

Prospective Clinical Study to Assess the Outcome of three Dimensional Osteotomy for Cubitus Varus Deformity

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Abstract

Aim: To evaluate the outcome of three dimensional osteotomy for cubitus varus deformity.

Methods: This prospective study conducted in the Department of Orthopaedics, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India, for 12 months. A total of 40 patients attending at the department of orthopaedic surgery for the treatment of cubitus varus deformity within the defined period were enrolled in this study. Patients with cubitus varus deformity after malunited supracondylar fracture of the humerus, patients who will voluntarily give consent to be enrolled in the study, in case of minors, the consent of the guardians was taken, age between 8 to 20 years and duration of fractures >1 year.

Results: Among 40 subjects, the duration of injury was <35 months in 22 (55%) subjects and ≥35 months in 18 (45%) cases. Among 40 subjects, majority of the patients 30 (75%) was previously treated with closed reduction (CR) and cast immobilization, only 6 (15%) patients were treated with CR and percutaneous pinning and 4 (10%) patients were initially maltreated by Bonesetters. The distribution of study population according to duration of bone union after osteotomy. In 30 (75%) cases, duration of union was 8- 10 weeks, in 6 (15%) cases duration of union was 10-12 weeks while only in 4 (10%) cases duration of union was >12 weeks up to 16 weeks according to radiology. Before 15 years of age, duration of bone union following corrective osteotomy took 8-10 weeks in 26 (65%) cases and 10-12 weeks in 2 (5%) cases. On the other hand, in age >15 years' group, duration of union was 8-10 weeks in 4 (10%) cases, 10-12 weeks in 4 (10%) cases and 12-16 weeks was in 4 (10%) of patients. The pre- and post-operative means (±SD) carrying angle were $-18.55^{\circ} \pm 3.46^{\circ}$ and $9.50^{\circ} \pm 1.77^{\circ}$ respectively. This indicated a significant difference between the two groups. Again, the preoperative means (±SD) range of motion were $117.50^{\circ} \pm 6.98^{\circ}$ (flexion), $18.75^{\circ} \pm 3.41^{\circ}$ (extension) and $29.65^{\circ} \pm 5.97^{\circ}$ (internal rotation) respectively. The post-operative means (±SD) range of motion were $130.00^{\circ} \pm 4.90^{\circ}$ (flexion), $5.00^{\circ} \pm 3.57^{\circ}$ (extension) and $3.2 \pm 1.83^{\circ}$ (internal rotation) respectively. In current study, only 4 (10%) patients had under correction of deformity, 2 (5%) patient developed nerve injury that was neurapraxia type of radial nerve injury, which was improved within 8 weeks and 2 (5%) patients developed infection that led to stiffness of elbow joint. The outcome of the subjects was graded according to Mayo elbow performance score: excellent were 16 (40%), good were 18 (45%), fair was 4 (10%) and poor were 2 (5%) patients.

Conclusion: Cubitus varus usually presents as a cosmetic problem rather than functional one. After analyzing the results of the present study, it can be concluded that three-dimensional osteotomy is a safe technique with satisfactory outcome in the treatment of cubitus varus deformity.

Keywords: Outcome, Osteotomy, Cubitus varus, Deformity

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Introduction

Distal humeral fracture is the most usual upper limb fracture in adolescents, with an incidence of about 60% in all elbow fractures[1] Cubitus varus deformity, as the most common complication of the distal humeral fractures in adolescents, accounts for approximately 30% to 58%[2,3] In addition to the varus on the coronal plane, the cubitus varus can also include the three-plane deformities of the overextension on the sagittal plane and the internal rotation on the horizontal plane[4] Besides, due to the poor ability of distal humeral epiphysis to correct the existed varus deformity, the cubitus varus deformity will persist into adulthood without any improvement[5,6] Thus, the cubitus varus deformity will not only affect the esthetic appearance and restrict the elbow motion, but also delay the daily life and learning of adolescents to a certain extent[7]

Since the humeral supracondylar wedge osteotomy (HSWO) was first proposed in 1939[8]it has become the most significant surgical procedure to correct the cubitus varus deformity.[9,10] However, the focus of the operation is often to correct the varus on the coronal plane, which neglects the sagittal or horizontal deformities and results in the unsatisfactory correction effects.[11,12] Although partial surgeons subjectively hope to implement the three-dimensional correction[11] however, due to the varied difference of deformities in individuals, it is difficult to obtain the truly precise correction under the small incision during the operation, which requires repeated at- tempts, with long operation time and a large amount of blood loss. In order to improve the preciseness, the HSWO requires being more accurate and individualized. With the development of digital medicine, especially the rapid

advancement of 3D printing technology currently, personalized guide plates can be designed to assist the precise implementation of orthopedic operations.[13,14]

However, conventional preoperative planning with two dimensional plain radiographs has not always provided sufficient information to understand the complex three dimensional deformity.[15] Many studies have been published previously by a great number of authors performing various osteotomies for correction of cubitus varus deformity. King and Secor described a medial opening wedge osteotomy depicting an 84% ‘perfect correction’[16]Langenskiold and Kivilaakso did lateral closing wedge with occasional lateral rotation and claimed to have only 45% normal carrying angle. Sweeny described same osteotomy where in 35% patient deformity not eradicated[17] In 1974, Rang described a study of lateral closing wedge osteotomy having 85% satisfactory result[18]

Material and methods

This prospective study conducted in the Department of Orthopaedics, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India, for 12 months, after taking the approval of the protocol review committee and institutional ethics committee. A total of 40 patients attending at the department of orthopaedic surgery for the treatment of cubitus varus deformity within the defined period were enrolled in this study. The patients were selected on the basis of the inclusion and exclusion criteria. The patients were diagnosed clinically and radiologically.

Inclusion criteria

Inclusion criteria for current study were; patients with cubitus varus deformity after malunited supracondylar fracture of the humerus, patients who will voluntarily give consent to be enrolled in the study, in case of minors, the consent of the guardians was taken, age between 8 to 20 years and duration of fractures >1 year.

Exclusion criteria

Exclusion criteria for current study were; marked osteoarthritic change of the elbow joint on radiographs, patients with any neurological deficit, patients who were mentally and physically unfit, anesthesiologically unfit patients and patients associated with other serious injuries or comorbid medical illness.

Methodology

After taking informed consent, detail history taking and physical examination of each patient were performed. A structured case record form was used to interview and collect data. Patients were interviewed and case record form was filled up by the interviewer (The researcher himself). Patients were assessed properly both clinically and radiologically and preoperative planning was done for correction of the deformity. Angle to be corrected was measured by adding varus angle with valgus angle of opposite normal

side. A skin incision was made at the posterolateral aspect of deformed arm. Three dimensional pyramidal shaped bone was removed from anterolateral base to posteromedial bone, closing the osteotomy site and fixation was done by using reconstruction plate, distal humeral plate or even K-wire. This osteotomy itself gives stability. Final outcome of three dimensional osteotomy was measured by measuring carrying angle, range of motion and Mayo elbow performance score: excellent (91-100), good (75- 90), fair (60-74), poor (<60) and to determine the final outcome of the study, excellent, good and fair grades were considered as satisfactory and poor grade was considered as unsatisfactory according to Mayo elbow performance score. Final follow up was given at 6 months or later. All the data were compiled and sorted properly and the quantitative data were analyzed statistically by using statistical package for social sciences (SPSS-22). The results were expressed as percentage and mean±SD. 95% CI and p<0.05 were considered as the level of significance. Comparisons of continuous variables between the two groups were made with paired Student's t-tests.

Results

Age and sex distribution of the studied patients is depicted in (Table 1).

Table 1: Age and sex distribution of the studied patients (n=40)

Age (years) and sex	N	(%)
8-10	10	25
11-15	18	45
16-20	12	30
Male	24	60
Female	16	40

Out of 40 patients 10 (25%) were 8-10 years of age, 18 (45%) were 11-15 years of age and 12 (30%) were 16-20 years old. The youngest and the oldest patients were of 8 and 20 years respectively. Among 40

subjects, majority 24 (60%) were male and only 16 (40%) were female. The distribution of study population according to mechanism of injury is shown in (Table 2).

Table 2: Distribution of study population according to mechanism of injury (n=40)

Mechanism of injury	N	(%)
Road traffic accident	06	15
Fall from bicycle	12	30
Fall while playing	22	55

Among 40 subjects, 22 patients (55%) had history of fall while playing, 12 patients (30%) had history of fall from bicycle and only 6 patients (15%) had history of road traffic accident. Among 40 subjects, 22 (55%) subjects had right sided deformity and 18 (45%) subjects had left sided deformity.

Among 40 subjects, the duration of injury was <35 months in 22 (55%) subjects and ≥35 months in 18 (45%) cases. The distribution of study population according to mode of previous treatment is shown in (Table 3).

Table 3: Distribution of study population according to mode of previous treatment (n=40)

Mode of previous treatment	N	(%)
Bone setters	04	10
CR and cast immobilization	30	75
CR and percutaneous pinning	06	15

Among 40 subjects, majority of the patients 30 (75%) was previously treated with closed reduction (CR) and cast immobilization, only 6 (15%) patients were treated with CR and percutaneous pinning and 4 (10%) patients were initially maltreated by Bonesetters. The distribution of study population according to duration of bone union after osteotomy. In 30 (75%)

cases, duration of union was 8- 10 weeks, in 6 (15%) cases duration of union was 10-12 weeks while only in 4 (10%) cases duration of union was >12 weeks up to 16 weeks according to radiology. The distribution of study population according to age and duration of bone union after osteotomy is shown in (Table 4).

Table 4: Distribution of study population according to age and duration of bone union after osteotomy (n=40)

Age (years)	N (%)	Duration of union (weeks), N (%)		
		(8-10)	(10-12)	(12-16)
<15	28 (70)	26 (65)	02 (5)	00 (00)
>15	12 (30)	04 (10)	04 (10)	04 (10)

Before 15 years of age, duration of bone union following corrective osteotomy took 8-10 weeks in 26 (65%) cases and 10-12 weeks in 2 (5%) cases. On the other hand, in age >15 years' group, duration of union was 8-10 weeks in 4 (10%) cases, 10-12 weeks in 4 (10%) cases and 12-16 weeks was in 4 (10%) of patients. The assessment of the studied population in different parameters is depicted in (Table 5). The pre- and post-operative means (±SD)

carrying angle were $-18.55^{\circ} \pm 3.46^{\circ}$ and $9.50^{\circ} \pm 1.77^{\circ}$ respectively. This indicated a significant difference between the two groups. Again, the preoperative means (±SD) range of motion were $117.50^{\circ} \pm 6.98^{\circ}$ (flexion), $18.75^{\circ} \pm 3.41^{\circ}$ (extension) and $29.65^{\circ} \pm 5.97^{\circ}$ (internal rotation) respectively. The post-operative means (±SD) range of motion were $130.00^{\circ} \pm 4.90^{\circ}$ (flexion), $5.00^{\circ} \pm 3.57^{\circ}$ (extension) and $3.2 \pm 1.83^{\circ}$ (internal rotation) respectively.

This indicated a significant difference between the two groups in their flexion and extension of the elbow joint and internal rotation. The pre- and post-operative means (\pm SD) MEPS were 83.24 ± 6.94 and 89.00 ± 12.29 respectively ($p=0.08$), which indicates a non-significant difference

between these two groups. This indicates appearance of the elbow was improved but functionally no significant difference was observed pre and postoperatively. The distribution of the studied population according to complications is shown in (Table 6).

Table 6: Distribution of study population according to complications (n=40)

Complications	N	(%)
Under correction	04	10
Nerve injury	02	05
Infection	02	05
No complication	32	80

Table 7: Distribution of study population according to Mayo elbow performance score (n=40)

MEPS	Grading	N	%
Excellent	91-100	16	40
Good	75-90	18	45
Fair	60-74	4	10
Poor	<60	2	05

In current study, only 4 (10%) patients had under correction of deformity, 2 (5%) patient developed nerve injury that was neurapraxia type of radial nerve injury, which was improved within 8 weeks and 2 (5%) patients developed infection that led to stiffness of elbow joint. The distribution of the studied population according to Mayo elbow performance score is shown in (Table 7). The outcome of the subjects was graded according to Mayo elbow performance score: excellent were 16 (40%), good were 18 (45%), fair was 4 (10%) and poor were 2 (5%) patients. To determine the final outcome of the study, excellent, good and fair grades were considered as satisfactory and poor grade was considered as unsatisfactory according to Mayo elbow performance score. So, a total number of 38 (95%) patients were in the satisfactory group and only 2 (5%) patient was in the unsatisfactory group.

Discussion

The present study was undertaken to observe the clinical and radiological outcome of three-dimensional corrective

osteotomy for cubitus varus deformity. A total of 40 cases of cubitus varus deformity fulfilling the inclusion criteria were taken as sample. Patients were evaluated clinically and radiologically both pre and postoperatively for functional outcome and radiological fusion. No previous study comparing three-dimensional osteotomy with other ostotomies has been found so far, both in national and international ground. However, several authors publishing results of three-dimensional osteotomy for this deformity has been found. Uchida et al in their study in found 11 excellent result and 1 good result with a total of 12 patients in correcting all three deformities.[19] Usui et al published result of three dimensional osteotomy in 48 elbobws, where they found satisfactory result in 41 cases.[9] Chung et al performed three dimensional osteotomy in 23 patients having satisfactorily improved deformities in all of them.[20] So felt et al did a meta-analysis in 2015 on studies of various authors, 40 studies including 894 children. In their study, four major osteotomy techniques were included: lateral closing wedge, dome, complex

multiplanar and medial opening wedge with distraction osteogenesis. A mean angular correction of 27.6° (18.5° - 37.0°) was achieved across all classes of osteotomy. The overall rate of good to excellent result was 87.8 %. No technique shown significantly affects the surgical outcome, and the risk of complication across all osteotomy classes was 14.5%. Although a long term follow up done by Ippolito et al shown seventeen out of nineteen patient having lateral closing wedge osteotomy lost their post-operative humeroulnar angulation correction, they claimed eleven patients to have poor result.[21] In another comparative study between step-cut translational osteotomy and dome osteotomy, no significant difference between them was found by Davids et al[22] The results of current study demonstrate that post traumatic cubitus varus deformity occurs more in below 15 years of aged and male population. The youngest and the oldest patients were 8 and 20 years respectively. 70% of the study subjects were between 8-15 years of age and 30% of the study subjects were between 16-20 years of age. But out of 40 patients, in 36(90%) patients the age of incidence of fracture was

<14 years of age, only in 4 (10%) patients, the incidence of fracture was >14 years. Almost similar to the findings observed by the various investigators from different countries.[23,26] But the studies conducted by Bali et al showed that 100 % population was at the age of 6-14 years who was affected by supracondylar fractures of distal humerus.[27] Supracondylar fractures of the distal humerus are one of the most common fractures in children aged 2 to 8 years, usually due to some high energy mechanism of injury. Fall from height was the commonest form of injury which occurred in 22 (55%) patients, followed by fall from bicycle in 12 (30%) patients; and in 6 (15%) patients, trauma following road traffic accident occurred in this study. High energy trauma following road side accident occurs most commonly in younger children

and active population.[26] Duration of injury was <35 months in majority of the study subjects. Almost similar to the findings observed by the various researchers of different countries[23,24,26] Among the study subjects, majority had right sided post traumatic cubitus varus deformity due to supracondylar fracture of humerus. On the contrary, Suchinder et al found right and left humerus was equally affected.[28] Most of the cases (75%) were treated with closed reduction and cast immobilization before participation in this study. Only 15% patients were treated with closed reduction and percutaneous pinning, 10% patients took treatment from traditional bone setters. All study population was treated by three-dimensional corrective osteotomy and internal fixation with plates and screws or Kirchner wires or both methods. Duration of union was 8-10 weeks in 30 (75%) patients, 10-12 weeks in 6 (15%) cases and 12-16 weeks in only 4 (10%) cases, according to radiological evidence. Almost similar to the findings observed by the various researchers of different countries.[19,25,29] At final follow-up, each patient was assessed by different parameters. Those were carrying angle, elbow range of motion, Mayo elbow performance score (MEPS). The mean (\pm SD) carrying angle was significantly ($p < 0.001$) improved at the end of the final follow-up after 6 months or later in comparison to pre-operative periods. This finding was in agreement with the study of many researchers of different countries.[25,29,31] The mean (\pm SD) range of motion was significantly ($p < 0.001$) improved at the final follow-up at 6 months or later in comparison to pre-operative periods. This finding coincide with the study conducted by Takeyasu et al, Pandey et al, Takeyasu et al, Kumar et al.[25,29,31] The mean (\pm SD) Mayo elbow performance score was non-significantly ($p < 0.08$) higher at the final follow-up at 6 months or later in comparison to pre-operative periods. Our results are also similar to the studies previously conducted by different

researchers.[25,29,31] In current series at the time of operation all the fractures were closed. During operation strict asepsis was followed in every step and broad-spectrum intravenous antibiotic was given for three days. Initial recovery was uneventful in almost all of the cases. But during the course of the time only 4 patients had residual angulation and rotational deformity, 2 patients had neurapraxia type of radial nerve injury which recovered at 8 weeks and 2 patient developed wound infection that led to elbow stiffness and final outcome was poor. This finding was in agreement with Ippolito et al, Chung et al and Kumar et al but disagreement with Yun et al and Suchinder et al. [20,21,31]. In present study, final outcome was determined by excellent, good and fair grades according to Mayo elbow performance score and treated as satisfactory and poor grade was treated as unsatisfactory. Majority of the study population was found in satisfactory group at the end of the final follow-up. Almost similar to the findings observed by the various researchers of different countries.[25,29,31]

Conclusion

Cubitus varus usually presents as a cosmetic problem rather than functional one. After analyzing the results of the present study it can be concluded that three dimensional osteotomy is a safe technique with satisfactory outcome in the treatment of cubitus varus deformity. This procedure significantly improved carrying angle, elbow range of motion and internal rotation.

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