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Displaced supracondylar fractures of the humerus in children

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Abstract We performed an outcome study of completely displaced supracondylar fractures in children in order to assess the outcome of primary open reduction and internal fixation for these injuries. A total of 16 patients (mean age of 5.9 years) were included in the study. The mean follow-up was 2.6 years and patients were assessed after fracture healing using the criteria of Flynn et al. and Mark et al. Thirteen patients had an excellent result, two had good results with less than 10° loss of carrying angle and one had a fair result based on degree of loss of elbow flexion. Open reduction and internal fixation of these fractures is an effective and safe method of primary treatment and is associated with good outcomes. We recommend a low threshold of proceeding to open treatment in these serious injuries.

Résumé Nous avons conduit un suivi de fractures supracondyliennes du coude chez l'enfant afin d'évaluer les effets d'une réduction ouverte primaire et d'une fixation interne sur ces lésions. Seize patients sont inclus dans cette étude, avec un âge moyen de 5.9 ans. La durée moyenne du suivi fut de 2.6 ans et les patients furent examinés après consolidation, utilisant les critères de Flynn et al. et Mark et al. Treize patients présentèrent un résultat excellent, deux eurent de bons résultats avec une perte d'angle de charge inférieure de 10°, et un obtenait un résultat moyen à cause d'une perte de flexion du coude. La réduction ouverte avec la fixation interne des fractures complètement déplacé est une méthode efficace qui donne de bons résultats. Nous recommandons un passage plus fréquent aux traitements ouverts dans ces cas de lésions graves.

Introduction

There remains controversy in the literature with regards to the definitive management of completely displaced supracondylar fractures (type III) in children. Effective treatment is required in these patients in order to prevent the recognised complications of malunion and cubitus varus, loss of movement at the elbow and residual pain or neurovascular deficit.

The differences among authors relate mainly to the choice between treatment by percutaneous K-wire fixation [1, 8] or open reduction and wiring under direct vision [2, 7]. Although closed treatment of such fractures is advocated by some [4], it is strongly discouraged by others who feel the results are suboptimal [9]. Skeletal traction is not commonly used and the numbers of cases studied are therefore few but when analysed show good results [9].

We undertook the current study to further define the effectiveness of open reduction and internal fixation of these fractures by analysing our experience using a protocol defining an open approach to management.

Patients and methods

We performed a retrospective study of children presenting to a regional orthopaedic hospital over a 2-year period with completely displaced (type III) supracondylar fractures of the humerus treated by open methods. We used the Gartland classification system in reviewing the radiographs of all these patients in order to confirm the initial clinical description (Fig. 1a,b). A total of 16 such patients were identified and called for review.

The mean age of the patients was 5.9 years (range 3–10 years). All were closed injuries and on admission four had absent radial pulses with well-perfused hands and four had nerve palsies (two median, one ulnar and one radial nerve palsy). There were eight girls and eight boys in the study, all having extension-type fractures with six of these displaced posteromedially and ten posterolaterally. Seven of the fractures were on the left side and nine on the right.

All patients were treated with open reduction and K-wire fixation, using either a crossed (Fig. 2a,b) or a parallel wire technique, both of which have been shown to be effective in previous studies

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Fig. 1 **a** Antero-posterior X-ray of grade III supracondylar fracture. **b** Lateral X-ray of grade III supracondylar fracture

Fig. 2 **a** Post-operative A-P X-ray demonstrating position after open reduction and internal fixation with crossed K-wires. **b** Post-operative lateral X-ray demonstrating position after open reduction and internal fixation with crossed K-wires

Table 1 Outcome criteria of Mark et al. [5]

Result grade	Loss of motion	Loss of carrying angle	Pain/neurovascular lesion
Excellent	None	None	None
Good	<20°	<10°	None
Fair	20–50°	10–20°	Minimal pain with excessive use No neurovascular lesion
Poor	>50°	>20°	Pain or neurovascular lesion

Table 2 Outcome criteria of Flynn et al. [1]

Result grade	Loss of carrying angle	Loss of motion
Excellent	0–5°	0–5°
Good	6–10°	6–10°
Fair	11–15°	11–15°
Poor	>15°	>15°

[12]. Nine cases were managed primarily by open reduction/internal fixation, while six others proceeded to open management due to failure to maintain reduction with closed manipulation and K-wiring. One patient had an absent radial pulse but a well-perfused hand on presentation, and exploration of the brachial artery was performed as part of the procedure and found to be normal. Six fractures were approached medially, seven laterally, two by a combined medial and lateral approach and one posteriorly.

All patients were placed in a dorsal plaster backslab postoperatively. Seven of these were later changed to full cast with a mean duration of splintage for the whole group of 4.7 weeks. The mean duration of hospital stay (including subsequent admission for removal of wires under anaesthesia in all patients) was 2.5 days.

All the children were routinely followed as outpatients and were additionally recalled for a final assessment for the purposes of this study at a mean period of 2.6 years (range 24–65 months) following their initial surgery. They were assessed using the criteria cited by Mark et al. [5] and also those of Flynn et al. [1]

(Tables 1, 2), with both the patient and their parents being interviewed with regard to their own satisfaction with the treatment and its outcome.

Results

All patients and parents expressed satisfaction with the outcome, being specifically asked about cosmetic appearance and functional recovery. No patient experienced any subjective functional impairment or loss of elbow movement.

According to the criteria of both Mark et al. [5] and Flynn et al. [1], 13 patients had an excellent result. According to Flynn et al. a further two had a good result and one a fair/good result whereas by the criteria of Mark et al. these three patients had a good result. No patient experienced a poor result by either criterion (Table 3). There were no patients with any residual neurological deficit or arm pain, with three of the nerve palsies originally settling within 2 weeks of injury and the other one resolving in approximately 4 months. Both of the patients with only good results (according to Flynn et al.) had nerve palsies on admission, reflecting the typically severe nature of these injuries.

Table 3 Patient results according to outcome criteria ($n=16$)

Result grade	Mark et al.	Flynn et al.	Nature of deficit
Excellent	13	13	—
Good	3	2	1.5° loss of flexion 2.6° loss of carrying angle
Fair	0	1	15° loss of flexion
Poor	0	0	—

Of the two patients with good results, one had a 5° loss of flexion and the other had a 6° loss of the carrying angle. The patient with the fair/good result had a loss of flexion of 15°, which qualifies as fair according to Flynn et al. and good according to Mark et al., the only case where the two methods differed in our series. Of these three cases, one had a lateral surgical approach and the others a medial approach.

Discussion

The ultimate object of any treatment of completely displaced supracondylar fractures of the humerus (type III) is the recovery of full function with no deformity or residual neurovascular deficits. It is the means by which this can be reliably and safely achieved that has caused some controversy.

Most authors now tend to favour primary surgical intervention in the form of either percutaneous K-wiring or open reduction and internal fixation. Hadlow et al. [4] and Grant et al. [3] however argue that all type III fractures should be managed by manipulation and casting initially and that only if reduction is subsequently lost during follow-up should surgery be contemplated. They consistently produced good to excellent results with this regime but the concern in general with closed management of these injuries has been the fear of Volkmann ischaemic contracture and cubitus varus deformity [9].

Poor results have been noted with closed management by Pirone et al. [9] and other authors [11] and they concluded that closed reduction and cast application was inappropriate for displaced fractures. They recommend, as do others [6, 8, 9], crossed K-wire fixation with limited indications (open or irreducible fractures or arterial injury) for open reduction due to an increased risk of infection and stiffness. Other studies have not shown an increased risk of infection or stiffness, however, achieving good to excellent results and recommending a more routine application of this mode of management [2, 7].

Sibly et al. [10] further demonstrated no correlation between stiffness and type of surgical approach used, although the posterior approach has been criticised in the

past in this regard. There appeared to be no difference in our series between the different approaches used with regard to cosmetic and functional outcome.

We agree with authors who consider that closed reduction and casting is insufficient treatment for these serious injuries and would recommend that all these patients should have reduction and operative fixation. Open reduction is indicated in cases of irreducibility, unsatisfactory reduction and fixation with percutaneous K-wires and suspected neurovascular injury but we would further recommend having a low threshold for proceeding to open reduction and internal fixation in any case of completely displaced (type III) fracture.

Our experience demonstrates that early and primary open treatment is associated with relatively few complications and can be routinely expected to produce excellent results in difficult cases.

References

1. Flynn JC, Matthews JG, Benoit RL (1974) Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years experience with long-term follow-up. *J Bone Joint Surg [Am]* 56:263–272
2. Furrer M, Mark G, Ruedi T (1991) Management of displaced supracondylar fractures of the humerus in children. *Injury* 22:259–262
3. Grant HW, Wilson LE, Bisset WH (1993) A long-term follow-up study of children with supracondylar fractures of the humerus. *Eur J Pediatr Surg* 3:284–286
4. Hadlow AT, Devane P, Nicol RO (1996) A selective treatment approach to supracondylar fracture of the humerus in children. *J Pediatr Orthop* 16:104–106
5. Mark G, Innocenti M, Ruedi T, Yacchia GE (1985) Die supracondylare Humerusfraktur beim Kind. *Helv Chir Acta* 51:617–620
6. Mehlman CT, Crawford AH, McMillion TL, Roy DR (1996) Operative treatment of supracondylar fractures of the humerus in children: the Cincinnati experience. *Acta Orthop Belg* 62 [Suppl 1]:41–50
7. Mohammed S, Rymaszewski LA (1995) Supracondylar fractures of the distal humerus in children. *Injury* 26:487–489
8. Paradis G, Lavalee P, Gagnon N, Lemire L (1993) Supracondylar fractures of the humerus in children: technique and results of crossed percutaneous K-wire fixation. *Clin Orthop* 297:231–237
9. Pirone AM, Graham HK, Krajchich JI (1988) Management of displaced extension-type supracondylar fractures of the humerus in children. *J Bone Joint Surg [Am]* 70:641–650
10. Sibly TF, Briggs PJ, Gibson MJ (1991) Supracondylar fractures of the humerus in childhood: range of movement following the posterior approach to open reduction. *Injury* 22:456–458
11. Wilkins KE (1997) Supracondylar fractures: what's new? *J Pediatr Orthop B* 6:110–116
12. Zions LE, McKellop HA, Hathaway R (1994) Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. *J Bone Joint Surg [Am]* 76:253–256