Reverse V osteotomy of the distal humerus for the correction of cubitus varus

We reviewed 22 children with cubitus varus who had been treated by a reverse V osteotomy and fixation by cross-pinning and wiring. The mean pre-operative humeral-elbow-wrist angle was -16.9˚ (-25˚ to +9˚) and at the latest follow-up it was +7.3˚ (-2˚ to +14˚). No child had a lateral prominence greater than 5 mm after correction. An excellent result was achieved in 20 children and a good result in two. We believe that this osteotomy has the advantages of better inherent stability, the avoidance of a prominent lateral condyle after correction and firm fixation allowing early movement.

Cubitus varus is the most common long-term complication of supracondylar fracture of the humerus in children. The deformity rarely limits function, but the parents and child often complain of the unsightly appearance. Many surgical techniques have been described to correct this deformity, including lateral closing-wedge, medial open-wedge, rotational dome and step-cut osteotomies. Several fixation devices have been used, including pins, staples, screws, plates and external fixators. However, a high rate of complications such as non-union, stiffness of the elbow and neurovascular injury has been reported. The result may be unsatisfactory because of insufficient or subsequent loss of correction. Prominence of the lateral condyle can also give rise to a poor cosmetic result. We have used a new (reverse V-shape) osteotomy with fixation by cross pins and wiring to try to address these problems and now describe our results.

Patients and Methods
Between 1993 and 2003 we treated 22 children (19 boys and 3 girls) for cubitus varus using a reverse V osteotomy. The mean age at surgery was 9.5 years (3 to 15). A total of 17 patients had sustained a supracondylar humeral fracture, two a lateral condylar fracture, two a medial condylar fracture and one a transphyseal separation. All the children had good elbow function with a full range of movement. The indication for surgery in all was cosmetic deformity. The aim of surgery was to correct the elbow so that it was anatomically and functionally identical to the opposite normal side. Before planning the osteotomy, full-length radiographs of both upper limbs were taken with the elbow in full extension and the forearm in full supination. The method described by Oppenheim et al was used to determine the humeral-elbow-wrist angle in both arms. Valgus angulation was described as positive (+) and varus angulation as negative (-). The amount of correction required was determined by adding the valgus angulation of the normal side to the varus angulation of the deformed side.

Pre-operative planning of the osteotomy. Correction of the varus angulation. Before surgery a paper tracing was made as a template for the osteotomy (Fig. 1). The humeral-elbow-wrist angle was calculated for both the normal and the deformed elbows. The outline of the deformed elbow was traced onto paper from the radiograph and cut out. The lateral supracondylar ridge in the elbow with cubitus varus was seen as a straight line compared with the smooth curve seen in the normal elbow. A point A was marked on the lateral supracondylar ridge in the elbow with cubitus varus seen as a straight line compared with the smooth curve seen in the normal elbow. A point B was marked on the lateral supracondylar ridge on the cut-out at approximately 5 mm to 10 mm above the olecranon fossa. A line was then drawn perpendicular to the lateral supracondylar ridge across the humerus from this point. Where this line intersected the medial supracondylar ridge was marked as point B (Fig. 1a). The line AB is the first osteotomy cut. A second line was drawn from point B in the proximal humeral direction at an angle which had previously been the calculated angle of correction. Then, a third line was drawn from point A which inter-
Correction of the lateral or medial condyle prominence. The wrist angle to the normal valgus of the opposite elbow. (Fig. 1b). This technique converted the humeral-elbow-wrist angle to the normal valgus of the opposite elbow. After removal of this triangle, the distal humerus and forearm was rotated laterally and translated medially so that point A comes to meet point C. Hence, a triangle was formed with the angle ABC being the angle of desired correction and the angle ACB (which is always 90˚). Figure 1b – After removal of the triangle ABC, the distal humerus is rotated laterally and translated medially such that point A comes to meet point C.

Diagrams of the pre-operative planning for the correction of varus. Figure 1a – The line AB is perpendicular to the lateral supracondylar ridge located 5 mm to 10 mm above the olecranon fossa. The point C is determined proximal to the line AB by the angle ABC (angle to be corrected) and angle ACB (which is always 90˚). Figure 1b – After removal of the triangle ABC, the distal humerus is rotated laterally and translated medially so that point A comes to meet point C.

Results
Of the 22 children, 20 had an excellent and two a good result at the final follow-up at a mean of 16 months (12 to 36) after operation (Figs 3 and 4). All the osteotomies had united by ten weeks after operation. The mean pre-operative humeral-elbow-wrist angle in the deformed elbow was -16.9˚ (-25˚ to +9˚) of varus and the mean post-operative angle in the corrected elbow was 7.3˚ (-2˚ to +14˚). The mean humeral-elbow-wrist angle in the normal elbow was 7.2˚ (3˚ to 12˚) of valgus and the mean correction obtained was 24.1˚ (17˚ to 36˚). A total of 20 children had no lateral prominence and two had a mild prominence of less than 5 mm. There were complications in two. One had an undisplaced fracture of the step-cut spike intra-operatively which did not limit the start of elbow movement and healed satisfactorily. The other developed palsy of the ulnar nerve on the first post-operative day. The ulnar nerve was explored the next day, but no evidence of injury was found and the palsy resolved spontaneously.

Discussion
The surgical techniques which have been described for the correction of cubitus varus differ in their approach to the distal humerus, the method of osteotomy and the type of fixation.
fixation.1-8 The common surgical approaches to the distal humerus are lateral, medial, posterolateral and posterior.1-17 In our study, we used a posterolateral approach since we thought that it was more cosmetic compared with the other alternatives. Lateral closing-wedge, medial opening-wedge, step-cut and dome-shaped osteotomies have been described.1-11 In 1988, DeRosa and Graziano1 described a step-cut osteotomy for correction of cubitus varus. This was based on precise cutting of the wedge so that a cortical spike on the distal fragment allowed fixation by a single cortical screw. This functioned in the same way as an intact periosteal hinge, allowing control of the osteotomy. We believe that the technique which we describe has significant advantages over the original step-cut osteotomy. The osteotomy is performed at a higher level which provides better fixation of bone. It also provides more space for fixation of the distal fragment so that if performed in an adult, a reconstruction plate or a dynamic compression plate can be used with more than two screws in the distal fragment. Although the original step-cut osteotomy provided some stability because of its configuration, the cortical beak was too narrow and prone to fracture or cut-out of the screw. Our osteotomy is inherently stable because of its firm wedge fit with adequate bony columns on both the medial and lateral sides.

A lateral prominence due to translation of the distal fragment is a frequent cause of a poor cosmetic result.13-15 A lazy-S or a Z-deformity is commonly seen. Wong et al15 reported a lateral condylar prominence in 14 of the 22 patients in their series. They suggested that this might remodel with time. However, Ippolito et al,14 in a long-term follow-up of corrective osteotomy for cubitus varus, described persistence of this deformity at final follow-up. Levine et al10 pointed out the importance of medial displacement of the distal humerus to decrease the prominence of the lateral humeral condyle. The amount of displacement was decided by the gross appearance at operation. However, medial displacement disrupted the periosteum on the medial side leading to instability and difficulty with fixation. Dome osteotomy has been popularised by Japanese surgeons,7 and allows the residual prominence of the lateral condyle to be corrected by rotation in both the coronal and horizontal planes.2,18 However, the decision regarding the exact amount of translation required is based on the surgeon’s intraoperative assessment.2,7,10,16,18 There is no provision for pre-operative calculation and there is always a chance that over- or undertranslation may occur. Our technique of pre-operative planning can prevent the lateral prominence by the
precise calculation of the location of the point C of the osteotomy.

Various methods of fixation of the osteotomy both internal and external have been described. Kirschner (K-) wire fixation is simple, can be used in a child with an open physis and can be easily removed after union. However, external immobilisation for three to five weeks is usually recommended with simple K-wire fixation. Plate and screw fixation offers the best stability, and allows early movement of the elbow. The use of a cortical screw as described by DeRosa and Graziano may be complicated by loss of fixation because of fracture of the narrow beak used for fixation. External fixation may be in the form of a simple uniplanar fixator or an Ilizarov ring fixator. These may have some advantages, but can be inconvenient and uncomfortable for the child. Our technique of K-wire fixation was modified to increase stability. Both cross-pins were inserted from the lateral side reducing the chance of iatrogenic injury to the ulnar nerve. This configuration provided resistance to both varus and valgus forces at the site of the osteotomy.

<table>
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<th>Result</th>
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Fig. 4a: Pre-operative clinical appearance of an eight-year-old boy with left-sided cubitus varus.
Fig. 4b: Pre-operative anteroposterior radiograph (right) showing a varus deformity of 22˚ compared with the normal right side (left).
Fig. 4c: Post-operative AP radiographs and d) photograph showing the good cosmetic result.
additional wiring of the K-wires enhanced the stability of the construct.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References