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# Reverse V Osteotomy of the Distal Humerus for the Correction of Cubitus Varus

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## Abstract

**Introduction:** Cubitus varus deformity is triplanar, consisting of sagittal, coronal, and rotational components. There are numerous osteotomy techniques proposed in the past to address the correction of this deformity. Most osteotomies are aimed at correcting varus components only and are labelled as uniplanar osteotomies. The goal of the osteotomy is to correct the alignment of the elbow joint to a normal range of 5 to 15 degrees and create a stable joint. Cubitus varus deformity in children is a late complication of supracondylar humerus fracture.

**Aim:** The study aimed to correct the elbow so that it was anatomically and functionally identical to the opposite normal side.

**Methods:** It is an observational study; 14 children were treated for cubitus varus using a reverse V osteotomy. The study children were treated from January 2021 to December 2021 at Faridpur Medical College and Hospital, Faridpur, Bangladesh. A total of 14 patients had sustained a supracondylar humeral fracture, two lateral condylar fractures, two medial condylar fractures, and one trans-physical separation. All 14 children were treated for cubitus varus using a reverse V osteotomy.

**Result:** Among the majority, about sixty percent of children were from the age range of 1-2 years. We used Oppenheim's (1989) grading system to grade our results. This grading system has four labelled (Excellent, Good, Fair, and Poo) which are based on carrying angle (Degree) and range of movement (Degree) Table 1. Table 2 shows the assessment of the results according to modified Oppenheim's grading system. According to our study, 11(78.57%) children had an excellent outcome without complications, and 3(21.43%) children had a good result without complications.

**Conclusion:** We recommend this technique as a safe, reliable, reproducible, and technically easy procedure for the correction of cubitus varus deformity.

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## Introduction

Corrective osteotomy of the distal humerus is the procedure of choice, as it is most successful in reducing symptoms and recurrence of cubitus varus deformity. The goal of the osteotomy is to correct the alignment of the elbow joint to a normal range of 5 to 15 degrees and create a stable joint. Cubitus varus deformity in children is a late complication of supracondylar humerus fracture. Malunion is the primary cause [1]. Most patients usually achieve normal elbow function after fracture healing. The deformity results

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in an unsightly appearance. Cosmesis is the primary concern of the child's parents for deformity correction [2]. Although considered a cosmetic issue, many long-term complications of this deformity have been reported. These include ulnar nerve dislocation, ulnar neuropathy, snapping of the medial head of the triceps, secondary distal humeral or lateral condylar fracture, avascular necrosis of the distal humeral epiphysis, joint ganglia, osteoarthritis, posterior dislocation of the radial head, and posterolateral rotatory instability [3]. Cubitus varus deformity is triplanar, consisting of sagittal, coronal, and rotational components. There are numerous osteotomy techniques proposed in the past to address the correction of this deformity. Most osteotomies are aimed at correcting varus components only and are ldddddddd as uniplanar osteotomies. Biplanar osteotomies correct both sagittal and coronal malalignment. Tridimensional osteotomies tend to correct rotational malalignment in addition to hyperextension and varus components. In a systematic review, Solfelt et al. [4] reported an overall complication rate of 14.5% and a poor outcome rate of 12.2% with the corrective procedures. The residual varus was the most common complication (5.9%), followed by nerve injuries (2.5%), infection (2.5%), and re-operation (2.3%). There was no single technique found to be safe and highly effective. To date, no standard gold technique gives the maximum possible deformity correction and cosmetic appearance that satisfies patient caretakers and minimizes complications. We used a modified reverse V osteotomy (fishtail osteotomy) with the calculated medial translation of distal fragments to correct varus and sagittal plane deformity and to prevent lateral condyle prominence. Yun et al. [5] described reverse V osteotomy (fixed by cross-pinning and wiring) for treating cubitus varus. This technique is advantageous over step-cut osteotomy because it provides more space for fixation over the distal segment. This simple technique provides adequate stability of the step cut with minimal complications. This study aims to report the clinical, radiological, and cosmetic outcomes of the modified reverse V osteotomy technique. The surgery aimed to correct the elbow so that it was anatomically and functionally identical to the opposite normal side.

## Methodology and Materials

It is an observational study, a total of 14 children were treated for cubitus varus using a reverse V osteotomy. The study children were treated from January 2021 to December 2021 at Faridpur Medical College and Hospital, Faridpur, Bangladesh. A total of 14 patients had sustained a supracondylar humeral fracture, two a lateral condylar fractures, two a medial condylar fractures and one trans-physical separation. All the children had good elbow function with a full range of movement. The indication for surgery in all was cosmetic deformity.

### Inclusion criteria:

- All patients had a childhood humeral fracture history.
- Patients were aged under <15 years

### Operation procedure:

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 [6-10]. Valgus angulation was described as positive (+), and varus angulation as unfavourable (-). The amount of correction required was determined by adding the valgus angulation of the typical side to the varus angulation of the deformed side (Figure 1).

The line AB is perpendicular to the lateral supracondylar ridge located 5 mm to 10 mm above the olecranon fossa. Point C is determined proximal to line AB by the angle ABC (angle to be corrected) and angle ACB (which is always 90°) (Figure 1). After removal of the triangle ABC, the distal humerus is rotated laterally and translated medially, so that point A comes to meet point C (Figure 2).

The humeral-elbow wrist angle is measured on the standard elbow, and the meeting point X of the axes of the humerus and forearm is located (Figure 3). Corrected construct with no medial or lateral prominence so that X and Y coincide (Figure 4). Corrected construct with lateral prominence (Figure 5). Point Y shows the intersection point between a line perpendicular to the forearm axis drawn from point X and the humeral axis. Y is medial to X, and point C must be moved medially by the distance X-Y to correct the lateral prominence. Corrected construct with medial prominence (Figure-6). Y is lateral to X, and point C must be moved laterally by the distance X-Y to correct the medial prominence. Which intersected the second line at 90°? This point of intersection was marked as point C (Figure 1). Thus,

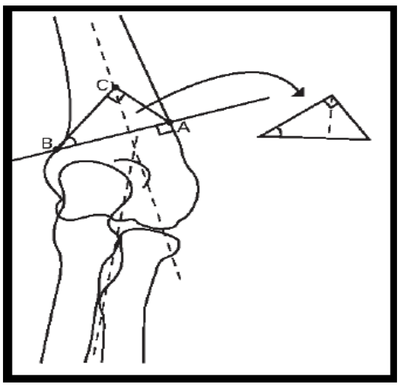


**Figure 1:** The line AB is perpendicular to the lateral supracondylar ridge located 5 mm to 10 mm above the olecranon fossa. Point C is determined proximal to line AB by the angle ABC (angle to be corrected) and angle ACB (which is always 90°).

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a triangle was formed with the angle ABC being the angle of the desired correction and the angle ACB being 90°. This triangle, which was then cut from the paper outline, was the area to be resected during surgery (Figure 1). After removal of this triangle, the entire distal humerus and forearm were rotated laterally and translated medially such that point A came to meet point C (Figure 2). This technique converted the humeral-elbow wrist angle to the normal valgus of the opposite elbow.

Diagrams of the pre-operative planning for the correction of varus. The line AB is perpendicular to the lateral supracondylar ridge located 5 mm to 10 mm above the olecranon fossa. Point C is proximal to line AB by the angle ABC (angle to be corrected) and angle ACB (Always 90°). After removal of the triangle ABC, the distal humerus is rotated laterally and translated medially, so that point A comes to meet point C. A line at right angles to the forearm axis was drawn from point X and crossed the humeral axis point at Y. Point C of the triangle ABC had to be moved medially or laterally by the distance X to Y for lateral or medial translation, respectively. This led to a slight change in the location of points A, B, and C but did not change the desired angles. Method of osteotomy and fixation. The surgery was performed under tourniquet control with the patient in the lateral position. The elbow was flexed to 90°, and a posterolateral approach was used. A longitudinal skin incision about 6 cm to 8 cm was made over the posterolateral aspect of the distal humerus. After superficial dissection, the triceps tendon was elevated from the lateral aspect to expose the distal humerus. The lateral supracondylar ridge was identified, and the point a marked. We used a small goniometer intra-operatively to construct the pre-operatively planned triangle. The first, second, and third osteotomy cuts were performed according to the pre-operative measurements with an oscillating saw and osteotomy. The triangular area

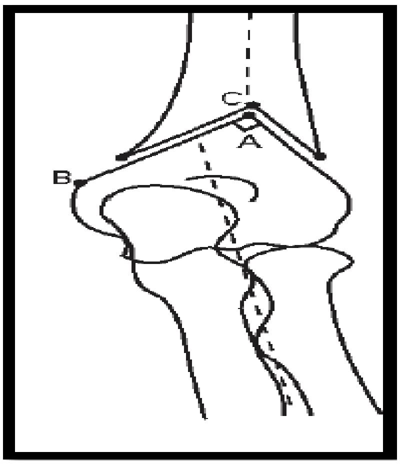


Figure 2: After removal of the triangle ABC, the distal humerus is rotated laterally and translated medially, so that point A comes to meet point C.

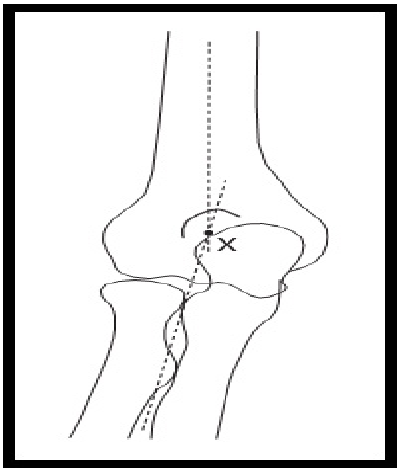


Figure 3: The humeral-elbow wrist angle is measured on the standard elbow, and the meeting point X of the axes of the humerus and forearm is located.

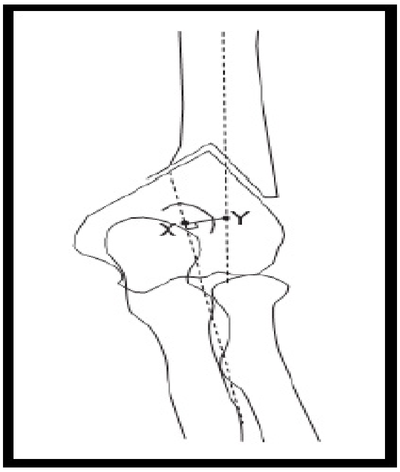


Figure 4: Corrected construct with no medial or lateral prominence so that X and Y coincide.

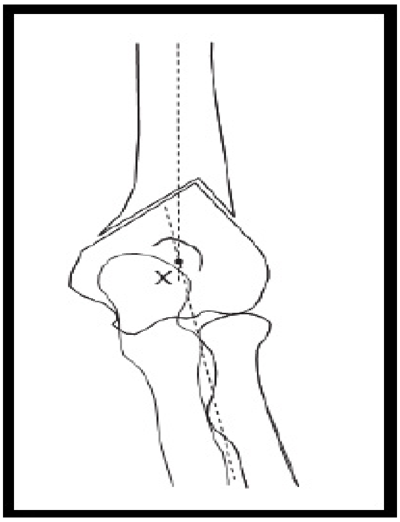


Figure 5: Corrected construct with lateral prominence.

ABC was resected, and the distal humerus and forearm rotated laterally to correct the varus deformity. Fixation was achieved with two lateral cross-wires and wiring, with care to avoid injury to the ulnar nerve. Postoperatively, a posterior elbow splint was applied in 90˚ of flexion. Active exercises were started two weeks after surgery.

## Result

This observational study was conducted with 14 children treated for cubitus varus using a reverse V osteotomy. All children had a childhood humeral fracture. Among the majority, about sixty percent of children were from the age range 1-2 years, 5(35.71%) children were from the age range 2-3 years, and only one child was from 0-1 years (Table 3). Table 4 shows the age distribution of the children studied, where 7(50%) children were from the age range 7-10 years, 5(35.71%) children were from the age range 3-6 and only two children under fifteen years. In our study, there are 9(64.29%) children were male, and 5(35.71%) children were female (Figure 7). We used Oppenheim's (1989) grading system to grade our results. This grading system has four grades (Excellent, Good, Fair, and Poo) which are based on carrying angle (Degree) and range of movement (Degree) (Table 1). Table 2 shows the assessment of the results according to modified Oppenheim's grading system (Table 5). According

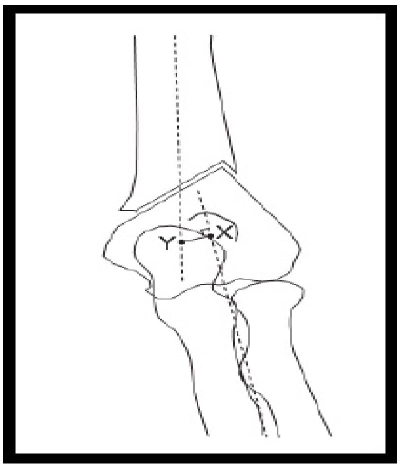


**Figure 6:** Point Y shows the intersection point between a line perpendicular to the forearm axis drawn from point X and the humeral axis. Y is medial to X, and point C must be moved medially by the distance X-Y to correct the lateral prominence. Corrected construct with medial prominence.

**Table 1:** The grading system of Oppenheim (1989).

| Grade | Carrying angle (Degree) | Range of movement (Degree) |
|---|---|---|
| Excellent | 0 | 0 |
| Good | 0-5 | 45200 |
| Fair | 45205 | 44136 |
| Poor | >10 | >20 |

**Table 2:** Assessment of the results according to a modified Oppenheim et al. [11] system.

| Outcomes | Frequency | Percentage | Complication |
|---|---|---|---|
| Excellent | 11 | 78.57 | No |
| Good | 3 | 21.43 | No |

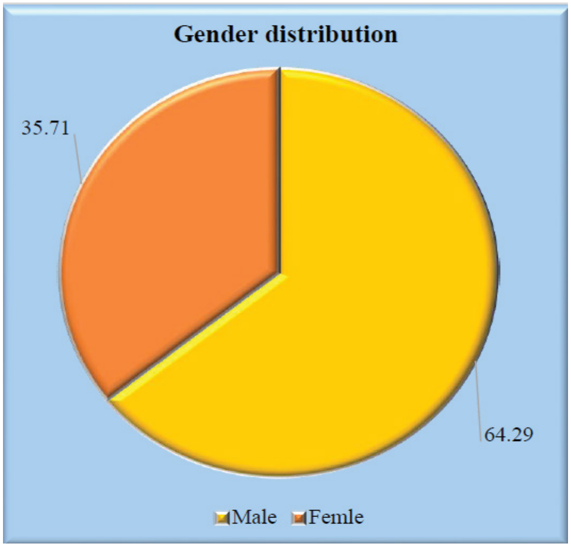


**Figure 7:** Gender distribution of the study children.

**Table 3:** Age distribution of the patients based on childhood humeral fracture.

| Age range (Years) | Frequency | Percentage |
|---|---|---|
| 0-1 | 1 | 7.14 |
| 44958 | 8 | 57.14 |
| 44987 | 5 | 35.71 |

**Table 4:** Age distribution of the study children during the study.

| Age range (Years) | Frequency | Percentage |
|---|---|---|
| 45080 | 5 | 35.71 |
| 45206 | 7 | 50 |
| ≤15 | 2 | 14.29 |

**Table 5:** Socio-demographical status of the study children.

| Variables | Frequency | Percentage |
|---|---|---|
| Upper | 2 | 14.29 |
| Middle | 4 | 28.57 |
| Lower | 8 | 57.14 |

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to our study, 11(78.57%) children had an excellent outcome without complications, and 3(21.43%) children had a good result without complications (Figure 8-10).

## Discussion

The surgical techniques described for the correction of cubitus varus differ in their approach to the distal humerus, the method of osteotomy, and the type of fixation [6-13]. The standard surgical approaches to the distal humerus are lateral, medial, posterolateral, and posterior [14-22]. In our study, we used a posterolateral approach since we thought it was more cosmetic than the other alternatives. Lateral closing-wedge, medial opening-wedge, step-cut, and dome-shaped osteotomies have been described [6-16]. In 1988, DE Rosa and Graziano [6] described a step-cut osteotomy for the correction of cubitus varus. This was based on the 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 the described technique has significant advantages over the original step-cut osteotomy. The osteotomy is performed at a higher level, providing better bone fixation. 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 the translation of the distal fragment is a frequent cause of poor cosmetic results [18-20]. A Lazy-S or a Z-deformity is commonly seen. Wong et al. [20] 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. [19] in a long-term follow-up of corrective osteotomy for cubitus varus, described the persistence of this deformity at the final follow-up [19]. Levine et al. [15] pointed out the importance of medial displacement of the distal humerus to decrease the prominence of the Post-operative a) anteroposterior and b) lateral radiographs six weeks after the osteotomy showing good healing and fixation by crossed K- wires inserted from the lateral side with additional wiring lateral humeral condyle. The amount of displacement was decided by the gross appearance of the operation. However, medial displacement disrupted the periosteum on the medial side, leading to instability and difficulty with fixation. Dome osteotomy has been popularized by Japanese surgeons and allows the residual prominence of the lateral condyle to be corrected by rotation in both the coronal and horizontal planes [7,12,23]. However, the decision regarding the exact amount of translation required is based on the surgeon's intraoperative assessment [15,21,23]. There is no provision for pre-operative calculation, and there is always a chance that over or under-translation may occur. Our technique of pre-operative planning can prevent lateral prominence by precisely calculating the location of point C of the osteotomy. Various methods of fixation of the osteotomy, both internal and external, have been described [6]. Kirschner (K-) wire fixation is simple, can be used in a child with an open physics and can be easily removed after the union. However, external immobilization for three to five weeks is usually recommended with simple K-wire fixation [23]. Plate and screw fixation offers the best stability and allows early elbow movement. [11] Usually, there is an insufficient length for the fixation of the distal fragment [11-17]. The loss of fixation may complicate De Rosa and Graziano's [6] use of a cortical screw because of a fracture of the narrow beak used for fixation.

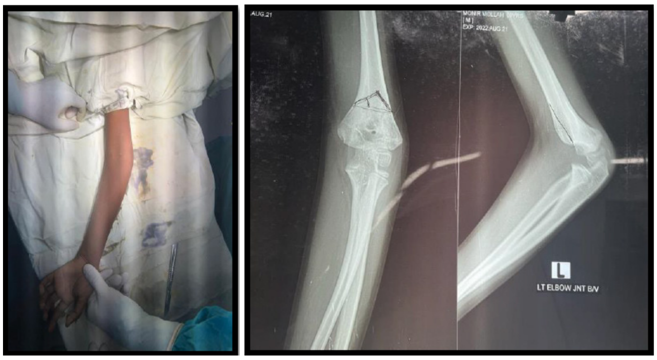


**Figure 8:** Pre-operative digital photographs of the patients.

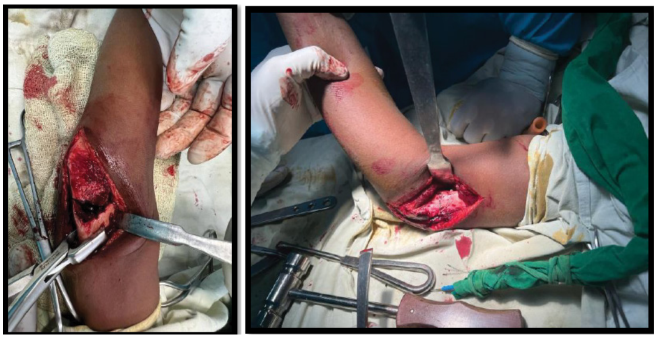

**Figure 9:** Digital photographs during operation.

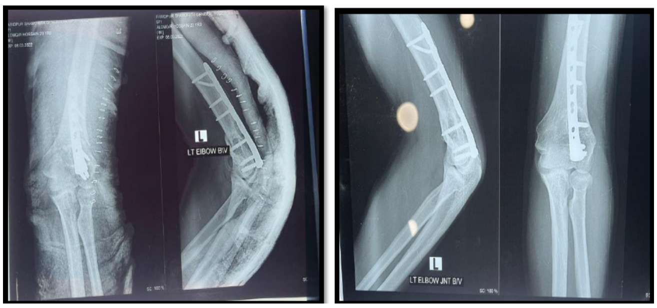


**Figure 10:** Post-operative photographs of the patients.

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External fixation may be in the form of a simple uniplanar fixator or an Ilizarov ring fixator [7,9,15,16]. These may have some advantages but can be inconvenient and uncomfortable for the child [7,15]. 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 varus and valgus forces at the osteotomy site [25]. We believe that additional wiring of the K-wires enhanced the stability of the construct. Pre-operative clinical appearance of the children's left/right sided cubitus Varus, b) pre-operative anteroposterior radiograph (right) showing a varus deformity of 22° compared with the average right side (left), c) post-operative AP radiographs and d) photograph showing the good cosmetic result.

## Conclusion and Recommendations

In conclusion, we recommend this technique as a safe, reliable, reproducible, and technically easy procedure for the correction of cubitus varus deformity.

## Limitations of the study

The limitations of our study include a small sample size; no comparison was made with other established techniques in this study.

## Funding

No funding sources

## Conflict of interest

None declared

## Ethical approval

The study was approved by the Institutional Ethics Committee.

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