Research Journal of Biological Sciences 3 (11): 1283-1286, 2008
ISSN: 1815-8846

Open Surgical Treatment of Extension Type Displaced Supracondylar Fractures of the Humerus in Children Through Combined Medial and Lateral Approaches

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Abstract: Supracondylar fracture of the humerus is the most common fracture in the elbow region in children. Many methods have been proposed to treat Gartland type III supracondylar fractures of the humerus in children: one of them is open reduction and internal fixation with Kirschner wires through combined medial and lateral approaches. From Jan 1995 to Jan 2002, 60 children with extension type, Gartland type III supracondylar fracture of humerus underwent surgery using open reduction internal fixation method through combined medial and lateral approaches in Shohada and Imam Khomeini hospitals, Tabriz, Iran. The cases suffered from either of the following: severely displaced fracture, open fracture, primary neurovascular complication or unsuccessful closed reduction. Children were followed-up for a mean time of 5 years. Sixty children (63% boys, 37% girls), mean age 6.5 years (3-9 years) were followed up. Pin-tract infection occurred in 2 patients and was successfully treated with pin removal and antibiotics. Three cases of iatrogenic nerve injury (2 median and 1 ulnar) were reported but patients gradually regained full neurological function by a mean of 2.5 months. All fractures healed within 6-8 weeks. No compartment syndrome, non-union, mal-union, myositis ossificans, deformities or vascular deficits were noted. Only 10% of patients had a reduction of the carrying angle (less than 20°). Six (10%) patients lost less than 20° of movement in flexion of the elbow. Ninety percent of children had excellent results and the others had good results according to the criteria developed by Innocenti. Operative reduction and pin fixation through combined medial and lateral approaches is one of the best methods to treat Gartland type III fractures.

Key words: Surgical treatment, supracondylar fractures, children, medical and lateral approaches

INTRODUCTION

Supracondylar fractures of the humerus are one of the most common fractures in children (Cheng and Shen, 1993).

It is also generally accepted that supracondylar fracture of the humerus is the most common fracture in the elbow region in children (Davis *et al*., 2000; Hart and Kester, 1999). The peak age of injury is usually said to be between 4 and 8 years. This specific age distribution is because the bone is weaker at this stage of development and the ligamentous laxity predisposes the elbow to hyperextension (Wu *et al*., 2002).

Supracondylar fractures are categorized according to the position of elbow at the time of fracture: 96% of all supracondylar fractures of the humerus are extension-type injuries that occur during falls onto the outstretched hand, while between 1 and 2% occur through falls onto the olecranon with the elbow flexed (Cheng and Shen, 1993).

Several systems of classifying supracondylar fracture have been devised. Gartland's is the most common classification (Gartland, 1959):

Type I : Undisplaced fractures.
Type II : Minimally displaced fractures with some bony contact (the posterior cortex is intact).
Type III : Completely displaced.

Early complications of supracondylar fracture include neurological and vascular injury. If not treated properly, this type of fracture can lead to considerable limitation in elbow's motion and even deformities of the limb.

The management of supracondylar fractures of the humerus has evolved from more conservative approaches such as closed reduction and traction to a more aggressive approach such as open reduction and internal fixation and percutaneous pinning in recent years. The aim of treatment is to gain a functional and cosmetically acceptable upper limb with a normal range of movement.

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Many methods have been proposed to treat displaced Gartland type III supracondylar fractures of the humerus in children: One of them is open reduction and internal fixation with Kirschner wires from different approaches (Omid *et al*., 2008).

This study is performed to study the long term results of open surgical treatment of extension type, Gartland type III supracondylar fractures of the humerus in children through combined medial and lateral approaches in Shohada and Imam Khomeini hospitals, Tabriz, Iran in a 7-years period.

MATERIALS AND METHODS

From Jan 1995 to Jan 2002, 60 children with extension type supracondylar fracture of humerus underwent surgery using open reduction internal fixation method in Shohada and Imam Khomeini hospitals, Tabriz, Iran.

Only children with type III Gartland fracture were included in the study. Children with flexion type fractures or those with other fracture sites were excluded. All cases were indicated for the above method because they suffered from one of the following: severely displaced fracture, open fracture, primary neurovascular complication or unsuccessful closed reduction (Table 1). The surgical procedure was performed either on the admission day or the day after admission.

After general anesthesia, the surgery was performed on the supine patient. The first incision was chosen according to the position of the proximal displaced part (antrolateral in majority of cases). So, the first incision was lateral and the second medial. The lateral incision enabled the surgeon to have a good view of radial nerve and artery. The other major neurovascular components such as median and ulnar nerves were completely exposed via medial incision.

After performing reconstruction in those with radial or median nerve injury, anatomical reduction with 2 crossed Krischner pins was achieved. wires were left protruding for 3-4 cm to facilitate subsequent removal without further anaesthesia.

All patients received a back slab and had radiographs taken.

The limb was immobalized using a long cast while the elbow was 90° flexed and the forearm in pronation for 3-4 weeks. The patients were generally discharged after 2-4 days. The cast and the pins was removed after 3-4 weeks and patients were instructed to start passive and active movements of the elbow.

The children were followed up for averagely 5 years after the surgery. Elbow movements and carrying angle of both operated and normal sides were measured and compared at the final follow-up. Immediate postoperative radiographs were used to determine the maintenance of reduction.

Table 1: Inclusion criteria for open reduction and internal fixation with Kirschner wires from medial and lateral approaches

Inclusion criteria	N(%)
Primary neurovascular injury	3(5)
Severely displaced fracture	18(30)
Open fracture	4(6.6)
Unsuccessful closed reduction	35(58.4)
Total	60(100)

RESULTS

Sixty children (63% boys, 37% girls) with Gartland type III fracture and either of the inclusion criteria (Table 1), were operated on with the above method. The mean age of the 60 patients was 6.5 years (range, 3-9 years). The mean follow-up period was 60 months (range, 26-84 months). All fractures were of extension type, 40 (67%) involved the left elbow and 4 (6.6%) were open fractures. Three (5%) patients had primary neurological deficit (median nerve, n = 1; radial nerve, n = 2).

Pin-tract infection occurred in 2 patients and was successfully treated with pin removal and antibiotics. Three cases of iatrogenic nerve injury (2 median and 1 ulnar injuries) were reported but patients gradually regained full neurological function by a mean of 2.5 months.

All fractures healed within 6-8 weeks. No compartment syndrome, non-union, mal-union , myositis ossificans, cubitus varus or valgus deformity or residual vascular deficits were noted. The results are summarized in Table 2.

The carrying angle of the operated and normal side was measured at the final follow-up: 54 (90%) patients had no reduction of the carrying angle and the rest had up to 20° reduction. Six (10%) patients lost less than 20° of movement in flexion of the elbow. Ninety percent of children had excellent results and the others had good results according to, the criteria developed by Innocenti.

Table 2: Complications after Open surgical treatment of supracondylar fractures of the humerus in children through combined medial and lateral approaches

Complications after surgery	N(%)
Neurological deficits	3 (5)
Pin-tract infection	2(3.3)
myositis ossificans	-
Non-union	-
Mal-union	-
Delayed union	-
Cubitus varus or valgus	-
Residual vascular deficits	-

DISCUSSION

Humeral supracondylar fracture is the second most common fracture in children younger than 7 years (O'Hara *et al*., 2000). The different methods recommended for supracondylar fractures of the humerus in children suggest that more research should be done to select the best method. A selective approach to treatment is required based on the classification of the fracture and the soft-tissue complications present.

Open reduction and fixation with K-wires is gradually going to replace other methods of treatment especially in cases with open fractures, neurovascular deficits and unsuccessful closed manipulation.

Biomechanical studies have shown that a medially and laterally crossed Kirschner-wire configuration is 25% more rigid than 3 lateral pins and 37% stronger than 2 parallel lateral pins (Barlas *et al*., 2006).

In our study, the mean age of the children enrolled for the operation was 6.5 years, two-third of which were boys. This is consistent with other studies such as Cheng and Hart (Cheng and Shen, 1993; Hart and Kester, 1999).

The injuries have predominantly involved the left, or non-dominant side, in many studies (Davis *et al*., 2000; Hart and Kester, 1999; Cheng *et al*., 2001). This is in contrast to ours which shows 67% of cases had the right limb involved.

In a study of 52 displaced fractures treated with open reduction through a lateral approach, Weiland *et al*. (1978) reported a moderate loss of motion of 10% (5) of the elbows but no cases of infection, nonunion, or myositis ossificans.

As mentioned above, we also had no case of non union and myositis ossificans but 2 pin-tract infections were reported. Six (10%) patients lost less than 20° of movement in flexion of the elbow which is similar to the report of Weiland *et al*. (1978).

Neural recovery, regardless of which nerve is injured, generally occurs after 2-2.5 months of observation, but it may take up to 6 months. Some researchers believe that there's no need to plan any treatment for iatrogenic nerve injury (Kasser and Beaty, 2006). The authors reported the same results about the observed neural deficits. The rate of compartment syndrome in the setting of a supracondylar fracture is estimated to be 0.1-0.3% (Battaglia *et al*., 2002), however; there was no case of compartment syndrome in our series which is probably due to immobilization of the elbow in a position well below 90° of flexion.

According to, the authors 90% of children showed excellent results and 10% good results at the final follow-up. This is different from the findings of Diri who has reported a rate of 12.8% poor result after the same surgical techniques (Battaglia *et al*., 2002). Reitman *et al*. (2001) reported that 78% (51) of 65 patients treated with open reduction (through either a medial or a lateral approach) had an excellent or good result (Diri *et al*., 2003).

CONCLUSION

Operative reduction and pin fixation through combined medial and lateral approaches is one of the best methods to treat Gartland type III fractures, especially in cases of severely displaced fracture, open fracture, primary neurovascular complication or unsuccessful closed reduction. The authors recommend that other comparative studies be preformed in order to highlight the advantages (and probable disadvantages) of the combined approach versus other approaches such as medial, lateral or anterior.

ACKNOWLEDGEMENT

The authors wish to thank the colleagues in orthopeadic wards of Shohada and Imam Khomeini hospitals, Tabriz.

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