TRANSARTICULAR FIXATION FOR SEVERELY DISPLACED SUPRACONDYLAR FRACTURES IN CHILDREN

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We have reviewed 34 children who had been treated by open reduction through a medial incision and transarticular pinning for a severely displaced supracondylar fracture of the humerus.

Follow-up ranging from nine months to 20 years showed that 27 of 34 elbows (79%) had excellent or good results, with satisfactory resolution of neurovascular problems and no complications due to the method of treatment.

The management of severely displaced, unstable supracondylar fractures of the humerus in children continues to be controversial. This is shown by the variety of conservative and operative treatments which have been advised.

Non-operative management by straight traction with the elbow in extension was first reported by Dunlop (1939); this method has recently been reviewed by Piggot, Graham and McCoy (1986). Treatment in extension in plaster has been described (El-Sharkawi and Fattah 1965), and in a Thomas splint (Bosanquet and Middleton 1983). Dunlop later advised that traction should be applied with the elbow in flexion (Allen and Gramse 1945).

The use of skeletal traction on a flexed elbow has been described by Smith (1947), who used a transverse Kirschner wire through the ulna, and by Palmer et al (1978) who used an olecranon screw. Closed reduction followed by percutaneous pinning has been reported by several authors (Swenson 1948; Flynn, Matthews and Benoit 1974; Ariño et al 1977; Nacht et al 1983).

A variety of approaches have been advised for open reduction. The posterior approach (Sandegård 1943; Madsen 1955), has been criticised as likely to result in loss of extension. The anteromedial approach, fixing the fracture with a pin through each condyle as fixation, was

Table I. Radiographic classification of supracondylar fractures of the humerus (Holmberg 1945)

Grade	
1	Undisplaced or minimally displaced greenstick fractures
2	Medial or lateral displacement on anteroposterior view Good contact on lateral view
3	Rotational displacement
4	Complete displacement No contact on the lateral view

advocated by Carcassonne, Bergoin and Hornung (1972), who reported excellent or good results in 39 of 40 patients. Danielsson and Pettersson (1980) recommended a medial exposure with condylar pin fixation through a small lateral incision. Weiland et al (1978) performed the reduction through a lateral exposure, with a smaller medial incision for the insertion of the second wire. Ramsey and Griz (1973) used a medial approach with two crossed wires into each condyle.

We now report the use of open reduction and internal fixation by a transolecranon pin, as described by Childress (1972). This method has been used by the senior author (MGHS) over a 20-year period for 42 severely displaced or compound supracondylar fractures in children (grade 4 of Holmberg 1945, Table I). To our knowledge there has been no previous report of the results of this method in a series of patients.

PATIENTS AND METHODS

Open reduction and percutaneous pinning was used to treat 42 children presenting to the Royal Hospital for Sick Children in Glasgow with severe supracondylar humeral fractures. Their average age was seven years three months, ranging from one year seven months to 12

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years two months. There were 23 boys and 59% of the fractures involved the non-dominant arm. There were three open fractures, and 14 patients had some clinical evidence of neurovascular complications: four lacked a palpable radial pulse, four had radial nerve palsies (two partial, two total), and eight had median nerve palsies. Sixteen patients, most of them early in the series, had had attempts at closed reductions, but 26 were treated primarily by immediate open reduction for the following reasons:

- 1) failed closed reduction may increase injury to soft tissue, and damage the bony interdigitations which help in accurate open reduction;
- 2) soft tissues can be decompressed by evacuation of the haematoma and haemostasis is possible;
- 3) open reduction ensures against soft tissue or neurovascular interposition; and
- 4) anatomical reduction is possible.

Operative technique. Using general anaesthesia and a high tourniquet, the fracture is exposed through an incision centred on the medial epicondyle. The ulnar nerve is identified and protected. Brachialis is defined and swept forward, thus protecting and, if necessary, freeing the median nerve and brachial artery. The fracture haematoma is evacuated, and the bone ends cleaned so that it is relatively easy to reduce the fracture anatomically.

Table II. Results of treatment of supracondylar fractures of the humerus (Flynn et al 1974)

Result	Function (loss of movement)	Appearance (change in carrying angle)
Excellent	0° to 5°	0° to 5°
Good	6° to 10°	6° to 10°
Fair	11° to 15°	11° to 15°
Poor	> 15°	> 15° (cubitus varus)

The elbow is flexed to 90° and a 2.4 mm guide wire is passed percutaneously through the olecranon, across the elbow joint, into the distal fracture fragment and up the centre of the humeral shaft. Care is required to avoid the wire leaving the bone at the olecranon fossa. The tourniquet is then released, the circulation is checked and haemostasis is secured. The wound is closed and the pin bent to prevent migration.

A plaster back slab is used for three weeks, and the plaster and pin are then removed in the out-patient clinic. Light general anaesthesia was required for some of the earlier cases.

Clinical review. All the patients who had been treated by this method were requested to attend for clinical and radiological review: 34 of the original 42 were seen. Six

patients were lost to follow-up and two were excluded because follow-up was less than six months.

Subjective opinions were recorded and measurements made of elbow movements and carrying angle, using the uninjured side as control. Standard radiographs were taken. Each elbow was scored for function by the alteration in the flexion/extension arc and for appearance by the change in the carrying angle (Flynn et al 1974, Table II). The overall result was recorded as the worse of the two scores.

RESULTS

The average stay in hospital was four days (1 to 15); the longer periods were related to failed attempts at closed manipulation, early inexperience with the method, and associated injury or neurovascular damage.

Two patients had early postoperative complications. In one case, the guide wire migrated proximally and required general anaesthesia for removal from just under the skin; in the other a mild pin track infection settled rapidly after the wire was removed. All wounds healed by primary intention. One child developed a Volkmann's ischaemic contracture. This was attributed to a delay of eight hours between the injury and operation, due to attempts at closed reduction at the referring hospital.

The 34 elbows were reviewed at an average follow-up of 6.8 years (range nine months to 20 years). The results are given in Table III. In one child the pin fixation had missed the proximal humerus, allowing a 20° varus deformity which later required a supracondylar osteotomy. This was a failure of technique, and although the final result was a normal carrying angle and only a 10° loss of extension/flexion, the result was classified as poor. Only one patient had loss of more than 15° of the extension/flexion arc, but five had a change in carrying angle of more than 10°.

Taking the worse score for either angle, 79% of the patients had an excellent or good result, with loss of less than 11° of arc and less than 11° change in carrying angle. All but two of the 14 patients with nerve injuries recovered fully; two had residual partial paresis of the median nerve.

DISCUSSION

Many different methods have been proposed for the treatment of supracondylar fractures. Simple closed manipulation has been considered to be adequate, but with severe displacement the results may be both cosmetically and functionally unacceptable. Piggot et al (1986) confirmed that closed manipulation of Holmberg grade 4 fractures produces poor results; his treatment by traction produced good cosmetic results, but sometimes at the expense of function. Treatment by traction may leave posterior displacement of the distal fragment; remodelling is required to correct this. There is also the

Table III. Results at late review of 34 elbows

		Number
Function (loss of movement)	0° to 5°	27
	6° to 10°	4
	11° to 15°	2
	> 15°	1
Appearance (change in carrying angle)	0° to 5°	23
	6° to 10°	6
	11° to 15°	0
	> 15°	5
Overall score	Excellent	20
	Good	7
	Fair	1
	Poor	6

disadvantage of prolonged hospitalisation and the need for careful, experienced, observation during this time.

For many years open reduction of elbow fractures has been believed to cause severe stiffness (Blount 1954). However, this has arisen mainly after lateral or posterior

approaches or prolonged periods of immobilisation. A medial approach seems to give very few problems with stiffness. Closed percutaneous wiring of these fractures has many advocates (Flynn et al 1974; Ariño et al 1977; Nacht et al 1983), but this is difficult in the presence of severe swelling and there is a risk of pin track infection and of damage to nerves.

The technique we report allows accurate reduction of these severe fractures, with fixation that has the advantage of including the joint. The use of a relatively thick 2.4 mm guide wire has avoided fracture of the transarticular fixation, and we have seen no evidence on any radiograph of any resulting articular damage.

Open reduction by a medial approach and fixation by a single transarticular pin is a safe and reliable method for the primary management of severely displaced (Holmberg grade 4) supracondylar fractures in children.

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