Comparison Between Oblique Lateral Closing Wedge Osteotomy and Dome Osteotomy for Cubitus Varus

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Abstract

Cubitus varus deformity usually results as a late complication of supracondylar fracture of the distal humerus. Different types of corrective osteotomies have been described, but a gold standard has not yet been established. This study aims to compare the results of oblique lateral closing wedge osteotomy and dome osteotomy for cubitus varus correction in skeletally immature patients. This study was conducted on 20 cases, which were operated during the period between July and December 2021. We performed oblique lateral closing wedge osteotomy on half of the patients and the other half managed with dome osteotomy. The mean age of patients was 9 years, 40% of them were males and 60% were females. The cases were divided into two equal parts 50% were affected in the dominant side and the other 50% were in the non-dominant side. Knowing that all patients were skeletally immature and had an average varus angle of 17.66°. The results of Range of elbow flexion-extension motion were affected in active flexion by ten degrees or less in 5 patients (50%) for oblique lateral closing wedge osteotomy and 7 patients (70%) for dome osteotomy, more than ten degrees up to twenty degrees in 3 patients (30%) for oblique lateral closing wedge osteotomy and 2 patients (20%) for dome osteotomy, and more than twenty degrees in 2 patients (20%) for oblique lateral closing wedge osteotomy and 1 patient (10%) for dome osteotomy. The difference in the carrying angle between the normal side and side where an operation was carried out was 5 degrees or less in 7 cases (70%) for oblique lateral closing wedge osteotomy and 6 patients (60%) for dome osteotomy, and more than five to ten degrees in 3 cases (30%) for oblique lateral closing wedge osteotomy and 4 patients (40%) for dome osteotomy. With net result, for oblique lateral closing wedge osteotomy 6 patients had excellent results (60%), 2 patients had good results (20%), and 2 patients had poor results (20%). While for dome osteotomy 7 patients had excellent results (70%), 2 patients (20%) had good results and only 1 patient had poor results (10%). Supracondylar lateral closing wedge osteotomy via lateral approach is safe, cost-effective, simple and with a low rate of complications. The dome-shaped osteotomy fixed by crossed pins is a relatively simple procedure and more effective in minimizing lateral condylar prominence.

Keywords: Cubitus varus, Deformity, Osteotomy.
1. Introduction

Supracondylar fractures of the humerus are the second most frequent type of bone injury in children [1,2], the occurrence of supracondylar fractures of the humerus accounts for 55 to 75% of patients with elbow fractures [3,4], representing 3-7% of overall pediatric fractures [5], ninety-five percent are displaced in extension and occur secondary to a fall on an outstretched arm.

Typically, malunion of supracondylar fractures often leads to cubitus varus, or "gunstock deformity" [6]. Cubitus varus is a tri-planar deformity consisting of varus angulation in the coronal plane, internal rotation in the axial plane and extension in the sagittal plane [7].

Although cubitus varus has been conventionally described as a cosmetic deformity with little functional significance, there is growing awareness of long-term complications, including chronic pain, ulnar nerve palsy, tardy posterolateral rotatory instability, snapping elbow and an increased risk of lateral condyle and other secondary fractures [8].

Once symptomatic, the lateral ulnar collateral ligament (LUCL) is irreversibly attenuated and morphologic changes in the ulnohumeral joint necessitate more extensive surgery to include distal humeral osteotomy, LUCL reconstruction, and possibly ulnar nerve transposition [9], for this reason, it may be appropriate to offer surgical treatment in the vast majority of patients with this complaint.

Various treatment options proposed include observation, hemi epiphysiodesis and growth alteration, and corrective osteotomy [10].

Corrective osteotomy is the preferred method, as it yields the highest probability of success [11]. Various osteotomy techniques have been developed to address these problems, including a lateral closing-wedge osteotomy [12], medial opening wedge [13], dome osteotomy, a variety of more complex osteotomies [14] and distraction osteogenesis [15].

This study was done to evaluate and compare the results of lateral closing wedge osteotomy and dome osteotomy for correction of cubitus varus deformity after malunited supracondylar fractures in children.

2. Patients and Methods

This prospective study included twenty patients having cubitus varus deformity after malunited supracondylar fractures managed with surgical correction by Oblique Lateral Closing Wedge Osteotomy and Dome Osteotomy at the Department of Orthopedic Surgery, Sporting Health Insurance Hospital and AL-Zahraa University Hospital During the period from June 2021 to December 2021. Last patient follow up period for 6 months.

All patients were skeletally immature of either sex, had substantial cubitus varus with potential for late squeal (a carrying angle exceeding 5° to 10° of varus), appropriate clinical settings (i.e., active patient, cosmetic concerns, asymmetry to unaffected contra lateral limb, open physis), age more than five years old, one year after inciting trauma or event (plateaued range of motion and remodelling potential). Skeletally mature patients and symptomatic patients either with instability or with lateral condyle fracture were excluded.

All patients in this study were clinically assessed, especially the range of movements and carrying angle measured clinically by a goniometer, Computerized radiology (CR) with 100% magnification anterior posterior (with elbow in full extension and forearm in full supination & lateral radiographs of the elbow were taken of deformed limb and contralateral side for comparison. The carrying angle of each elbow was measured. In all patient’s humerus-elbow-wrist angle was measured on both sides and the correction needed was calculated.

Prophylactic preoperative I.V antibiotic (3rd generation cephalosporin) was used 30
minutes before surgery, the dose was calculated according to body weight. A pneumatic tourniquet was used in all cases. The patients were placed in supine position on the operating table and the operative elbow was centered on a hand table for lateral closing wedge osteotomy operation, the lateral approach was applied, two Kirschner wires were placed to guide the osteotomy cuts, the periosteum incised longitudinally at the planned osteotomy site and bone exposed laterally, enough subperiosteal elevation was performed anteriorly and posteriorly to place retractors on the bone to the medial side to expose the humerus up to the olecranon, the medial periosteal sleeve was maintained, and A triangle which represents the osteotomy. Was drawn with diathermy with its base is the lateral edge of the humerus according to the preoperative calculation of the wedge to be removed. The K-wires were used to draw the two arms of the triangle by introducing them from lateral to medial at the two ends of the base of triangle to meet each other's just before the medial cortex under image intensified radiology. The initial osteotomy was done 0.5 to 1 cm superior to the olecranon fossa and parallel to the elbow joint line. The other cuts for this osteotomy were made according to the preoperative measurements using multiple drill holes and osteotome and which were preferred due to their less thermal effect which might affect the union. the perpendicular triangle of bone after making continuous small bone holes along the planned triangle line using thin Kirschner wires and osteotome was excised., Confirm the reduction on both anteroposterior and lateral fluoroscopy, Fixation starts with the introduction of the K-wire which is already inserted at the distal fragment to cross the osteotomy after closure of the wedge and introduction of another K-wire 5 mm to 10 mm from the first, another two augmentation K-wires of 1.5 to 2mm were introduced from the proximal to the distal fragment directed from the lateral to medial aspect of the humerus aiming at the medial epicondyle with great care not to exceed the medial cortex to prevent injury of the ulnar nerve. Lateral position with arm supported and forearm hanging with 90° elbow flexion for dome osteotomy operation, A midline posterior approach was used in patients who underwent dome osteotomy, The periosteum was first incised with a sharp scalpel along the midline. Then, it was stripped from the midline with ½ reflected to the lateral side and the other ½ to the medial side, the intersection of the midline axis and the upper margin of the olecranon fossa (Point O) was designated as the center of the dome. With the OA segment as the base, a second line was drawn from Point O to form an angle equal to the planned correction angle (α). The intersection of this line and lateral cortex was point B. The length of segment OB was designated as the radius of the dome. The arc of the domed osteotomy was defined based on these parameters, Percutaneous cross 'K' wire fixation for the osteotomy was done. The tourniquet was deflated after securing fixation, hemostasis was done with electro-coagulation. Irrigate and the surgical wound was with the elbow flexed 90°. Cut and bent the Kirschner wires and left outside the skin, Closure was meticulous including the closure of periosteum with 2-0 Vicryl, subcutaneous tissue is closed with simple inverted 2-0 Vicryl and finally the skin is closed with 3-0 proline, a sterile dressing was applied. Above elbow posterior splint in 90°-degree flexion for four weeks. assessment of the general condition of the limb, vital data, neurological status and circulation was done for the first 24 hours, Wound care and dressing should be changed daily for the first two days. Then every three days, Active exercises of the fingers and wrist were encouraged from the first postoperative day, Intravenous antibiotics were given for the next two days in the post-operative period and a further 5 days of oral antibiotics were given, with analgesic and anti-edematous medications,
Stitches were removed after two weeks of operation. Postoperative X-ray was taken, carrying angle and LCPI were calculated. X-ray was repeated after four weeks. K-wires were removed when there was sufficient union. Follow up was done every four weeks, with X-rays till complete radiological union and complete expected results were obtained. The score system of [16] (was used in this study to evaluate the results. An excellent result was one with loss of carrying angle of 5° or less, and loss of the range of flexion and extension by 10° or less. A good result was one in which the loss of carrying angle was from 6° to 10°, and the loss of flexion and extension was 20° or less. A poor result was one in which the difference in carrying angle was over 10° or the range of flexion and extension was limited by more than 20°.

Variables of each patient were recorded and analyzed concerning age, sex, carrying angle, range of motion, patient satisfaction, limb involvement and outcome.

2.1 Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version (15). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent-sample t-test of significance was used when comparing between two means. A chi-square (x²) test of significance was used to compare proportions between two qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant which: P-value which <0.05.

3. Results

Twenty patients have cubitus varus deformity managed by surgical correction by oblique lateral closing wedge osteotomy and dome osteotomy. They were followed up for 6 months. The mean age of patients was 9 years, 40% of them were males and 60% were females. The cases were divided into two equal parts 50% were affected on the dominant side and the other 50% were in the non-dominant side. The range of elbow flexion-extension motion was affected in active flexion by ten degrees or less in 5 patients (50%) for oblique lateral closing wedge osteotomy and 7 patients (70%) for dome osteotomy, more than ten degrees up to twenty degrees in 3 patients (30%) for oblique lateral closing wedge osteotomy and 2 patients (20%) for dome osteotomy, and more than twenty degrees in 2 patients (20%) for oblique lateral closing wedge osteotomy and 1 patient (10%) for dome osteotomy (Tables 1&2). This result reflected that patients who underwent for lateral closing wedge osteotomy 50% have excellent results.30% good & 20% poor results. And 70% have excellent results.20% good & 10% poor results patients underwent for dome osteotomy. The difference in the carrying angle between the normal side and side where the operation was carried out was 5 degrees or less in 7 cases (70%) for oblique lateral closing wedge osteotomy (patients (60%) for dome osteotomy, and more than five to ten degrees in 3 cases (30%) for oblique lateral closing wedge osteotomy and 4 patients (40%) for dome osteotomy, and no patients have to carry more than 10° for either oblique lateral closing wedge osteotomy or dome osteotomy (Tables 3&4). This result reflected that patients who underwent lateral closing wedge osteotomy 70% have excellent results.30% good & 0% poor results. And 60% have excellent results.40% good & 0% poor results patients underwent for dome osteotomy. Male patients were found more satisfied with the end results after corrective osteotomy of their deformed elbows. (Table 5, 6).
Table (1): ROM of the elbow joint (Lateral closing wedge).

<table>
<thead>
<tr>
<th>Range of motion affection</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10deg</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>10 - 20deg</td>
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<td>30</td>
</tr>
<tr>
<td>20deg</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>100</td>
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</tbody>
</table>

Table (2): ROM of the elbow joint (Dome osteotomy).

<table>
<thead>
<tr>
<th>Range of motion affection</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10deg</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>10 - 20deg</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>20deg</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

Table (3): Carrying angle comparison with normal side (Lateral closing wedge).

<table>
<thead>
<tr>
<th>Carrying angle difference</th>
<th>No</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>0-5deg</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>&gt;5-10 deg</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>&gt;10 deg</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>100</td>
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</table>

Table (4): Carrying angle comparison with normal side (Dome osteotomy).

<table>
<thead>
<tr>
<th>Carrying angle difference</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5deg</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>&gt;5-10 deg</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>&gt;10 deg</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>100</td>
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</table>

Table (5): Relation between the end results & sex of patients (Lateral closing wedge).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Excellent N</th>
<th>Excellent %</th>
<th>Good N</th>
<th>Good %</th>
<th>Poor N</th>
<th>Poor %</th>
<th>Total N</th>
<th>Total %</th>
<th>X²</th>
<th>p. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4</td>
<td>40%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>4</td>
<td>40%</td>
<td>20.0</td>
<td>0.011</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>20%</td>
<td>2</td>
<td>20%</td>
<td>2</td>
<td>20%</td>
<td>6</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6</td>
<td>60%</td>
<td>2</td>
<td>20%</td>
<td>2</td>
<td>20%</td>
<td>10</td>
<td>100%</td>
<td></td>
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</table>

p. value<0.05 significant

Table (6): Relation between the end results & sex of patients (Dome osteotomy).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Excellent N</th>
<th>Excellent %</th>
<th>Good N</th>
<th>Good %</th>
<th>Poor N</th>
<th>Poor %</th>
<th>Total N</th>
<th>Total %</th>
<th>X²</th>
<th>p. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4</td>
<td>40%</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
<td>4</td>
<td>40%</td>
<td>20.0</td>
<td>0.011</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>30%</td>
<td>2</td>
<td>20%</td>
<td>1</td>
<td>10%</td>
<td>6</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
<td>70%</td>
<td>2</td>
<td>20%</td>
<td>1</td>
<td>10%</td>
<td>10</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These results reflected that of patients who underwent lateral closing wedge osteotomy 40% had excellent results for boys and 20% for girls. 0% good results for boys and 20% for girls & 0% poor results for boys and 20% for girls. And 40% have excellent results for boys and 30% for girls. 0% good results for boys and 20% for girls & 0% poor results for boys and 10% for girls for patients who underwent dome osteotomy. All patients were satisfied with the results except two patients (10%), who complained of the operative scar with good correction of the deformity for dome osteotomy.

3.1 Complications

Five (25%) showed necrosis of skin over the lateral condyle due to the subcutaneous end of the K-wires which was treated with dressing and removed after signs of full union. Two cases (10%) were not satisfied with the cosmetic appearance of the unsightly hypertrophied scar. Five cases (25%) had mild limitation of active elbow flexion due to imperfect hyperextended lower-end humerus reduction which did not affect the functional range.

3.1.1 Case Presentation

Case 1:

Seven years old male child, student, right-handed. Presented with cubitus varus left side, carrying angle 21° with internal rotation and slight hyperextension.

Figure 1: Pre-operative plain-x rays AP- Lateral views.
He was managed with oblique lateral closing wedge osteotomy. At the end of the follow-up, there was no pain. Carrying angle of 4°, full range of elbow motion (0-140°) and showing excellent results according to M.C Bellmore et al scoring (17).

Figure 2: Pre-operative clinical photo.

Figure 3: Plain x-ray AP and Lateral views at one month post-operative showing complete union and deformity correction.
Case 2:

Five and half years old female child, student, right-handed. Presented with bilateral cubitus varus, right side carrying angle 18° and left 16° with internal rotation and no hyperextension on both sides. The right side was managed with a dome osteotomy. At the end of the follow-up, there was no pain. Right Carrying angle 6°, full range of elbow motion (0-140°) and show excellent results according to M.C Bellmore et al scoring [17].

Figure 4: Preoperative x ray & clinical photo.

Figure 5: Post-operative- X-ray & clinical photo.
4. Discussion

The pediatric supracondylar humerus fracture has a high rate of malunion and tends to be malunited over time. The incidence of pediatric supracondylar fracture was quite high, 5% of all pediatric and adolescent fractures. At the same time, the incidence of malunited of the supracondylar humerus lately was named a cubitus varus deformity varies from 3% to 57% [18]. Several recommendations have been proposed to treat pediatric supracondylar fracture, but the result and the strength of evidence were varied, Osteotomy is the only way to correct a cubitus varus deformity with a high probability of success. There was no statistically significant difference between our results compared with other published series.

In our study, twenty patients having cubitus varus deformity, half managed by surgical correction by oblique lateral closing wedge Osteotomy and other half by dome osteotomy. The mean age of patients was 9 years, 40% of them were males and 60% were females. The cases were divided into two equal parts 50% were affected in the dominant side and the other 50% were in the non-dominant side. Knowing that all patients were skeletally immature and had an average varus angle of 17.66°.

We first compared our results for each technique to previously reported results then compared to each other.

A significant ($p < 0.01$) correction of carrying angle was achieved with both techniques, with no statistically significant differences between them. Although internal rotation deformity was corrected by both techniques, the correction was significantly greater with the dome osteotomy ($p < 0.01$).

In [19] described lateral closed wedge osteotomy and reported that the preoperative carrying angle of the involved elbow was measured for all patients and averaged 22.8° of varus (range 14.5°-34°).

Postoperatively, the carrying angle of the involved elbow improved to 3.3° of valgus (range 4° of varus to 15° of valgus); this compared to a carrying angle of the opposite normal elbow- of 9.3° of valgus (range 7° to 15° of valgus). The average correction of carrying angle was 25.5° (range 15°-36). In [20], described dome osteotomy Preoperative carrying angle of normal side ranged from 8° to 14° (mean: 10.40±1.72) and that of effected side ranged from -24 to -14 (mean: -18.07±3.10) and the difference was significant ($p<0.001$).

In our study according to Pre and postoperative range of motion were measured for all patients. Preoperatively, the range of motion averaged 4.1° of extension (range 0°-15°) to 128° of flexion (range 115°. 140°). Postoperatively, average the range of motion was 2.33° of extension (range 0°-5°) and 133° of flexion (range 115°-140°).

In [21] described lateral closed wedge osteotomy reported the mean preoperative range of motion was about 127° (range 115°-140°), while the mean range of motion at the time of the last follow-up was about 122 (range 110°-135°).

In [20] described dome osteotomy reported that the preoperative extension angle was 2.00±4.14° which was reduced to reach 1.33±3.52° postoperatively but this change was not significant ($p=0.334$).

In our study, At the end of follow-up, 13 patients had excellent results (65%), 6 lateral closed wedge osteotomy and 7 dome osteotomy; 4 patients had good results (20%) 2 lateral closed wedge osteotomy and 2 dome osteotomy and 3 patients had poor results (15%) 2 lateral closed wedge osteotomy and 1 dome osteotomy, with net result 80 % were satisfactory lateral closing wedge and 90% for dome osteotomy.

In [9] described lateral closing wedge in the correction of cubitus varus and used the same criteria They reported 92% of patients had an excellent result and none had a lateral prominence [22] described dome osteotomy in the correction of cubitus
Cubitus varus and used the same criteria on 10 children, the indication was usually cosmetic. The patients were followed for 2 years, all patients showed excellent to good results. No patients had poor outcomes study revealed Male patients were found more satisfied with final end results after corrective osteotomy of their deformed elbows, Difference in the result between patients of different ages was found to be statistically significant with younger age (5-10), and the non-dominant side showed significant better results than dominant side.

5. Conclusion

Cubitus varus is a common complication of supracondylar fracture of the humerus in children. Supracondylar lateral closing wedge osteotomy via lateral approach is safe, cost-effective, simple and with a low rate of complications. The dome-shaped osteotomy fixed by crossed pins is a relatively simple procedure and obtains three-dimensional correction of the deformity. The osteotomy site is inherently more stable than a lateral wedge osteotomy and is also effective in minimizing the lateral condylar prominence.

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Conflicts of interest: No competing interests.

References


