FRACTURES OF THE PROXIMAL HUMERAL EPIPHYSIS

THEIR INFLUENCE ON HUMERAL GROWTH

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We have reviewed the notes and radiographs of 57 patients with fractures of the proximal humeral epiphysis and examined 30 of them at 2 to 8 years after injury. Regardless of treatment the maximum shortening of the humerus was 2 cm and residual varus angulation was insignificant. Manipulation of a displaced, fresh fracture did not improve the final outcome with respect to humeral growth or function; and open reduction is very rarely indicated.

According to Neer and Horwitz (1965), fractures of the proximal humeral epiphysis constitute 3% of all epiphyseal injuries. The most frequently reported complications are humeral shortening, varus angulation, and restricted shoulder movement (McBride and Sisler 1965; Sherk and Probst 1975). Reported modes of treatment have ranged from aggressive attempts at reduction to simple neglect (Aitken 1936; Nilsson and Svartholm 1965; Fraser, Haliburton and Barber 1967; Dameron and Reibel 1969; Ogden 1982; Callahan 1984).

We have reviewed 57 consecutive fractures of the proximal humeral epiphysis to evaluate the influence on the growth of the humerus of the amount of displacement and the age at the time of injury.

MATERIAL AND METHODS

Between 1976 and 1982, a total of 57 patients with fractures of the proximal humeral epiphysis were treated at the Children's Hospital of Eastern Ontario. There were 31 boys and 26 girls with ages ranging from 8 years 11 months to 15 years 1 month. All the injuries were of Salter–Harris Type I or Type II; we confirm that Type III, IV, or V fractures of this epiphysis are rarely, if ever, seen (Aitken 1963; Salter and Harris 1963; Ogden 1982). There were no pathological fractures. Of the 57 patients, 30 returned for follow-up examination, on average 3 years 8 months (range 2 to 8 years) after their fracture. Radiographs were taken and humeral length was measured from anteroposterior views of both humeri.

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0301-620X/86/4129 $2.00

RESULTS

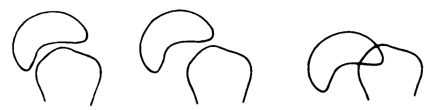
The results were considered in three groups: Group 1 patients had no attempt at reduction of the fracture, Group 2 had one or more attempts at closed reduction followed by immobilisation by one of a variety of methods, and Group 3 had an open reduction (Fig. 1). The fractures were graded according to their initial displacement (Neer and Horwitz 1965): Grade I, less than 5 mm; Grade II, less than one-third of the width of the shaft; Grade III, one to two-thirds of the shaft width; Grade IV, over two-thirds of the width, including those with total displacement.

	GRADE I	GRADE II	GRADE III	GRADE IV
GROUP 1 (NO REDUCTION)	5	11	1	0
GROUP 2 (CLOSED REDUCTION)	0	9	13	11
GROUP 3 (OPEN REDUCTION)	0	2	3	2

Fig. 1

Table to show the distribution of 57 cases into four grades of displacement and three treatment groups (see text for definitions).

Group 1, who had no reduction, included 17 patients, 11 with Grade II displacement. Treatment was by a sling and a Velpeau bandage for from one to three weeks. No fracture displaced further during treatment and there were no recorded complications. Five of these patients, one with Grade I and four with Grade II injuries, were available for follow-up. All showed a full range



	II	III	IV
CR & Velpeau	5	2	5
CR & spica cast	2	8	2
CR & hanging cast	1	0	0
CR & traction	1	3	4

Fig. 2

Management of 33 patients in Group 2. All had one or more attempts at closed reduction, CR.

of movement and none had any complaint. There was no discrepancy in humeral length in the patients with Grade I displacement and in those with Grade II the mean discrepancy was only 3.5 mm. The ages at the time of injury had been from 11 years to 14 years with a mean of 12 years 8 months.

Group 2 included 33 patients with Grades II, III or IV injuries. They had closed reduction under general anaesthesia followed by immobilisation using a variety of methods (Fig. 2). Eighteen patients from this group were available for follow-up. The radiographically measured mean humeral discrepancy for the seven Grade II fractures was 3.5 mm (range 0 to 11 mm); for the seven Grade III fractures it was 7.7 mm (range 2 to 18 mm) and for the four Grade IV fractures it was 12 mm (range 3 to 20 mm). All the patients had a full range of movement and no functional complaints.

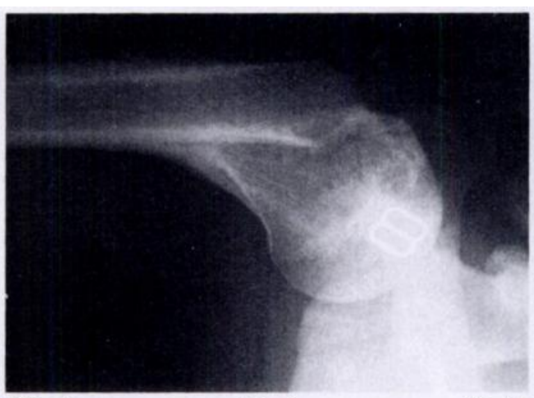
All 33 patients in this Group had been manipulated, but only 11 (two with Grade III and nine with Grade IV displacement) had enough improvement to change the grade of displacement. Three of the nine fractures originally in Grade IV were reassessed, and showed humeral shortening of 11, 8 and 3 mm, all less than the mean of 12 mm for all Grade IV injuries. However, manipulation of fresh fractures in an attempt to reduce the displacement did not seem to have altered the final result significantly.

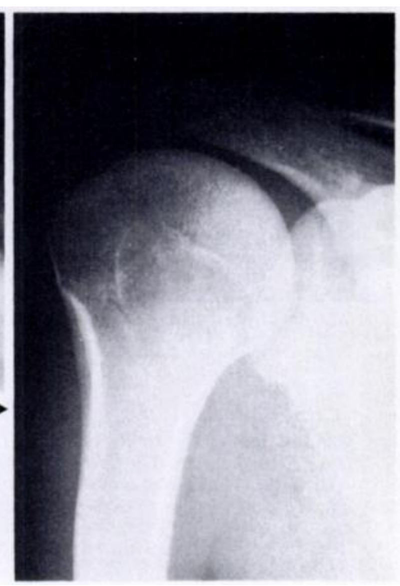
No loss of position from one grade to another was seen regardless of whether immobilisation was by plaster spica, soft dressing or traction. There was impressive remodelling of the fractures with gradual resolution of even severe varus deformities (Figs 3, 4 and 5).

In Group 3, seven patients underwent open reduction, six for failure to achieve an acceptable position by closed methods, and one because of vascular problems. There were no open fractures. Two patients also had severe tenting of the skin by displaced bony fragments, usually the jagged metaphysis penetrating through the anterior deltoid muscle, providing an additional reason for open reduction. The reports of these operations specifically mentioned soft-tissue interposition in only one case, while all seven included comments on the difficulty of achieving anatomical alignment even after complete surgical exposure. Only three patients had enough correction of displacement to improve the grade of their fracture. No complications were recorded during or after the operations and all wounds and fractures healed uneventfully.

The one patient who presented with a cool, pulseless arm was an 11-year-old boy who had fallen from a six-foot fence and had sustained a completely displaced Salter–Harris Type II fracture. An arteriogram showed interruption of the brachial artery at the lateral border of the axilla. Open reduction and Kirschner-wire fixation of the fracture were performed at the time of attempted arterial reconstruction. The fracture was reduced to Grade II displacement. At follow-up four years later humeral shortening was 17 mm. There was a full range of movement, and his only complaint was of some symptoms of claudication in the arm.

Six of the seven Group 3 patients returned for follow-up, two from each of Grades II, III and IV. The





◀ Fig. 3 Fig. 4 Fig. 5 ▶

Radiographs of the shoulder of a 14-year-old girl who fell from her horse. Figure 3 – Anteroposterior view to show the displacement. Figure 4 – Axillary view to show healing with the same amount of deformity. Figure 5 – Anteroposterior view two years later showing almost perfect remodelling.

measured humeral shortening was much the same as the mean shortening found after attempted closed reduction for the same grades of fracture. All six patients were critical of the appearance of their scar but none complained of any functional deficit and all had a full range of movement.

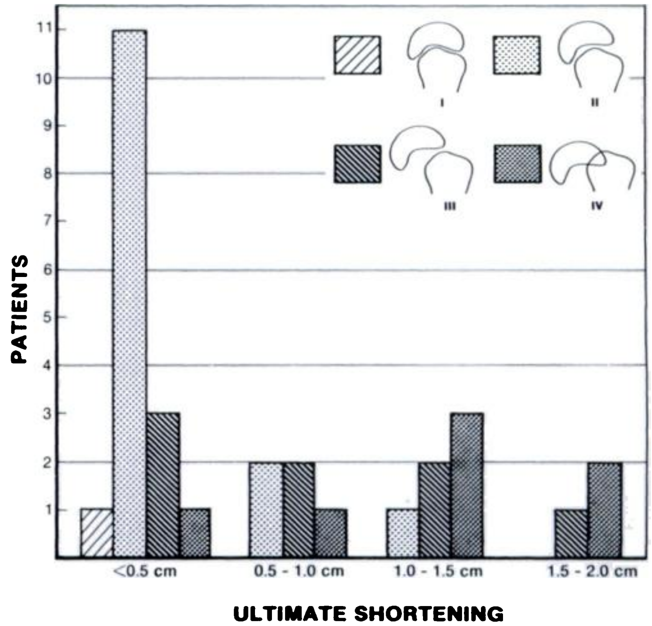


Fig. 6

Bar chart to show the relation between initial displacement and ultimate shortening. Only nine patients had shortening greater than 1 cm and eight of these had Grade III or Grade IV displacement.

DISCUSSION

This retrospective study of 57 patients treated by eight surgeons over a six-year period cannot provide a valid comparison of the outcome between reduced and unreduced groups since the patients were not randomly selected for these categories.

Humeral shortening has been previously documented in three series. McBride and Sisler (1965) followed up 12 cases for 18 months to 12 years after injury and used clinical measurement. They found no humeral shortening in Grades I or II but 2.5 inches discrepancy in one Grade IV injury. Neer and Horwitz (1965) reviewed 89 cases and documented humeral length discrepancies ranging from 0.5 to 3 cm in 11 of their patients. Five patients with Grade I or II fractures had up to 3 cm of shortening but, although 38.5% of Grade III and IV fractures had measurable shortening, this never exceeded 3 cm. Dameron and Reibel (1969) reviewed 69 cases and followed up 46 of them, with radiographic measurement of humeral length on long anteroposterior films. Of the 46 patients, 14 showed some shortening with a maximum of 4 cm.

We were able to reassess 30 of our 57 cases at least two years after injury. Of these, 27 had radiographically measurable humeral shortening, though only nine (30%) had more than 1 cm discrepancy (Fig. 6). The maximum relative shortening in our series was 2 cm. This was seen in a 14-year 8-month-old girl who had sustained a completely displaced fracture when she fell from her bicycle

Fig. 7

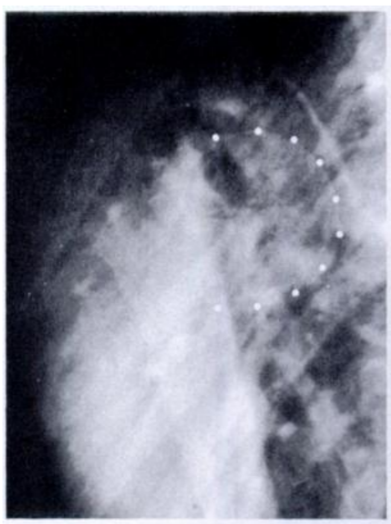


Fig. 8

Radiographs of the right shoulder of a 14-year-old girl who fell from her bicycle. Figures 7 and 8 – Anteroposterior and lateral views taken five days after injury. Manipulation failed to improve this position and permission for open reduction was refused. Figures 9 and 10 – Two and a half years later comparison of both humeri shows excellent remodelling. The length discrepancy is 2 cm, the largest seen in this series.

Fig. 9

Fig. 10

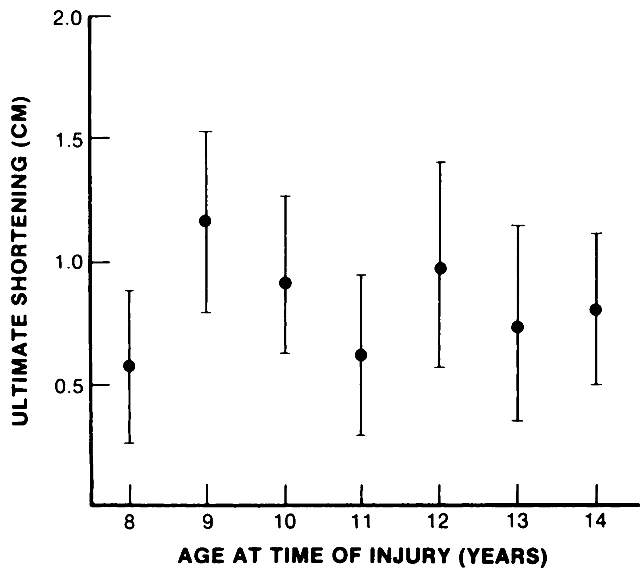


Fig. 11

Diagram of ultimate shortening related to age at time of injury. There is no consistent pattern of relationship.

and was referred to our hospital five days after injury. The position could not be improved by manipulation under general anaesthesia and permission for open reduction was refused. Two and a half years later, she had a full range of movement and no complaints, while radiographs showed remarkably good remodelling (Figs 7 to 10).

No patient was clinically aware of any discrepancy in length and there were no cases of humeral overgrowth. In our series, all between 8 and 15 years old, the age at the time of fracture did not influence the ultimate amount of shortening (Fig. 11), though Neer and Horwitz (1965) found shortening to be more prevalent in the 11- to 15-year age group. The ultimate outcome of this injury does not seem to be affected by significant humeral shortening irrespective of the age of the patient or the grade of displacement.

Fractures of the proximal humeral epiphysis displace so that the distal fragment usually lies anterior and lateral to the proximal fragment, leading to anterior and varus angulation (Neer and Horwitz 1965; Sherk and Probst 1975; Ogden 1982). The 80% of humeral growth which takes place at this proximal end must contribute to the remarkable remodelling, and in addition, the gleno-humeral joint is the most mobile in the body. All our patients showed extensive remodelling of the proximal humerus when the fracture had healed with severe displacement and none complained that the shoulder had an unusual contour. Similar observations have been previously reported (Smith 1956; Aitken 1963; McBride and Sisler 1965; Neer and Horwitz 1965; Campbell and Almond 1977; Callahan 1984).

Conclusions. Manipulation of this fracture improved the position in only 11 of 33 patients and the final result in these cases was not significantly better than that in those who healed with the same degree of initial displacement. Open reduction improved the displacement in only three of seven patients, inflicting a cosmetically unattractive scar for no obvious advantage.

Most of these fractures should be treated simply by a sling and bandage until pain-free, then mobilised early. The only exceptions are those fractures with complete displacement where tenting makes skin breakdown likely and those with concomitant vascular injury.

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