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Dr. Rakesh Thakkar
Associate Professor, Department of Orthopedics, Shri Shankaracharya Institute of Medical Sciences Junwani, Bhilai, District Durg, Chhattisgarh, India

Dr. Suneet Rajshekhar
Associate Professor, Department of Orthopedics, Shri Shankaracharya Institute of Medical Sciences Junwani, Bhilai, District Durg, Chhattisgarh, India

Dr. Sankalp Dwivedi
Professor, Department of Surgery, Dean, Shri Shankaracharya Institute of Medical Sciences Junwani, Bhilai, District Durg, Chhattisgarh, India

Corresponding Author:
Dr. Rakesh Thakkar
Associate Professor, Department of Orthopedics, Shri Shankaracharya Institute of Medical Sciences Junwani, Bhilai, District Durg, Chhattisgarh, India

A prospective study of malunited supracondylar fracture of humerus in children treated with lateral closed wedge (LCW) osteotomy

Dr. Rakesh Thakkar, Dr. Suneet Rajshekhar and Dr. Sankalp Dwivedi

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Abstract
Background: Cubitus varus is the most common late complication of displaced supracondylar fractures of the humerus in children and may lead to long-term problems such as increased chances of lateral humeral condyle fractures, posterolateral instability of the elbow, and tardy ulnar nerve palsy Supracondylar humeral fractures are most common elbow fractures in children. The most common complication among all is malunion leading to cubitus varus deformity.Lateral closing wedge osteotomy is the easiest, the safest, and inherently the most stable osteotomy to correct the varus deformity with minimal correction of hyperextension.
Aim: To examine the malunited supracondylar fracture of humerus in children treated with lateral closed wedge (LCW) osteotomy with cubitus varus.
Material and Methods: A total of 25 children of malunited supracondylar fracture of humerus were treated by lateral closed wedge osteotomy fixed by two screws and figure of eight tension band wire.The fixation was supplemented with one lateral K-wire. Post-operatively, according to Oppenheim's criteria patient were evaluated and parents and patient's satisfaction with final appearance and function of the limb was taken into consideration.
Results: According to the Oppenheim *et al*. criteria, is similar to our study, excellent outcome was noted in 18(72%) cases, good outcome in 5(20%) cases and poor outcome in 2(8%) cases. 18(92%) patients/parentswere satisfied with the final outcome.
Conclusion: Lateral closing wedge osteotomy with a lateral K-wire is a sound, cost-effective, technically less demanding modality of treatment for varus deformity with less complications.

Keywords: lateral K-wire, cubitus varus, deformity, malunited supracondylar humerus fracture, children, lateral closing wedge (LCW) osteotomy

Introduction
Supracondylar humeral fractures are over all third most common fractures, and most common elbow fractures, in children and adolescents [1-3]. There are various complications of supracondylar humeral fractures. The most common complication among all is malunion leading to cubitus varus deformity. Cubitus varus deformity is more commonly noted to be a problem than cubitus valgus, probably because posteromedial fractures are more common [4-9]. However, varus deformity may be more frequently reported simply because it is more cosmetically noticeable. Corrective osteotomy is the only way to correct a cubitus varus deformity with a high probability of success. A variety of corrective osteotomies have been described each having some advantages and complications. Based on most of the orthopedicians experience a lateral closing wedge osteotomy is the easiest, the safest, and inherently the most stable osteotomy. It corrects the varus deformity with minimal correction of hyperextension. The present study was conducted to study malunited supracondylar fracture of humerus in children treated with lateral closed wedge (LCW) osteotomy. Malunion may be the result of (1) inadequately treated or untreated fracture, (2) loss of reduction in patients treated with cast due to inadequate reduction or improper cast application, (3) inadequate fixation in surgically treated patients, and (4) comminution or impaction of medial column leading to late collapse into varus. The deformity consists of three components – coronal malalignment with varus, hyperextension, and internal rotational deformity.

Out of these three deformities, since hyperextension occurs in the plane of elbow movements, it can remodel to some extent in younger children <10 years, and hence, its correction may not be necessary.

Material and Methods

It was a record-based study, patients who attended the department of Orthopedics, Shri Shankaracharya Institute of Medical Sciences Junwani, Bhilai, Distt. Durg, Chhattisgarh, over the period of 1 year after ethical committee approval 25 cases of posttraumatic cubitus varus deformity (following malunion of supracondylar fracture humerus in children) who underwent corrective osteotomy were included in this study. All patients were clinically evaluated before surgery. Carrying angle and range of motion of normal and affected side were documented. Two patients had restriction of flexion beyond 90° due to an anterior bony bump, whereas rest of the patients had functional range of motion with most having a change in arc of motion with increased hyperextension and correspondingly loss of terminal flexion. Preoperatively, amount of deformity was calculated using the humeroulnar angle drawn on X-rays by intersection of the long axis of the humerus and ulna. Normal carrying angle of opposite side was added to this to calculate the size of the wedge that needed to be excised to achieve correction. In this prospective randomized controlled study, 25 children of malunited supracondylar fracture of humerus were included. All the cases were treated by lateral closed
wedge osteotomy fixed by two screws and figure of eight tension band wire. The fixation was supplemented with one lateral K-wire. Written and informed consent for surgery was obtained from parents and guardians.

Inclusion criteria

1. Age more than 5 years and less than 16 years.
2. Cubitus varus secondary to malunion of supracondylar fracture of humerus.

Exclusion criteria

1. Age more than 16 years
2. Cubitus varus deformity secondary to other fractures around elbow (Intercondylar or physical injury).
3. Malunited supracondylar fracture of humerus with neurological complications.

Patients were thoroughly evaluated for the deformity and any other associated complaints in the outpatient department for pain, whether the deformity was varus or valgus, three bony point relationship was checked in both elbows to know the cause of the varus deformity i.e., supracondylar fracture humerus or physical injury, lengths of both arms and forearms were measured to rule out physeal injury. Clinical carrying angle was determined by drawing the long axis of the humerus and ulna of both hands, presence of any complications of varus deformity. All patients which were admitted and selected for operative treatment underwent the pre-op workup such as routine hematological investigations, Chest X-ray, paediatric & anaesthesia fitness. Radiographic measurements included angle measurements on the anteroposterior and lateral views. Regional infraclavicular or supraclavicular blockor general anaesthesia was given. Lateral closing wedge osteotomy was performed and the wedge as calculated on X-rays was removed. The osteotomy was fixed by two screws with TBW. The fixation supplemented with 1 lateral K-wire. Post operatively, operative limb was immobilized in A/E cast at 100 degree flexion with full supination of forearm. Strict limb elevation was given for first 5 days. First check dressing was done on postoperative day 2 by making a window at incision site.

On postoperative day 14 suture removal was done, the window closed and cast continued for 6 weeks. After 6 weeks the cast was removed and check X-rays taken and the correction of deformity achieved was measured clinically and radiologically. Mobilization started when radiological evidence of callus was evident. Many criterias have been suggested for grading the results of malunited supracondylar fracture of humerus corrected by any of the fore-mentioned osteotomies. In this study, Oppenheim *et al.* criteria was used as it appears to be the most commonly used criteria in various studies of malunited supracondylar fracture of humerus [9]. It is very simple and easy to interpret. It uses the normal extremity as the standard for comparison of carrying angle and range of movement. The results are read as excellent, good and poor. Post-operatively, according to Oppenheim's criteria patient were evaluated and parents and patient's satisfaction with final appearance and function of the limb was taken into consideration.

Results

No patient developed postoperative stiffness, and all patients had a good range of motion. Patients were selected from age group of 5 years and above upto 16 years of age with the average age being 13.08 years, youngest patient in our study was 6 year old, and oldest being 15 years of age. Maximum patients were from age group of 8 to 10 years. Number of male patients were 15(60%) while female patients were 10 (40%). Amongst the cases included left (non-dominant) side was involved more frequently i.e.,in 15 cases constituting as in Table 1.
60% of total, as compared to the right (dominant) side which suffered injury in 5 cases (20%).

Table 1: Varus angle pre-operative

Pre-operative carrying angle of the affected side in degrees	No. of Patients	Percentage (%)
(-11)-(-15)	2	8
(-16)-(-20)	15	60
(-21)-(-25)	7	28
(-26)+	1	4
Total	25	100

Pre-operatively, amongst 25 patients, majority 15 patients (60%) had varus angle of (-16) to (-20) degrees. Out of 25 cases most of the cases were seen 2 years after the initial injury (7/25) while 5, 4, 2, 1, and 1 cases were seen after 3, 5, 4, 6 and 7 years of initial injury respectively.

Table 2: Functional loss in terms of loss of motion post operatively.

Post-operative functional loss of movement in degrees	No. of Patients	Percentage (%)
No Loss	13	52
1-5	7	28
6-10	2	8
11-15	1	4
16-20	2	8

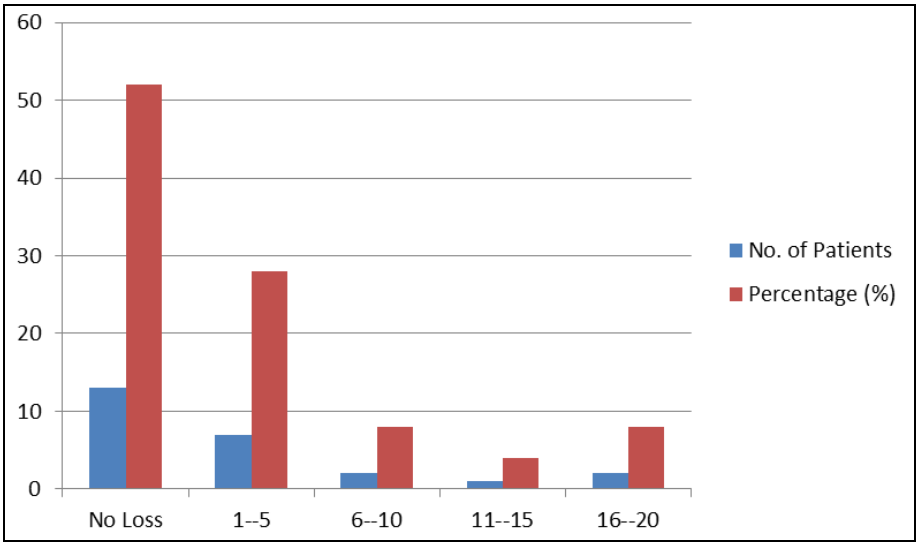

Fig 1: Loss of motion post-operative.

Amongst the 25 patients studied, 13 patients (52%) had no loss of movement, 05 patients (28%) had loss of 1 to 5 degrees of terminal flexion, 2 patients had loss of 6 to 10 degrees of terminal flexion while another 1 patient (4%) had loss of terminal 11 to 15 degrees of flexion and 2 patients (8%) had loss of terminal 15 to 20 degrees of terminal flexion compared to the normal opposite limb as in figure 1 and table 2. Out of 25 patients studied, 10 patients (40%) were 6-7years old, when they suffered from primary injury in the form of supracondylar fracture humerus while, 6 patients (24%) were 8-9 years old, 4 patients (16%) were 4-5 years old and only 2 patients (8%) were 10-11 years old. No nerve injury (ulnar/radial/median) was noted among 25 patients. Pin loosening/ pin track infection of superficial type was detected in 2 patients (8%). Wound infection was noticed in 1 patient (4%) which were managed on OPD bases. Two cases had poor result due to loss of reduction. In both the patients the wedge that needed to be removed was more than 1.2 cm. During osteotomy it was difficult to maintain the medial hinge. Even after removal of wedge it, required translation of the distal fragment medially to achieve on table correction of carrying angle. This resulted in opening of medial hinge on tightening the tension band wire, and thus loss of reduction. Supplemental single K-wire from lateral side proved to be insufficient to achieve and maintain stabilization of osteotomy as in figure 2.

Fig 2: Supplemental single K-wire from lateral side proved to be insufficient to achieve and maintain stabilization of osteotomy

Discussion

Late complications of supracondylar humerus fracture in children treated with non-operative treatment without proper reduction and fixation is cubitus varus. Various osteotomies and fixation modalities have been described for the correction of cubitus varus deformity secondary to elbow fractures. Lateral closing wedge osteotomy is the easiest, safest and inherently stable method of correction. The type of fixation of osteotomy is a concern to achieve good results. We have used Lateral closing wedge osteotomy fixed with two cortical screws and tension band wire at the osteotomy site with addition of a laterally based K-wire for correcting the cubitus varus deformity. Our modification gives good control to proximal as well as distal fragments. To give better control on translation, rotation and angulation which reduces the chances of recurrence. By using cortical screws, the hold achieved is superior and hence loosening and thus loss of reduction is prevented. Applying proximal screw posteriorly and the distal screw anteriorly helps correct the hyperextension. Tension band wire used in a figure of 8 pattern produces gradual compressive forces at the osteotomy site and thus helps in achieving and maintaining reduction, early callus formation and in turn healing of the osteotomy site. Addition of K-wire from lateral aspect gives improved stability and rigidity to the fixation. Applying above elbow cast in 90-100 degrees supination immediately post operatively helps maintain the reduction achieved and also prevents the lateral K-wire from loosening. The lateral closing wedge osteotomy has good result and outcome. This study has considered patient/parent satisfaction and clinical assessment while evaluating the results of lateral closing wedge osteotomy. In this study a hypertrophic scar was observed in 02 patients. Neuropraxia is one of the postoperative complications of the lateral closing wedge osteotomy fixed with K-wires. Since a laterally based Kwire was used for additional stability there was

no postoperative nerve palsy seen in our series. It was observed in our study that lateral closing wedge osteotomy using screws and tension band wire with additional lateral K-wire is a sound and effective modality for the treatment of cubitus varus secondary to malunited supracondylar fracture of humerus in children. It gives the advantage of stable fixation and decreased duration of hospital stay. Increased stability is achieved by using an additional K-wire laterally. Loss of reduction is prevented by immobilizing the limb in above elbow cast immediately post operatively. Maintaining 90-100 degrees of flexion has reduced the incidence of vascular complications in post-operative period, with no incidence of Volkman's ischemic contracture in our study. Injury to ulnar nerve is effectively reduced to its minimum by applying a single K-wire from lateral aspect. This study results demonstrate a lateral closing wedge osteotomy canachieve a good correction of cubitus varus without unsightly scar in the majority of patients.18 out of 50 (97%) in our series had excellent and good results. The only poor result was due to fixation failure, which occurred in two patients and restriction of range of motion which occurred in 1 patient. The results showed 18 excellent, 05 good and 02 poor results, which are comparable to other national and international studies.

Conclusion

Complex three-dimensional osteotomy is not always necessary for cubitus varus correction, and a simple lateral closed wedge osteotomy fixed using lateral K-wires has given good results in our series of patients Lateral closing wedge osteotomy with a lateral K-wire is a sound, cost-effective, technically less demanding modality of treatment for varus deformity due to malunited supracondylar fracture of humerus in children with minimum complications which has proved true in our study.

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