

Medial approach for operative treatment of the widely displaced supracondylar fractures of the humerus in children

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ABSTRACT

Twenty-seven widely displaced supracondylar fractures of the humerus in children were treated by open reduction and cross K-wire fixation by the medial approach over a 30-month period. The mean follow-up was 14 months, average age 8 years and the mean delay in presentation 49 hours. Medial approach provided an excellent view of the medial bone pathology via an internervous plane and enabled an anatomical reduction in all cases. Cross K-wire fixation obviated the need to immobilize the elbow at 90 degrees or more flexion. No postoperative neurovascular complication was noted. Most patients regained full range of motion within 6 weeks of pin removal and no change in the carrying angle was noted. Delayed presentation, repeated manipulations and massage were responsible for loss of motion. Superficial pin tract infection was noted in 5 patients and resolved with dressings and antibiotics. No deep infection occurred. Medial approach for open reduction and internal fixation of the widely-displaced supracondylar fracture of the humerus is safe and

straightforward, ensuring anatomical reduction and excellent function.

Key words: *irreducible supracondylar humerus fracture, medial approach, medial column comminution*

INTRODUCTION

Supracondylar fractures of the humerus are common pediatric injuries seen in the emergency department. They occur most frequently between 5 and 8 years of age. The vast majority are the extension type and it is only the Gartland type III variant⁶ with complete off-ending of the fracture fragments that is associated with acute complications such as brachial artery injury, nerve injury and compartment syndrome which receive immediate attention. Cubitus varus is an often neglected but nevertheless important long-term problem. Closed reduction and percutaneous pinning is the accepted primary treatment modality. However, delay in presentation and the non-availability of image facility precluded successful closed management. If anatomical reduction is not possible by closed means,

open reduction and internal stabilisation by Kirschner wires (K-wires) ensures a safe anatomical restoration and maintenance of alignment.

Among the approaches described for open reduction are the medial, lateral, combined medial and lateral, posterior, anteromedial and the transverse anterior. The posterior approach has been abandoned by most surgeons due to the high incidence of restriction in motion. The anteromedial approach allows visualization of the neurovascular structures and their repair if required. This approach shows the anterior soft tissue pathology very well but does not allow a 180° view of the medial column. The lateral approach too does not address the problem of medial comminution and tilt. The medial approach is routinely used at our institution for open reduction and internal stabilization of the widely displaced supracondylar fracture of the humerus. Our experience of the last three years with the use of this approach is presented.

MATERIALS AND METHODS

During the period from January 1996 to December 1998, 155 patients with supracondylar fractures of the humerus were managed at our institute. According to Gartland's classification, 33 children had grade III displacement. Patients with neurovascular complications are not included in this study as the approach was dictated by the injured structure. The brachial artery was damaged in 4 patients, one child had a wrist drop and one child came with wet gangrene of the limb. Twenty-seven children with widely displaced supracondylar fractures of the humerus treated by immediate open reduction and internal fixation are included in this study. There were 22 boys and 5 girls. The average age was 8 years (range 2–14 years) and the mean delay in presentation was 49 hours (range 2–240 hours). Twenty-six patients had an extension type fracture and one child had a flexion injury. Most patients were operated on within 6 hours of admission. The average follow-up period was 14 months (range 3–35 months).

Technique

Operations are carried out under general anaesthesia with tourniquet control. After preparation and draping, a strict medial incision is made starting 3–5 cm proximal to the elbow crease and extending 2 cm beyond it. Obliteration of the bony landmarks is not a

problem. The ulnar nerve is identified and mobilised to the length of the skin incision. The brachialis is elevated from the proximal fragment and the fracture hematoma drained. The entire anterior breadth of the proximal humerus is well visualised due to subperiosteal stripping of the brachialis by the hematoma per se. The elbow is flexed to 20° and gentle traction given to visualize the distal fragment. Occasionally a sharp periosteal elevator is necessary to reflect the entrapped common flexor origin distally 2–3 mm. After the entire breadth of the distal fragment is visualised anteriorly 2–3 mm distal to the fracture line, the fracture is reduced by gentle traction and flexion with the thumb pressing the olecranon anteriorly. The quality of reduction is assessed by inspecting the medial column anteriorly, medially and posteriorly and the fracture line anteriorly. A pair of artery forceps may be used to feel for a step in the lateral column. Generally the fracture spikes interdigitate to lock the reduction. Maintaining the elbow in 60° to 80° flexion with gentle traction is essential to prevent posterior tilt. Excessive traction can antevert the distal fragment. Cross K-wires are passed medially and laterally, distal to proximal. It is important not to apply too much pressure while drilling the medial wire or else a tilt will result as the distal fragment is driven into the soft, comminuted proximal medial column. Elbow movements are checked. If extension is not full the lateral wire has impaled the lateral collateral ligament or the common extensor origin and its insertion site is changed. The wires are cut long and left protruding for 3 cm to facilitate subsequent removal without anaesthesia. The tourniquet is deflated and the wound washed with saline. After checking for the capillary refill the subcutaneous fascia and skin are closed. The elbow is immobilised at less than 90° flexion in supination. A check film is obtained.

Follow-up

The child is sent home after 24–48 hours on oral antibiotics. The sutures are removed at 2 weeks and the posterior slab reapplied at 90° flexion in mid-prone position. The slab and wires are removed at 4–6 weeks and elbow mobilisation started. The child is followed up at 6 weeks, then at 12-weekly intervals until maximal recovery of movement. Assessment at final follow-up included clinical measurement of the carrying angle of both the elbows and range of elbow motion using a goniometer. The neurovascular status was recorded.

RESULTS

Visible medial column comminution was seen in fifteen cases (Table 1). Anatomical reduction was achieved in all the cases. There were no postoperative neural or vascular complications. Twenty-two patients regained full range of motion within 6–8 weeks of pin removal. No case of cubitus varus was seen in the present series. Of the five patients with restriction of elbow motion, two patients had restriction of both

flexion and extension while the other three had only extension loss. Patients with restriction in movement were presented late compared with the others (Table 2). No myositis ossificans or deep infection was seen. Superficial pin tract infection occurred in five cases. Pin tract infection is not a problem with open reduction and internal fixation and resolves with dressings once the pins are removed. Based on Flynn’s criteria,⁵ 22 patients had a satisfactory outcome (Table 3).

Table 1
Clinical data of all patients

	Age	Sex	Elbow operated	Time elapse (hours)	Closed reduction tried	Visible medial column comminution	Pin tract infection	Range of motion	Cubitus varus	Follow-up (months)
1	4	F	Left	6	Yes	-	No	Full	-	35
2	12	F	Left	168	No	+	No	Restricted	*	32
3	7	M	Left	240	No	-	No	Restricted	*	32
4	8	F	Left	240	No	-	No	Restricted	*	30
5	10	M	Left	3	Yes	+	Yes	Full	-	28
6	6	M	Right	24	Yes	-	No	Full	-	8
7	13	M	Right	24	Yes	+	No	Full	-	7
8	11	M	Left	30	No	+	No	Full	-	7
9	11	M	Left	4	Yes	+	Yes	Full	-	19
10	6	F	Left	36	No	-	Yes	Full	-	18
11	10	M	Left	2	Yes	+	No	Full	-	16
12	5	M	Right	24	Yes	-	No	Full	-	17
13	10	M	Right	72	No	+	No	Full	-	18
14	7	F	Right	48	No	-	No	Full	-	14
15	7	M	Right	4	Yes	-	No	Full	-	12
16	8	M	Left	6	Yes	-	No	Full	-	12
17	7	M	Right	48	No	+	Yes	Full	-	12
18	10	M	Left	4	Yes	+	No	Full	-	8
19	9	M	Left	24	No	+	No	Restricted	*	8
20	9	M	Right	168	No	+	No	Restricted	*	8
21	14	M	Right	48	No	+	No	Full	-	7
22	11	M	Left	24	Yes	+	No	Full	-	7
23	10	M	Left	4	Yes	+	Yes	Full	-	9
24	14	M	Right	4	Yes	+	No	Full	-	10
25	2	M	Right	4	Yes	-	No	Full	-	3
26	6	M	Left	6	Yes	-	No	Full	-	3
27	6	M	Left	72	No	-	No	Full	-	3

* Cannot be commented upon due to restriction of extension.

Table 2
Patients with restriction in movement

Decreased range of movement	No. of patients	Time elapse (hours)
No	22	11(2–72)
Yes	5	168(24–240)

Table 3
Grading according to Flynn's criteria

		Motion loss (degrees)	Carrying loss (degrees)*	No. of patients
Satisfactory	Excellent	0–5	0–5	22
	Good	6–10	6–10	0
	Fair	11–15	11–15	4
Unsatisfactory	Poor	>15	>15	1

* No cases with carrying angle loss were seen in the present study.

DISCUSSION

Open reduction and internal fixation of the widely displaced supracondylar fracture of the humerus is now an accepted primary treatment modality.^{12,16} It is a safe procedure yielding good results.^{4,12,16} The once feared complications of surgical treatment of a supracondylar fracture — i.e. myositis ossificans, permanent significant loss of motion and deep infection — are not seen following open reduction via the medial,^{2,12,16} anterior^{4,8} or lateral^{11,19} approach. Medial column comminution and internal rotation of the distal fragment predispose to the medial tilt, which causes loss of the carrying angle. This is the most common complication.^{9,18,19} The medial tilt may be obscured on X-rays and not always easily appreciable.^{18,19} After closed reduction and percutaneous fixation the tilt can be best appreciated only after the elbow is completely extended and if present it will require wire removal, repeat reduction and fixation. Another problem is a decrease in the range of motion.^{1,7,14} Open reduction itself does not increase the morbidity and most series demonstrating significant loss of motion were reported by surgeons who used the posterior approach (Table 4).

The medial approach offers an excellent view of the medial column pathology compared with other approaches. Unlike the posterior approach, it follows an internervous plane between the musculocutaneous (brachialis) and the radial (triceps) nerve causing no

further damage to the injured elbow. Ulnar nerve identification, mobilisation and retraction eliminate the risk of iatrogenic ulnar nerve palsy that may occur with blind pinning. The neurovascular structures anteriorly are well protected by the brachialis and the entire anterior aspect of the proximal and distal fragment is well visualised. Anatomic reduction of the medial supracondylar column under vision minimizes the chances of an inaccurate reduction. An added advantage of open reduction is decompression of the hematoma which reduces the risk of compartment syndrome by decreasing the resistance to venous outflow.¹⁵ Cross K-wire stabilization enables immobilization at less than 90° flexion further improving venous outflow.

Our average follow-up period of 14 months is adequate to comment on the results of open reduction and internal fixation because the end result is usually seen within 4 to 6 months of surgery. This is the time by which most of the children regain complete range of motion.^{11,16,18} Further follow-up is rarely needed and complications unusual. Late development of an abnormal carrying angle is rarely seen.⁸ An uncorrected medial tilt during the initial treatment is only unmasked when complete extension is regained. Growth disturbance is seldom the cause of change in the carrying angle.^{9,18} The supracondylar fracture, by definition, occurs through the metaphysis sparing the epiphysis. Open reduction of the fracture gave us a better understanding of the pathology. Comminution, uncommon in pediatric injuries due to the relative porosity of cortical bone was seen in 15 of the 27 cases. Reduction under vision of the comminuted medial supracondylar pillar is best offered by the medial approach. Despite a high incidence of comminution, cubitus varus was not seen in our study. Shifrin using the medial approach, also reported zero incidence of varus (Table 4).¹⁶ However, the change in carrying angle was the most frequently encountered complication by Weiland who used the lateral approach.¹⁹ Inadequate reduction with residual medial tilt was the reason for cubitus varus deformity and they accepted that inaccurate reduction was due to the limitation imposed by their surgical approach. Furthermore, Weiland acknowledged errors in appreciation of persistent medial tilt under roentgenographic control.¹⁹ Surgeons using the posterior approach have also reported a significant incidence of cubitus varus (Table 4).

In our study, late presentation is one of the reasons for reduced range of motion in 5 patients. The average delay in these cases was 168 hours (7 days). Carcassone reported an average delay of 7 hours, the longest being 90 hours.² Flynn reported the longest delay of 48

Table 4
Incidence of cubitus varus

Study	No. of patients	Approach	Cubitus varus or more than 10° change (percent)	Decreased range of motion (percent)	Comments
Sandegard (1943)	79	Posterior	53	91	
Gruber & Hudson (1964)	23	Posterior	0	21	Only extension loss
Alonso Llamas (1972)	31	Posterior	10	90	Predominantly flexion loss
Sibly & Briggs (1991)	35	Posterior	20	66	All cases pinned in retroversion. Predominantly extension loss
Kekomaki et al (1984)	32	Anterior ⁺	10	18	Short transverse incision used
Fleuriat-chateau et al (1998)	34	Anterio ⁺	0	6	
Weiland et al (1978)	52	Lateral	15	10	
Carcassone et al (1972)	40	Medial ⁺	*	*	>10° change in carrying angle or in range of motion in 2.5% of cases
Ramsey & Gruz (1973)	15	Medial [#]	25	0	
Shifrin et al (1976)	>100	Medial	0	*	Functional results reported as excellent
Danielsson & Petersson (1980)	17	Medial and lateral	11	29	
Kumar & Malhotra (1999)	27	Medial ⁺	0	18	Delayed presentation, massage and repeated manipulations lead to loss of motion

⁺ Flynn's criteria – Table 3

⁺ Carcassone criteria:

Excellent	— Normal elbow joint in function and appearance
Good	— Either limitation of flexion or extension of less than 10° or modification of carrying angle by less than 10° (but together classed as unsatisfactory)
Unsatisfactory	— Either limitation of flexion or extension by more than 20° or change in carrying angle of more than 10°
Poor	— Limitation of flexion or extension by more than 50° or change in carrying angle of more than 20° or permanent palsy

[#] Change in carrying angle more than 5°.

* No mention

hours.⁵ Two children in our series had repeated manipulations elsewhere and three had undergone massage by quacks. The increase in soft tissue trauma prevented normal joint motion. Three of the 15 patients with medial column comminution and 2 out of 12 children with non-comminution had restriction of elbow motion. Soft tissue trauma is the most important prognostic indicator for recovery of range of elbow motion. Bone can regenerate and remodel unlike skeletal muscle that always heals with fibrosis. Extension loss is more obvious and disabling than a

similar reduction in flexion and is due to fibrosis in the torn brachialis. A posterior tilt will alter the arc of movement in favour of extension and may in fact compensate for an inaccurate reduction. Using the posterior approach, Sibly pinned all their 35 cases in retroversion and still reported a predominant extension loss.¹⁷ Gruber and Hudson also reported only extension loss with the posterior approach⁷ whereas Alonso Llamas reported mainly a flexion loss in his cases (Table 4).¹ Exposing the fracture posteriorly traumatises the uninjured triceps and is associated

with significant motion loss compared with other approaches.

There was no incidence of iatrogenic ulnar nerve palsy in our study, which is comparable with other reports using the medial approach.^{2,12,16} Visualisation of the ulnar nerve, careful dissection and retraction eliminate the risk of ulnar nerve palsy. Blind pinning is generally associated with an incidence of 2–3% of temporary ulnar nerve palsy.^{5,13} Lyons reported a 5% incidence.¹⁰ Kekomaki using the anterior approach considered the medial pin insertion a critical step of the operation due to the chance of ulnar nerve entrapment, a risk that persists with this approach.⁸

Nerve palsy requires pin removal, which may compromise the reduction and necessitate repeat reduction and/or exploration.

We conclude that early operative management of the widely displaced supracondylar fracture of the humerus in children using the medial approach is relatively simple and uncomplicated. It offers the best exposure of the medial column pathology. This approach minimizes the chances of an inaccurate reduction, which is responsible for a less-than-excellent result. Iatrogenic ulnar nerve palsy is avoided. The functional and cosmetic results are highly satisfactory.

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