New Fixation Method Using Two Crossing Screws and Locking Plate for Cubitus Varus Deformity in Young Adult Elbow: Case Report

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Many types of osteotomy have been proposed for the treatment of cubitus varus deformity of the elbow, and various methods for fixation of the osteotomy site have also been described. However, no method has been perfect. We treated two cases of cubitus varus elbow deformity with step-cut osteotomy using a new fixation method with two crossing screws and an anatomically designed locking plate. Active assisted elbow range of motion (ROM) exercise was permitted at postoperative 3 days, after removal of the drainage. Preoperative and postoperative humerus-elbow-wrist angles and ranges of motion of the two patients were compared. At 3 months follow-up, each patient had recovered the preoperative elbow ROM, and achieved the complete bony union of the osteotomy site and proper correction of the cubitus varus deformity. In addition, the appropriate remodeling of the lateral bony protrusion was observed. Therefore, we introduce a new fixation method for achievement of stable fixation allowing immediate postoperative elbow motion after corrective osteotomy for cubitus varus deformity in young adults.

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Key Words: Cubitus varus deformity; Corrective osteotomy; Step cut osteotomy; Crossing screw

Cubitus varus deformity is a common complication of pediatric supracondylar fracture of the humerus. This deformity is caused by angular and rotational malunion, due to physeal growth arrest or malunion. The deformity is thought to consist of extension, internal rotation, and varus angulation. Although cubitus varus does not cause functional disability, surgery is often required for cosmetic reasons. Corrective osteotomy is usually performed in children or young adults. In the past, because of the high rate of complications of valgus osteotomy, including stiffness, loss of fixation, infection, myositis ossificans, and neurovascular injury, corrective osteotomy was rarely performed. Thus, major concerns for surgical correction of cubitus varus deformity are how to achieve sufficient correction and also restore preoperative arc of motion, without loss of fixation after surgery. To achieve satisfactory results, accurate correction through osteotomy should be followed by rigid fixation and early motion of the elbow.

Recently, various types of osteotomy and fixation have been proposed to correct this deformity, including lateral closing wedge osteotomy, dome osteotomy, three-dimensional osteotomy, and step cut translational osteotomy. Of these osteotomy techniques, step cut osteotomy is a popular technique. Step cut osteotomy increases the contract area at the osteotomy site and the lateral spike remains on the distal part, which is further fixed to the proximal segment with a screw.

Placement of a lag screw using a screw increases fixation stability on the osteotomy site, resulting in better fracture healing, and, fixation using 2 crossing screws can provide additional stability on rotation and displacement at the osteotomy site. We designed a new fixation technique, which not only creates a large contact area for rigid fixation but also achieves rigid fixation using a cross screw and locking plate for rigid fixation and early motion and early union.
Case Report

Two patients were treated for cubitus varus deformity using 2 crossing screws and locking plate fixation after step cut osteotomy. Both were male, ages 22 and 37 years (Table 1). The deformity resulted from a malunited supracondylar fracture that occurred in the childhood period, respectively (Fig. 1). The two patients complained of the cubitus varus deformity due to cosmetic problem, not limitation of range of motion (ROM) of the elbow joint. Corrective osteotomy was scheduled for correction of the cubitus varus deformity.

Anteroposterior radiographs of both elbows with the elbows in full extension and supination were obtained before surgery. The humerus-elbow-wrist (HEW) angle was measured on the anteroposterior radiographs (Fig. 2A), and the correction angle was determined by comparing the difference of HEW angle between the affected and the normal elbow. Preoperative planned correction degree and postoperative achieved correction degree of both patients are described in Table 1.

Patients underwent surgery under tourniquet control in the lateral decubitus position. A posterior longitudinal skin incision was made in the posterior midline of the distal humerus, while the ulnar nerve was decompressed and protected, and the triceps muscle was dissected using a paratricipital approach. The initial transverse osteotomy line was made 1.0 cm superior to the olecranon fossa and perpendicular to the long axis of the humerus (Line AB) (Fig. 2B). Then, from the medial end of this first line (Point B), the second line was drawn (Line BC), which made an angle between the first and second lines equal to the desired correction angle (Angle *) (Fig. 2C). Next, from the lateral end of the first line, the third line was drawn (Line AD), which made an angle between the second and third lines equal to the angle between the affected and the normal elbow. Preoperative planned correction degree and postoperative achieved correction degree of both patients are described in Table 1.

Table 1. Clinical Data of Two Patients

| Variable                                | Case 1          | Case 2          |
|-----------------------------------------|-----------------|-----------------|
| Age (yr)/Affected side                  | 37/Right        | 22/Left         |
| Follow-up (mo)                          | 5               | 5               |
| Humerus-elbow-wrist angle (°)           | 18 varus/12 valgus | 9 varus/13 valgus |
| Preoperative (affected side/normal side)| 13 valgus/12 valgus | 15 valgus/13 valgus |
| Correction degree                       |                 |                 |
| Preoperative planned correction degree  | 30              | 24              |
| Postoperative achieved correction degree| 31              | 26              |
| Range of motion (°)                     |                 |                 |
| Preoperative                            | 0–140           | 0–140           |
| Postoperative                           | 0–140           | 0–140           |

Fig. 1. (A) Pictures show patient with cubitus varus of right elbow. (B) Radiographs of both elbows.
between the first line and the lateral supracondylar ridge line (Angle #) (Fig. 2D). Finally, our desired triangle was outlined and removed (Fig. 2E).

The osteotomy site was fixed with K-wire temporarily (Fig. 3A, B). Then, we checked the HEW angle and elbow ROM intraoperatively. To obtain rigid fixation of the osteotomy site, one 4.5 mm cannulated screw and one 3.5 mm cortical screw were used in cross configuration. After step cut osteotomy, a lateral spike was too small for the 4.5 mm cannulated screw, therefore we used the 3.5 mm cortical screw for lateral fixation. A 4.5 mm cannulated screw was placed from anteromedial to posterolateral direction, and a 3.5 mm cortical screw was placed from posterolateral to anteromedial direction (Fig. 3C, D). Two screws were placed in crossing configuration on the coronal and sagittal
planes. Final fixation was performed to the posterolateral surface of the humerus by application of an anatomically designed, congruent locking plate (Synthes, Oberdorf, Switzerland) (Fig. 3E, F). There was no impingement between screws of the plate and the two crossing screws. However, if impingement occurred, it could be resolved with change of the plate position to more proximal or distal. Active assisted ROM exercises including flexion, extension, supination, and pronation began at postoperative 3 days, after removal of drainage. Active elbow motion was allowed at postoperative 6 weeks and strengthening exercise was started at postoperative 12 weeks. Patients returned to daily activity when radiographs showed union of the fracture site. Preoperative HEW angles were 18° varus and 9° varus, respectively. Postoperative HEW angles were corrected to 13° valgus and 15° valgus. Each patient had recovered the preoperative elbow ROM at 6 weeks and 8 weeks (Fig. 4A). Postoperative ROM of the elbow joint was 0° to 140°. Union was defined as the absence of pain and the presence of a bridging callus in 3 of the 4 cortices seen on the anteroposterior and lateral radiographic views. They achieved the complete bony union of the osteotomy site and proper correction of the cubitus varus deformity at postoperative 3 months. In addition, the appropriate remodeling of the lateral bony protrusion was observed at the last follow-up (Fig. 4B). There was no complication in both patients, and both patients were satisfied with correction of the cubitus varus deformity.

**Discussion**

Various surgical techniques for cubitus varus deformity were introduced. These techniques have been categorized as osteotomy methods and fixation methods. Three major types are the simple lateral closing wedge, the step cut lateral closing wedge, and the dome rotational osteotomy. Lateral closing wedge osteotomy is easy and safe, but achievement of strong internal fixation is difficult. A dome osteotomy can reorient the distal fragment in both the coronal and the horizontal plane. However, it is often difficult to rotate the distal portion in the coronal plane due to the contracture of the surrounding soft tissue. Step cut osteotomy provides relatively more contact area. Some authors have reported on lateral condyle protrusion after step-cut osteotomy. However, in these cases, the appropriate remodeling of the lateral bony protrusion was observed during the follow-up period (Fig. 3B).

The fixation methods after osteotomy include internal fixation and external fixation. Internal fixation is a one-stage operation that requires accurate planning. K-wire fixation is simple, but external immobilization is usually recommended with simple K-wire fixation. Plate and screw fixation offer the best stability, and allow early movement of the elbow. However, some authors reported insufficient length for fixation of the distal fragment. But, we achieved adequate fixation of the distal fragment using 2 screws in addition to an anatomically designed locking plate. External fixation including a simple uniplanar fixator and Ilizarov ring fixator may provide some advantages, but can be inconvenient and lead to pin track infection or elbow stiffness, etc. In addition, those are not tolerated as well as internal fixation.

Recently, several authors reported on an internal fixation method using a plate. Gong et al. described fixation with a lag screw and lateral plating. And Lim et al. described a fixation with double plating through a lateral approach. Excellent results were obtained using each technique. We agree that both techniques have advantages of stable fixation and allowing early recovery of elbow motion. However, our technique can obtain not only fixation of both medial and lateral cortex, but also increase the contact area of bone surface. We think that it can lead to better fracture healing.

Therefore, we designed a new fixation method for step cut osteotomy for achievement of rigid fixation permitting immediate postoperative elbow ROM exercise after corrective osteotomy for cubitus varus deformity in young adults. There are several advantages of this fixation technique. We used 2 crossing screws (1 cannulated screw and 1 cortical screw). Fixation using two crossing screws through the osteotomy site can provide stronger...
fixation at the osteotomy site. In addition, the placed lag screw using a cannulated screw and locking plate increases fixation stability, leading to better fracture healing.

Therefore, our new fixation method for correction of cubitus varus deformity could achieve stable fixation permitting immediate postoperative elbow motion after corrective osteotomy in young adults. We achieved the preoperative elbow ROM and complete bony union of the osteotomy site and proper correction of cubitus varus deformity. Our new fixation method using 2 crossing screws and a locking plate after corrective osteotomy can be a reasonable alternative for correction of a cubitus varus deformity.

Consent
Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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