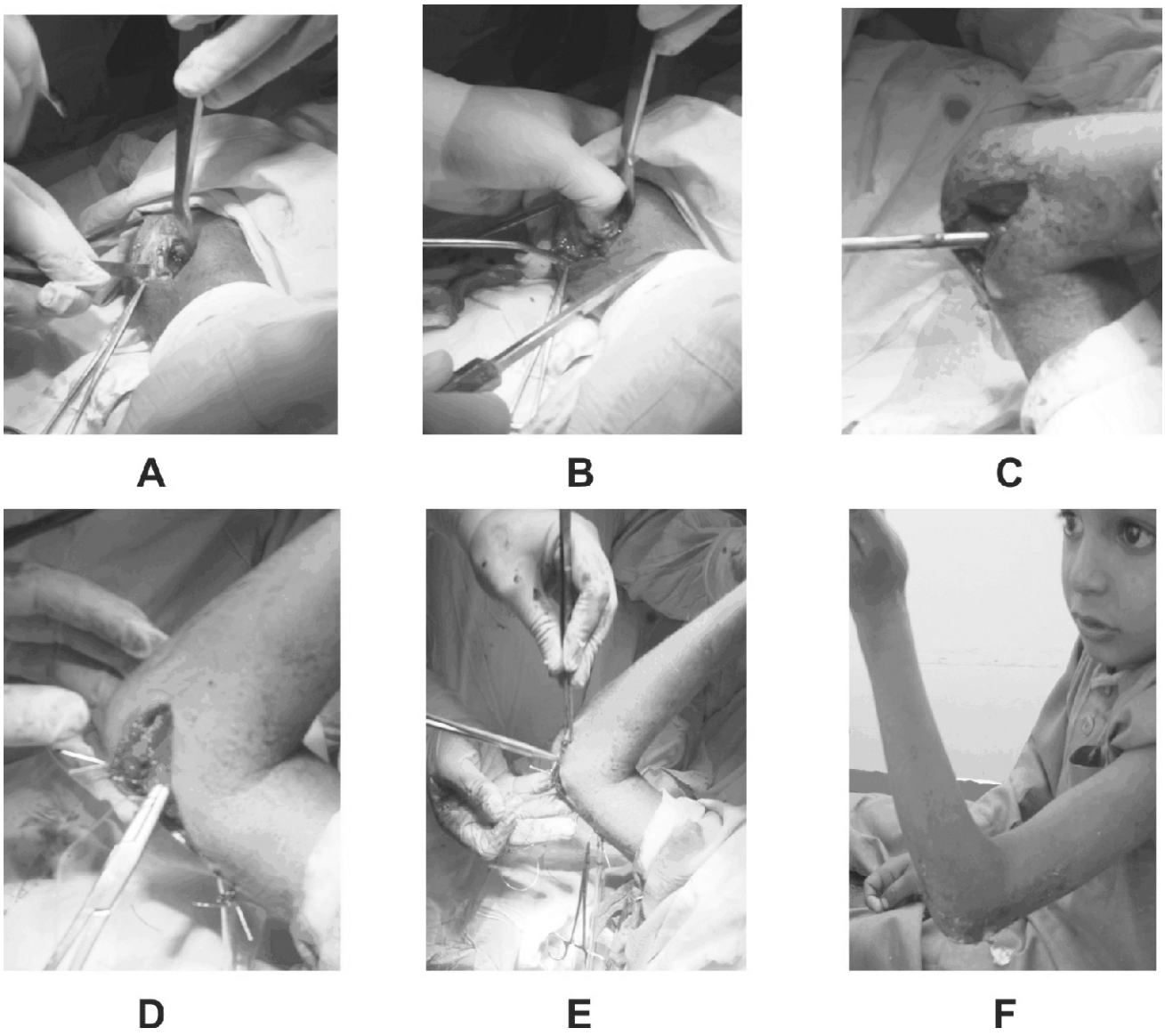

Figure-1: (A) open reduction through Lateral Approach , (B) Reduction with Bristow spike (C)Maintenance of reduction for fixation, (D)K-wire fixation,(E) Wound closure, (F) After 3 weeks for removal of stitches.

maximum range. In late cases curettage of the sclerosed fracture end of the distal humerus was done. Anatomical reduction was attempted in every case; however, it was not possible in fractures more than 10 weeks old as a result of new bone formation and remodeling at the fracture surfaces. In these cases we accepted the best possible reduction. The wound was drained. Subcutaneous and skin closure was carried out. Postoperatively, an above-elbow POP was applied. Window made for wound care in the operation room. Immobilization for about 4-6 weeks depending upon the status of the union. The wires were removed between 5–8 weeks. Exercises of the elbow were started after removal of the pop. We advised not to do under any circumstances forced passive movement of the elbow. Children usually regain a good range of movement

without any need for physiotherapy. For the assessment of results, the patients were evaluated clinically for pain, range of motion, carrying angle, and deformity at the local site (i.e., lateral prominence) Radiographs were taken immediate, at six weeks, three months and one year after operation. The radiological points noted during evaluation were reduction, status of the growth plate, evidence of avascular necrosis of the fractured fragment, congruity of the joint, status of union, and deformity. The criteria as defined by Aggarwal et al[5] were followed with little modification [Table-I].

Table -I. Criteria as defined by Aggarwal et al with little modification

Category	Clinical Assessment	Caring Angle	Range of movements	Radiological Assessment
Excellent	• Perfect alignment • No lateral prominence • No symptoms	No alteration	Full	• Perfect reduction • No premature fusion • No avascular necrosis
Good	No lateral deformity	No alteration	Limitation of terminal range not more than 15˚	• Union with minimum displacement • Step/gape of not more than 2mm • No premature fusion • No avascular necrosis
Fair	• Mild deformity at local site • Superficial pin tract infection • Premature removed of wires due to deep pin tract infection, leading to loss of reduction	Alteration in carrying angle of up to 10˚ Cubitus varus	Limitation of terminal range up to 25˚	• Union with minimum displacement • Step/gap of 2-5mm • Premature fusion of the physis • No avascular necrosis
Poor	Visible deformity at local site	Change in carrying angle more than 10˚	Gross limitations of movements more than 30˚	• No union • Step/gap more than 5mm • Premature fusion of physis • Avascular necrosis

RESULTS

22 cases have been completed for final evaluation. 15 patients were boys and seven were girls. The mean age was 8 years (range 4-14 years). Left side was involved in 13(59%) cases and right side in 9(41%).10 patients presented to us without having received any treatment whereas 6 patients had a plaster cast applied elsewhere before they came to us.4 patients initially treated by bone setters. 2 cases had no history of treatment were misdiagnosed as soft tissue injury.

Excellent to good results were observed in all the12 patients presenting at 1–4 weeks post injury. In 5 patients presenting at 5–8 weeks, the results were excellent in one, good in 2, fair in1 and poor in one patient. In 5 patients presenting at 9-12 weeks good in 1 fair in 2 and poor in 2 patients [Table-II].

Over all rating as per Aggarwal et al. criteria, 12(54.54) patients had excellent result, 4(18.18%) had good result, 3(13.64%) had fair result, and 3(13.64%) had poor result [Table-II].

On clinical evaluation, No complaint of pain and wounds healed well in all cases. No additional morbidity of cosmetic appearance due to open reduction. None of our patients had any preoperative or postoperative signs of ulnar nerve involvement. One patient had symptoms of radial nerve traction injury after operation and achieved complete recovery 3 months later. No elbow joint

Table-II. Results as per criteria as defined by Aggarwal et al with little modification

Grading	Delay between injury and surgery			Total	Percentage
	1-4 weeks	5-8 weeks	9-12 weeks		
Excellent	11	1	-	12	54.54%
Good	1	2	1	4	18.18%
Fair	-	1	2	3	13.64%
Poor	-	1	2	3	13.64%
Total	12	5	5	22	100.00%

infections. .In 12 patients the results were eventless (excellent)[Figure-2]. Pin tract infection in three patients. These were successfully treated with pin care and oral antibiotics without pin removal. Loss of reduction due to technical error in one patient which was corrected in second sitting eventually with good result. Gradually the movements at the elbow increased up to good range in all cases except in one case with gross restriction of elbow movements, visible deformity and avascular necrosis of the lateral condyle that was badly treated by the bone setter for 12 weeks before surgery. On radiology reduction was excellent to good in 16, fair in another 4, and less than satisfactory in 2. The average time for union was 8 weeks. The fracture united in all cases; however, malunion was observed in three patients as lateral prominence was evident both clinically and radiologically. Premature fusion in two patients one of them with cubitus valgus more than 10 degree. The results were better in those who were operated upon within 8 weeks of injury [Table II] as well as in those presenting with lesser degree of displacement of the fragment. These were the complications in this study. To avoid complications it is important to carry out careful dissection of the soft tissue attachments and to mobilize the fragment without the use of force.. If the surgeon is aware of the possibilities, examines carefully good radiographs of both elbows, asks for other views whenever necessary, and treats the injury with appropriate measures at earliest possible time, he will avoid the pitfalls and poor results.

DISCUSSION

An undisplaced fracture may be treated in a long-arm cast for 4 weeks. If this treatment is used, however, close observation every 5 to 7 days is necessary. Good radiographs out of plaster should be made at each visit for 6 to 8 weeks to determine the status of the fracture[1]. This may require considerable time and effort. Launey et al showed displacement in 5 of the 17 fractures treated by cast immobilization; four of them required surgery at a later date[6].

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 arthrograms or with the aid of image intensification only in fresh cases[7,8]. These facilities may not be available in the rural and suburban areas in most developing countries.

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[1,2] Although there could be some difference of opinion regarding the approach, fixation method (wire vs. screw), or period of immobilization

Figure-II.

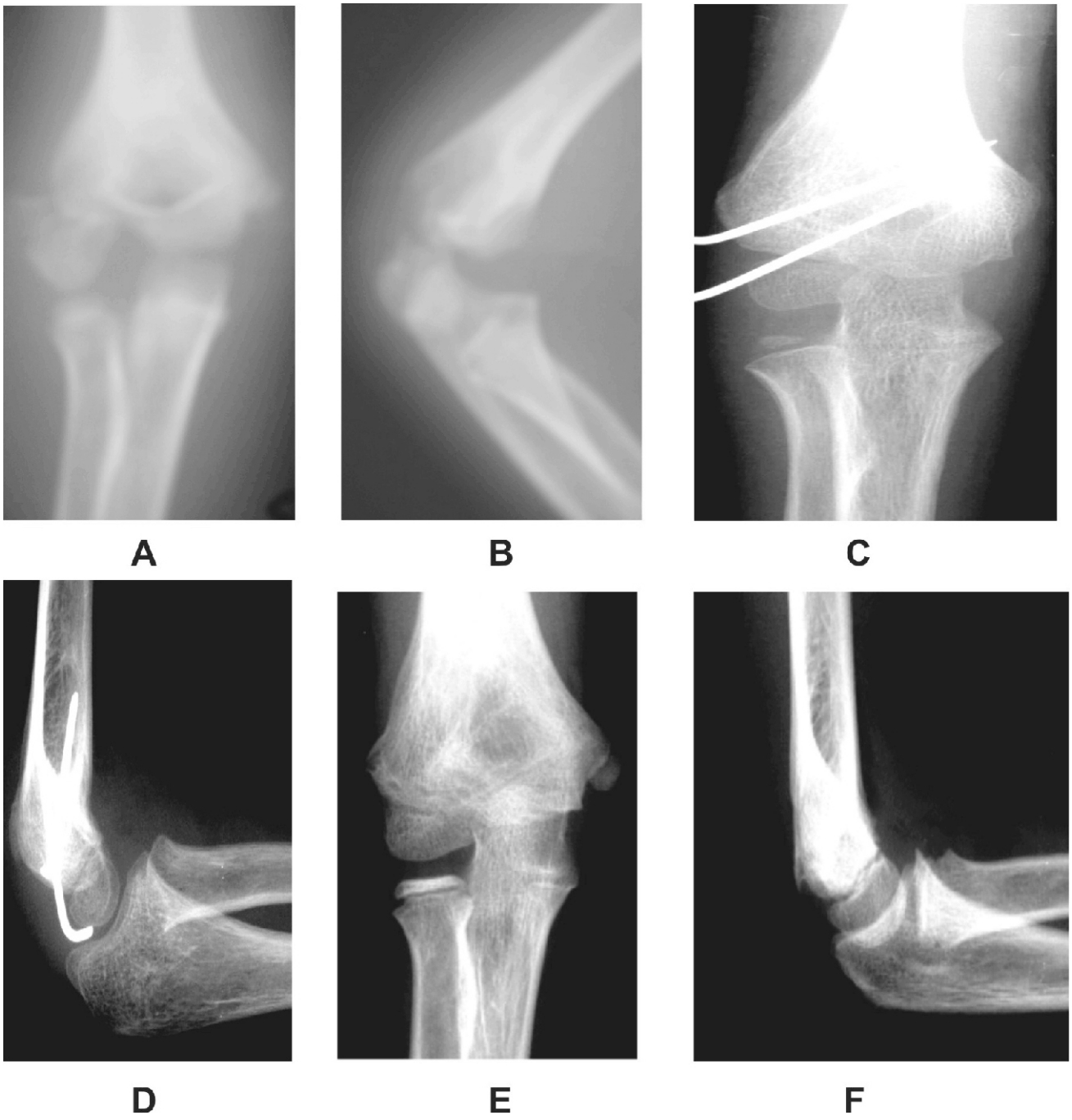

Figure-2. Anteroposterior (A) and lateral (B) radiographs of the injury reveal a displaced Milch 2 fracture. After open reduction, two lateral pins were placed (C, D) .Radiograph obtained after 11 months showing fracture union anteroposterior(E) and lateral(F) radioghaphs.

etc[9,10]. The minimally displaced fractures with high potential for displacement should be fixed at the earliest when the surgery is technically less demanding and functional outcome is relatively more predictable. The appropriate treatment of this injury is immediate open reduction by the lateral approach and fixation with at least two fine Kirschner wires[11]. The k-wires can be removed in the office setting, avoiding a second operative procedure. This method of management gives very good results.

We appreciate that this series consists of a small number of patients. Our study is comparable in size to those reported by other investigators. In 19 of the 20 fractures fixed by screw, the results were rated as excellent at 1-year follow-up by Baharuddin M in 2001[12]. Wattenbarger et al 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[3].

In our study excellent results are in 11 out of 12 cases operated within 4 weeks. The problem arises when the patient presents late due to socioeconomic reasons, lack of awareness, missed diagnosis, or improper initial treatment. 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[1]. 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[13]. Recently, a 20° tilt AP radiograph has been suggested to demonstrate fragment dislocation more precisely than a standard radiograph[14]. Many believe that the presence of an intact articular cartilage hinge is the key to stability in these fractures[15]. High-resolution ultrasound, MRI, and contrast arthrography have been used to demonstrate whether the cartilage hinge has been disrupted[16]. 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. However these facilities may not be available everywhere.

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. Dhillon et al do not recommend osteosynthetic procedures even after 6 weeks[17]. Despite the disappointing results and the general disapproval of surgery, there are several reports in the recent literature in favor of surgery. Mazurek and Skorupski operated a 7-year-old boy with nonunion of 1-year duration using an olecranon osteotomy approach, with open reduction, bone grafting, and K-wire fixation, and reported excellent result at 6 months[18]. 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[19]. The fracture united in all delayed cases in our study with comparable results reported by other investigators.

The problems and the resulting complications may not be as bad when the patient presents within 12 weeks of the injury, as careful dissection and modifications in the surgical technique can provide a satisfactory reduction without compromising the blood supply[20]. In our opinion, another reason for fixing these fractures is to enable the physis to take part in the growth process of the distal humerus; otherwise, the physis will close prematurely, resulting in even more severe deformity. Better results were observed in patients with less displaced fragment as compared to severely displaced. Duration since injury, in our opinion, is the most important factor that decides the outcome. The results were better [Table II] in fractures that were less than 8 weeks old as compared with those of longer duration.

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. Such cases may have functional limitations and poor cosmesis. These malunions have limited ability to remodel because the deformities are perpendicular to the plane of elbow motion. The treatment of such conditions is even more difficult and is fraught with complications.

CONCLUSIONS

We conclude that open reduction and internal fixation is an effective treatment in all displaced fractures of the lateral condyle of the humerus presenting up to 12 weeks after injury on the basis of low surgical complication rate and high union rate. The results become poorer with increase in duration after the injury and grade of displacement. This procedure can be performed by majority of orthopaedic surgeons even in small peripheral centers. Fractures around the elbow are no longer hopeless.

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Life is pleasant.
Death is peaceful.
It's the transition that's troublesome.

(Isaac Asimov)