

How to Cite:

Kumar, S., Jashanpreet, J., & Singh, R. (2022). A clinical study of outcomes of supracondylar osteotomy in correcting cubitus varus deformities. *International Journal of Health Sciences*, 6(S1), 9972–9987. <https://doi.org/10.53730/ijhs.v6nS1.7361>

A clinical study of outcomes of supracondylar osteotomy in correcting cubitus varus deformities

Dr Sumit Kumar

Assistant Professor, Department of Orthopaedics, Maharaja Agrasen Medical College, Agroha, Haryana, India

Corresponding author email: drsumitkamboj30@gmail.com

Dr Jashanpreet,

Medical Officer, Department of Pathology, Government of Haryana, India

Dr Raj Singh,

Professor, Department of Orthopaedics, Pt. B. D. Sharma, PGIMS, Rohtak, Haryana, India

Abstract---Background: It is the most frequent complication of treatment for supracondylar humeral fractures in children. Although cubitus varus has been conventionally described as a cosmetic deformity with little functional significance, Supracondylar fracture of humerus is one of the commonest fractures sustained by children. It is one of the difficult fractures to treat due complications like malunion, neurovascular injury, ischemic contracture. Much attention paid to prevention of malunion by anatomical reduction either by closed or open method. The present study evaluates a technique of correction of post-traumatic cubitus varus in children with a laterally based closing-wedge osteotomy of the distal humerus with medial displacement of distal fragment, through a lateral approach and fixation with percutaneous Kirschner wires. Material and Methods: A Retrospective study, which was conducted in department of Orthopaedics of Maharaja Agrasen Medical College, Agroha, Haryana, India, in 42 children with cubitus varus deformity following supracondylar fracture of humerus, were treated by lateral closing wedge osteotomy with medial displacement of distal fragment and fixation with percutaneous K-wires. Out of these, 36 children who satisfied the inclusion and exclusion criteria, and were available for assessment of final outcome were included in this study. Results: 69.4% of the patients had excellent results, 16.7% patients had good results and 13.9% patients had poor results according to this criteria. The 5 poor results were due to residual varus deformity in one patient

and due to increase in Lateral Prominence Index more than 2.5% in 4 patients. 91.7% of the patients were satisfied with the cosmetic outcome. Although a lateral bump was noticeable in 4 (11.1%) patients postoperatively, only 2 of them were dissatisfied by its cosmesis. A noticeable scar was present in 2 of the patients. The cosmetic dissatisfaction was due to the lateral bump in 2 patients and due to residual varus deformity in one patient. Complications were present in 19.4% of patients. This included a transient ulnar neuropraxia in one patient (2.8%), pin-tract infection in 3 patients (8.3%), pin-tract infection along with pin loosening and backout in one patient (2.8%) and skin blebs in two patients (5.5%). Conclusion: However, osteotomy for correction of cubitus varus is safe, effective and gives cosmetically more acceptable elbow. Corrective osteotomy done in childhood, takes advantage of the better chances of union and remodelling. Lateral closing wedge osteotomy and fixation with percutaneous K- wires with medial displacement of distal fragment is a relatively simple technique, avoids neurovascular injuries, and gives excellent results without much problem of lateral prominence and good cosmetic appearance.

Keywords---Complications, Supracondylar fracture, cubitus varus, lateral closing wedge osteotomy, percutaneous K-wires, recovery, Supracondylar Osteotomy.

Introduction

Supracondylar fracture of humerus is one of the commonest fractures sustained by children. It is one of the difficult fractures to treat because of rather frequently occurring complications like, malunion, stiffness of elbow, nerve injury, vascular injury and volkman's ischaemic contracture .[1-4] The goal in treating these fractures is to reestablish the anatomy of distal humerus with least complications and with enough stability. Much attention has been paid to the problem of malunion of supracondylar fractures of humerus by obtaining, as anatomical a reduction as possible either by closed or open method. Cubitus varus (gunstock deformity) is the most common long-term complication of supracondylar fractures of the humerus in children. Reported in up to 58% of patients, its occurrence is higher in fractures originally managed conservatively.[5,6] Components of cubitus varus deformity are: a) medial angulation, b) medial rotation, c) extension of distal fragment with or without d) medial condyle epiphyseal injury leading to delayed growth of medial condyle and cubitus varus deformity.[7] Although many causes have been proposed for varus malunion of supracondylar fractures , the biomechanical forces acting around the elbow which causes a medial tilt of the distal fracture fragment resulting in malunion has been most accepted.[8,9] Cubitus varus does not often cause functional disability and surgery is mostly required for cosmetic reasons. It is better corrected during childhood with different methods of corrective osteotomy. Many surgical techniques to correct a cubitus varus deformity are described in literature.[10-12] These include opening wedge, closing wedge and three-dimensional osteotomies and reverse ' V ' osteotomy .[13-19] Lateral Closed wedge osteotomy is easy to perform but some

authors have been critical of this method, alluding to problems with a lateral condylar prominence (lazy-S deformity) or an unsightly scar. 10,21,22 The lateral closing-wedge osteotomy of French has been one of the most popular. By design, this method is primarily a uniplanar osteotomy. Although many authors reported successful correction of the varus alignment and correction of the rotary component,[13,14,24-30] the overall cosmetic appearance of the elbow has received little attention. To avoid the cosmetically unacceptable 'lazy S' deformity of the elbow, various surgical techniques like Pentalateral osteotomy, Modified step cut osteotomy and Lateral closed-wedge osteotomy with medial displacement of distal fragment have been introduced.[31] But very few indian studies are available regarding medial displacement of distal fragment. The present study evaluates a technique of correction of post-traumatic cubitus varus in children with a laterally based closing-wedge osteotomy of the distal humerus with medial displacement of distal fragment, through a lateral approach and fixation with percutaneous Kirschner wires.

Materials and Methods

A Retrospective study, which was conducted in department of Orthopaedics of Maharaja Agrasen Medical College, Agroha, Haryana, India, in 42 children below the age of 15 years with cubitus varus deformity following supracondylar fracture of humerus, were treated by lateral closing wedge osteotomy with medial displacement of distal fragment and fixation with percutaneous K-wires. Out of these, 36 children who satisfied the inclusion and exclusion criteria, and were available for assessment of final outcome were included in this study. Patients who lost to follow up, had other modalities of treatment and older than 15 years are excluded. The pre-operative and postoperative data regarding each patient, including the details of follow up (which was already over), was collected from their case records and from radiographs available with the patient and those in the data bank of radiology department. The data for subjective evaluation (questionnaire regarding cosmetic satisfaction) was collected from patients or their parents through direct interview during this study period. All patients were evaluated pre operatively by history, clinical examination, radiographs (AP, Lateral views of elbow) and with investigations and written informed consent. In clinical examination, carrying angle of both elbows measured with goniometer in full extension. Measurements of Range of movements of both elbows, internal rotation of deformity and lateral prominence index is calculated. The purpose of the corrective osteotomy is to produce an elbow joint with a final appearance closely similar to that of the unaffected side. Before planning, radiographs of both upper extremities were taken in the same position with the elbow joints fully extended and the forearms fully supinated. The radiograph of the affected side was then traced. The traced forearm was superimposed on top of the reversed radiograph of the unaffected forearm, and the unaffected humerus is traced. The angle between the central axes of both the affected and the unaffected humerus, when the forearm remain superimposed, is the angle of correction. The angle of correction was copied onto a card in form of a triangle with two equal limbs and with several marks in both limbs at equal distances. The planned triangle was cut out and sterilized. Under general anaesthesia in supine position, under aseptic precautions, with application of tourniquet, lower humerus is exposed subperiosteally through a lateral approach because it gives adequate exposure

and makes it easier to remove a lateral based wedge without much retraction of the lateral soft tissues. The planned lateralbased wedge is marked in the supracondylar area, taking into consideration, the amount of extension deformity at the malunited fracture site. Hohmann retractors are inserted subperiosteally to protect the medial, posterior and anterior structures. The wedge is then excised; the medial cortex is broken carefully by avoiding injury to ulnar nerve. The osteotomy is closed slowly and carefully. Distal fragment is medially displaced till the lateral borders are flush. During closure of the osteotomy, the posterior cortex of the distal fragment could be hinged over that of the proximal fragment to correct the internal rotation deformity if present. The osteotomy is fixed by two percutaneous Kirschner wires passed from the distal lateral to proximal medial cortex. The pins are bent to prevent migration, cut off outside skin and to allow removal in the outpatient clinic without anaesthesia. Carm imaging is done to assess the correction and fixation. Wound is closed in layers and a well padded above -elbow slab is applied with elbow in 90 degrees of flexion. A careful observation for complications id done at regular intervals.Immediate post operative radiographs were taken to assess correction of deformity and security of fixation of osteotomy with appropriate antibiotic coverage. Follow - up Sutures were removed after two weeks in out patient clinic.Pop slab was kept for 5 -6 weeks (depending on the age of the patient). Kirschner wires were removed after 6 weeks postoperatively depending on x-ray taken to assess union, followed by active range of motion (ROM) exercises. At each followup visit, the children were assessed for range of motion, carrying angle, and the presence of any bony prominence over the lateral condylar region or an unsightly scar at the site of surgery and the data was entered in case records. Radiographs were performed in the immediate postoperative period, at 5-6 weeks (on removal of POP), when the patient regained full range of motion and at final follow up. All these data were obtained from the case records and radiographs were collected from the patient or from the radiology data bank, and were evaluated during the present study. As in Figure 1 and Figure 2.

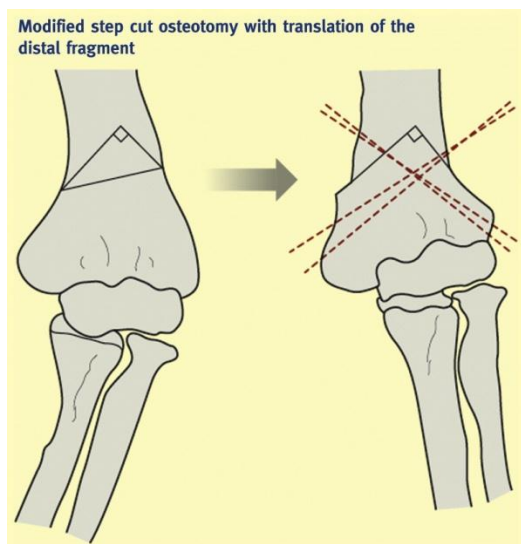


Figure 1. Supracondylar Fractures

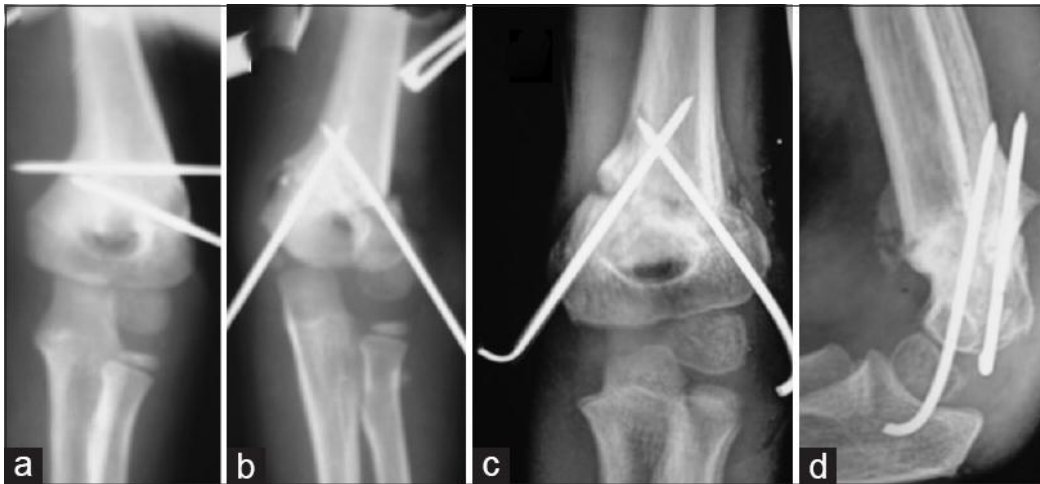


Figure 2. Correction of cubitus varus with lateral closed wedge osteotomy and cross K- wire fixation

Method of evaluation

Follow up of the patients ranged from 1 year to 10 years. Assessment include the subjective evaluation of the lateral condylar prominence, cosmesis and scar; and objective evaluation. These were used as strict criteria to categorize the results. Radiographic assessment included the measurement of the carrying angle and LCPI. The operative time, blood loss, neurological complications, infection, wound healing and pin tract condition were recorded. The results of the osteotomy are categorized as excellent, good and poor as in Table-2

Statistical Analysis

This retrospective study included 36 children. Sample size was justified using the Formula: $N = (Z_{\alpha/2} + Z_{\beta})^2 \times 2(SD)^2 d^2$.

Where SD is the Standard deviation obtained from previous similar study, Kumar in year 2014 = 2.4 d= accuracy of the estimate=2 $Z_{\alpha/2}$ = Normal deviate for two tailed hypothesis = 1.96 Z_{β} = 1.64 (Type II Error) N = Sample size Substituting the above formula we get a sample size of 37. Descriptive statistical analysis was carried out in the present study. Results on continuous measurements are presented on Mean value (Min-Max) and results on categorical measurements are presented in Number%. Variables will be correlated wherever relevant. Using statistical software SPSS 20.0 data and Microsoft word and excel generated tables and figures RESULTS In this study 36 children with cubitus varus who were treated by supracondylar lateral closing wedge osteotomy with medial displacement of distal fragment and fixation with percutaneous K-wires were evaluated objectively and subjectively.

Descriptive statistics of the patients

A) Age: Mean age of the study group was 9 ± 3.43 years. There were 23 children in the age group 5 – 10 and 13 children in the age group 11 – 15.

- B) Side: 17(47.2%) patients had cubitus varus of Right side and 19 (52.8%) patients had deformity of Left elbow.
- C) Sex Distribution: There were 23 boys and 13 girls in this study.
- D) Initial mode of treatment: 5 (13.9%) out of the 36 children, with cubitus varus in this study were initially managed surgically by closed reduction and percutaneous pinning with K-wires for supracondylar fracture. Rest were treated conservatively during the initial injury. As in table 1 and Figure 3

Table 1

Initial treatment	Number of patients (n)	Percentage (%)
Conservative	31	86.1
Surgical	5	13.9

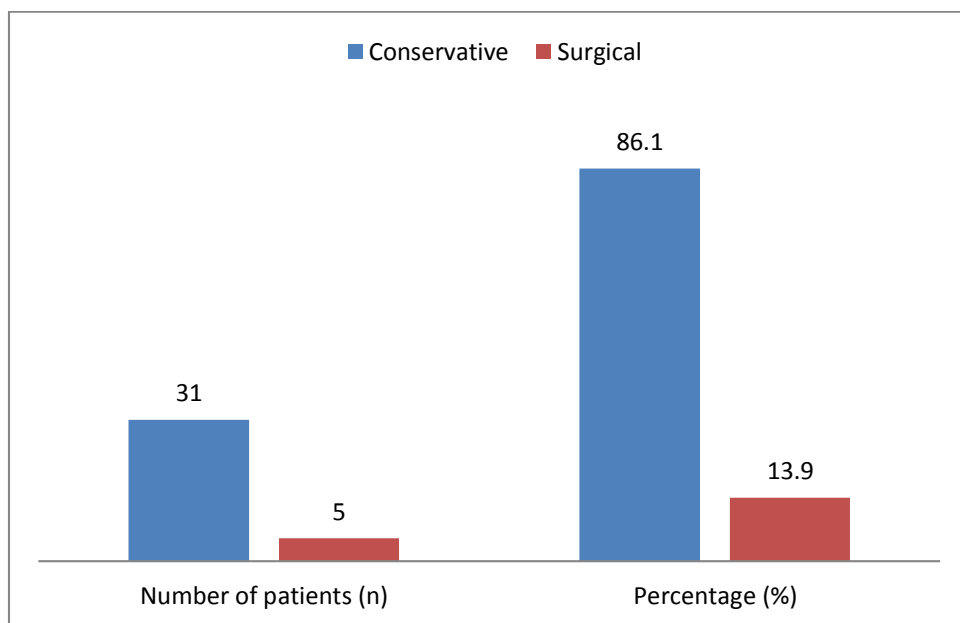


Figure 3. Initial treatment

- E) Recurrent #, Lateral condyle # : 6 children had a relevant past history of trauma. 3 children with cubitus varus had sustained lateral condyle fracture and 2 children had sustained a refracture at the old supracondylar fracture site. One girl, had sustained supracondylar re-fracture one year after the initial supracondylar fracture and again sustained a lateral condyle fracture two years later. So altogether 4 children (11.11%) with cubitus varus had a history of lateral condyle fracture. As in table 2 and Figure 4.

Table 2
Re# - Refracture, L/C# - Lateral condyle fracture

Past History	N	%
Re#	2	5.55
L/C#	3	8.33
"Re #,L/C #"	1	2.77
Total	6	16.6

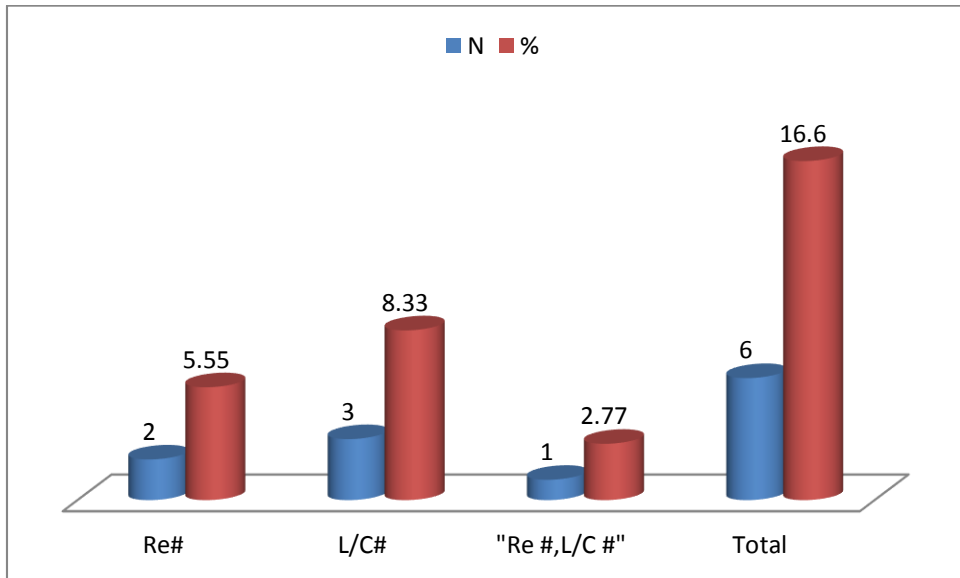


Figure 4. Recurrent, Lateral condyle fractures

F) Duration from injury to surgery: The mean duration was 3.6 years and the range was from 1 year to 10 years.

Table 3

	Mean (Years)	SD
Duration from original injury to surgery	3.60	2.01

Pre-operative clinical and radiological assessment

Table 4

Parameter		Mean	Standard Deviation
Pre op carrying angle (In degree)	Affected limb	16.5278	3.95320
	Unaffected limb	7.5833	1.20416
Pre op ROM (Total range)	Affected	136	13.97

including hyperextension in degrees)	limb Unaffected limb	142.50	3.58
Pre op-Internal rotation deformity(In Degree)		5.9722	8.09051
Pre op lateral prominence index		0.4150	5.66949

Post operative objective evaluation

A) Association between carrying angle pre operative and post operative (Wilcoxon Signed Rank test) (affected limb): The mean pre-operative carrying angle was -16.52 degrees and the mean post-operative carrying angle was +5.75 degrees and the P-value is < 0.001 ,which means the change was highly significant statistically.

Table 5

Carrying angle	N	Mean	SD	P Value
Pre operative carrying angle(in degrees)	36	16.5	3.95	<0.001**
Post operative carrying	36	+5.75	3.19	

SD- standard deviation (p< 0.05- Significant*, p < 0.001 - Highly significant**).

B) Association between carrying angle of unaffected limb and post operative carrying angle of affected limb: The mean carrying angle of normal limb was 7.58 degree and that of affected limb (post-operative) was 5.75 degree and the change was statistically significant (P-value <0.001).

Table 6

Carrying angle	Mean	SD	P Value
Pre operative carrying angle(Unaffected limb)	7.58	1.20	<0.001**
Post operative carrying angle(affected limb)	5.75	3.19	

(p< 0.05- Significant*, p < 0.001 - Highly significant**).

C) Association between Range Of Movements preoperative and post operative at 1 year (Wilcoxon Signed Rank test): The mean pre operative total ROM(including hyperextension) was 136 degree and the mean post-operative total ROM after 1 year was 136.5 degree, with no statistically significant change (P-value 0.331).

Table 7

Total ROM	N	Mean	SD	P Value
Pre operative carrying angle(in degrees)	36	136.00	13.97	<0.331**
Post operative carrying	36	136.50	6.72	

(p< 0.05- Significant*, p < 0.001 - Highly significant**).

D) Association between Lateral Prominence Index(LPI) pre operative and post operative (Wilcoxon Signed Rank test): The mean Lateral Prominence Index(LPI) had decreased from +0.415 pre-operatively to -1.485 post operatively. But the change was not statistically significant (P-value 0.06).

Table 8

Lateral Prominence Index	Mean	SD	P Value
Pre operative	0.4150	5.66949	
Post operative	1.4853	6.18311	0.06

($p < 0.05$ - Significant*, $p < 0.001$ - Highly significant**).

E) Internal rotation deformity pre operative and post operative: The mean internal rotation deformity decreased from 5.97 degree pre operatively to 0.94 degree post operatively and the change was statistically significant (P-value 0.001).

Table 9

Internal rotation deformity	Mean	SD	P Value
Pre operative	5.97	8.09	
Post operative	0.94	2.47	0.001*

($p < 0.05$ - Significant*, $p < 0.001$ - Highly significant**).

F) Result as per oppenheim et al.. [30] criteria: 69.4% of the patients had excellent results , 16.7% patients had good results and 13.9% patients had poor results according to this criteria. The 5 poor results were due to residual varus deformity in one patient and due to increase in Lateral Prominence Index more than 2.5% in 4 patients. As in Table 10 and Figure 5.

Table 10

Result	N	%
Excellent	25	69.4
Good	6	16.7
Poor	5	13.9

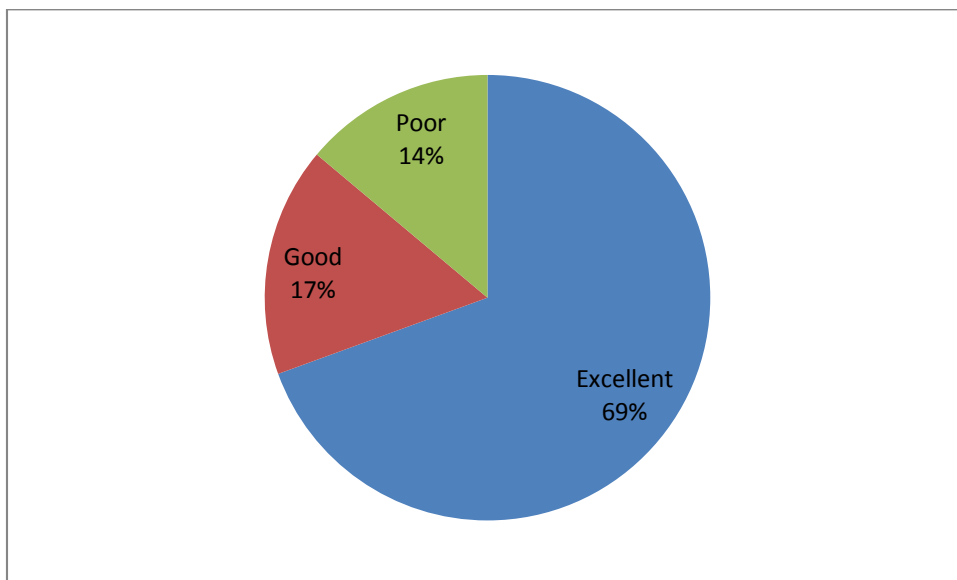


Figure 5. Results shown in patients

Post - operative Subjective evaluation

91.7% of the patients were satisfied with the cosmetic outcome. Although a lateral bump was noticeable in 4 (11.1%) patients postoperatively, only 2 of them were dissatisfied by its cosmesis. A noticeable scar was present in 2 of the patients. The cosmetic dissatisfaction was due to the lateral bump in 2 patients and due to residual varus deformity in one Patient.

Evaluation of complications

Complications were present in 19.4% of patients. This included a transient ulnar neuropraxia in one patient (2.8%), pin-tract infection in 3 patients (8.3%), pin-tract infection along with pin loosening and backout in one patient (2.8%) and skin blebs in two patients (5.5%). All pin tract infections responded to wound care and antibiotics and healed during the follow up visits, except in one patient who required early pin removal .Persistant deep infection was not reported.

Discussion

We did not find any one technique to be the safest or most effective on the basis of statistical evidence. However, complex multiplanar Although an estimated overall poor surgical outcome rate of 12.2% and a complication rate of 14.5% across all osteotomy classes is higher than is desirable, many authors pointed out that a complication does not necessarily equate to a poor functional result or decreased patient satisfaction. For example, nerve injuries resulting in a poor initial outcome resolved 78% of the time. Patients were reported to appreciate improvements in cosmesis, even when there was some residual deformity. Nerve injury is perhaps the most feared complication of supracondylar osteotomy, and we confirmed a rate of 2.5% across all osteotomy techniques. Fortunately, patients can be counselled that most nerve injuries are transient. Cubitus varus

is one of the most common complications of supracondylar fractures of the humerus in children treated with nonoperative management. Its reported incidence varies from 4% to 58%.^{5,6} It may result from inadequate reduction, from loss of reduction with consequent malunion, or rarely from disturbance of growth at the lower end of the humerus. Most authors consider the deformity to result from inadequate reduction that leaves a residual rotatory deformity that can collapse into a medial tilt resulting therefore in a varus deformity. [25,36] Or it could be due to the mechanical forces acting across the fractures, leading on to varus tilt. Cubitus varus does not often cause functional disability and surgery is often required for cosmetic reasons. It is better corrected during childhood. Various osteotomies for correction of cubitus varus deformity like Medial open wedge osteotomy, Lateral closing wedge osteotomy of French, Modified french technique, Dome osteotomy, 3-dimensional osteotomy etc. Lateral closing wedge osteotomy is the easiest, safest and an inherently stable method of correction. The type of fixation of osteotomy is a concern to achieve good result. Roach et al. believed that unstable, nonrigid fixation led to slip of the fragments and loss of correction. The fixation with percutaneous K-wires frequently led to loosening of the fixation with recurrence of deformity, pin tract infection, skin sloughing, nerve palsy and rarely brachial artery aneurysm.[30,20] Most investigators would agree that 4 factors can ultimately determine the outcome of supracondylar osteotomy of humerus: 1)adequate correction of carrying angle, 2)stability of fixation of osteotomy, 3) avoiding a lateral bump and 4)avoiding post operative complications which will compromise the results. In this study, results of 36 patients with cubitus varus deformity treated by lateral closing wedge osteotomy with medial displacement of distal fragment and fixation with lateral percutaneous K-wires were evaluated. The analysis of results are made in terms of age, side, gender distribution, associated injuries and final clinical, radiological and cosmetic outcome.

Descriptive patient data

The mean age of the patients in this study was 9 ± 3.43 years. Age of the patients ranged from 5 - 15 years according to the inclusion criteria. This is comparable with the study by Kumar D in 2014, in which the age of patients ranged from 5 to 15 years with a mean age of 9.07 ± 3.07 years. Cubitus varus following supracondylar fractures is usually a static deformity. Hence they can be corrected as soon as bone remodelling after index fracture is completed and reasonable ROM achieved. There is no need to wait for skeletal maturity. Doing this surgery in childhood, also takes advantage of the better chances of union in this age group. Wong et al (1990) have opined that lack of remodelling in older age groups results in the persistence of lateral prominence. Majority of the children in the present study were boys (63.9%). Most investigators have found similar male predominance. Wong reported 23 male and 4 female patients. 5 (13.9%) out of the 36 children, with cubitus varus in this study were initially managed surgically by closed reduction and percutaneous pinning for supracondylar fracture. Nacht JL reported mean carrying angle loss of 5.8 degree in 20 patients after closed reduction and percutaneous K-wire fixation for supracondylar humerus fracture [31,32,33]. He observed cubitus varus in 3 out of 38 children in his study. That means cubitus varus can occur not only in supracondylar fractures treated conservatively, but also with surgically managed cases if proper reduction is not

achieved. Four patients with cubitus varus in this study had history of Lateral condyle fracture of the same elbow after the initial injury (supracondylar fracture). Davids "Post traumatic cubitus varus may predispose a child to subsequent lateral condylar fracture and that this deformity should be viewed as more than just a cosmetic problem". Post-operative carrying angle: The main deformity in cubitus varus is the reversal of carrying angle of the elbow. The purpose of surgery is to correct this. In our study, the mean post-operative carrying angle was +5.75 degree with an average difference of 1.83 degree from that of the normal side. We were able to achieve good correction in majority of our patients. Only one patient had residual varus at follow up and was advised resurgery. That patient had pintract infection, pin loosening and back out necessitating early K-wire removal. So the cause for residual varus was post-operative loss of reduction due to infection and pin loosening. Most investigators had achieved good correction of varus deformity with lateral closing wedge osteotomy. Wacl EL in 2007 reported the average post operative carrying angle as 5 degree with a difference of 1.6 degree from opposite side. Voss in 1994 studied lateral closing wedge osteotomy and observed that in 97% of the patients, the deformity was corrected to within 5 degrees of the contralateral elbow. [34,35]

Post-operative Range of Motion

In our patients, active range of motion exercises were started after K-wire removal at 5-6 weeks post operatively. Almost all patients achieved the preoperative range of movements with the mean difference in total ROM being 0.5 degree between pre-operative (136 degree) and post-operative (136.5 degree) at 1 year follow up. Supracondylar osteotomy for cubitus varus is mainly a cosmetic surgery and no functional change - change in ROM- is usually expected, unless there is a myositis or excess callus formation. Wael EL44 also observed little or no differences in the range of motion (ROM) of the elbow except in one child who had slight limitation in elbow flexion of about 60.

Lateral Prominence Index (LPI)

A prominent lateral condyle after correction of angulation was reported as a main complication of lateral closing wedge osteotomy (Wong 22). In this study the distal fragment was displaced medially after full thickness osteotomy of distal humerus, to eradicate this problem. Although the mean LPI decreased from 0.415 to -1.485 post-operatively, the results were not consistent in all patients. 9 of the 36 patients (25%) had an increase in LPI post operatively, and 4 of them had a noticeable lateral bump at follow up. But out of these 9 children only 2 were dissatisfied with cosmesis; which means that an increase in LPI does not always affect the cosmetic outcome. Kumar D46 studied Dome osteotomy and observed a mean change of $-1.29 \pm 1.68\%$ in LPI and the change was significant ($p=0.010$). They advocated dome osteotomy as a better method to address the problem of lateral prominence, although it is technically more demanding. Our results were better when compared with the results of Wong 22, who reported that 14 out of 27 patients were noted to have a significant lateral prominene. So medial displacement of the distal fragment can be used as a method to decrease the lateral prominence although the intact periosteal hinge on the medial side can

make this difficult and excess callus formation on the lateral side can also contribute to a lateral bump.

Objective outcome

As per the criteria described by Oppenheim et al... 30 69.4% of the patients had excellent results, 16.7% patients had good results and 13.9% patients had poor results. The poor results were due to residual varus deformity in one patient and due to increase in Lateral Prominence Index more than 2.5% in 4 patients. Srivastava AK studied lateral closed wedge osteotomy and reported that 85% patients showed excellent results and 15% good results while none showed fair or poor results in the follow up.[37,38] Wael EL reported 91.7% excellent results and 8.3% with good results according to Oppenheim 30 criteria . But the sample size was very less. A meta-analytical summary estimate for overall rate of good to excellent results with 4 different types of osteotomies was 87.8% in the meta analysis done by Solfelt DA

Cosmetic outcome

91.7% of the patients were satisfied with the cosmetic outcome. This is comparable with the results of Srivastava AK 57 in which 95% patients were satisfied with cosmesis. Post operative complications like pin tract infection, skin blebs or transient neuropraxia did not affect the final cosmetic outcome. The reason for cosmetic dissatisfaction was the lateral prominence in two patients. Complications: The overall rate of complications was 19.4% and it was high when compared with the meta analysis by Solfelt DA 47 - 14.5% which included 4 types of osteotomies. Pin tract infection was the main complication which accounted for 11.11%. Dome osteotomy by Kumar 46 also reported pin tract infection in 20% cases. The results were better when compared with the complication rate of Oppenheim 30 - 24%- which included 5 nerve palsies, 3 infections and 12 patients with residual varus out of the 45 patients who underwent lateral closing wedge osteotomy. These results make it obvious that pin tract infection and pin loosening are a matter of concern, when percutaneous K-wires are used for fixation of osteotomy. So dome osteotomy can be rigidly fixed to maintain the correction. In our series there was no loss of angle of correction and loosening of correction, and no revision of surgery was required. Lateral condylar prominence is troublesome cosmetic deformity which occurs in different osteotomies [39,40].

Limitations

In terms of limitations, the results of this systematic review must be interpreted with caution. Almost all of the studies included were retrospective case series, and because the entire body of evidence shows signs of selective publication, the available literature is more likely to underestimate the risk of complications than to overestimate them. We recommend that surgeons performing a surgical correction of cubitus varus deformity be aware of the potential complications; counsel the patient regarding the probability of nerve injury, residual varus or unsightly scarring; and choose the method most suitable to the age and deformity of the patients.

Conclusion

However, osteotomy for correction of cubitus varus is safe, effective and gives cosmetically more acceptable elbow. Corrective osteotomy done in childhood, takes advantage of the better chances of union and remodelling. Lateral closing wedge osteotomy and fixation with percutaneous K- wires with medial displacement of distal fragment is a relatively simple technique, avoids neurovascular injuries, and gives excellent results without much problem of lateral prominence and good cosmetic appearance.

Source for funding –None

Conflict of interests: None

References

1. Aronson DD, Prager BI. Supracondylar Fractures of humerus – a modified technique of closed pinning. CORR .1987;219 : 174 – 184.
2. Pirone AM, Graham HR, Krajbich JI. Management of displaced extension – type supracondylar fractures of the humerus in children..1988;70(5): 641–650.
3. Mostafavi HR , Spero C. Crossed pin fixation of displaced supracondylar humerus fracture in children. CORR. 2000 jul; 376: 56-61.
4. Egol KA, Koval KJ, Zuckerman JD. Pediatric elbow. In: Egol KA, Koval KJ, Zuckerman JD 4th ed. USA: Lippincott Williams and Wilkins; 2010. p.604-607.
5. Hoyer A. Treatment of supracondylar fracture of the humerus by skeletal traction in an abduction splint. 1952 ; 34-A : 623- 637.
6. Piggot J, Graham MK, McCoy GF. Supracondylar fracture of the humerus in children : treatment by straight lateral traction. 1986 ; 68-B : 577-583.
7. Kasser JR, Voss F, James R, Trepman, Elly, et al.... (1994) Uniplanar Supracondylar osteotomy with preset K-wire for cubitus varus. Journal of Pediatric Orthopaedics 14(4): 47.
8. Labelle H, Bunnell WP, Duhaime M, Poitras B. Cubitus varus deformity following supracondylar fractures of the humerus in children. 1982;2(5):539-546.
9. Laupattarakasen W, Mahaisavariya B, Kowsuwon W, Saengnipanthkul S. Pentalateral osteotomy for cubitus varus : clinical experience of a new technique1989; 71-B : 667-670.
10. Song HR, Cho SH, Jeong ST, Park YJ, Koo KH (1997) Supracondylar osteotomy with Ilizarov fixation for elbow deformities in adults. J Bone Joint Surg Br 79(5): 748-752.
11. Kumar K, Sharma VK, Sharma R, Mafulli N. Correction of cubitus varus by French or dome osteotomy : A comparative study. J Trauma Injury, Infection, Critical Care .2000 ; 49 : 717-721.
12. Bellemore MC, Barrett IR, Middleton RWD, Scougall JS, Whiteway DW (1984) Supracondylar osteotomy of the humerus for correction of cubitus varus. J Bone Joint Surg Am 66(B): 566-572.
13. McCoy GF, Piggot J. Supracondylar osteotomy for cubitus varus. The value of the straight arm position. Journal of Bone and Joint Surgery, British Volume. 1988 Mar 1;70(2):283- 286.

14. Kanaujia RR, Ikuta Y, Muneshige H, Higaki T, Shimogaki K (1988) Dome osteotomy for cubitus varus in children. *Acta Orthop Scand* 59(3): 314-317.
15. Uchida Y, Ogata K, Sugioka Y (1991) A new threedimensional osteotomy for cubitus varus deformity after supracondylar fracture of the humerus in children. *J Pediatr Orthop* 11(3): 327-331.
16. Kim HS, Jahng JS, Han DY, Park HW, Kang HJ, et al.... (1988) Modified step-cut osteotomy of the humerus. *J Pediatr Orthop B* 7(2): 162-166.
17. Tien YC, Chih HW, Lin GT, Lin SY (2000) Dome corrective osteotomy for cubitus varus deformity. *Clin Orthop Relat Res* (380): 158-166.
18. Yun YH, Shin SJ, Moon JG (2007) Reverse V osteotomy of the distal humerus for the correction of cubitus varus. *J Bone Joint Surg Br* 89(4): 527-531.
19. King D, Secor C (1951) Bow elbow. *J Bone Joint Surg Am* 33-A(3): 572-576.
20. Ippolito E, Moneta MR, D'Arrigo C. Post-traumatic cubitus varus : long-term follow-up of corrective supracondylar humeral osteotomy in children. 1990 ; 72-A : 757-765.
21. Wong HK, Lee EH, Balasubramaniam P. The lateral condylar prominence : a complication of supracondylar osteotomy for cubitus varus. 1990 ; 72B : 859-861.
22. Devnani AS. Lateral closing wedge supracondylar osteotomy of humerus for post-traumatic cubitus varus in children 1997 nov-dec; 28 (9-10): 643- 647.
23. French PR. Varus deformity of the elbow following supracondylar fractures of the humerus in children. *The Lancet*. 1959 Sep 26;274(7100):439-41.
24. Beslikas TA, Kirkos JM, Sayegh FE, Papavasiliou VA. Supracondylar humeral osteotomy in children with severe posttraumatic cubitus varus deformity. 1999 ; 65(1) : 65-71.
25. Carlson CS, Rosman MA. Cubitus varus : a new and simple technique for correction. *J* 1982 ; 2 : 199-201.
26. Graham B. Supracondylar osteotomy of the humerus for correction of cubitus varus. *J* 1990 ; 10 : 228-231.
27. Mahaisavariya B, Laupattarakasem W. Osteotomy for cubitus varus : a simple technique in 10 children. 1996 ; 67 : 60- 62.
28. Oppenheim WL, Clader TJ, Smith C, Bayer M. Supracondylar humeral osteotomy for traumatic childhood cubitus varus deformity. 1984 ; 188 : 34-39.
29. Moon MS, Kim SS, Kim ST, Lee SR, Lee BJ, Jin JM et al.... Lateral closing wedge osteotomy with or without medialisation of the distal fragment for cubitus varus. 2010 Aug 1;18(2):220.
30. Wilkins KE. Residuals of elbow trauma. 1990 ; 21 : 291-314.
31. Davids JR, Maguire MF, Mubarak SJ, Wenger DR. Lateral condylar fracture of the humerus following posttraumatic cubitus varus. *Journal of Pediatric Orthopaedics*. 1994 Jul 1;14(4):466-70.
32. Wael EL. The equal limbs lateral closing edge osteotomy for correction of cubitusvarus in children. *Acta Orthopedica Belgica*. 2007;73:580-7.
33. Kumar D, Singh S, Kumar S, Srikant TH, Rai T Clinical Outcome of Dome Osteotomy in Cubitus Varus. *MOJ Orthop Rheumatol*. 2014;1(4): 00022.
34. Solfelt DA, Hill BW, Anderson CP, Cole PA. Supracondylar osteotomy for the treatment of cubitus varus in children. *Bone Joint J*. 2014 May 1;96(5):691-700.

35. Yamamoto I, Ishii S, Usui M, Ogino T, Kaneda K. Cubitus varus deformity following supracondylar fracture of the humerus : a method for measuring rotational deformity. *Clin Orthop relat res* .1985 ; 201 : 179-185.
36. Roach JW, Hernandez MA., 3rd Corrective osteotomy for cubitus varus after Supracondylar fracture. *J Paediatr Orthop*. 1991;14:187-91.
37. Nacht JL, Ecker ML, Chung SM, Lotke PA, Das M. Supracondylar fractures of the humerus in children treated by closed reduction and percutaneous pinning. *Clinical orthopaedics and related research*. 1982 Dec(177):203-9.
38. Srivastava AK, Srivastava D C, Gaur S C. Lateral closed wedge osteotomy for cubitus varus deformity. *Indian J Orthop* 2008;42:466-70.
39. MatsushitaT, NaganoA, Arcosteotomy of the humerus to correct cubitus varus. *Clinical Orthop Relat Res*. 336 (1997) 111-15. doi:10.1097/00003086-199703000- 00015.
40. Wilkins KE: Fractures and Dislocations of the Elbow Region, In Rockwood CA, Wilkins KE, King RE (eds), *Fractures in Children*. Ed 4. Philadelphia, JB Lippicott company 604-605, 1990.