ABSTRACT

Purpose. To evaluate the outcome after closed reduction and pinning using a Kirschner wire inserted laterally and another inserted vertically through the olecranon for displaced supracondylar humeral fractures.

Methods. 39 boys and 11 girls aged 2 to 12 (mean, 7.27) years underwent closed reduction and pinning using a Kirschner wire inserted laterally and another inserted vertically through the olecranon for posteromedially (n=28), posterolaterally (n=7), or posteriorly (n=15) displaced extension-type supracondylar humeral fractures (Gartland types II and III).

Results. Compared with the uninjured elbows, the injured elbows had a mean loss of flexion of 4.52º (p<0.001), a mean loss of extension of 1.7º (p=0.008), and mean change in carrying angle of 3.47º (p<0.001). According to the Flynn grading system, outcome was excellent in 35 patients, good in 9, fair in 2, and poor in 4. Outcome did not differ significantly between patients aged 2 to 4, 5 to 8, and 9 to 12 years or between those operated on within 24 hours of injury and those operated on 2 to 5 days after injury. One patient developed superficial pin tract infection, and 2 patients developed cubitus varus deformity. No patient sustained iatrogenic nerve injury.

Conclusion. Transolecranon vertical and lateral Kirschner wire fixation is a viable option for displaced supracondylar humeral fractures in children, especially when there is massive swelling.

Key words: bone wires; child; humeral fractures

INTRODUCTION

Supracondylar fractures in children are common, accounting for 65% of all elbow fractures in children. In types II and III displaced supracondylar humeral fractures, closed reduction is difficult to achieve because of the thin bone between the coronoid and olecranon fossae as well as stripping of the periosteum. In addition, hyperflexion for maintenance of fracture reduction leads to swelling, compartment syndrome, and neurovascular compromise. Closed reduction...
and percutaneous pinning enables the cast to be kept in <90° flexion and thereby reduces the risk of complications. The optimal pin configuration for displaced supracondylar fractures in children remains controversial. This study evaluated the outcome after closed reduction and pinning using a Kirschner wire inserted laterally and another inserted vertically through the olecranon for displaced supracondylar humeral fractures.

MATERIALS AND METHODS

This study was approved by the ethics committee of the hospital, and informed consent was obtained from each patient. Between 2011 and 2013, 39 boys and 11 girls aged 2 to 12 (mean, 7.27) years underwent closed reduction and pinning using a Kirschner wire inserted laterally and another inserted vertically through the olecranon for posteromedially (n=28), posterolaterally (n=7), or posteriorly (n=15) displaced extension-type supracondylar humeral fractures (Gartland types II and III) of the left (n=37) or right (n=13) side. Associated injuries included radial nerve palsy secondary to posteromedial fracture (n=2), median nerve palsy secondary to posterolateral fracture (n=2), and loss of radial pulse but maintenance of distal perfusion (n=2). Those with an open fracture, an irreducible fracture, a fracture with vascular injury (pulseless arm with poor perfusion), or those presented 5 days after the injury were excluded.

After routine blood, urine, and radiographic work-up, 25 patients underwent surgery within 24 hours of injury and the remaining 25 underwent surgery 2 to 5 days after injury because of late presentation. Under image intensification, all fractures were reduced by correcting displacement, angulation, and rotation in the coronal and sagittal planes. Two 1.6-mm Kirschner wires were inserted for fixation (Fig.). The first one was inserted from the lateral column in full flexion across the fracture at 30° to 40° to the opposite cortex of the humerus. The elbow was extended to about 90°, and the second one was inserted vertically through the olecranon across the fracture into the metaphysis of the humerus. The elbow was immobilised in a plaster-of-Paris back slab in 90° flexion for 3 weeks.

Postoperatively, slab and wires were removed at 3 weeks if clinical and radiological evidence of bone union was present. In the absence of clinical evidence, the Kirschner wires were retained for one further week. When there was clinical evidence but insufficient radiological evidence, Kirschner wires were removed but a Plaster-of-Paris splint was retained until 4 weeks. Intermittent active flexion-extension exercises of the elbow were encouraged. Lifting heavy weights was not allowed until 12 weeks.
Patients were evaluated at 3 months using the Flynn grading system, based on the difference in carrying angle (cosmetic factor) and range of movement (functional factor) between the injured and uninjured elbows (Table 1).

The *t*-test was used to compare the injured and uninjured elbows. The null hypothesis was that the mean extension and carrying angle in the injured elbows after fixation would be the same as those in the uninjured elbows (controls). The Fisher’s exact test was used to compare different patient groups. A *p* value of <0.05 was considered statistically significant.

### RESULTS

The mean follow-up duration was 13 months. Radiological evidence of healing was present at 3 weeks in 6 patients, at 4 weeks in 39, and at 6 weeks in 5.

Compared with the uninjured elbows, the injured elbows had a mean±standard deviation (SD) loss of flexion of 4.52±4.16º (*p*<0.001, *t*-test), a mean±SD loss of extension of 1.7º±4.32º (*p* = 0.008, *t*-test), and mean±SD change in carrying angle of 3.47º±4.70º (*p*<0.001, *t*-test).

According to the Flynn grading system, outcome was excellent in 35 patients, good in 9, fair in 2, and poor in 4. The outcome did not differ significantly between patients aged 2 to 4, 5 to 8, and 9 to 12 years (*p* = 0.931, Fisher’s exact test, Table 2) or between those operated on within 24 hours of injury and those operated on 2 to 5 days after injury (*p*<0.001, *t*-test).

All 4 patients with associated nerve palsy recovered completely. The 2 patients with a loss of radial pulse had no sign of vascular compromise after emergency closed reduction. One patient developed superficial pin tract infection, and 2 patients developed cubitus varus deformity. No patient sustained iatrogenic nerve injury.

### DISCUSSION

Closed reduction and percutaneous Kirschner wire fixation is the treatment of choice for displaced supracondylar humeral fractures, but it is difficult to perform in the presence of severe swelling, and there is a risk of pin track infection and nerve injury, especially to the ulnar nerve with a medial pin placement.

The transolecranon lateral wire technique differs from the posterior intrafocal pinning technique (for fixation) and the pin leverage technique (for reduction) in terms of the point of entry and location of the Kirschner wires. The transolecranon wire is inserted near the tip of the olecranon and passed proximally into the metaphysis of the humerus, whereas the posterior pin is inserted from the posterior aspect of the distal arm across the fracture site for fixation/reduction. In a similar technique
using 2 Kirschner wires for fixation, the first wire is inserted into the distal humeral epiphysis immediately lateral to the olecranon (but not through it as in our technique) at the junction of the trochlea and capitellum and into the medullary canal of the diaphysis, and the second wire is inserted near the first but at 30° across the fracture line at a point well medial to the other pin, penetrating the medial cortex of the diaphysis.

In our study, 92% of patients achieved satisfactory outcome. This is comparable with other studies. 87.5% achieved satisfactory outcome after fixation using 2 lateral wires inserted through the trochlea-capitellar junction; 80% achieved satisfactory outcome after fixation using crossed medial-lateral and lateral wires; 91.4% achieved satisfactory outcome after fixation using lateral cross wires; 91.9% to 96.3% achieved excellent/good outcome after fixation using one to 2 posterior intrafocal wires; 95% to 100% achieved excellent/good outcome after a pin leverage technique for reduction and 2 to 3 lateral wires for fixation.

Although the transolecranon wire limits the flexion and extension of the elbow, this did not affect the final outcome as the elbow was fixed in a plaster-of-Paris splint for a minimum of 3 weeks. The elbow had to be maintained in the same degree of flexion while applying the plaster-of-Paris splint to avoid the risk of wire bending or breakage, especially the transolecranon wire. No wire backout occurred, probably because the transolecranon transarticular wire was held firmly by fixation into 3 cortices and the metaphyseal cancellous bone of humerus. No articular damage occurred because smooth pins were used. No infective arthritis occurred despite the Kirschner wire across the joint, probably because of aseptic precautions intra and post-operatively. Nonetheless, the risk of articular damage and infectious arthritis may preclude the use of this technique, especially in patients with wounds near the entry site or with an open fracture.

One limitation of this study was the lack of a control group for comparison.

CONCLUSION
Transolecranon vertical and lateral Kirschner wire fixation is a viable option for displaced supracondylar humeral fractures in children, especially when there is massive swelling, as the olecranon is still palpable even in a swollen elbow. The risk of iatrogenic ulnar nerve injury is low.

DISCLOSURE
No conflicts of interest were declared by the authors.

REFERENCES
1. Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,350 children. J Orthop Trauma 1993;7:15–22.
2. Altenberg AR, Boyd HB. Fractures about the elbow in children. Arch Surg 1944;49:213.
3. Blount WP. Fractures in children. Baltimore: Williams and Wilkins; 1955: 26–37.
4. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years' experience with long-term follow-up. J Bone Joint Surg Am 1974;56:263–72.
5. O’Hara LJ, Barlow JW, Clarke NM. Displaced supracondylar fractures of the humerus in children. Audit changes practice. J Bone Joint Surg Br 2000;82:204–10.
6. Mulpuri K, Wilkins K. The treatment of displaced supracondylar humerus fractures: evidence-based guideline. J Pediatr Orthop 2012;32(Suppl 2):S143–52.
7. Skaggs DL, Hale JM, Bassett J, Kaminsky C, Kay RM, Tolo VT. Operative treatment of supracondylar fractures of the humerus in children. The consequences of pin placement. J Bone Joint Surg Am 2001;83:735–40.
8. Fahmy MA, Hatata MZ, Al-Seesi H. Posterior intrafocal pinning for extension-type supracondylar fractures of the humerus in children. J Bone Joint Surg Br 2009;91:1232–6.
9. Lee HY, Kim SJ. Treatment of displaced supracondylar fractures of the humerus in children by a pin leverage technique. J Bone Joint Surg Br 2007;89:646–50.
10. Fowles JV, Kassab MT. Displaced supracondylar fractures of the elbow in children. A report on the fixation of extension and flexion fractures by two lateral percutaneous pins. J Bone Joint Surg Br 1974;56:490–500.
11. Davis RT, Gorczycja JT, Pugh K. Supracondylar humerus fractures in children. Comparison of operative treatment methods. Clin Orthop Relat Res 2000;376:49–55.
12. El-Adl WA, El-Said MA, Boghdady GW, Ali AS. Results of treatment of displaced supracondylar humeral fractures in children by percutaneous lateral cross-wiring technique. Strategies Trauma Limb Reconstr 2008;3:1–7.