ORIGINAL ARTICLE

Effect of fracture classifications on outcome of lateral condyle humerus fracture in children – Prospective study

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ABSTRACT:

Introduction: Lateral humeral condyle fracture is second most common in incidence after supracondylar fracture comprising of 10% -20% of all elbow fractures. These classifications have been used to guide the choice of treatment, however no study reporting outcome with respect to fracture classification has been reported. We present our results of treatment of fracture lateral condyle humerus in cohort of 38 patients and effect of the fracture morphology according to Milch type, Jakob stage and according to conventional classification based on displacement on functional and clinical outcome.

Material and Methods: From June 2007 to December 2009, 38 children treated for isolated fracture of lateral condyle of humerus were included. Functional clinical outcome according to Hardacre criteria and Dhillon Scores was evaluated.

Results: Mean union duration, mean range of motion and mean carrying angle was not significant with respect to Milch fracture type, Jakob fracture stage and conventional classification of fracture lateral condyle humerus irrespective of modality of treatment.

Conclusion: Irrespective of whether the fracture is intraarticular or extraarticular, or is displaced undisplaced, good outcome can be expected if anatomical reduction is achieved and maintained in lateral condyle humerus fractures.

Key Words: Lateral condyle humerus fracture, classification

INTRODUCTION:

Lateral humeral condyle fracture is second most common in incidence after supracondylar fracture comprising of 10% - 20% of all elbow fractures, still treatment and diagnosis remains the challenge. [1,2,3,4,5] Diagnosis ,assessment of displacement and epiphyseal extension of condylar fracture is difficult because capitellum is largely cartilaginous in children and is not well visualized on plain radiograph.[6,3,7,8,9] Many studies have addressed ways to decrease the complication rate8, [11,12,13,14] including various methods of reduction,[15,1,16,2,9 ,14] types of fixation, [6 ,3] amount of casting, length of Kirschner wire fixation,[31,19,20,21] and finally whether the wires should be left out of (percutaneous Kirschner wires) or buried under (subcutaneous Kirschner wires) the skin . All authors on the subject emphasize that an anatomical reduction is required. The late complications are malunion, nonunion and these cause deformity, loss of motion, traumatic arthritis, or tardy ulnar neuritis. Various fracture classifications have been suggested and Milch, Jakob and conventional classification are used frequently. These classifications have been used to guide the choice of treatment, however no study reporting outcome with respect to fracture classification has been reported. We present our results of treatment of fracture lateral condyle humerus in cohort of 38 patients and effect of the fracture morphology according to Milch type, Jakob stage and according to conventional classification based on displacement on functional and clinical outcome.

Materials and Methods: From June 2007 to December 2009, 38 children treated for isolated fracture of lateral condyle of humerus were included. Of 38 patients 28 were male and 10 were female. 20 patients were in the age range between 2-5 years, 14 patients were between 6 to 9 years age range and 4 patients were above 10 years. 18 patients were right handed and 20 patients were left handed. Mode of injury was fall while playing in all kids sustaining varus stress at elbow. Of 38 fracture lateral humeral condyle, 12 were of Milch type 1 and 26 were Milch type 2. 9 patients were included in Jakob Stage 1, 10 in Jakob stage 2 and 19 in stage 3. Nine patient who were classified as undisplaced and Jakob stage 1 were treated with cast in situ. 19 patients were treated with open reduction internal fixation with K wires, 5 patients were treated with open reduction internal fixation with k wire and cannulated cancellous screw and 5 patients were treated with closed reduction internal fixation with cannulated cancellous screw with prior arthrography.

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SURGICAL TECHNIQUE:

The patient was positioned supine with the arm and forearm lying on the operating table but close enough to the edge to facilitate imaging by C arm. The arm is prepared and draped in a sterile manner, then is exsanguinated and the tourniquet inflated. Arthrography can help in differentiating displaced Salter-Harris Type-I fractures from elbow dislocations and Salter-Harris Type-2 fractures from Type-4 lesions[47]. As most part of lateral condyle is cartilaginous in children, extent of fracture into the joint cannot be well visualized on routine radiograph. Arthrography is of particular importance in such cases.[47] Omnipaque dye was injected into the joint if preoperative arthrography is planned. If dye found to enter ulnohumeral joint it makes the fracture unstable. In this series two cases underwent arthrography and were diagnosed of unstable fractures requiring fixation (Figure -1)

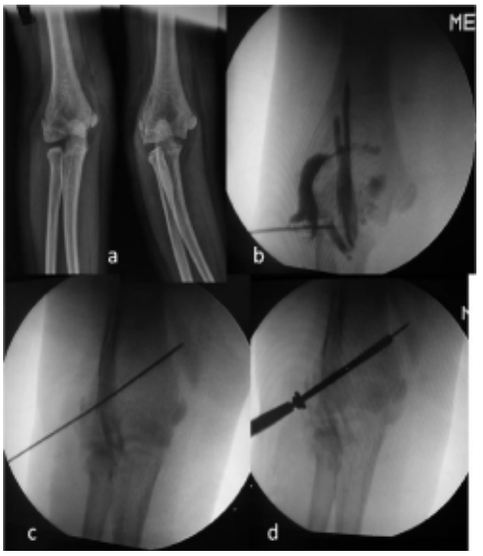

Figure 1 – 7 Year old male child with fracture lateral condyle humerus (a), arthrography was done to confirm the intraarticular extension of the fracture line (b). fracture was then fixed with a cannulated cancellous screw.

Figure 2- case of displaced lateral condyle fracture(a,b) exposed via lateral approach (c) . the rotated fragment is cleaned and fixed using a screw and 2 K wires.

In cases that required open reduction lateral approach through an incision over lateral condyle was taken (Figure 2). The surgical interval between the brachioradialis and the triceps was used. The fracture site was irrigated to remove the interposing hematoma and soft tissues. Distal and posterior dissection was avoided to prevent damage to the circulation of the fragment, which can cause osteonecrosis. The periosteum of the proximal fragment, which overhangs the fracture site, may have to be stripped back slightly to remove it from the fracture site. Visualization of the joint articular surface is crucial to ensure a aurate reducton. In some cases, the fragment was rotated 180° (Figure 2) in such situations, it was easier to visualize the fragment by applying a varus movement to the elbow, which reproduces the mechanism of injury and opens the fracture site so that it may be easily seen. The distal fragment was joysticked with a help of K wire and manipulated gently to achieve reduction. Flexion at the elbow reduces the extensor origin pull on the fragment facilitating reduction. The key component of this procedure was to ensure anatomic reduction of the joint articular surface. The anatomic reduction was confirmed under C arm (Figure 2) and internal fixation was secured with either K wires and/or cancellous screw (Figure 2-3). If distal metaphyseal fragment is large and in an older child screw fixation was preferred, as good compression can be achieved. The K wires are kept inside the skin.

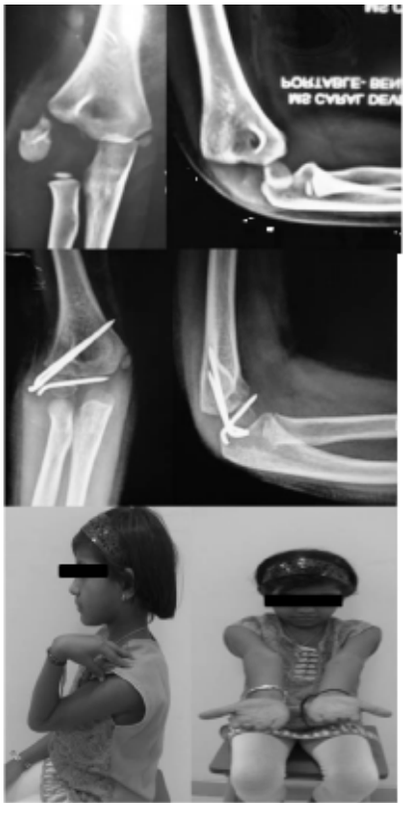

Figure 3 – Case of displaced lateral condyle fracture treated with K wire fixation and showing good range of elbow flexion extension at follow up.

The arm is wrapped with cotton cast padding, and an above elbow cast was applied. For elevation to prevent dependent edema, the arm is placed in a sling after the procedure. If swelling is too much or tension over skin is high above elbow posterior slab is applied which is converted into above elbow cast at 1 week follow up. Reduction was assessed on immediate post operative and 1 week post operative radiographs. The elbow was immobilized for 4 weeks and anteroposterior and lateral radiographs are taken after removing the cast. In all our cases new bone formation was appreciated at the end of four weeks and patients were started with elbow range of motion exercises. Follow up evaluation was done using Dhillon[48] functional and overall grading and Hardacre49 criteria. Hardacre Criteria considers functional and cosmetic base which was used for the evaluation of our results. Excellent result means no loss of motion, no alteration in carrying angle, and no symptoms. Good result is characterized by a satisfactory functional range of motion, lacking no more than 15 degrees of complete extension with no arthritic or neurological symptoms. Poor results included disabling loss of motion, conspicuous alterations of carrying angle, arthritic symptoms, ulnar neuritis, radiographic findings of nonunion or avascular necrosis.

Statistical analysis was done using independent sample test and ANOVA test. Patients were classified into subgroups based on Milch class, Jakob stage and conventional classification according to displacement. P value <0.05 was considered to be statistically significant.

Dhillon Grading System48

Overall score			
Function score			
Pain/weakness	Range of motion	Carrying angle	Score
Nil			
Occasional		Varus <0	2
After Heavy work	>30-130	Valgus 20-30 Varus 0-10	
With normal activity	<30-110	Valgus >30	0
Motor or Sensory weakness		Varus >15	

Functional grade points: Excellent-6, Good 5, Fair 4, Poor <4

Overall Grade points: Excellent-9, Good 7-8, Fair 5-6, Poor<5

RESULT:

Milch Type: There were 26 children with Milch type 2 and 12 children with Milch type 1 fracture.

Mean union duration in month in children with type 1 fracture (n-12) was 2.43 ±0.787 months (range 2-2.5 month) and in children with type 2 fracture (n-26) was 2.86 ± 0.655 month (range 2-4 month). Mean range of motion in degrees in Children with type 1 fracture (n-12) was 135° ± 4.082 (range 0°-140°) and in Children with type 2 fracture (n-26) was 121.43° ± 17.113 (range 10°-140°). Mean Carrying angle in degrees in children with type 1 fracture (n-12) was 8.14° ± 0.900 (range 7°-9°) while in Children with type 2 fracture (n-26) was 6.67°± 2.153 (range 7°-9°). There was no significant difference in mean union duration (P value 0.165), mean range of motion (P value-0.05) and mean carrying angle (P value-0.093) in children with type 1 and type 2.

Jakob Stage: There were 9 children with Jakob Stage 1 lateral condyle humerus fracture (n-1), 10 children with Jakob stage 2 (n-10) and 19 children with Jakob stage 3 (n-19). Mean union duration in month in children with stage 1 fracture (n-9) was 2 ± 0.34 month (range 2-2.5 month), in children with stage 2 fractures (n-10) was 2.80 ± 0.837 month (range 2-4 month) while in children with stage 3 fractures (n-19) was 2.89 ± 0.658 month (range 3-4 month). Mean range of motion in degrees in Children with stage 1 fracture (n-9) was 136.67°± 2.887 (range 0-140°), in Children with stage 2 fracture (n-10) was 134.00°± 5.477 (range 0-140°) while in children with stage 3 Fracture (n-19) lateral humerus condyle was 120°± 17.321 (range 10-140°). Mean Carrying angle in degrees in Children with stage 1 fracture (n-9) was 7.53°± 0.577 (range 8-9°), in Children with stage 2 fracture (n-10) was 8.20°± 0.837 (range 7-9°) while in 19 children with stage 3 fracture lateral humerus condyle was 6.58°±2.244 (range 7-9). There was no significant difference in mean union duration (P value 0.139) mean range of motion in (P value-0.06) and mean carrying angle (P value-0.309) in children with stage 1, stage 2, stage 3 fracture lateral humerus condyle .

Conventional classification: There were 9 children with initial displacement between fracture fragments < 2 mm (n-9), 12 children with initial displacement between 2-4 mm (n-12) and there were 17 children with initial displacement > 4 mm (n-17). Mean union duration in month in children with initial displacement less than 2 mm (n-9) was 2 ± S.D 0.000 month (range 2-2.5 month), in children with initial displacement between 2-4 mm (n-12) was 2.75 ± 0.957 month (range 2-2.5 month) while in children with initial displacement more than 4 mm (n-17) was 2.90 ± 0.641 month (range 2-4 month). Mean range of motion in degrees in Children with less than 2 mm (n-9) was 136.25°± 2.500 (range 0-140°), Children with initial fracture displacement 2-4 mm (n-12) was 132.50°± 5.000 (range 0-140°) while in children with initial fracture displacement more than 4 mm (n-17) was 121°± 17.442 (range 10-140°).The mean carrying angle in degrees in Children with initial fracture displacement less than 2 mm (n-9) was 7.75°± 0.957 (range 7-9°), in Children with initial fracture displacement 2-4 mm (n-12) was 8.50°± 0.577 (range 8-9°) while in children with initial fracture displacement more than 4 mm (n-17) was 6.6°± 2.186 (range 7-9°). There

was no significant difference in mean union duration(P value 0.058) mean range of motion (P value 0.068) and mean carrying angle (P value-0.170) in children with fracture lateral condyle humerus with respect to conventional classification.

Out of 12 children with Milch type 1, five patients were treated with operative management and 7 were treated with cast in situ. All 12 (100%) patients had excellent result according to Hardacre criteria and Dhillon functional and overall grading. Remaining 26 patients with Milch type 2 fracture were treated with operative management. Out of these 26 patients, 14 (53.84%) patient had excellent result, 10 patients (38.46%) had good results and 2 patients (7.69%) had poor results according to Hardacre criteria. According to Dhillon overall scores, 17 (65.38%) out of 26 had excellent results, 8 (30.76%) had good results and 1 (3.84%) patient had fair results. Dhillon functional scores were excellent for 17 patients (65.38%), good for 6 patients (23.07%), fair for 2 (7.69%) and poor for 1 patient (3.84%).

All nine patients (100%) in Jakob stage 1 were treated nonoperatively and had excellent results according to Hardacre and Dhillon functional and overall score. Remaining 29 patients in jakob stage 2 and 3 were treated operatively. 10 Patients (100%) with Jakob stage 2 fracture also had excellent results according to Hardacre criteria. 8 (80%) out of 10 patients had excellent Dhillon functional and overall scores while 2 (20%) patient had good functional and overall scores. Out of 19 patients with Jakob stage 3 fracture lateral condyle 7 patients (36.84%) had excellent results, 10 patients (52.63%) had good result and 2 patients (10.52%) had poor results according to criteria laid by Hardacre. Dhillon functional score were excellent for 12 (63.15%), good for 4 (21.05%), fair for 2 (10.52%) and poor for 1 (5.26%) patients with stage 3 fracture. Also Dhillon overall scores were excellent for 12 (63.15%), good for 6 (31.57%) and fair for 1 (5.26%) patient with stage 3 fractures.

Patient who had displacement between fracture fragments less than 2 mm (n-9) were treated nonoperatively. Remaining 29 patients with displacement more than 2 mm were treated operatively. All Patients (100%) who had displacement between fracture fragment less than 2 mm (n=9) and 2-4 mm (n-12) had excellent results according to Hardacre criteria and Dhillon functional and overall score. Out of 17 patient who had displacement between fracture fragments more than 4 mm, 5 (29.41%) had excellent, 10 (58.82%) had good and 2 (11.76%) had poor results according to Hardacre criteria. Dhillon functional scores were excellent for 8 (47.05%), good for 6 (35.29%), fair for 2 (11.76%) and poor for 1 patient (5.88%). Also Dhillon overall scores were excellent for 8 (47.05%), good for 8 (47.05%) and fair for 1 (5.88%) patient.

DISCUSSION:

A fracture of the lateral humeral condyle is more likely to result in a significant functional loss of elbow motion when it is inadequately treated[22]. Studies on lateral condyle fracture mostly comment on diagnostic investigations (MR[17], USG[24], and radiographs[25]) or management protocol45, 46, 36-44. This is a unique paper correlating the fracture classification and the clinical outcomes to establish the prognostic significance of the commonly used classifications.

Milch proposed his classification in 1964.26 In Type I: Fracture line courses lateral to the trochlea and passes through the capitello-trochlear groove. In Type II: Fracture line extends into the apex of the trochlea. The Milch type I could be considered as a variant of the Salter-Harris type IV physeal injury, while the Milch type II fracture is equivalent to a Salter-Harris type II physeal fracture26. Jakob et al.27described lateral condyle fractures in relation to the degree of displacement and rotation of the fracture fragment. Stage I displaced fractures have less than 2mm of displacement with an intact articular surface. In Stage II displaced fractures, there is 2–4mm of displacement with moderate displacement of the articular surface. Stage III displaced fractures demonstrate significant displacement associated with rotation of the fragment. Conventionally fracture lateral humerus condyle is classified as undisplaced or displaced less than 2 mm and fracture fragment displaced 2-4 mm and fracture displacement more than 4 mm. Kyoung Hwan Koh et al28 found no differences in demographic data or clinical results, as determined using the Dhillon scoring system, between fracture types. Furthermore, the incidences of cubitus varus and of a radiographic carrying angle decrease were also not different for the fracture stages. These results were similar to our study. The incidences of lateral condylar overgrowth and osteophyte formation on radiographs were not found to be dependent on fracture type. However, the incidence of clinical lateral prominence was found to differ significantly between Jakob types I and II and between types I and III (both $P<0.001$) by growth disruption owing to unstable Kirschner wire fixation. In their study, clinical overgrowth of the lateral condyle was observed more commonly for Jakob type II and III fractures than for type I fracture. Furthermore, significant differences were observed between all 3 treatment methods (cast, closed reduction internal fixation, open reduction internal fixation) with respect to clinical overgrowth of the lateral condyle, and in nearly 77% of patients, overgrowth and osteophyte of the lateral condyle persisted at a mean 19.8 months post injury. So prominence of lateral condyle can be attributed to method of treatment. However none of our cases had lateral condyle overgrowth and this may be due to small sample size.

All deviations over 10 degrees in the varus or valgus deformity after treatment of fracture lateral condyle Humerus are dependent upon the incomplete reduction of the fracture fragments during the operation.29-35 Thus anatomical reduction is the most important factor in preventing this deformity. Comparison between outcomes of the three commonly used classifications showed no significant difference in union time, range of motion and carrying angle in our series. Although these classifications dictated choice of

treatment they did not affect the outcome. Thus irrespective of fracture classification and whether the fracture is displaced or undisplaced, good outcome can be expected if anatomical reduction is achieved and maintained in pediatric lateral condyle humerus fractures.

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	Total no. of Patient (n)	**Union time (weeks) Mean±SD**	**Range of motion (degree)**	**Carrying angle in degree**
Milch	38			
Type 1	12	2.43±0.787	135.00°±4.082	8.14°±0.900
Type 2	26	2.86±0.655	121.43°±17.113	6.67°±2.153
P value		0.165	0.050	0.093
Jacob	38			
Stage 1	9	2.00±0.000	136.67°±2.887	7.53°±0.577
Stage 2	10	2.80±0.837	134.00°±5.477	8.20°±0.837
Stage3	19	2.89±0.658	120.00°±17.321	6.58°±6.58
P value		0.139	0.06	0.309
Conventional	38			
< 2 mm	9	2.00±0.000	136.25°±2.500	7.75°±0.957
2-4 mm	12	2.75±0.957	132.50°±5.000	8.50°±0.577
>4 mm	17	2.90±0.641	121.00°°±17.442	6.60°±2.186
P value		0.058	0.068	0.170

P value calculated using Independent sample test and ANOVA test.

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