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ORIGINAL STUDY

Medial approach for fixation of displaced supracondylar fractures of the humerus in children

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This study aimed at evaluating our protocol for displaced Gartland Type 3 supracondylar fractures of the humerus in children. Forty-eight children had 49 fractures during the study period, from 1997 to 2002 ; they were included in the study. Their mean age was 7.02 years. They all were treated with crossed K-wires. The medial wire was always put under direct vision through a medial approach. All fractures were manipulated maximum twice. Ten patients (23.25%) required open reduction which was done through the same medial approach which we use for medial pin placement. No patient had iatrogenic ulnar nerve neuropathy. At final review radiographs were taken of the normal and operated sides and films were compared with immediate post-op films. The postoperative mean value of Bauman's angle in the affected elbow was 76.7° with a range of ± 1.0° and 74.8° with a range of ± 0.6° on the unaffected elbow. Carrying angle and movements of operated and normal sides were measured at review. According to Flynn's criteria, all patients showed satisfactory results. We conclude that cross K-wiring gives excellent results ; the medial approach provides an excellent view of the supracondylar area, leaves a cosmetically acceptable scar and enables to avoid iatrogenic injury to the ulnar nerve.

INTRODUCTION

The supracondylar fracture of humerus is the second most common fracture in children (16.6%) and the most frequent before the age of 7 years (table I) (*3*). The peak age of incidence for this fracture is the first decade of life ; it is more common in boys than in girls (*13*). Most of the fractures are extension type. Treatment for Gartland's Type 3 fracture is controversial and often technically difficult ; complications are common (*7*). Cubitus varus is the most frequent problem with a mean incidence of 30% in the series reviewed by Smith (*18, 20*). This deformity is due to medial tilting of the distal fragment, associated with rotation. It does not remodel with growth, is not progressive and is not due to physeal injury. As the major vessel and nerves pass around the elbow, so injury to these structures is possible. Volkmann's ischaemic contracture is now extremely rare, with an incidence of 1.1‰ (*22*) but is still seen (*4, 14, 17*). Stiffness of the elbow may occur, particularly after repeated manipulations and open reduction internal fixation especially with the use of the posterior approach (*8*). In most cases, however, with time there is improvement and the

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Table I. — Incidence (%) of Fractures of the Distal Humerus

Injury	Incidence (%)
Supracondylar Fracture	60-85%
Lateral condyle Fracture	12-17%
Medial epicondyle Fracture	12%
Medial condyle, Lateral epicondyle and Transcondylar fractures combined	2%

Table II. — Gartlands 'Classification

Grade	Fracture
I	Undisplaced Fracture
II	Obvious Fracture line with displaced distal fragment but intact posterior cortex
III	Complete displacement noted : Posteromedial or Posterolateral

functional result is not greatly impaired. Many methods have been proposed for treatment of displaced Gartland's type 3 supracondylar fractures of the humerus in children (table II), such as manipulation under anaesthesia and cast application (*2, 10*), skin or overhead skeletal traction (*5, 16*), closed reduction and percutaneous K-wires in different configurations (*6*) and open reduction internal fixation with K-wires from different approaches (*13*). Closed reduction and percutaneous pin fixation was first described by Swenson in 1948 (*21*) and it is now the most commonly used procedure by the paediatric orthopaedic surgeons in UK (*11*). The shaft of the distal humerus is thin and even if perfect reduction is obtained the fracture is very unstable so we have to fix the fracture with K-wires. The most common and stable configuration is medial and lateral crossed K-wiring (*6, 27*) but because of swelling it is always difficult to find the correct entry point of the medial K-wire, so the ulnar nerve is at risk in at least 4%-15% of patients (*19*). Considering this finding we made the protocol to treat this fracture by manipulating maximum twice, and if not successful, then do open reduction through the medial approach. We always put the medial K-wire after exposing the medial epicondyle and securing the ulnar nerve. We wished to determine the results of our protocol, so we performed this study.

MATERIALS AND METHODS

A retrospective study was conducted for the patients admitted from October 1997 to October 2002. We admitted 48 children with 49 Gartland's type 3 supracondylar fractures of the humerus. They were treated by closed or open reduction and cross K-wires ; the medial wire was put after exposing the medial epicondyle with a small incision. Of the 49 patients, we reviewed 43 (87.75%) at follow-up clinic. At the time of fracture, the average age of the patients was 7.02 years (range : 2 to 14) and 83% of the fractures occurred in boys. Final review time averaged 48 months (range : 25 to 84). All these fractures were closed and of the extension type and 28 of these (65.11%) were involving the right elbow. Two patients had an ipsilateral fracture of the upper extremity. One of them had a fractured radius and ulna and another had a fracture of the distal ulna. Four patients (9.30%) had a primary neurological deficit and among these 3 were from the median nerve and one from the radial nerve. The fractures were fixed within 12 hours from admission. and had not more than two attempts of manipulation (table III). All patients had crossed K-wires. In 10 patients (23.25%) we were unable to reduce the fracture by closed methods, so we had to do the open reduction through a medial approach. After placing the pins, the elbow was extended and the carrying angle was compared to that on the non-affected side. All the patients received a back slab and check radiographs were taken systematically.

The last follow-up examination consisted of measuring elbow movements and carrying angle. All patients had radiographs taken at review of the operated and normal side, and films were compared with the immediate postop films and with those of the normal side. These radiographs were used to determine the maintenance of reduction on radiographs. Bauman's angle was measured on the anteroposterior views as described by Dodge (*5*).

RESULTS

No patient had deep infection but 5 had superficial pin tract infection which resolved with oral antibiotics. There was no iatrogenic injury to any nerve and in particular the ulnar nerve. All these fractures healed within the expected time. There

Table Ill. — Duration for different stages of treatment

Duration	Minimum	Maximum	Mean
Injury to admission (hours)	0.33	6.10	1.34
Injury to surgery (hours)	2.05	16.05	8.34
Admission to surgery (hour)	1.32	09.55	4.46
Hospitalisation (days)	1	7	1.86

Table IV. — Results according to Flynn's Criteria (No of patients/percentage)

Results	Rating	Cosmetic Factor (Change in carrying angle)	Functional Factor (Loss of motion)
Satisfactory	Excellent Good Fair	34 (79.06%) 07 (16.27%) 02 (4.65%)	30 (69.76%) 09 (20.93%) 04 (09.30%)
Unsatisfactory	Poor	0%	0%

was no cubitus varus deformity. No patient had pain or symptoms related to the elbow. No residual vascular deficits were noted. The primary neurological deficits were observed and patients were regularly followed as outpatients. Since they showed progressive improvement over time, no neural testing was done. All patients gradually regained full neurological function at a mean of 4.5 months (range : 2 to 6).

None of the patients or parents asked for revision of the scar.

The postoperative mean value of Bauman's angle in the affected elbow was 76.7° with a range of ± 1.0° and 74.8° with a range of ± 0.6° on the unaffected elbow. The comparison of Bauman's angle measured on the films which were taken immediately after surgery and those at final follow-up revealed no significant differences between them (> 0.05).

At the last clinical examination the carrying angle of the affected and unaffected extremity were measured and 34 patients had a carrying angle reduced by 0 to 5° (79.06%), 7 patients had this reduction between 6° to 10° (16.27%) and 2 patients had this change between 11° to 15° (4.65%). There were 30 patients (69.8%) who lost less than 5° flexion/extension movement, and 9 patients (20.9%) who lost 6 to 10' of flexion and 4 patients (9.3%) had flexion reduced 11° to 15°. There was no cubitus varus or valgus deformity of the elbow.

The final results were evaluated by Flynn's criteria and all patients assessed had satisfactory results (table IV). There was no iatrogenic injury to any nerve or vessel.

DISCUSSION

The aims of the treatment of displaced supracondylar fracture are to achieve functionally and cosmetically satisfactory results and avoid any complications. Assuring a low cost and decreasing the hospitalisation period are very important for both surgeon and patient's parents.

Traction is still an effective method of treatment (*26*) but is expensive and when the extremity is swollen, it is very risky to attempt skin traction. Furthermore, it increases the incidence of cubitus varus and prolongs the hospital stay (*17, 18, 20*). Closed reduction and percutaneous pinning has many proponents (*6, 23, 24*), but it is associated with 4% to 15% iatrogenic ulnar nerve injury. The chances of ulnar nerve injury vary according to the position of the elbow at the time of operation. It occurs more when the pin was applied in the hyperflexed elbow and less without hyperflexion (*19*).

Iatrogenic injury to the ulnar nerve may occur even when the medial epicondyle is palpable (*23*). Clinically it is not possible to accurately predict the location of the ulnar nerve prior to blind percutaneous crossed K-wire fixation of supracondylar fractures of the humerus, so now there is discussion regarding the use of intraoperative nerve stimulation to localise the ulnar nerve prior to placement of the medial pin (*25*). Due to this risk many surgeons put two pins from the lateral side (*1*) but biomechanical studies have shown (*27*), however, that a crossed medial and lateral K-wire configuration is more strong or stable than 2 or 3 wires from the lateral side. Redisplacement of the fracture has been reported to be significant after the use of lateral K-wires (*1, 9*). A lateral Kwire configuration may not allow full extension of the elbow thus preventing examination of the carrying angle at operation. To open the fracture from the medial side allows us to identify the ulnar nerve and also helps us to reduce the fracture as 75% of Gartland's type 3 fractures are displaced posteromedially (*13*). The most heavily criticised has been the posterior approach (*8*) as it insults the virgin tissues which were saved from the initial injury, because of the posterior displacement of the distal fragment and it causes loss of elbow movements and infection.

We advise to expose the medial epicondyle in every patient and put the wire in the apex of the medial epicondyle after securing the ulnar nerve, in order to decrease the risks of iatrogenic injury to the ulnar nerve. Also we recommend putting medial and lateral K-wires for maximum stability and strength. By exposing from the medial side, the scar acceptability has also increased. To decrease the chances of stiffness of elbow we recommend, reducing the manipulation attempts to maximum two and to fix this fracture within 12 hours of admission.

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