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CROSSED VERSUS LATERAL PERCUTANEOUS PINNING FOR TREATMENT OF DISPLACED PEDIATRIC SUPRACONDYLAR HUMERAL FRACTURES BY CLOSED REDUCTION AND PERCUTANEOUS PINNING

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ABSTRACT

Background: Supracondylar humeral fractures are the most common elbow injuries in pediatric population. Their treatment is controversial when displacement has occurred whether open or closed reduction. closed reduction with percutaneous pinning using either two lateral pins or crossed pinning. **Objective:** The aim of this is to compare the functional, cosmetic and radiological outcome between lateral & crossed pinning method for percutaneous fixation of displaced type II and III supracondylar humeral fractures in pediatric patients. **Patients and Methods:** A prospective comparative randomized study of 50 patients 34 (68%) male & 16 (32%) female with displaced type II & III supracondylar humeral fracture in patients below 10 years (mean age 6.74 years) this study was conducted at Al-Jumhoori Teaching Hospitals in Mosul from January 2020 to October 2020. All patients were treated surgically by closed reduction and percutaneous pinning using either lateral pinning (group A 25 patients) or crossed pinning (group B 25 patients). The mean follow up was 3months. **Results:** Forty three (86%) of patients had minimal loss of Baumann angle (21 (84%) patients in group A & 22 (88%) patients in group B) according Skaggs criteria. Forty five (90%) of patients had excellent cosmetic outcome (22 (88%) patients in group A & 23 (92%) patients in group B). Thirty three (66%) of patients had excellent functional outcome (17 (68%) patients in group A & 16 (64%) patients in group B) according to Flynn criteria. Surgical time in group A was (37.04±1.76 minutes) while in group B was (39.36±2.39 minutes). One (4%) patient in group A & three (12%) patients in group B had pin tract infection. Two (8%) cases of iatrogenic ulnar nerve injury were found in group B which recovered completely after 4 weeks. No statistically significant difference were found between two groups except for surgical time (P-value0.0003). **Conclusions:** Both methods were good and relatively safe for fixation of displaced supracondylar humeral fracture. No statistically difference regarding functional, cosmetic and radiological outcomes, however, the surgical time in group A was shorter than group B and iatrogenic ulnar nerve injury still encountered in group B.

KEYWORDS: Supracondylar humeral fracture, lateral pins, crossed pins, outcome.

INTRODUCTION

It is the most common elbow injury in pediatric patients accounting for 16% of all pediatric fractures.[1] and account for 55% to 80% of total elbow fractures.[2] It is 3rd only to the distal forearm and clavicle for frequency of fractures in pediatric.[3] Boys are injured more often than girls and more than half the patients are under 10 years old.[4] The most common age of injury is 5 to 7 years.[1] Injury often occurs on the non-dominant part of the limb.[3] This type of fractures may lead to bony deformity in the future and may be complicated by Volkmann's contracture[5] Nowadays, techniques that used for treatment of supracondylar humeral fractures have significantly decreased the rates of malunion and compartment syndrome.[6] Supracondylar humeral fractures divide into two types extension-type fractures, account for approximately 95% 98% caused by a fall onto outstretched hand in full extended elbow. Flexion type fractures, account for 3% - 5%, result from direct blow to the posterior aspect of the elbow .one of the

clinical evaluation in Supracondylar humeral fractures is assessment of Carrying angle (humeral- ulnar- wrist angle), it is considered normal between 5 – 15 ^{o}[7,8] Radiographic Assessment: High-quality radiographs are essential to show the evidence, degree of displacement, comminution & intra-articular extension of the fracture line.[7] AP view may Shows that the distal fragment is translated, angulated sideways or rotated. Measurement of Baumann's angle is useful in assessing the degree of medial angulation before & after reduction[4] Baumann's angle referred to humero-capitellar angle, formed by the long axis of the humerus and the physeal line of the lateral condyle, normally range from 65-81^{0} .Angle greater or lesser than this range is concerning for fracture displacement (compared to non-injured elbow)[3,7] Every 5 degree change in Baumann's angle can lead to 2 degrees change in carrying angle[3] In the past, a majority of these fractures were treated with long arm casting with the elbow in a position of greater than 110° of flexion. This flexed posture helps to maintain the fracture reduction, but lead to problems with vascular compromise and subsequent Volkmann's contracture.[6,9] Displaced supracondylar fractures may show instability following closed reduction unless the elbow is immobilised in a flexion position. This may compromise circulation and be followed by the development of a varus deformity which has a reported incidence of 9% to 57%.[3,10,11] The dangers and difficulties of closed reduction, with the application of a cast, include the risk of circulatory embarrassment of the forearm and hand, the tendency to recurrence of displacement, and the increased incidence of cubitus varus deformity.[4,6] At present time the most common used methods of treatment of these fractures are closed reduction with percutaneous wire fixation and Open reduction and wire fixation. Closed reduction with percutaneous wire fixation has excellent results with negligible complications.[1,5,8] Open reduction and wire fixation has been advised for cases associated with neurovascular injuries and for fractures which are not satisfactorily reduced.[7,9]

PATIENTS AND METHODS

A prospective randomized comparative case study was carried out at Al-Jumhoori Teaching Hospitals, Mosul, Iraq from January 2020 to October 2020. After obtaining ethical committee approvals, full written informed consent was taken from the parents before including their patients in this study. Fifty patients (34 male and 16 female) were included in this study. Age at or below 10 years with Closed Gartland type II and III supracondylar fractures, injury within 3 days and Competent clinical neurovascular examination of the affected limb were included in this study . We exclude patients having Gartland type I and flexion type supracondylar fractures and history of injury more than 3 days, Patient's Family refusal to participate in this study, Patient with open supracondylar fractures, Multiple traumatized patients and associated vascular injury of the affected limb with sign of ischemia. The Pre-operative preparations any child between 3-10 years old present to the emergency department with history of trauma to the elbow was being examined and evaluated for possibility of having Supracondylar humeral fracture, then checking his general and local condition regarding any associated trauma. Vascular and neurological examination was done, and then AP and lateral radiographs of the involved elbow were performed. All displaced Supracondylar humeral fractures were admitted to the hospital and the injured elbow was temporarily splinted with above elbow back slab at 30 – 45^{o} of flexion and the affected limb elevated at the level of heart to decrease or prevent edema. Patients with absent distal radial pulsation but the hand was viable not ischemic were being included, here we were prepare for possibility of open reduction and internal fixation & we inform the vascular surgeon to be standby during surgery; fortunately brachial artery exploration was not needed in our study. All the patients were sent for pre-operative investigations including complete blood count, viral screen test (HIV, HBS, HCV and COVID 19). All the patients were prepared for operation. The timing until operative procedure being done was between 5 - 36 hours from admission to the hospital. The time of operative procedure measured from the time of beginning of closed reduction until the end of application of cast. We divided our included patients randomly (every other patient) into 2 equal groups according to the method of fixation Group A 25 (50%) patients for lateral pins fixation. Group B 25 (50%) patients for cross pins (medial and lateral) fixation. The operative Procedures General anesthesia was used for all the patients in supine position. Prophylactic antibiotic injection was used for all patients which was 3rd generation cephalosporin (ceftriaxone vial 50 mg/kg intravenous) with respect to any associated drug allergy in every patient, two from the all participant patients had allergy to cephalosporin group and they received aminoglycoside (gentamicin injection 6 mg/kg/day single dose only) instead. The carrying angle was measured in the un-affected side. The injured elbow was placed on the plate of the imaging fluoroscopy. Closed reduction was done and the technique was gentle traction with counter traction in the longitudinal axis of the arm. The elbow is extended and the forearm supinated. The traction was maintained; the displacement of distal fragment was corrected by applying a valgus - varus force. Correction of the rotation of the distal segment. The posterior displacement was corrected by pressure over the distal segment of the fracture from its back gently by the surgeon thumb. The elbow joint hyperflexed slowly thus the elbow secured in hyperflexion (Figure1). The forearm is supinated or pronated accordingly. (Pronation in PM displacement while supination in PL displacement to get more stability).The accuracy of reduction was confirmed by fluoroscopy AP & Lateral views (Figure2). The anatomical site of entry, the stability on operative table and the position of elbow for pin placement are nearly uniformed in all the participants. The pins size

(1.67 – 2.0 mm) was being selected according the age & body fit of the child.

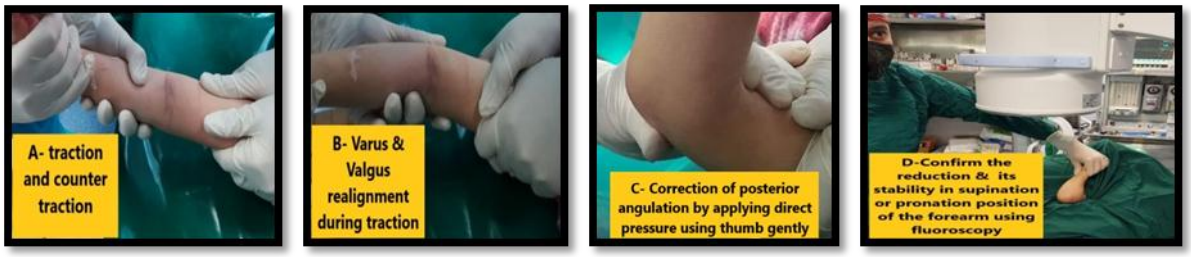

Figure 1: A,B,C & D Shows the procedure in sequences during closed reduction of SCH fracture.

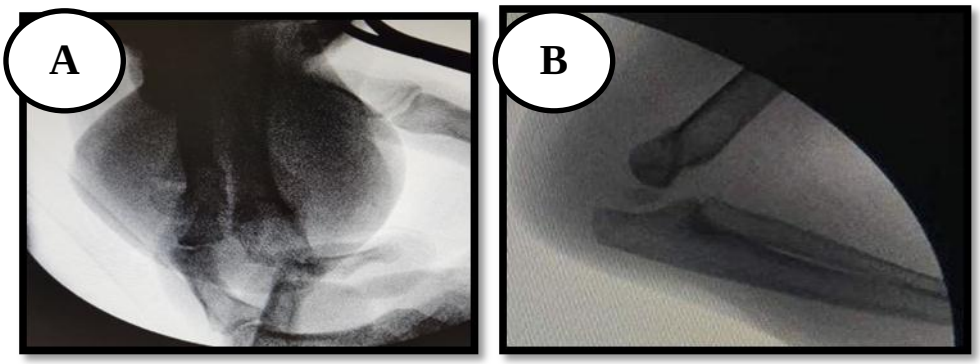

Figure 2: A & B. Shows Ap. & Lat. views of reduction in hyperflexion position before introducing pins.

The reduction stability was being checked under fluoroscopy in either position of forearm pronation or supination to see what is the maximal reduction and stability of the fracture. The distal pulsation re-evaluated after complete fracture reduction (Figure3).

Figure 3: (A,B&C). Forearm position(A-pronation,B-supination) for stability, C-distal pulse evaluation.

In hyperflexion position of the elbow after reduction accomplished the 1st lateral pins was placed at center of the lateral epicondyle and directed medial and cephalic till reach and pass the medial distal humeral cortex, the 2nd one was put more medially. Sometimes 3rd pin may be added for better stability. The angle of direction of pins to the longitudinal axis of humerus during insertion was around 30^{o} (Figure 4).

Figure 4: Shows the direction of pin entrance.

Group A underwent lateral pins fixation (Figure 5), group B underwent cross pins (medial-lateral) fixation (Figure 6).

Figure 5: Shows intra-operative X-ray of the lateral pinning in group A

Figure 6: Shows the cross pinning fixation.

During medial pin placement, after we were completed the insertion of the lateral pin the elbow extended, the ulnar nerve palpated and rolled back by surgeon's thumb (Figure 7), sometimes we did a mini incision for identification the tip of medial epicondyle, this was done in obese children or in the presence of severe swelling (ulnar nerve or medial epicondyle was difficult to palpate).

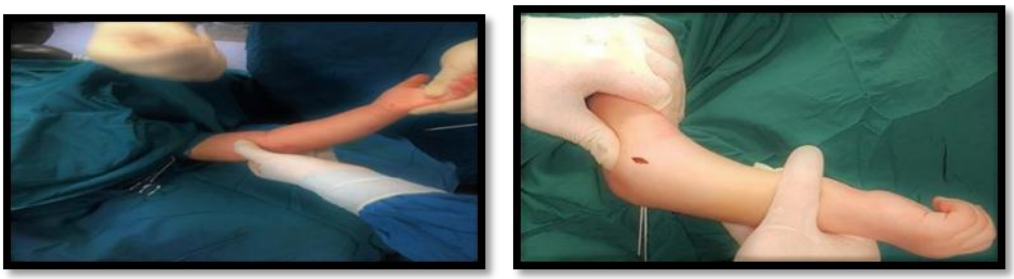

Figure 7: Shows the steps that we used to minimize the risk of IUNI. the mini incision used to explore a safe tract of entrance of medial pin.

The medial pin inserted anterior to the apex of medial epicondyle & directed lateral and cephalic passing the lateral distal humeral cortex (Figure 6). The reduction and stability of fixation were being checked for the last time under fluoroscopy. The pins were bent and cut off outside the skin (Figure 8) to allow easy removal later and to prevent irritation or proximal migration.

Figure 8: Pins are bended and cut to prevent migrations.

After the procedure of fixation was completed, the elbow was fully extended and the surgeon measures clinically

the *Carrying Angle* using goniometer and compared it with the non-affected side (Figure 9).

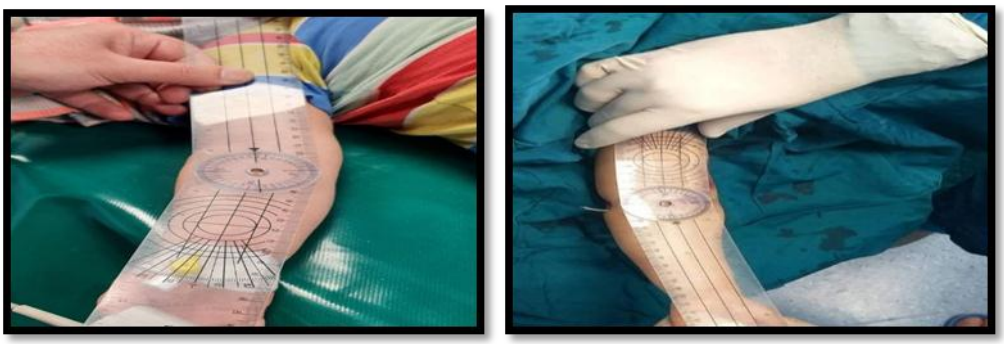

Figure 9: Measurements of carrying angle in both sides.

The Baumann Angle measured by the aid of fluoroscopy monitor using goniometer and compared to un-injured side at the end of procedure (Figure10).

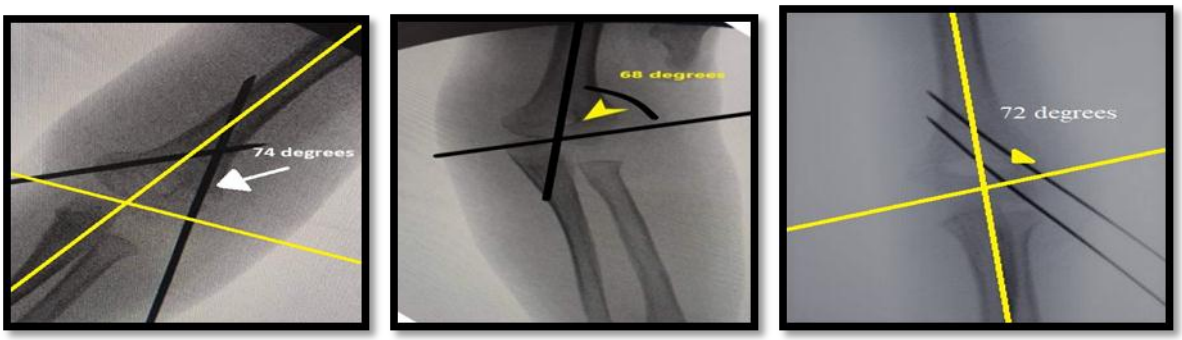

Figure 10: Shows the degrees of Baumann angle after reduction compared to the other side.

Back slab was applied, elbow held with less than 90^{o} of flexion (forearm pronated in PM displacement and supinated in PL displacement). Postoperative X-ray was taken for all patients (Figure 11).

Figure 11: Shows the application of back slab on the injured limb.

After completing the procedure of fixation, two intra-operative readings were being documented for every patient that will being used for comparison in our study, the 1st one clinically by measuring the carrying angle (figure 9), and the 2nd one was the Baumann angle from the fluoroscopy screen (figure 10) on AP view (both injured and uninjured side). These data were being the base line reading for our follow up for these 2 angles during the patient next visits. The patients then kept in the surgical ward for the next 24 hours for observation of the vascularity (distal pulsation and capillary refilling) and swelling of the operated limb. All patients were kept on postoperative antibiotic orally for three days and paracetamol 10mg/kg/dose after discharge. The parents were instructed about the follow up program which was 4 main visits in the 1st, 3rd, 6th week and at the end of 3rd month after operation. During follow up visits in the outpatient department, clinical, radiological, and functional outcome evaluations were performed which include assessment of neurovascular status. Infection whether it was superficial or deep and the patient need another surgery. Assessment of carrying angle and Baumann angle. Passive range of movement. At the end of the 3rd week, the back slab and pins were removed in the majority of patients except for 7 of them (4 in group A and 3 in group B) had mean of 5 days delay after the

estimated date of last visit. The site of pin's entrance treated with local skin care and dressing, examination of the ulnar nerve especially in group B and assessment of passive range of elbow motions. Regarding the clinical and radiological assessment of the patients in both groups we depend in this study on the measurement of carrying and Baumann angles in 4 serial readings and compared with the un-injured side. The 1st reading was intra-operatively immediately after fracture fixation, the 2nd reading during the 1st visit (after one week), the 3rd reading were before pins removal and the last one at 6th week of follow up. At 3 months of follow up, every child was evaluated for full, minor or major loss of function, and normal anatomical restoration. The functional and cosmetic outcome was being assessed according to Flynn criteria (Table 1).

Table 1: Flynn Criteria.

Parents/Patients satisfactions	*Carrying angle loss (degrees)*	*Motion loss (degrees)*	*Results*
Satisfactory	0-5	0-5	Excellent
Satisfactory	5-10	5-10	Good
Satisfactory	10-15	10-15	Fair
Unsatisfactory	>15	>15	Poor

The radiological outcome of the injured elbow was assessed according to Skaggs criteria (Table 2).

Table 2: Skaggs Criteria.

Baumann Angle loss (degrees)	*Results*
<6	None
6-12	Mild
>12	Major

The data that collected in our study were statistically analyzed using SPSS/PC soft were version 23. ***P – Value*** less than 0.05 is considered statistically significant.

RESULTS

Fifty patients (34 males and 16 females) included in this study that was being done at Al-Mosul Hospitals**,** equally divided into 2 groups A and B. The mean age was 6.74 years (6.76 years in group A and6.72 years in group B) respectively (P-value = 0.9) (Figure12).

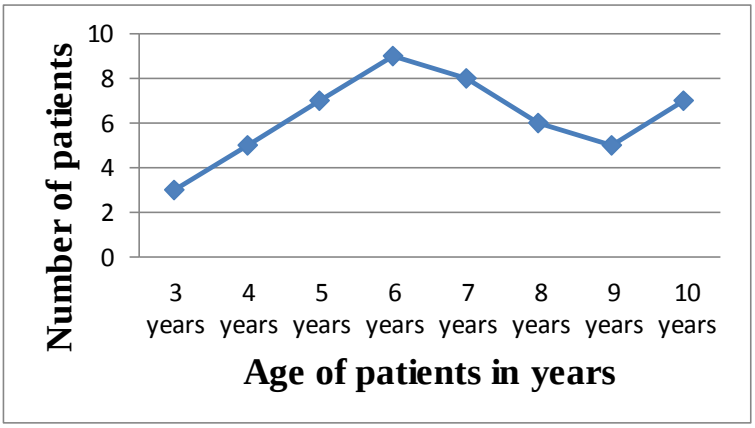

Figure 12: Show the prevalence of fracture in each age group for all the participants' patients.

The male to female ratio in group A was 2.57:1(18 (72%) males and 7 (28%) females), while in group B was 1.77:1(16 (64%) males and 9 (36%) females) (P-value = 0.55) (Figure 13).

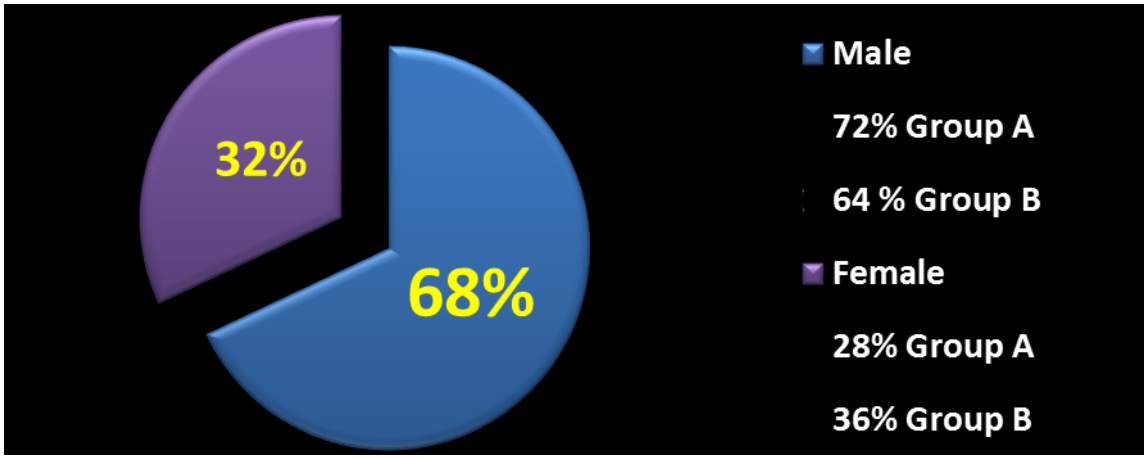

Figure 13: Show the percentage of occurrence of the fracture in male and female in both groups.

The most common cause of the injury in all patients of this study was falling on outstretch hand with hyper-extended elbow, this is occurred during playing in 30 (60%) patients, followed by fall from a height in 19 (38%) patients, and in one (2%) patient the trauma was resulted by direct blow (Figure 14).

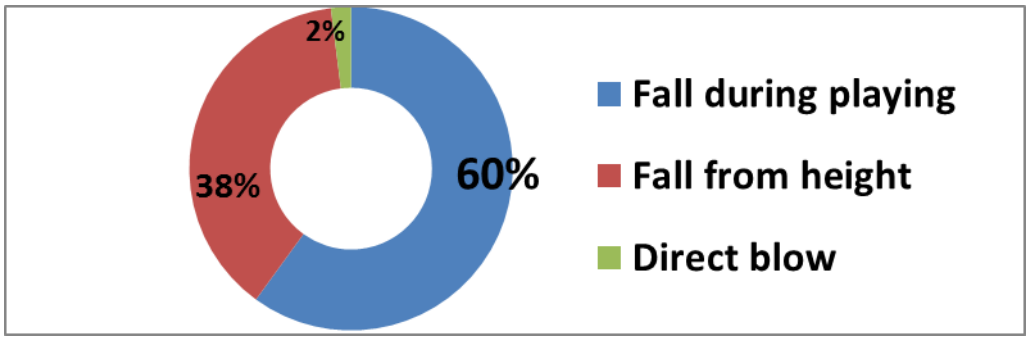

Figure 14: Show the percentage of the causative trauma of the fracture.

The left side was affected more than right side in both groups of our study, left side 54%, and right side 46% (Figure 15). In group A the left side was in 13 (52%) patients, and the right side was in 12 (48%) patients, while in group B the left side was in 14 (56%) patients, and the right side was in 11 (44%) patients (P-value = 0.78).

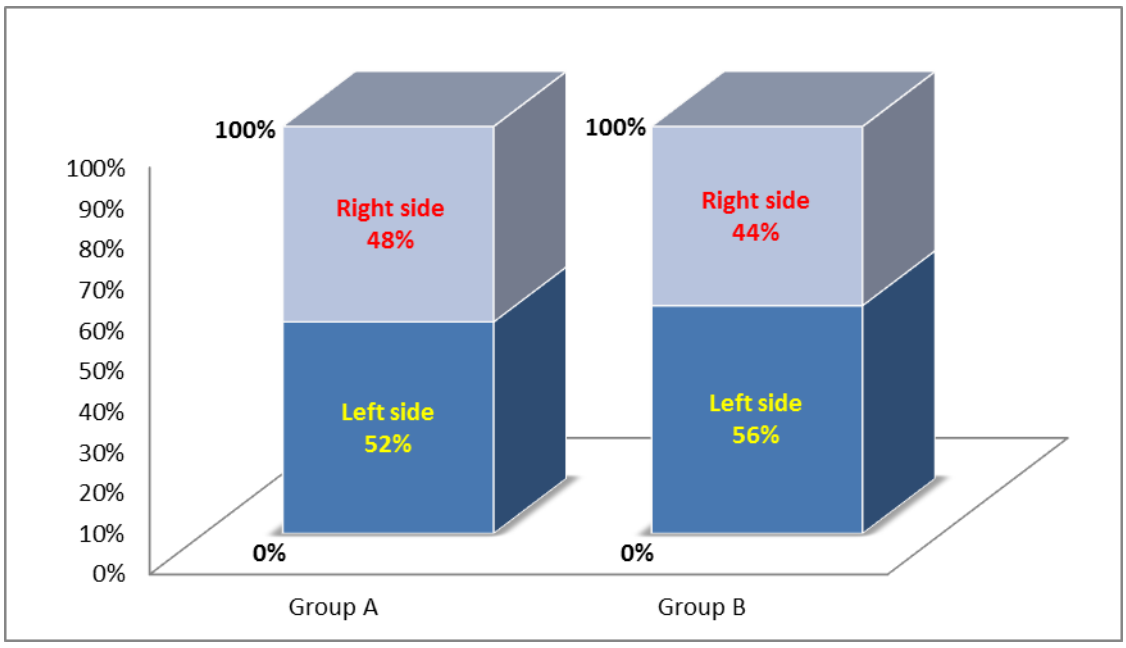

Figure 15: Show the percentage of injured side in both groups.

The radial pulsation at presentation for the all participants was normal in 36 (72%) patients, weak in 13 (26%) patients, and absent but the hand looks normal and viable in 1 (2%) patients (P-value = 0.16). The most common type of the fractures in our study was Gartland IIIA with PM displacement (Figure 16) in 32 (64%) patients (17 (68%) in group A and 15 (60%) in group B). The second type was Gartland IIIB with PL displacement in 11 (22%) patients (5 (20%) in group A and 6 (24%) in group B).The third one was Gartland type II with pure posterior displacement in 7 (14%) patients (3 (12%) in group A and 4 (16%) in group B) (P-value = 0.56) (Table 3).

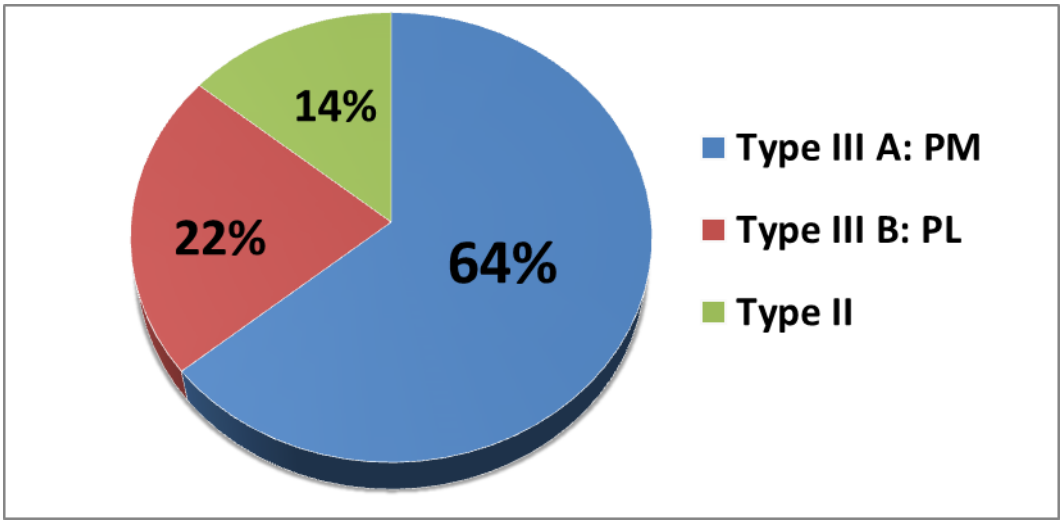

Figure 16: Show the percentage of fracture type according displacement.

All the patients reported the injury on the same day of their trauma. 60 % of the all participant underwent surgery on the same day (14 (56%) of the group A and 16 (64%) of the group B), 34% on the next day (10 (40%) of the group A and (7) 28% of the group B), and 6% on the next 2 days (1 (4%) of group A and 2 (8%) of group B) the delay to the surgery was 5 – 36 hours (P-value = 0.82).The average surgical time was (37.04±1.76) minutes in patients of Group A and (39.36±2.39) minutes in patients of Group B which was statistically significant (P-value = 0.0003).The average duration of follow up was 12.36 weeks in group A and 12.4 weeks in group B (P-value = 0.9), the duration of follow up was ranged from 11weeks to 14 weeks for both groups (Table 3).Pin tract infection was found in one (4%) patient of group A and Three (12%) patients of group B (Figure 17). The infections were limited to superficial tissue and treated with regular wound care and daily dressing and short course of oral antibiotic, all pin tract infection healed uneventful (Figure 18) (P-value = 0.3) (Table 3).

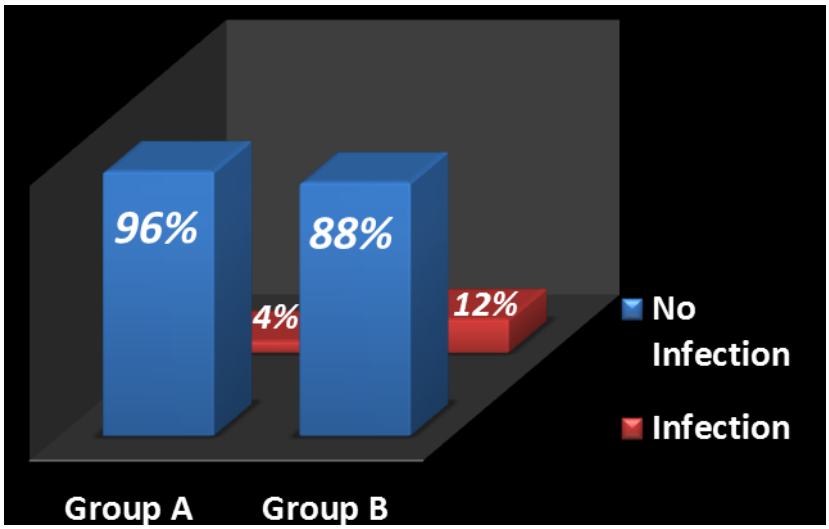

Figure 17: Show percentage of pin tract infection.

Figure 18: Clinical photograph of elbow show redness and some discharge due to pin tract infection.

Two (8%) cases of IUNI were found in group B following placement of medial pin (Table 3) they just complain from parasthesia along the ulnar nerve distribution. Both of them recovered within 4 weeks (P-value = 0.16).

Table 3: Demonstrate comparison of variables between both groups.

Variables		Group A 25 patients	Group B 25 patients	*p-value*
Mean age in years		6.76±2.00	6.72±2.22	0.94**
Gender	Male	18 (72.0%)	16 (64.0%)	0.55**
	Female	7 (28.0%)	9 (36.0%)	
Side affected	Right	12 (48.0%)	11 (44.0%)	0.78**
	Left	13 (52.0%)	14 (56.0%)	
Classification & Displacement	IIIA	17 (68.0%)	15 (60.0%)	0.56**
	IIIB	5 (20.0%)	6 (24.0%)	
	II	3 (12.0%)	4 (16.0%)	
Average surgical time (minutes)		37.04±1.76	39.36±2.39	0.0003
Average delay from trauma to operation (days)	Same day	14 (56.0%)	16 (64.0%)	0.82**
	2nd day	10 (40.0%)	7 (28.0%)	
	3rd day	1 (4.0%)	2 (8.0%)	
Average follow-up (weeks)		12.36 ± 1.12	12.4 ± 1.11	0.90**
Pin tract infection	negative	24 (96.0%)	22 (88.0%)	0.30**
	positive	1 (4.0%)	3 (12.0%)	
IUNI	Negative	25 (100.0%)	23 (92.0%)	0.16**
	positive	-	2 (8.0%)	

The means of carrying and Baumann angle of the injured side were assessed in four occasions, the 1st reading was immediately after fracture fixation, 2nd reading was in the 1st visit after one week, 3rd reading done before pins removal at 3 – 4 weeks and the last reading after 6 weeks of follow up. These reading were compared to the un-injured side in every patient at every visit (Table 4).

Table 4: Demonstrate the analysis of data that was conducted by use of *ANOVA* test to compare 4 reading in every patient in group A and group B.

Group A

	Un-injured side Mean ± SD	Fracture side intra-operative Mean ± SD	Fracture side 1st week post-operative Mean ± SD	Fracture side 3rd week post-operative Mean ± SD	Fracture side after 6 weeks Mean ± SD	P-value
Carrying angle	10.32±3.11	10.24±2.60	9.92±3.06	9.88±3.03	9.88±3.03	0.93
Baumann angle	72.48±4.62	72.44±3.87	72.60±4.19	72.56±4.19	72.56±4.19	0.98

Group B

Clinical and Radiological angles	Un-injured side Mean ± SD	Fracture side intra-operative Mean ± SD	Fracture side 1st week post-operative Mean ± SD	Fracture side 3rd week post-operative Mean ± SD	Fracture side after 6 weeks Mean ± SD	P-value
Carrying angle	11.28±2.73	10.64±2.81	10.64±2.81	10.64±2.81	10.64±2.81	0.8

Baumann angle	**71.20±3.97**	**71.88±3.75**	**71.88±3.75**	**71.88±3.75**	**71.88±3.75**	**0.89**

21 (84%) of patients in group **A** and 22 (88%) of patients in group **B** had minimal loss of reduction (< 6^{o}) of Baumann angle. 4 (16%) patients in group A and 3 (12%) patients in group B had mild loss of reduction (6 – 12o) of Baumann angle, no patients in both groups had major loss of reduction (>12o), this result was according to Skaggs criteria (Table 5).

Table 5: Skaggs's criteria, loss of reduction of Baumann angle and its grading.

Group A	Group B	Loss of Baumann angle in degrees	Grading
21 patients (84%)	**22 patients (88%)**	**<6**	**None**
4 patients (16%)	**3 patients (12%)**	**6-12**	**Mild**
_	**_**	**>12**	**Major**

22 (88%) of patients in group A had a carrying angle loss less than (5^{o}), 3 (12%) patients had loss between (5^{o} – 10^{o}). No patients had loss more than (10^{o}) in this group. 23 (92%) of patients in group B had a carrying angle loss less than (5o), 2 (8%) patients had loss between (5o – 10o). No patients had loss more than (10o) in this group. This result was estimated by Flynn criteria (Table 6).

Table 6: Flynn's criteria, for grading the cosmetic and carrying angle loss.

Group A	Group B	Carrying angle loss(^{o})	Grading	Family satisfactions
22 patients (88%)	**23 patients (92 %)**	**0^{o} - 5^{o}**	**Excellent**	**Satisfactory**
3 patients (12%)	**2 patients (8 %)**	**5^{o} - 10^{o}**	**Good**	**Satisfactory**
_	**_**	**10^{o} - 15^{o}**	**Fair**	**Satisfactory**
_	**_**	**>15^{o}**	**Poor**	**Unsatisfactory**

In group A the loss of range of motion was less than (5^{o}) in 17 (68%) patients, 6 (24%) patients had loss between (5^{o} – 10^{o}) and more than (10^{o}) loss in 2 (8%) patients. In group B the loss of range of motion was less than (5o) in 16 (64%) patients, between (5o – 10o) in 8 (32%) patients, and one (4%) patient had loss of range of motion more than (10o). The functional outcome and patient's family satisfaction was assessed by Flynn's criteria (Table 7).

Table 7: Flynn's criteria for loss of range of motion and family satisfactions.

Group A	Group B	Loss of range of motion(^{o})	Grading	Family satisfactions
17 patients (68 %)	**16 patients (64 %)**	**0^{o} - 5^{o}**	**Excellent**	**Satisfactory**
6 patients (24 %)	**8 patients (32 %)**	**5^{o} - 10^{o}**	**Good**	**Satisfactory**
2 patients (8%)	**1 patient (4%)**	**10^{o} - 15^{o}**	**Fair**	**Satisfactory**
_	**_**	**>15^{o}**	**Poor**	**Unsatisfactory**

The mean loss of Baumann angle in our study was (3.36±2.98) in group A while it was (4.12±2.57) in group B (table 8). (*P- value* = 0.33). The mean loss of carrying angle in our study was (2.60±2.30) in group A while it was (3.12±1.96) in group B (table 8). (P- value = 0.39). The mean loss of range of motion in our study was (6.56±3.09) in group A and (6.72±2.54) in group B (table 8). (*P- value* = 0.49). There is no statistically significant difference between both groups A and B in this study regarding Baumann's angle, carrying angle and range of motion of the affected elbow (Table 8).

Table 8: Compares the functional and radiological outcome between 2 groups during follow up.

Parameters	Group A Mean ± SD	Group B Mean ± SD	*P- value*
Loss of carrying angle through 3 weeks follow up compared to un affected side.	**2.60 ± 2.30**	**3.12 ± 1.96**	**0.39**
Loss of Baumann angle through 3 weeks follow up compared to un affected side.	**3.36± 2.98**	**4.12 ± 2.57**	**0.33**
Loss of range of motion at the end of follow up.	**6.24 ± 2.42**	**6.72 ± 2.54**	**0.49**

The difference in the injured and un-injured side between the two groups at the end of follow up was assessed by the use of two independent samples t-test. Radiological and clinical union occurred within a similar time period.

There was neither clinical deformity like cubitus varus nor major limitation of elbow movement at the end of follow up. All the fractures were healed well and uneventfully.

DISCUSSION

Supracondylar humeral fractures are the most frequent trauma of the pediatric elbow joint which can cause functional and cosmetic problems and constitute approximately two third of elbow fractures in children. The most common cause was fall on outstretch hand,[2,3] The current study shows, in all of the 50 patients the male affected more than female (68% male and 32% female), a study done by ***Prashant et al*** and ***Kandel et al*** shows a similar result,[12,13] The age had being selected in this study 10 years and below it; the mean age was 6.74 years (6.76 in group A and 6.72 in group B), a study done by ***Pavone et al*** shows the mean age was 5.69 years in lateral pinning group and 6.26 years in crossed pinning group,[14] which was similar to the result of the current study.This study shows that fractures affect the left side more than right side, ***Prashant et al*** and ***Abubeih et al*** shows that the left side also was affected more than right side,[14,15] A study done by ***Herdea et al*** about the relationship between the dominant hand and the occurrence of fracture, they found that non dominant side affected more than the dominant side. They conclude that children tend to protect their dominant hand by falling on their non-dominant one [(16)]. The majority of fractures in this study were caused by fall on outstretch hand with hyperextended elbow, this is occurred during playing in 30 (60%) patients, fall from height in 19 (38%) patients and only one (2%) patient the fracture caused by direct blow. ***Prashant et al*** shows (include 62 patients) that causative agent of the fracture was trauma during playing in 40 (64.51%) patients, fall from a tree in 17 (27.41%) patients and fall from bicycle in 5 (8.06) [(12)]. The radial pulsation at time of presentation in the present study was positive in 36 (72%) patients, weak in 13 (26%) patients and absent but the hand look viable and well perfused in 1 (2%) patient. ***Prashant et al*** shows that the radial pulsation was normal in 23 patients (37.09%), weak in 34 patients (54.83%) and absent with viable hand in 5 patients (8.06%) [(12)]. According to **Gartland classification** the most common type in this study was IIIA, followed by type IIIB and type II SCH fracture. ***Naik et al*** shows comparable results.[17] this may be due to the causative mechanism of fracture. The **duration of follow up** in the current study was range from 11 to 14 weeks in both groups with mean average 12.36 and 12.4 weeks in group A and B respectively. A study done by ***Foead et al*** shows the average follow up of their 55 participant patients was range from 3.13 – 14.73 months with mean average 8.93 months.[18] This difference in duration of follow up between this study and the others may be due to the follow up systems (referral system) that being used in their countries and the degree of co-operation between patients and medical staff. The **surgical time** in the current study shows that group A their operation was done at shorter time than group B which is also noted by ***Naik et al***.[17] ***El-Ngehy et al*** also noted that in lateral pinning group had shorter operative time than crossed pinning group.[19] This can be explained by that the lateral entry group had fewer steps than cross entry group and in cross entry sometimes mini incision technique being used to avoid IUNI. **Pin tract infection** in this study was occurred in one (4%) patient in group A and three (12%) patients in group B and they were treated by short course of antibiotic and local wound care, ***Naveen & Chaitanya*** noted in their study (include 40 patients) that pin tract infection in lateral entry group was (10%) and (5%) in crossed entry group.[20] For this reason, ***Gaston et al*** suggested oral antibiotic therapy to minimize the risk of infection.[21] On the topic of **iatrogenic ulnar nerve injury** (IUNI) in the current study 2 (8%) patients of group B with only sensory loss manifestations, which resolved spontaneously within 4 weeks; ***Prashant et al*** show in his study 2 case (6.5%) of IUNI in crossed entry group one of them had sensory loss only while the other had sensory and motor deficits, both of them recovered within 3 weeks and 4 months respectively.[12] ***Naik et al***.[17] also show a comparable result, while ***Maity et al***.[22] show in their study no case of IUNI was being documented in crossed entry group, they mentioned that they did a mini incision technique uniformly to the all patients of crossed entry group. On the subject of **Carrying Angle**, the present result was comparable to ***Foead et al*** regarding the mean loss of carrying angle was (3.70±4.24) in lateral entry group and (3.57±4.67) in crossed entry group.[18] Measuring the carrying angle in the contralateral side is important factor for adjustment of the fractured side together with rigid and stable fixation. According to Flynn criteria.[41] our study also was comparable to ***Foead et al*** regarding the percentage of distributions (excellent and good) of cosmetic outcome and carrying angle.[18] As regards **Baumann angle**, ***Prashant et al*** found that the mean loss of Baumann angle was (4.74±1.29) in lateral entry group and (4.99±0.87) in crossed entry group.[12] Perfect anatomical reduction and stable rigid fixation play an important role during fixation of such fractures. According to Skaggs criteria.[23] this study shows that 4 (16%) patients of group B have mild loss (6^o – 12^o) of Baumann angle; ***Prashant et al*** found that 2 (6.4%) patients in the lateral entry group had mild loss of Baumann angle [(12)].Regarding the **loss of range of elbow motion**, the result of current study shows that there is no statistically significant difference between the two group, ***Govindasamy et al*** show a comparable result.[24] however we have 2 (8%) patients in group A and one (4%) patient in group B have fair outcome according to Flynn criteria.[25] ***Naik et al*** noted in their study (include 57 patients) that in lateral entry group (28 patients) only one (3.5%) patient have fair outcome according Flynn criteria in loss of range of elbow movement.[17] This current study shows that there is neither major clinical deformity (distorted carrying angle) nor major limitation of elbow movement; this result was comparable to ***Govindasamy et al*** study.[24] ***Pavone et al*** shows in their

study that one of 22 patients (5.5%) of crossed entry group developed varus deviation (6^{o}).[4] There is no statistically significant difference between these two techniques of fixation of SCH fracture in children regarding carrying angle, Baumann angle and functional range of elbow movement. ***Prashant et al***, ***Pavone et al***, Govindasamy et al also document the same result.[12,14,24] ***Zhao et al*** performed a meta-analysis study of randomized controlled trials to compare the risk of IUNI, quality of fracture reduction in terms of radiographic outcomes, and function in terms of Flynn criteria and elbow range of motion; they found that there are no statistical differences in radiographic outcomes, function, and other surgical complications and they conclude that the crossed pinning fixation is more at risk for IUNI than the lateral pinning technique. Therefore, they recommend the lateral pinning technique for treatment of SCH fractures.[26]

CONCLUSIONS

From the current comparative prospective study we conclude that:No statistically significant differences were found between group A and B regarding functional, cosmetic and radiological outcomes.There is statistically significant difference between group A and B regarding the time of operation which was shorter in group A.Iatrogenic injury of ulnar nerve still encountered in group B.

Recommendations

Because of there is no statistically significant difference between the two methods of treatment of displaced pediatric supracondylar humeral fracture, we recommend for using lateral pinning technique because of shorter time of surgical procedure and avoidance of iatrogenic ulnar nerve injury.This study has limited number of patients and short time, so we recommend doing wider studies to achieve more reliable result.

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