Correction of Cubitus Varus with Lateral Closed Wedge Osteotomy and Cross K-Wire Fixation: Results of a Prospective Series of 19 Patients

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Abstract

Background: Cubitus varus is the most common late complication of displaced supracondylar fractures of the humerus in children and may lead to long-term problems such as increased chances of lateral humeral condyle fractures, posterolateral instability of the elbow, and tardy ulnar nerve palsy. Various complex corrective osteotomies have been described in literature with no consensus. We conducted this study to evaluate whether a simple lateral closed wedge osteotomy can give predictably good results in these patients. Materials and Methods: Nineteen children with malunited supracondylar fracture humerus leading to cubitus varus deformity underwent lateral closed wedge osteotomy, which was fixed with cross K-wires. Patients were evaluated for carrying angle, elbow range of motion, complications if any, and radiological correction of humeroulnar angle. Results: Osteotomy healed in all patients by 8 weeks (range 4–8 weeks, mean of 5.5 weeks). Excellent correction was achieved in 18 patients, whereas one patient had inadequate correction. Preoperative varus ranging from 10° to 30° (average – 17°) improved to 0°–12° valgus (average-8°). Two patients had minor complications in the form of pin tract infections which resolved with local care and antibiotics. There was no loss of correction or pin loosening. Sixteen patients had excellent result, whereas three patients had fair result as per Bellemore’s criteria. Conclusion: Complex three-dimensional osteotomy is not always necessary for cubitus varus correction and a simple lateral closed wedge osteotomy fixed using cross K-wires can give good results with proper planning and execution.

Keywords: Cross K-wire, cubitus varus, deformity, lateral closed wedge osteotomy, malunited supracondylar humerus

INTRODUCTION

Supracondylar fractures of the humerus are the most common pediatric elbow injuries with a peak incidence around 5–7 years of age. Cubitus varus is the most common late complication of displaced supracondylar fractures in children with reported incidence from 3% to 58%. It is also called as gunstock deformity. Although trochlear avascular necrosis (AVN) or growth disturbances can cause cubitus varus which is progressive, the most common cause of cubitus varus in patients with supracondylar fracture of the humerus is malunion.

Malunion may be the result of (1) inadequately treated or untreated fracture, (2) loss of reduction in patients treated with cast due to inadequate reduction or improper cast application, (3) inadequate fixation in surgically treated patients, and (4) comminution or impaction of medial column leading to late collapse into varus.

The deformity consists of three components – coronal malalignment with varus, hyperextension, and internal rotational deformity. Out of these three deformities, since hyperextension occurs in the plane of elbow movements, it can remodel to some extent in younger children <10 years, and hence, its correction may not be necessary. Internal rotation deformity is well compensated by shoulder joint movements and hence does not cause significant functional limitation and usually does not require correction. Varus deformity does not remodel and requires...
correction could be achieved. Although the major indication for surgery of cubitus varus deformity is cosmetic correction of the unsightly deformity, few studies with long-term follow-up of patients with cubitus varus have shown that these patients may face problems such as increased chances of lateral humeral condyle fractures,[7,8] posterolateral instability of the elbow,[9] and tardy ulnar nerve palsy.[10,11]

Various types of osteotomies have been reported in literature with no consensus on the ideal modality. Complex three-dimensional osteotomies have been described advocating correction of all three components of the deformity. However, these osteotomies are technically difficult to perform. We conducted this study to evaluate whether a simple lateral closed wedge osteotomy can give predictably good results. The aims and objectives of the study were to assess the functional and radiological outcome of patients who underwent cubitus varus deformity correction with a simple lateral closed wedge osteotomy and also to evaluate whether fixation of osteotomy with cross K-wires construct is strong enough to maintain correction till osteotomy unites. In the present prospective study, we are presenting results of 19 cases of posttraumatic cubitus varus deformity treated with this technique.

**Materials and Methods**

Approval by the institutional ethics committee was obtained. Nineteen cases of posttraumatic cubitus varus deformity (following malunion of supracondylar fracture humerus in children) who underwent corrective osteotomy between May 2012 and December 2017 were included in this study. All patients were operated at least 1 year posttrauma to rule out growth disturbances as a cause for the deformity. There were 14 males and 5 females with age at the time of corrective surgery ranging from 6 years to 13 years (average 8.5 years). Follow-up ranged from 1 year to 5 years 6 months (average 2 years). All patients consented to the use of their details and clinical photos for this publication.

All patients were clinically evaluated before surgery. Carrying angle and range of motion of normal and affected side were documented. Two patients had restriction of flexion beyond 90° due to an anterior bony bump, whereas rest of the patients had functional range of motion with most having a change in arc of motion with increased hyperextension and correspondingly loss of terminal flexion. Preoperatively, amount of deformity was calculated using the humeroulnar angle drawn on X-rays by intersection of the long axis of the humerus and ulna. Normal carrying angle of opposite side was added to this to calculate the size of the wedge that needed to be excised to achieve correction.

**Operative procedure**

All patients were operated in supine position under general anesthesia. After elevating tourniquet, the distal humerus was exposed using lateral approach. Under IITV guidance, the osteotomy site was marked with K-wires passed as per templating done on preoperative X-rays. To stabilize the osteotomy, two percutaneous K-wires, one each from lateral and medial side of the distal humerus, were passed up to the distal osteotomy site, taking care to prevent injury to the ulnar nerve while passing the medial K-wire. The osteotomy was done by making multiple drill holes along the guide wires and completing it with osteotomes. In patients who had significant hyperextension, anterior cortex of proximal segment was nibbled off to create an oblique osteotomy surface to achieve correction of the hyperextension deformity. The desired wedge of bone was removed, the osteotomy gap was closed, and the predrilled stabilization K-wires were advanced, crossing above the osteotomy site and engaging the opposite cortex, thus giving a cross K-wire fixation [Figure 1]. In the two patients having anterior bony bump, bumpectomy was also done to improve flexion. Wound was closed in layers, and above-elbow plaster slab was applied.

**Results**

Patients were followed up at 2, 4, 6, 8, and 12 weeks and then at every 3 monthly intervals till at least 1 year. Osteotomy sites healed in all patients by 8 weeks (range 4–8 weeks, with a mean of 5.5 weeks). Once the osteotomy had healed, the K-wires were removed in OPD without need of any anesthesia.

No patient developed postoperative stiffness, and all patients had a good range of motion. The two patients who underwent bumpectomy had significant improvement of elbow flexion postoperative [Figure 2]. Five patients with increased hyperextension and significant change of arc of motion improved to normal arc postoperatively. All patients had normal pronosupination movements pre- and post-operatively.

Two patients developed superficial pin tract infections which responded well to oral antibiotics and pin tract dressings and

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*Figure 1: (a) Preoperative X-ray of normal side (b) preoperative X-ray of affected side showing calculation of deformity by humeroulnar angle and templating of wedge (c and d) postoperative X-rays showing correction of deformity (e-h) intraoperative IITV images showing surgical steps*
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Did not require premature pin removal. There were no deep infections, pin loosening, or loss of fixation, and correction achieved intra-operatively was maintained in all patients till osteotomy healing [Figure 3]. There were no neurovascular complications in any patients.

Excellent correction was achieved in 18 patients, whereas one patient had an inadequate correction with a rectus.

Preoperatively, patients had varus ranging from 10° to 30° (average –17°) which improved to 0°–12° valgus (average-8°) [Table 1 and Figures 1-4]. At the end of 1-year postoperation, all patients were pain free and asymptomatic. Sixteen patients had excellent result, whereas three patients had fair result as per Bellemore’s criteria [Table 2].

Discussion

Supracondylar fractures of the humerus are very common injuries in children, and its malunion usually leads to cubitus varus deformity. Although traditionally cubitus varus was regarded as just a cosmetic deformity, on long-term follow-up of these patients, various problems have been reported by many authors. Davids et al.[7] first reported six cases of lateral condylar fracture of the humerus in children with preexisting cubitus varus due to malunited extension-type supracondylar fractures of the humerus. Takahara et al.[8] reported nine patients with distal humeral fractures complicating varus deformity. O’Driscoll et al.[9] reported 24 patients of cubitus varus deformity who developed tardy posterolateral instability of the elbow 2–3 decades later. These patients presented with lateral elbow pain and recurrent instability. With cubitus varus, the mechanical axis, the olecranon, and the triceps line of pull are all displaced medially. The repetitive external rotation torque on the ulna permitted by these deformities can stretch the lateral collateral ligament complex and lead to posterolateral rotatory instability.[9] Tardy ulnar nerve palsy has also been associated with cubitus varus, and Ogino et al.[10] in 1986 were the first to report cubital tunnel syndrome due to cubitus varus deformity. With cubitus varus deformity, the olecranon fossa moves to the ulnar side of the distal humerus and the triceps shifts a bit ulnaward. It has been theorized that this ulnar shift might compress the ulnar nerve against the medial epicondyle, narrowing the cubital tunnel and resulting in chronic neuropathy. Abe et al.[11] reported 15 patients with tardy ulnar nerve palsy caused by cubitus varus deformity with a mean interval of 15 years between the trauma and onset of symptoms. A fibrous band running between the heads of the flexor carpi ulnaris was thought to cause ulnar nerve compression. It is clear from the above literature that cubitus varus is not such a benign deformity as was once considered and that surgical correction should be offered to patients with significant deformity.

Various types of osteotomies have been reported in literature – lateral closing wedge,[5,12] French osteotomy,[13] modified French osteotomy,[14] medial opening wedge,[15] step cut,[16] oblique,[17] dome,[18] and pentalateral,[19] but no one technique is statistically safer or more effective than any other.[20]

Since the deformity is a combination of varus, hyperextension, and internal rotation, many surgeons have advocated complex three-dimensional osteotomies to correct all the components of the deformity. Takagi et al.[6] compared two groups of patients,
the first group underwent three-dimensional osteotomy, whereas the second group only underwent coronal plane correction. They concluded that for osteotomies to correct cubitus varus deformity, correction of internal rotation is not needed. In fact they found that there was more loss of correction in the first group because rotation reduced the area of bone contact. They also found that children younger than 10 years showed remodeling of hyperextension on the final follow-up and concluded that in patients under 10 years of age, surgical correction of hyperextension is not needed when correcting the varus deformity.

Medial, posterior, and lateral approaches have been described for performing these corrective osteotomies. Medial approach requires ulnar nerve dissection and a graft in case of open wedge osteotomy. Posterior approach, although gives better exposure, may lead to loss of terminal flexion due to scarring of triceps and posterior soft tissues. Lateral exposure is easy and gives sufficient exposure for correction without the disadvantages of the previous two approaches and was the approach of our choice.

We chose lateral closing wedge osteotomy as it is a simple procedure with predictably good results. Lateral condylar prominence is an issue with lateral closing wedge osteotomy; but, even this prominence remodels in younger children.[21,22] Various authors have advocated various methods for stabilization of the osteotomy – K-wires, screws, screws with tension band, plates, and external fixator. Although plates have been found to give the best stability and are preferred modality of fixation in older children, cross K-wire construct used in our series gave sufficient stability without any loss of fixation in any of our patients. A big advantage with K-wires was that they could be removed easily once the osteotomy healed, and it saved the child from undergoing another surgery and anesthesia for implant removal.

**Conclusion**

Complex three-dimensional osteotomy is not always necessary for cubitus varus correction, and a simple lateral closed wedge osteotomy fixed using cross K-wires has given good results in our series of patients. This particular technique is technically
easy to perform and yields an inherently stable osteotomy site, which can be stabilised sufficiently with cross K-wires alone, making implant removal extremely easy after osteotomy healing.

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Conflicts of interest
There are no conflicts of interest.

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