

Open Reduction and Internal Fixation of Supracondylar Fractures of the Humerus: Revival of the Anterior Approach

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ABSTRACT

Introduction: Supracondylar fractures of the humerus occur commonly in the paediatric age group. Gartland type III fractures are treated by closed manipulation and percutaneous pinning with K-wires. Open reduction is indicated in open fractures, failed closed reductions and in a dysvascular limb. There are various approaches that can be utilized to perform an open reduction. The approach of choice must be safe, surgeon and patient friendly and should provide a good access to the fracture and the important surrounding structures. The anterior approach has been described as the most versatile approach. The aim of the study was to review the advantages and drawbacks of the anterior approach and to assess the functional outcome of fractures treated via this approach.

Materials and methods: Twenty five (15 male and 10 female) patients out of a hundred and twenty eight children with Gartland type III extension variety of supracondylar fractures of the humerus from underwent open reduction and internal fixation with K-wires via an anterior approach January 2007 to January 2011. The results were assessed at six months using Flynn's radiological and clinical criteria.

Results: Twenty five patients (19.53%) out of hundred and twenty eight patients underwent open reduction and internal fixation. According to Flynn's clinical and radiological criteria, 20 (80%) were found to have excellent and 5 (20%) good results.

Conclusion: The anterior approach is safe, easy and provides direct exposure of the surrounding neurovascular structures with good to excellent results.

Keywords: *anterior approach, open reduction, supracondylar fractures humerus*

INTRODUCTION

Supracondylar fractures of the humerus occur commonly in the paediatric age group with a peak incidence between ages 5 and 8 years¹. The extension variety comprises of approximately 97.7 % and is caused by a fall on the outstretched hand while the flexion type is rare.² Treatment is aimed at a good functional outcome and preventing cubitus varus or valgus deformity by obtaining an anatomical reduction.

According to recent reports, Gartland type III fractures (Gartland's classification²), are treated by closed

manipulation and percutaneous pinning with K-wires.³ Open reduction is indicated in failed closed reductions, a dysvascular limb and open fractures^{4,6}.

There are various approaches that can be utilized to perform an open reduction. The incision of choice must be safe, surgeon and patient friendly and should provide a good access to the fracture and the important surrounding tissues.

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The anterior approach has been described as the most versatile approach⁵. This approach was originally described by Hagenbeck in 1894 and the first recommendation and clinical results of this technique was published by Sorrel and Longuet in 1946⁷. Carcassonne et al⁸ popularized the approach and reported 97.5 % perfect and very good outcomes and Kekomani et al treated 32 cases and reported only one unsuccessful outcome⁹. Aronson et al reported good results in 11 fractures and suggested that the approach was a forgotten approach¹⁰.

The aim of this study was to review the advantages and disadvantages of this approach and to assess the functional outcome of fractures treated by this approach.

METHODS

Twenty five (15 male and 10 female) patients out of a hundred and twenty eight children with Gartland type III extension type supracondylar fractures of the humerus underwent open reduction and internal fixation with K-wires from January 2007 to January 2011. One hundred and three of these patients were treated by closed reduction and stabilization with percutaneous pinning with K-wires.

Failed closed reductions, open fractures and fractures with vascular complications underwent exploration, open reduction and fixation. A prospective study was conducted for a period of four years from January 2007 to January 2011 using the anterior approach to treat these fractures after taking informed consent from the patients.

The patient was placed supine and the limb was prepared and kept on a hand table. A tourniquet was placed prior to draping and was inflated when there was a need for open reduction.

The anterior approach was initiated with a transverse incision in the cubital fossa and extended vertically. The vertical extension depended on the position of the proximal fragment. (Fig. 1)



Figure 1. Skin incision

A deep incision of the skin, superficial fascia and subcutaneous fat was done to expose the brachialis muscle. Since the distal portion of the proximal fragment tears the brachialis muscle, it provides direct access to the fracture site (Fig. 2,3).

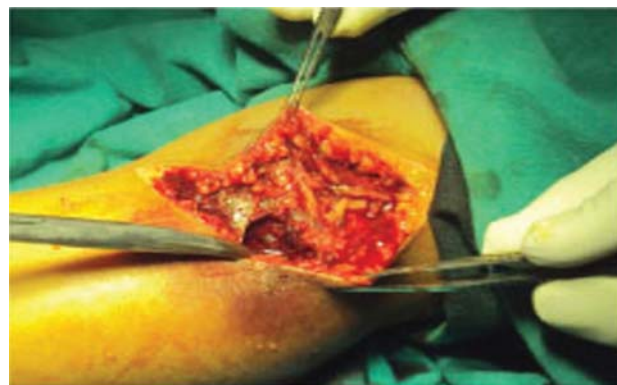


Figure 2. Tear in the brachialis muscle



Figure 3. Direct access to the fracture site

In most cases, this button-holing of the proximal fragment into the brachialis muscle was the cause of failed reductions (Fig. 4) while the joint capsule and the periosteum hindered reduction in some patients.

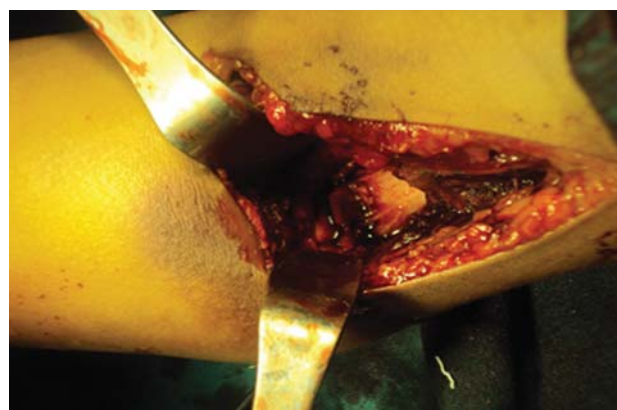


Figure 4. Skin incision The proximal fragment button-holed into the brachialis muscle

brachialis muscle, the fracture site was visualized and the intervening tissues were assessed. The median nerve and/or the brachial artery were usually found to be compressed by the proximal fragment in fractures with a postero-lateral displacement of distal fragment. The radial nerve was involved when the proximal fragment deviated laterally. The fracture hematoma and the surrounding structures were then decompressed and the intervening material was cleared. The reduction was then performed by the surgeon applying traction and using his fingers to push the proximal fragment posteriorly and his thumb to lever the distal fragment anteriorly. The elbow was brought into flexion at the same time by an assistant.

The reduction was checked by visualizing and palpating the anterior, lateral and medial sides of the fracture. On obtaining a satisfactory reduction, two K-wires were inserted using the image intensifier. The K-wire was first placed on the lateral side with the elbow in full flexion using the shoot-through AP view. Then the elbow was externally rotated and extended to 90 degrees and the second K-wire was placed through the medial epicondyle, palpating and pushing the ulnar nerve away with the surgeon's thumb.

After attaining proper length and stability, the ends of the K-wires were left outside the skin. The fracture site and the neurovascular structures were reassessed and closure was completed in two layers. A long arm back slab was applied with the elbow in 90 degrees of flexion.

A post-operative check X-ray was performed the following morning to confirm the reduction. A neurovascular examination was performed. Intravenous antibiotic was discontinued on the second post-operative day unless the patient had an open fracture where the antibiotic was continued for 7 days. The sutures were removed after two weeks. At the fourth week,¹¹⁻¹³ a check x-ray was ordered to confirm union and then the plaster slab and the K-wires were removed and the elbow was mobilized.

A follow-up examination was done at one, two, four, six, twelve, eighteen and twenty-four weeks. At the final follow-up, the results were assessed using Flynn's radiological and clinical criteria¹².

Table 1. Flynn's clinical and radiological criteria

Result	Restriction of flexion and extension	Loss in carrying angle
Excellent	0° to 5°	0° to 5°
Good	5° to 10°	5° to 10°
Unsatisfactory	10° to 15°	10° to 15°
Bad	< 15°	< 15°

RESULTS

Of the hundred and twenty eight children with Gartland type III supracondylar fractures of the humerus, open reductions had to be executed in twenty-five patients (19.53 %), the indications being fourteen failed closed reductions (10.93 %), six open fractures (4.68 %) and others associated with vascular complications (3.9 %). There were 15 male and 10 female patients. The commonest mode of injury was a fall on the outstretched hand (80 %). The average age of the patients was 6.88 years (range 5 - 9 years). The fracture was located on the left side in 15 patients and 10 on the right side. The average time from admission till the operation was 6.16 hours (range 3 - 12 hours). The distal fragment was displaced postero-laterally in 17 (70.37 %) and postero-medially in 8 patients.

Closed reductions failed in fourteen patients and the cause was mainly entrapment of the brachialis, the median nerve in two and the radial nerve in one patient. Six fractures were open. Five were graded as type I, and one was classified as type II, according to the Gustilo and Anderson classification of open fractures¹⁴. One of the type I fractures had a median nerve injury. They were all treated by a thorough lavage after wound extension and seven days of intravenous antibiotics. Five children had a diminished or absent radial pulse. Two of them had an associated median nerve injury. One patient had a compression of the median nerve and the brachial artery caused by the proximal fragment and had an absent pulse following decompression. The capillary refill time was normal in this patient. A thrombus was suspected and a vascular consultation was taken and he was treated conservatively by the vascular surgeon. His pulse returned after 48 hours. Another child had an absent radial pulse following manipulation which was restored after disengaging the compressing bony fragment.

The post-operative hospital stay averaged 3.72 days (range 3 - 8 days). The open fractures were treated with seven days of intravenous antibiotics prior to discharge. The others were discharged on the second post-operative day.

The patients were followed up after a week and the wound was inspected and dressed. The skin incision healed in all patients without problems by the second week and the sutures were removed. The plaster immobilization was continued for four weeks, as was the general trend in many studies^{11,13}. Radiographs were performed prior to removal of the K-wires and the plaster slab. All the fractures had united by this time. The nerve palsies recovered by the third post-operative month. Most (80 %) of the patients regained full elbow motion by 12 weeks.

There was one incidence of a pin-tract infection from a K-wire site. The culture sensitivity revealed no growth and it resolved after a course of oral antibiotics.

The patients were assessed at six months using Flynn's clinical and radiological criteria and 20 (80 %) were found to have excellent and 5 (20 %) good results.

DISCUSSION

We report 25 patients with Gartland type III supracondylar fractures of the humerus who were managed by open reduction and internal fixation via the anterior approach from January 2007 to January 2011. A hundred and twenty-eight supracondylar fractures were treated at our institute during this period.

The gold standard for the treatment of displaced supracondylar fractures is closed reduction and percutaneous pinning^{7,15}. Open reduction for supracondylar fractures is indicated in open fractures, failed closed reductions and a dysvascular limb^{5,7}.

The incidence of open reduction in different series⁸ varies between 2 % and 25 %. Surgery is safe and not associated with increased morbidity. In our study it was 19.53 %: the indications being fourteen failed closed reductions (10.93 %), six open fractures (4.68 %) and five associated with vascular complications (3.9 %).

Irreducible fractures are thought to be uncommon. The prevalence in the literature ranges from 2 to 15 %.¹⁶ Irreducibility was found mainly due to entrapment of the brachialis and median nerve. The proximal fragment was found to be button-holed in the brachialis. The issues of the intervening joint capsule and periosteum impeding reduction in the other cases when open reduction was required could be dealt with by using an anterior approach. There are various approaches described for internal fixation. A lateral, medial or even posterior approach can be used. However, these afford only a partial view of the fracture⁷.

The anterior approach provides an excellent access to the fracture site and surrounding neurovascular structures and decompresses the soft tissue hematoma. The scar is much more cosmetic and scar contraction limiting elbow extension is not an issue⁴. Although the anterior approach is not commonly used by many orthopaedic surgeons, it is the most versatile approach and can provide several advantages⁵. It is popular among surgeons in Scandinavian countries¹¹. The disadvantages of the medial and lateral approaches are poor visibility¹². The posterior approach has been reported to have a high rate of loss of motion and the risk of osteonecrosis secondary to the disruption of the posterior end arterial supply to the trochlea of the humerus^{4,17,18}.

Koudstaal et al⁷ showed that the anterior approach is safe, simple and easy to perform. They experienced a failure of closed reduction in 25 % of cases. A comparison was made between different surgical approaches and their results showed several advantages of the anterior approach and good to excellent results using Flynn's criteria were obtained in 84 percent of patients.

Postoperative ulnar nerve lesions were reported to be seen in 2 – 3 % of cases, but in our study, there were none, the reason probably being that the lateral K-wire was placed initially with the elbow in full flexion. The medial wire could be placed with the elbow in 90 degrees of flexion instead of full flexion, relaxing the nerve behind the medial epicondyle. The distance of the nerve from the point of wire insertion was further retracted away by the surgeon's thumb, making it safer.

Gennari et al¹⁹ conducted a study comparing the anterior and the posterior approach and concluded that using the posterior approach creates supplementary anatomic damage that can cause circulatory disorders in the external condyle and a higher percentage of limitation in mobility. Although the anterior approach is theoretically more demanding, it gives better functional results.

Mazzini et al²⁰ performed a systematic review of the literature to identify publications dealing with functional, cosmetic, and radiological outcomes, as well as post-surgical complications in patients with totally-displaced supracondylar fractures of the humerus managed with primary open reduction through different surgical approaches. Their results suggest that an anterior approach allows the achievement of better functional and cosmetic outcomes according to Flynn's criteria.

The drawback of the approach is that the surgeon must be aware of the anatomy and surrounding neurovascular structures, though no injury via this approach has been reported till date.

CONCLUSIONS

On conclusion, we found that the anterior approach is safe, easy and provides direct exposure of surrounding neurovascular structures with good to excellent results.

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