

DISCUSSION

Supracondylar fractures of the humerus are the commonest elbow injuries in children and the second commonest following distal end radius in children. It is common before seven years.⁽³⁶⁻³⁸⁾

Unlike many pediatric fractures, because there is a little remodeling potential in the coronal plane about the elbow which is a hinge joint allowing flexion-extension movement, anatomic reduction is important to ensure good outcome.⁽⁷⁴⁾

The goal of treatment in children's displaced supracondylar humeral fractures is anatomical reduction to achieve satisfactory functional and cosmetic results and to avoid complications.⁽¹³⁾

Because of the anatomy of the distal end of the humerus, it is difficult to obtain and maintain a stable closed reduction of the displaced supracondylar fracture of the humerus without fixation, so Gartland type III and most of type II fractures are generally indicated for fixation.^(74, 75)

Varieties of methods are used to treat supracondylar fractures of the humerus according to the degree of displacement and associated injuries.⁽⁵⁾

Dunlop popularized the method of skin traction in 1939. It is safe but requires long in-patient treatment and not all fractures presenting late are amenable by traction alone.⁽⁷⁶⁾

Pirone et al pointed out that the traditional method of closed manipulation and plaster immobilization. It results in higher incidence of malunion than other methods of treatment. D'Ambrosia reported a 24% incidence of cubitus varus deformity after treatment with closed reduction and plaster application.⁽⁷⁷⁾

Closed reduction and percutaneous pinning provides a stable fixation preventing rotational displacement, which may lead to a cubitus varus deformity, shorter hospitalization time and more importantly, the dilemma of whether to increase the stability of a closed reduction by hyperflexion, which may risk circulatory compromise, is avoided. Once the fracture is fixed internally, the elbow can be placed in a splint in a safe position.⁽⁵⁰⁾

The literature supports closed reduction and percutaneous pinning as the treatment of choice for these fractures however; they are associated with various complications, such as iatrogenic ulnar nerve injuries which occurs either during closed manipulation or percutaneous fixation of the fracture fragments, skin problems, Volkmann's ischemia, and cubitus varus.⁽⁶⁹⁾

Open reduction and internal fixation for displaced supracondylar humerus fracture is considered as a good modality of treatment when closed reduction fails.⁽⁷⁾

Millis et al. proposed open reduction when an adequate closed reduction was not obtained.⁽¹⁰⁾ Supracondylar fracture humerus could be irreducible due to interposition of brachialis muscle, median nerve, anterior periosteum and brachial artery. It may also be difficult to achieve satisfactory reduction of a severely swollen elbow.⁽⁷⁹⁾

Discussion

Guven et al stated that the posterior approach allows exact anatomic reduction with no resultant angular deformities and a range of motion that is comparable with other reported approaches giving excellent visualization especially one with posterior comminution.⁽¹³⁾

Sibly et al. in 2011 investigated closed reduction and immobilization versus open reduction with a posterior approach that the triceps was divided in an inverted V shape. They found minor loss of movement $<10^\circ$ in the open treatment group, they thought that the scar was invisible to patients because of its location and none of them were worried by its appearance.⁽⁸⁰⁾

Some authors believe that open reduction may have worse results than closed reduction and pinning as loss of motion, myositis ossificans, scar formation and infection are possible complications. However, in the majority of studies, the patients in the open reduction groups had severely displaced fractures, thus showing a more difficult pattern, which could explain the poorer results.⁽⁸¹⁾

Kumar et al. treated 44 patients with open reduction and pinning and found that 95% had a satisfactory outcome.⁽⁸²⁾ Cramer et al. found that open reduction itself does not appear to cause stiffness and decrease strength.⁽⁸³⁾ On the other hand, Reitman et al. found excellent results for only a 55% of elbows.⁽⁸⁴⁾

In this work 20 child with grade III supracondylar fracture humerus were treated by open reduction through posterior approach and percutaneous internal fixation by k-wires. The aim was to assess the results of this method in treatment of such fractures and its early complication.

According to Flynn's criteria the results were excellent in three children (15%) good in ten children (50%), faire in four children (20%), and poor in three children (15%).

The age incidence:

The average age was 5.88 years (range: 2.5-12 years).

Fowels and Kassab and⁽⁸⁵⁾ Holmberg⁽⁸⁶⁾ founded that the fractures occur most frequently between 5-10 years while Carcassone and his associates founded that it is between 5-8 years.⁽⁸⁷⁾

In EL-Malky study the average age was 7 years,⁽³⁷⁾ while in Graham's study it was 5 years.⁽⁸⁸⁾

The high incidence of supracondylar fractures of the humerus in these age groups may be explained by the fact that children in this age group usually are more prone to epiphyseal injury because of weak epiphysis. Children older than this age usually develop elbow dislocation more than supracondylar fracture when exposed to the same trauma as the supracondylar area of the humerus becomes more mature and strong than ligaments while children at these age groups have weak supracondylar area in relation to ligaments.⁽⁴⁾

Sex incidence:

In this study boys were more affected than girls, the ratio was 11 boys: 9 girls. This is coinciding with a study carried out by Irena et al. in 2012 on 78 patients. 29 of them were female and 49 were males.⁽⁸⁹⁾ This higher incidence in boys may be caused by hyperactivity that usually present in boys than girls.

Side incidence:

Left side is more affected than right side in our study in a ratio 15 left: 5 right nearly 3:1. This coincides with remarks of Fowels and Kassab,⁽⁸⁵⁾ and El-Malky.⁽³⁷⁾

This may be explained by the fact that majority of children are right handed so left arm is used in less skillful way in protection during falls, so it becomes more prone to injury.⁽⁴⁾

Mechanism of injury:

Indirect trauma is the main cause of fracture in this study as it was limited to extension type fractures. The way that fracture occurs in indirect trauma is that in hyperextension the anterior thick strong part of the capsule becomes taut, and the fulcrum of rotation becomes located at the supracondylar region.⁽³⁴⁾

Ulnar nerve injury:

In current study we did not had any ulnar nerve injury. Open reduction through posterior approach allow direct visualization of the ulnar nerve thus avoiding its injury and putting the k-wires under direct vision.

Birch et al. reported an iatrogenic neurological injury rate between 2 and 6% being the ulnar nerve the most frequently nerve affected due to the usage of medial K-wires.⁽⁹⁰⁾

Shim and Lee reported 63 consecutive paediatric cases treated by closed reduction and percutaneous cross-fixation. There was no iatrogenic ulnar nerve palsy in their collective.⁽⁹¹⁾

On the other hand in a study carried out by Gurkan et al. they treated 44 children with displaced extension-type SCHFs by open reduction and internal fixation and 55 children by closed reduction and percutaneous crossed pin fixation and they had two ulnar nerve injuries in the open reduction group and two in the closed reduction patients.⁽⁶⁷⁾

Lyons et al. have reported that most of ulnar nerve palsies after percutaneous cross-pinning were neuropraxia and recovered spontaneously after removal of the k-wires.⁽⁵²⁾

Irena et al. found that most cases of postoperative ulnar nerve injury in closed pinning that have been explored revealed direct iatrogenic injury from blind placement of the medial pin, including direct penetration or laceration of the nerve or tacking it down in a non-anatomical position.⁽⁸⁹⁾

Radiological assessment of reduction:

In current study it was found that the more accurate the reduction the better the results as regards the angular deformities. This coincides with the findings of many authors.^(14,92) This allows the fracture to unite in anatomical position more or less similar to the condition before injury with minimal or no change in the carrying angle and early recovery of range of movements.

Lee B, Lee S, Kim S, et al in 2011 examined 114 children with supracondylar fractures, and measured the Baumann's, humerotrochlear angle and the anterior humeral line and analyze the effectiveness of treatment which was performed. The results showed that radiographic assessment of these angles is a good indicator of the choice of treatment based on the degree of displacement of the fracture fragments.⁽⁹³⁾

Baumann's angle is commonly used to evaluate fractures as it maintains an estimation of the carrying angle.⁽¹²⁾ Worlock et al. stated that a change of 5° in the Baumann's angle usually results in a 2° change in carrying angle.⁽⁹⁴⁾ An increase in Baumann's angle produces varus deviation in relation to the proximal humerus.⁽¹²⁾

In our study we found that there was statistically significant relation between degree of Baumann angle and the final results. 3 children (15%) had a Baumann angle of >90° and had cubitus varus deformity later on. In those children the k-wires did not have a good purchase causing fracture malunion. Voss et al. stated that proper anatomic reduction and fixation during initial management prevents malunion.⁽⁹⁵⁾

Egemen et al stated that the anterior humeral line is directly related to the anterior and posterior translation of distal humeral fragment. He found that the anterior humeral line of 93 of patients were passing through mid one third of the capitulum, 18 patients revealed an anterior one third passing of the anterior humeral line.⁽⁹⁶⁾

In the present study we found significant relation between the position of the frontal humeral line of the injured elbow compared to the other normal side and the final results. there was significant increase in excellent and good results when it was passing in the middle and anterior third of the capitulum .While the anterior humeral line of 7 of our children was passing through middle one third of the capitulum, 9 children revealed an anterior one third passing of the anterior humeral line, on the other hand 3 children had it passing in front of the capitulum and in 1 child it was passing through posterior third. This gave an idea that more accurate reduction gave better result.

Humerothochlear angle was directly related to the angulation of distal humeral fragment. It provided adequate information on anterior–posterior angulation of fracture on sagittal plane. O'hara et al. prefer humerotrochlear angle for assessing quality of reduction. They observed that this angle decrease below normal values in patients with distal fracture fragment angulated posterior, and found it to increase in patients with distal fracture fragment angulated anteriorly.⁽⁹⁷⁾

In the current study we measured the humerotrochlear angle of the 20 child compared to the other normal side and found that good and excellent results were associated with an average of 30-40° .

Cubitus varus:

Cubitus varus is the most common complication of supracondylar fracture in children with an overall incidence ranging between 10-50%.⁽⁹⁸⁾ It may follow all forms of treatment including open reduction and internal fixation or percutaneous pinning. As the malunion in the coronal plane has no capacity for remodeling. Above all it impairs the cosmetic appearance of the elbow. Although cubitus varus does not interfere with the range of motion, it may be a functional problem in some activities. Rotational displacement of the distal fragment of the humerus may be due to inadequate initial reduction or redisplacement due to poor pin placement. Rotation of the distal fragment per se does not result in varus deformity but represents the major predisposing factor for tilt of the distal fragment.⁽⁴⁸⁾ The injury hindering the growth of the medial side was considered as a significant factor in the development of the deformity, but nowadays in the recent literature it is not accepted and no evidence to be a significant factor in the development of the deformity.⁽⁴⁾

In our study we had 3 children (15%) with cubitus varus deformity. Jacob et al. said that cubitus varus is the most common complication of this type of fracture and results in fracture malunion and occasionally the partial growth arrest of the medial condylar physis. Proper anatomic reduction and fixation during initial management prevents malunion. Minor varus angulation is generally considered a cosmetic, rather than functional, deformity.⁽¹²⁾

SUMMARY

This work was planned to assess the results of treatment of displaced supracondylar fractures of the humerus in children. The children were treated by open reduction and criss-cross k-wires internal fixation one through the medial epicondyle and one, sometimes two through the lateral epicondyle.

The material of this study included 20 cases of displaced supracondylar fractures of the humerus, Gartland's type III.

The age of the patients ranged between: 2.5 years and 12 years with a mean (5.88 ± 3.22) years.

There were 11 boys (55%) and 9 girls (45%).

All cases of the material were examined clinically and radiologically there were all of extension type.

The left elbow was affected in 15 patients (75%) and the right elbow was affected in 5 patients (25%).

The time lapse before surgery ranged between 0 to 4 days with average 2.11 days. There were 8 children operated within 2 days of injury (40%), while 6 children were operated after 1 day of injury (30%), on the other hand 2 children (10%) were operated after 3 days and 3 children (15%) were operated after 4 days.

In all but three cases the plaster and K-wires were removed after six weeks of surgery, in the remaining three cases the plaster and K-wires were removed after eight weeks.

The follow up period ranged from 6 to 10 months with an average of 8 months. Patients were followed up clinically and radiographically every 2 weeks during the period of follow up.

At the end of the follow up period there was;

- 3 cases excellent (15%)
- 10 cases good (50%)
- 7 cases unsatisfactory (35%)

The factors that had an effect (significant correlation) on the final clinical results in this study was the position of the k-wires, the degree of Baumann angle, the position of the frontal humeral line and the degree of humerotrochlear angle which gives an idea that the more perfect reduction the better was the results.

The complications encountered in this study were;

- Limitation of the elbow motion in 6 children

Summary

- Superficial skin infection in 7 children improved by broad spectrum antibiotics and daily dressing and 5 children had pin tract infection improved after removal of the k-wires.
- Three children had cubitus varus
- Five children had an ugly posteriorly located scare.