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Outcome of three dimensional osteotomy for cubitus varus deformity

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ABSTRACT

Background: Cubitus varus is the most common angular deformity resulting from supracondylar fracture of the humerus in children and adults. There are several options for correcting this deformity, but three dimensional osteotomy is now a popular method for the operative treatment of cubitus varus deformity. Objective of current study was to evaluate clinical and radiological outcome of three dimensional corrective osteotmy for cubitus varus deformity.
Methods: This prospective interventional study was conducted in the department of orthopaedic surgery, BSMMU, Shahbag, Dhaka from January 2016 to September 2020. Within this period, total 40 cases of cubitus varus deformity, age ranging from 8-20 years that has the inclusion criteria was enrolled as a study sample with proper consent. All the data were analyzed statistically by using SPSS-22.
Results: The results of present study showed significantly improved carrying angle, range of motion, internal rotation angle at the time of final follow-up period of six months or more. The outcome of the subjects was graded as excellent in 16 (40%), good in 18 (45%), fair in 4 (10%) and poor in 2 (5%) patients. Excellent, good and fair results were considered as satisfactory outcome and only poor result was considered as unsatisfactory outcome.
Conclusions: After analyzing the results of present study it can be concluded that three dimensional osteotomy is a safe technique with satisfactory outcome in treatment of cubitus varus deformity.

Keywords: Outcome, Osteotomy, Cubitus varus, Deformity

INTRODUCTION

Supracondylar fractures of the distal humerus are one of the most common fractures in children aged from 2 to 8 years, accounting for up to 30% of fractures in this age group.[1] They are the most common fracture around the elbow in children, accounting for up to 75% of these injuries.[2] Cubitus varus is the commonest long term complication of supracondylar distal humerus fractures with an average incidence of 30% with different forms of management[3]. Several causes for cubitus varus have been suggested. Medial displacement, posterior tilt and rotation of the distal fragment have been cited most often, but experimental studies showed that varus tilting of the distal fragment was the most important cause of change in the carrying angle. Other suggested causes include varus tilting of the distal fragment and growth disturbance in the distal humerus, especially overgrowth of the lateral condyle. Osteonecrosis and delayed growth of the trochlea, with relative overgrowth of the normal lateral side of the distal humeral epiphysis, is a rare cause of progressive cubitus varus deformity after supra-

condylar fracture. This progressive growth abnormality cannot be prevented by stabilization of the distal fragment because it probably is related to injury to the blood supply of the trochlea at the time of fracture.[4] Cubitus varus rarely causes any limitation in elbow function; however, it results in an unsightly cosmetic deformity with the children's parents often requesting intervention.[5] Late complications have been described in long standing cubitus varus, these include secondary lateral condylar fractures of the distal humerus, postero-lateral rotatory instability of the elbow, and tardy ulnar nerve palsy.[6,7] Humeral-osteotomy used to correct this deformity and to avoid late complications, such as tardy ulnar nerve palsy, posterolateral rotatory instability and secondary distal humeral fracture.[1,2] It is difficult to precisely correct a cubitus varus deformity to mirror the normal side because the deformity includes hyperextension and internal rotation. A variety of osteotomies has been proposed to correct the complex deformity, including lateral closing wedge, medial opening-wedge, dome, three dimensional, and step-cut osteotomies.[8-10] A surgical approach to correct internal rotation malalignment was first reported in, followed by several later reports on the need to correct internal rotation.[9,11,12] Anatomically accurate correction is the key to obtain good functional outcomes after corrective osteotomy, especially for the upper extremity.[13] However, conventional preoperative planning with two dimensional plain radiographs has not always provided sufficient information to understand the complex three dimensional deformity.[14,15] 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] French in published his original lateral closing wedge osteotomy paper without definite stats.[11] 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] Barrett and Middleton in 1989 described a series of modified French osteotomy having 74% correction rate. Newer techniques such as dome, step-cut, penta-lateral, three dimensional osteotomies are also described by a few authors but less published data are available in our country.[4] The purpose of current study was to evaluate clinical and radiological outcome of three dimensional corrective osteotomy for cubitus varus deformity. The aim of current study was to evaluate clinical and radiolgical outcome of three dimensional corrective osteotomy for cubitus varus deformity.

General and specific objectives

General objective of the current investigation was to evaluate clinical and radiolgical outcome of three dimensional corrective osteotomy for cubitus varus deformity. Specific objectives of current study were to assess the duration of union after three dimensional corrective osteotomy, to assess and compare the carrying angle, range of motion, and functional stability of elbow joint before and after osteotomy and to find out the incidence of complication after three dimensional corrective osteotomy.

METHODS

Current investigation was a prospective interventional study carried out in the department of orthopaedic surgery at Banganandhu Sheikh Mujib medical university (BSMMU), Shahbag, Dhaka, during January 2016 to September 2020. A total of 40 patients attending at the department of orthopaedic surgery at BSMMU, Shahbagh, Dhaka 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. 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.

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 onradiographs, patients with any neurological deficit, patients who were mentally and physically unfit, anesthetically unfit patients and patients associated with other serious injuries or co-morbid medical illness.

RESULTS

The study was conducted in the department of orthopaedic surgery at BSMMU, Shahbag, Dhaka, Bangladesh. According to the inclusion criteria, a total number of 40 cases of cubitus varus deformity were taken as sample after informed consent. Patients were evaluated clinically and radiologically both pre and postoperatively for functional outcome and radiological assessment of fusion. Final follow up was given after 6 months. 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. The distribution of study population according to side of deformity is shown in (Figure 1). Among 40 subjects, 22 (55%) subjects had right sided deformity and 18 (45%) subjects had left sided deformity. The distribution of study population according to duration of injury is shown in (Figure 2).

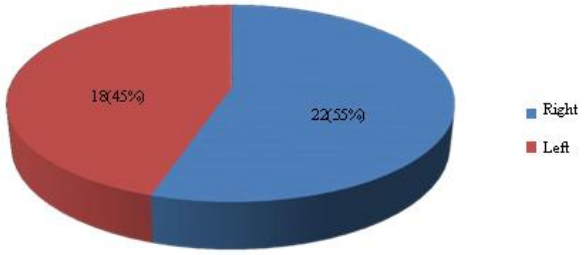

Figure 1: Distribution of study population according to side of deformity (n=40).

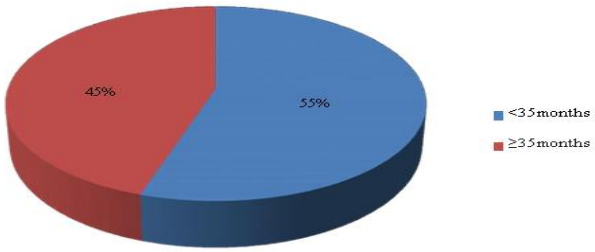

Figure 2: Distribution of study population according to duration of injury (n=40).

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 castimmobilization	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 is shown in (Figure 3).

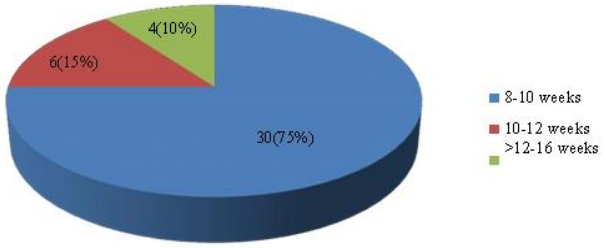

Figure 3: Distribution of study population according to duration of bone union after osteotomy (n=40).

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°±3.46° and 9.50°±1.77° respectively. This indicated a significant difference between the two groups. Again, the preoperative means (±SD) range of motion were 117.50°±6.98° (flexion), 18.75°±3.41° (extension) and 29.65°± 5.97° (internal rotation) respectively. The post-operative means (±SD) range of motion were 130.00°±4.90° (flexion), 5.00°±3.57° (extension) and 3.2±1.83° (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 (±SD) MEPS were 83.24±6.94 and 89.00±12.29 respectively (p=0.08), which indicates a non-significant difference between this 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 5: Assessment of the study population different parameters (n=40).

Parameters	Pre-operative	Post-operative	95% CI	P value
Carrying angle	-18.55°±3.46°	9.50°±1.77°	26.291 to 29.809	<0.001
Range of motion flexion	117.50°±6.98°	130.00°±4.90°	8.640 to 16.361	<0.001
Extension	18.75°±3.41°	5.00°±3.57°	-15.985 to -11.515	<0.001
Internal rotation	29.65°±5.97°	3.2°±1.83°	-29.276 to -23.623	<0.001
MEPS	83.24±6.94	89.00±12.29	-0.629 to 12.149	0.08

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 lead 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 were 4 (10%) and poor were 2 (5%) patients. The distribution of studied population according to functional outcome is depicted in (Figure 4). 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.

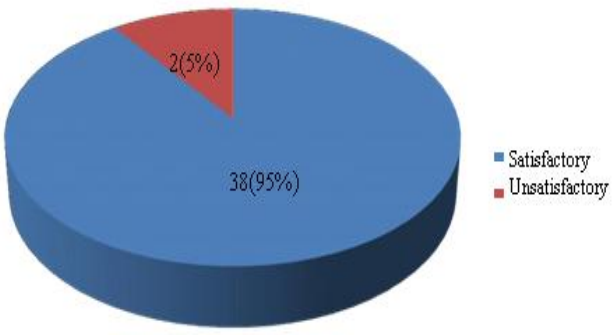

Figure 4: Distribution of study population according to functional outcome (n=40).

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] Sofelt 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 mutliplanar 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 follows up done by Ippolito et al shown seventeen out of nineteen patient having lateral closing wedge osteotomy lost their post-operative humero-ulnar 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 8-10weeksin 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 (±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 (±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 (±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 lead 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.[20,21,28,31] 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]

Limitations

Although optimal care had been taken by the researcher in every steps of the study, but there were some limitations like: current study was conducted in a single hospital so, the study population might not represent the whole community. The sample was taken purposively, so, there may be chance of bias which can influence the results. The study and follow-up period was short in comparison to other studies, small sample size, limited resources and facilities; computer simulation facility was not available.

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.

Recommendations

Similar type of study can be done for a longer duration with large sample size. Randomized comparative study should be carried out, and sample can be collected from different parts of country.

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