# Corrective supracondylar humeral osteotomies using the small AO external fixator

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**Traditional methods of correcting malunited distal humeral fractures in children involve complex wedge osteotomies held with pins or internal fixation devices. These require a large exposure and challenging fixation. We elected to perform simple transverse osteotomies, without wedges, using a lateral incision. These were maintained by the small AO external fixator. Between 1987 and 2004, five children with malunited distal humeral fractures were treated. Angular and rotational correction was obtained in each case. Bony union occurred at an average of 8 weeks. A simple osteotomy held by the small AO external fixator provides accurate correction, precise adjustability, and solid stability. *J Pediatr Orthop B* 15:194–197 © 2006 Lippincott Williams & Wilkins.**

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## Introduction

The surgical correction of malunited distal humeral fractures in children is challenging and complex. Traditional methods require exact wedge resections [1–4]. The osteotomy is typically maintained with pin fixation [2,4] or with internal hardware [5–7]. Internal devices are usually removed surgically once osteotomy healing is complete. Pin fixation requires extended periods of casting to protect the osteotomy until bony union has occurred [2]. Loss of fixation with pins is a known complication [8,9].

We elected to perform osteotomies of the distal humerus through a limited lateral approach using a single transverse osteotomy. On the basis of our experience with the small AO external fixator in other locations [10–15], we believed that this device would allow us to maintain an osteotomy with a rigid construct that is both precisely adjustable and light in weight. The stability of the small AO external fixator would permit immediate active range of motion. In addition, the fixator and pins can be removed in the office setting, avoiding a second operative procedure. We therefore selected the small AO external fixator to maintain osteotomies in the distal humerus.

## Methods

Between 1987 and 2004, five children with malunited distal humeral fractures presented at our institution. The average age was 6 years (range: 4–10 years). There were four boys and one girl. The four boys presented with malunited supracondylar fractures. They demonstrated cubitus varus angulation measuring an average of 20° (range: 16–28°) and internal rotation of the distal humerus. The girl presented with a lateral condyle fracture with cubitus valgus angulation of 33° and external rotation of the distal humerus. In each case, these deformities affected both function and cosmesis. Each child had an intact neurovascular examination at presentation.

Distal humeral osteotomy was performed after informed consent had been obtained. The child was placed supine with both upper extremities draped free. Proximal and distal pin clusters consisting of 2.5 mm end-threaded AO Schanz pins were inserted before the osteotomy. The distal pin cluster consisted of two or three pins placed laterally, parallel to and 1 cm proximal to the distal humeral growth plate. The proximal pin cluster consisted of two or three pins placed laterally, in line with the humeral shaft (Fig. 1a).

A small longitudinal incision was made laterally, between the pin clusters. The distal humerus was exposed and the periosteum was elevated. A right-angle osteotomy was performed just above the distal pin cluster, using a drill and osteotome. This technique allowed a complete bony cut while protecting the ulnar nerve on the medial side (Fig. 1b).

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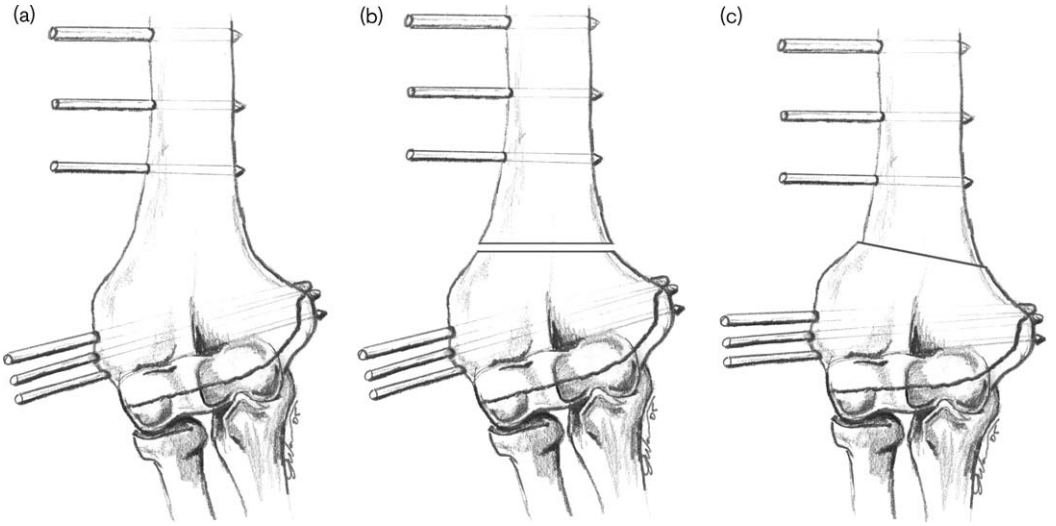
**Fig. 1**




(a) Placement of proximal and distal pin clusters is demonstrated. (b) Complete transverse osteotomy is performed. (c) Deformity in the distal humerus is corrected.

Correction of the rotational deformity was addressed first. Angular deformity was then corrected by minimal distal fragment displacement, locking the proximal cortex into the distal medulla (Fig. 1c).

Stabilization of the osteotomy by the external fixator required connecting the proximal and distal pin clusters with at least three 4 mm carbon fiber rods. The pins in each cluster were subsequently interconnected for additional stability (Fig. 2a and b). The elbow was then flexed and extended intraoperatively to confirm the stability of the osteotomy and to help locate and relieve pin tethering in the skin or fascia. Correction was assessed by intraoperative radiographic visualization and by comparison with the free draped contralateral arm, with particular attention to rotational alignment.

Postoperatively, pin sites were cleaned twice daily with a 50/50 solution of normal saline/hydrogen peroxide applied with a spray bottle. The pin sites were not manipulated. After 1 week, daily showering substituted for 1 daily pin care session. This protocol was taught to the patient's family before discharge. Half-dose cephalosporin (cephalexin, 25 mg/kg, divided three times daily) was given orally while the pins were *in situ*. This antibiotic protocol has been successful in avoiding pin tract infections in osteotomies elsewhere using the small AO external fixator [10–15] and was therefore continued in this series.

Physical therapy was started immediately. This protocol consisted of an active range of motion of elbow and forearm rotation. Isometric muscle strengthening exercises were also performed.

## Results

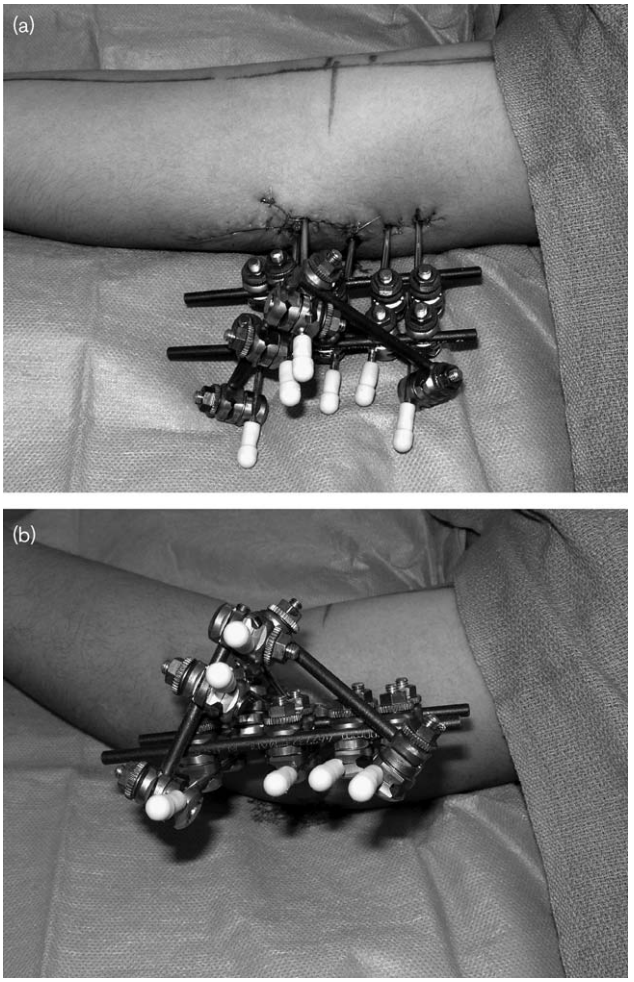
Distal humeral osteotomies were successfully performed in all five children (Fig. 3a and b). Rotation and angulation matched the parameters of the uninjured contralateral extremity. No neurovascular deficits occurred in the immediate or extended postoperative period. The small AO external fixator was well-tolerated. A full range of motion was achieved in all patients while the pins were *in situ*. No superficial or deep pin tract infections occurred. Loss of fixation did not occur. The osteotomies healed at an average of 8 weeks. All pins were removed in the office setting.

At a mean follow-up of 12 years (range: 1–18 years), the correction was maintained in each child. No growth disturbances occurred. Avascular necrosis did not occur in any of the children. Full strength and range of motion was preserved, as compared with the contralateral extremity. The minor surgical scarring was considered acceptable by the patient in each case.

## Discussion

Angular and rotational malunions are known complications of pediatric fractures in the distal humerus. These malunions are frequently also associated with rotational malalignment. In supracondylar fractures, the incidence of these complications has been reported to be as high as 50% [5]. Modern treatment of these fractures utilizing closed reduction and pin fixation has significantly reduced this complication rate [16]. Similarly, lateral condyle fractures can be associated with varus or valgus angulations because of growth arrest or malunion [5].

**Fig. 2**

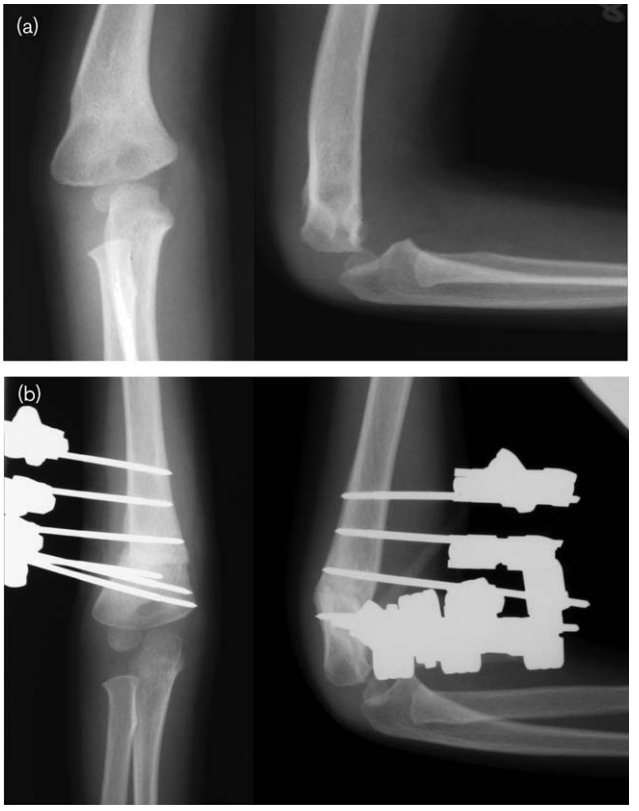



(a, b) The small AO external fixator maintains a distal humeral osteotomy in a 5.5-year-old boy. The usual short incision was extended to excise the scar of a previously failed open fracture reduction.

Children with these angular deformities may have functional limitations and poor cosmesis. Other complications include restricted elbow flexion and tardy ulnar nerve symptoms with cubitus valgus deformities. These malunions have limited ability to remodel because the deformities are perpendicular to the plane of elbow motion. Osteotomy of the distal humerus is necessary to correct these deformities [5].

Several authors have described correction with incomplete [17], closing wedge [1,4,18], dome [2], and step-cut osteotomies [3]. We feel that a simple transverse osteotomy can effectively correct most deformities in the distal humerus. The osteotomy must be complete to address associated rotational deformities. As compared with other methods, preoperative planning is simple when using a complete transverse osteotomy.

**Fig. 3**




(a) A 4-year-old boy presents with a malunited distal humerus fracture. (b) Correction maintained with the small AO external fixator.

Both medial and lateral surgical approaches have been reported. The medial approach requires an ulnar nerve transposition [17]. Proponents of the medial approach believe that the ulnar nerve is protected by direct visualization. In addition, the incision is hidden medially, potentially improving cosmesis. Other authors have also utilized the lateral approach, avoiding exposure and injury to the ulnar nerve [1,18]. We did not experience any iatrogenic ulnar nerve injuries using a laterally based procedure. We believe that the drill and osteotome technique is the safest method of protecting the nerve on the far side of the osteotomy without direct exposure. Furthermore, the AO external fixator is better tolerated in the lateral position. Our experience showed that lateral incisions healed satisfactorily with good cosmesis.

External fixation has been previously described in the correction of distal humeral malunions [5,17,18]. The osteotomies were either closing wedge [5,18] or incomplete [17]. All these methods required parallel pin placement and precise pin orientation to correct complex angular and rotational deformities. In two series combined, three of nine children developed pin tract infections. These were successfully treated with oral antibiotics without pin removal [17,18]. No elbow joint infections

were reported. Range of motion was initiated immediately with the pins *in situ* to avoid elbow stiffness [18].

Our method involves a simple complete osteotomy performed through a limited lateral approach. The osteotomy is maintained by the small AO external fixator, using 2.5 mm pins, which minimize scarring. This method permits precise intraoperative adjustability. The external fixator is light in weight and is well tolerated in the lateral position. This simple osteotomy and the fixation technique prevent osteotomy displacement and permit an immediate range of motion. Our pin care and antibiotic protocol has minimized pin tract infections in the distal humerus and at other sites [10–15]. Once bony union is evident radiographically, the pins can be easily removed in the office setting.

We appreciate that this series consists of a small number of patients. Fortunately, methods of distal humeral fracture management have improved, and these deformities are now uncommon. Our study is comparable in size to those reported by other investigators [17,18].

On the basis of our experience with five patients, we feel that using a simple lateral osteotomy and the small AO external fixator is an effective method of achieving good correction and precise control in supracondylar humeral osteotomies in children.

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