RCS
ADVANCING SURGICAL STANDARDS

UPPER LIMB

Ann R Coll Surg Engl 2013; **95**: 582–585
doi 10.1308/003588413X13629960047074

Managing supracondylar fractures of the distal humerus in children in a district general hospital

M Pullagura[1], S Odak[2], R Pratt[3]

[1]Gateshead Health NHS Foundation Trust, UK
[2]Warrington and Halton Hospitals NHS Foundation Trust, UK
[3]Northumbria Healthcare NHS Foundation Trust, UK

ABSTRACT

INTRODUCTION Controversy exists regarding the timing of surgery in children with displaced supracondylar fractures of the humerus.

METHODS We reviewed retrospectively the postoperative outcomes and complications in these children managed in a district general hospital.

RESULTS There were 81 children with displaced supracondylar fractures (64 Gartland type III and 17 type IIA). Of these, 46 children were treated within 6 hours of presentation and 35 were treated later. The rate of open reduction was higher in children treated early (23%) than in late cases (11%). There was no significant difference in the postoperative outcomes and complications between the groups.

CONCLUSIONS In children with a supracondylar fracture, the timing of surgical treatment (before or after six hours from presentation to hospital) had no effect on postoperative complications and outcomes.

KEYWORDS

Supracondylar fracture – Open reduction – Humerus – District general hospital

Accepted 12 April 2013

CORRESPONDENCE TO

Saurabh Odak, 2 Ward Close, Great Sankey, Warrington WA5 8XY, UK
E: mohanpk73@yahoo.co.in

Displaced supracondylar fractures have been managed traditionally as surgical emergencies with the rationale being to reduce the likelihood of open reduction and decrease the risk of peri and postoperative complications.[1] Previous studies have demonstrated no significant difference between early and delayed intervention with regard to length of operating time, functional outcome and incidence of postoperative complications.[2–5] The only noticeable difference between the groups is a slightly higher incidence of open reduction in delayed cases.[6] However, there is no clear definition of 'early' versus 'late' intervention and it ranges anywhere from 6 to 12 hours.[2–5,7,8]

Our practice of managing supracondylar fractures in a district general hospital setting was audited, assessing the difference in length of operating time, postoperative complications and outcome recorded at the final follow-up visit in those patients treated before and after six hours from presentation. Furthermore, the incidence was calculated for open reduction when surgery was performed out of routine working hours (after 9pm).

Methods

This was a retrospective analysis of all the children with displaced supracondylar fractures requiring surgical intervention who presented to our institution over a period of four years (January 2004 to January 2008). The department consists of 12 consultant general orthopaedic surgeons managing orthopaedic trauma including paediatric supracondylar fractures of the distal humerus. The everyday routine trauma theatre list runs until 9pm excluding Sundays, when it finishes at 6pm. As a departmental policy, children were always prioritised for surgery and were therefore operated first on the list.

The study population was identified from theatre records and a paediatric admission database. The casualty records, clinical case notes and radiographs were examined to determine the age, sex, time of injury and presentation, method of fracture reduction, duration of surgery, incidence of perioperative complications and final outcome.

Instead of the time of injury, the time of presentation was taken for analysis and standardisation purposes. This was

Table 1 Demographic characteristics of both groups

		Early group	Delayed group
Number of children		46	35
Male-to-female ratio		24:22	19:16
Mean age		5.8 years	7.4 years
Fracture type	Gartland II	6	11
	Gartland III	40	24
Mean interval between presentation and surgery		230 minutes	475 minutes
AIN palsy at presentation		5	2

AIN = anterior interosseous nerve

Table 2 Intraoperative findings in both groups

		Early group	Delayed group	*p*-value
Mean operative time		61 minutes	47 minutes	**0.02**
Fracture reduction	Closed	27	26	0.1
	Open	19	9	0.1
Approach	Posterior	5	2	0.1
	Medial	8	4	0.1
	Lateral	6	3	0.1
K-wire configuration	2 cross wires	39	33	
	3 cross wires (2 medial, 1 lateral)	4	2	
	Lateral wires only	3	0	

Table 3 Outcomes in both groups

		Early group	Delayed group
Loss of initial reduction		3	1
Method of reduction in the children with loss of reduction	Closed	2	1
	Open	1	0
K-wire configuration	2 cross wires	1	1
	2 lateral wires	1	0
Symptomatic nerve paraesthesia	Ulnar	2	1
	Median	3	1
	Radial	1	1
Fixed flexion at elbow		1	0

done for two reasons: first, the exact time of injury was not documented either in case notes or the ambulance records for many patients and second, being the only hospital in the trust providing inpatient paediatric care facilities, patients were received from other hospitals in the trust with resultant delays due to transfer. In such cases, the time of presentation was defined as when the child presented to the first hospital.

Furthermore, the child was reviewed by the orthopaedic team at the first hospital and was referred subsequently to the orthopaedic team at our institution, thereby facilitating early surgery. However, none of the children received any treatment apart from immobilisation in a plaster cast at the first hospital. Once the child presented to our institution, he or she was soon taken to the operating theatre based on the severity of the injury and the discretion of the on-call consultant orthopaedic surgeon.

Children were grouped either into the 'early' group, where surgery was performed within six hours of presentation (until 9pm), or the 'delayed' group, where surgery was

delayed for more than six hours after presentation. If there was a delay in surgery, the general department policy was to immobilise the limb in the position of presentation. No attempt of correcting the deformity was made in the emergency department. All the children on whom surgery was performed first on the next day's trauma list belonged to the delayed group (ie surgery was performed after six hours following presentation).

The fractures were classified based on Wilkins' modification[9] of Gartland's classification of supracondylar fractures.[10] The duration of surgery was determined from the anaesthetic charts. All the procedures were either performed or supervised by a consultant general orthopaedic surgeon. Open reduction was defined as opening the fracture site for reduction. A decision to open the fracture site was based on the discretion of the consultant orthopaedic surgeon, taking into consideration factors such as swelling and ease of reduction. A small medial incision on the medial side to identify and protect the ulnar nerve was considered to be closed reduction as the fracture site was not opened.

K-wires were used to stabilise the reduction. These were left exposed. Postoperatively, the limb was immobilised in a plaster of Paris backslab and the child was observed overnight. The backslab was changed to a complete plaster at the first outpatient visit, usually between seven and ten days postoperatively subject to satisfactory wound healing and radiography. The K-wires were removed between four and six weeks following surgery under a short general anaesthesia.

Statistical analysis was carried out using Fisher's exact test to compare the groups. A p-value of <0.05 was considered statistically significant. SPSS® version 16 (SPSS, Chicago, IL, US) was used for analysis.

Results

During the study period, 98 children were identified with displaced supracondylar fractures. Of these, 17 were excluded from the analysis (10 were treated without K-wire insertion, 2 had open fractures, 1 had another associated fracture and 4 had revision surgery). Eighty-one children were therefore included for final analysis. There were 45 boys and 36 girls with an average age of 6.6 years (range: 2–14 years). The mean duration of postoperative follow-up was 8.2 months (range: 6–14 months). Table 1 highlights the demographic features of both the groups.

There were more type III fractures in the early group (n=40) than in the delayed group (n=24). This could probably be accounted for by the more concerning nature of the injury and x-rays. As noted in Table 1, seven children presented with preoperative anterior interosseous nerve (AIN) palsy. Of these, two were in the delayed group and developed symptoms while awaiting surgery overnight. However, all children in both groups recovered from the nerve palsy following surgery.

Table 2 compares the intraoperative findings in both groups. The choice of K-wire configuration for fracture stabilisation was based on the discretion of the supervising consultant. Open reduction was performed in 19 of the 46 cases in the early group (41%) and 9 of the 35 cases in the delayed group (25%) (p=0.1).

Fourteen children had complications after surgery (Table 3). There was loss of initial reduction requiring revision in four children (three in the early group and one in the delayed group). Of these four children, three had initial closed reduction (two in the early group and one in the delayed group). Regarding the configuration of K-wires in these children, three had crossed K-wires (two in the early group and one in the delayed group) and one had two lateral K-wires. Minor paraesthesia was noted in ulnar (three children), anterior interosseous (four children) and radial nerve (two children) distribution postoperatively although all cases resolved without any permanent residue. One child who had a fixed flexion of 15° at 14 weeks following surgery was advised to attend in 6 months' time if still symptomatic but the child failed to attend.

Forty-three children were operated on during daytime working hours (until 9pm) and of these, sixteen (37%) required open reduction. Similarly, 12 of the remaining 38 children (31%) who were operated on during nighttime (after 9pm) required open reduction. This was not found to be statistically significant (p=0.64).

No infections or compartment syndrome were noted in the perioperative period and none of the children had any cubitus varus/valgus deformity at the last follow-up visit.

Discussion

A postal questionnaire of 121 practising paediatric orthopaedic consultants (with a response rate of 55%) in the UK showed that 54.5% of consultants manage displaced supracondylar fractures (type III) in a delayed manner (>8 hours) if there is no evidence of vascular compromise whereas 44.3% manage them early (<8 hours).[7] Similarly, 50% of the consultants felt it justified after midnight to delay the surgery for the next day. However, there was no mention of managing these fractures out of hours (after 5pm). This study clearly highlights the discrepancy in the timing of operating these injuries.

The suggestion of early intervention of these injuries is based on the argument that delays make closed fracture reduction difficult, with the increased likelihood of open reduction. Conversely, this has been disproved by many studies recently.[2–5]

The rate of conversion to open reduction has been reported previously from as low as 3% to as high as 40%[4,11–15] and in our series, the overall rate was 34%. In our study, there was a higher trend of open reduction when these fractures were managed early (41%) than when operated on later (25%) although this was not statistically significant (p=0.1). The mean operative time was higher in children in the early group (p=0.02). It could be argued that children with significant deformity and displacement were operated on early, and these cases were therefore more technically demanding procedures.

Furthermore, there were more children with Gartland type III fractures in the early group (n=40) than in the de-

layed group (n=24). Although there is some evidence to show increased incidence of open reduction if the surgery is delayed, the choice of open or closed reduction is highly dependent on the surgeon operating.[6]

Interestingly, there was no significant difference in rate of open reduction when the surgery was performed either during the day or the night (37% when carried out during the day vs 31% at night, p=0.64). This suggests that uncomplicated fractures (excluding open fractures and fractures with neurovascular compromise) can be managed on the first available list in the morning with good outcomes as reported by Iyengar *et al.*[2]

In our series, children presenting with features suggestive of AIN palsy were operated on early but we also noticed that two children developed AIN neurapraxia overnight while awaiting surgery on the next day's operating list. Despite this, the final outcome between the groups was similar (early vs delayed, day vs night). Iatrogenic nerve injury is most commonly reported in relation to the ulnar nerve (2–6%) with a variety of mechanisms.[8] In our series, AIN neurapraxia (four children) was more common than ulnar nerve neurapraxia (three children). However, none of the children reported any residual symptoms at the last follow-up visit.

The strengths of the study include a large patient series in a district general hospital setting. The limitations of our study include the lack of a control group and its observational nature. Similarly, the choice of open reduction was at the surgeon's discretion and we cannot therefore assume that the early group needed more open reductions on clinical grounds. Most of the studies published in the literature used the time of injury as the starting point for assessing the interval between injury and surgery. Conversely, the time of presentation was used as our starting point owing to the reasons mentioned above.

Conclusions

In uncomplicated supracondylar fractures with no neurovascular or skin complications, timing of surgery did not affect the complication rate. There was no difference in terms of postoperative complications and outcomes in these cases, regardless of whether they were operated on early or later, or during or after routine working hours.

References

1. Paradis G, Lavallee P, Gagnon N, Lemire L. Supracondylar fractures of the humerus in children. Technique and results of crossed percutaneous K-wire fixation. *Clin Orthop Relat Res* 1993; **297**: 231–237.
2. Iyengar SR, Hoffinger SA, Townsend DR. Early versus delayed reduction and pinning of type III displaced supracondylar fractures of the humerus in children: a comparative study. *J Orthop Trauma* 1999; **13**: 51–55.
3. Leet AI, Frisancho J, Ebramzadeh E. Delayed treatment of type 3 supracondylar humerus fractures in children. *J Pediatr Orthop* 2002; **22**: 203–207.
4. Mehlman CT, Strub WM, Roy DR *et al*. The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children. *J Bone Joint Surg Am* 2001; **83**: 323–327.
5. Sibinski M, Sharma H, Bennet GC. Early versus delayed treatment of extension type-3 supracondylar fractures of the humerus in children. *J Bone Joint Surg Br* 2006; **88**: 380–381.
6. Walmsley PJ, Kelly MB, Robb JE *et al*. Delay increases the need for open reduction of type-III supracondylar fractures of the humerus. *J Bone Joint Surg Br* 2006; **88**: 528–530.
7. Kim WY, Chandru R, Bonshahi A, Paton RW. Displaced supracondylar humeral fractures in children: results of a national survey of paediatric orthopaedic consultants. *Injury* 2003; **34**: 274–277.
8. Rasool MN. Ulnar nerve injury after K-wire fixation of supracondylar humerus fractures in children. *J Pediatr Orthop* 1998; **18**: 686–690.
9. Wilkins KE, King RE. *Fractures in Children. Volume 3*. 3rd edn. Philadelphia: Lippincott; 1991. pp526–617.
10. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet* 1959; **109**: 145–154.
11. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. *J Pediatric Orthop B* 2001; **10**: 63–67.
12. Cramer KE, Devito DP, Green NE. Comparison of closed reduction and percutaneous pinning versus open reduction and percutaneous pinning in displaced supracondylar fractures of the humerus in children. *J Orthop Trauma* 1992; **6**: 407–412.
13. Danielsson L, Patterson H. Open reduction and pin fixation of severely displaced supracondylar fractures of the humerus in children. *Acta Orthop Scand* 1980; **51**: 249–255.
14. Oh CW, Park BC, Kim PT *et al*. Completely displaced supracondylar humerus fractures in children: results of open reduction versus closed reduction. *J Orthop Sci* 2003; **8**: 137–141.
15. Reitman RD, Waters P, Millis M. Open reduction and internal fixation for supracondylar humerus fractures in children. *J Pediatric Orthop* 2001; **21**: 157–161.
16. National Confidential Enquiry into Perioperative Deaths. *The 2003 Report of the National Confidential Enquiry into Perioperative Deaths*. London: NCEPOD; 2003.