

AIM OF THE WORK

The aim of the present work was to assess the early results of fixation of displaced supracondylar fractures of the humerus in children through posterior approach

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PATIENTS

The study included 20 patients suffering from closed type III supracondylar fracture humerus. Type I, II and open fractures are excluded.

1. Age

The age of the patients included in this study ranged from 2 to 12 years old with a mean age of 5.88 ± 3.22 years. (Table I, fig.28)

Table (I): Distribution of the studied cases according to age

Age (years)	No	%
2 – <6	13	65.0
6 – <10	3	15.0
10 – 12	4	20.0
Total	20	100.0
Min. – Max.	2.50 – 12.0	
Mean \pm SD.	5.88 ± 3.22	
Median	4.50	

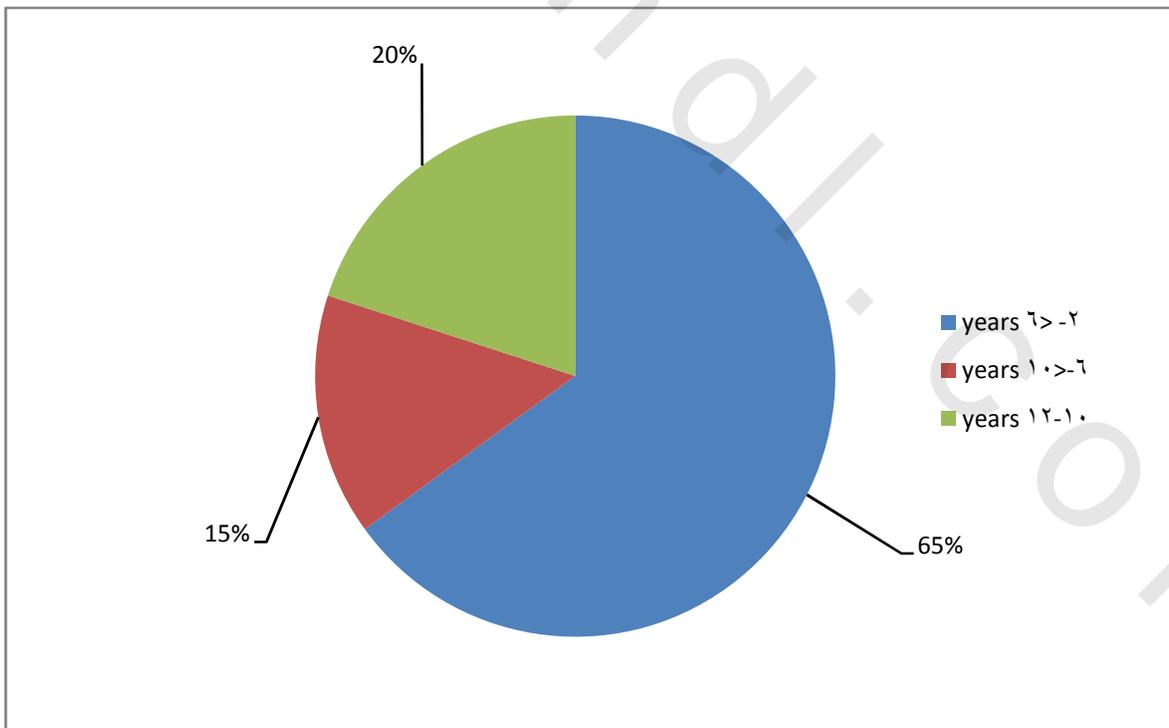


Figure (28): Distribution of the studied cases according to age

2. Gender

This study included 11 males (55%) and 9 females (45%). (**Fig.29**).

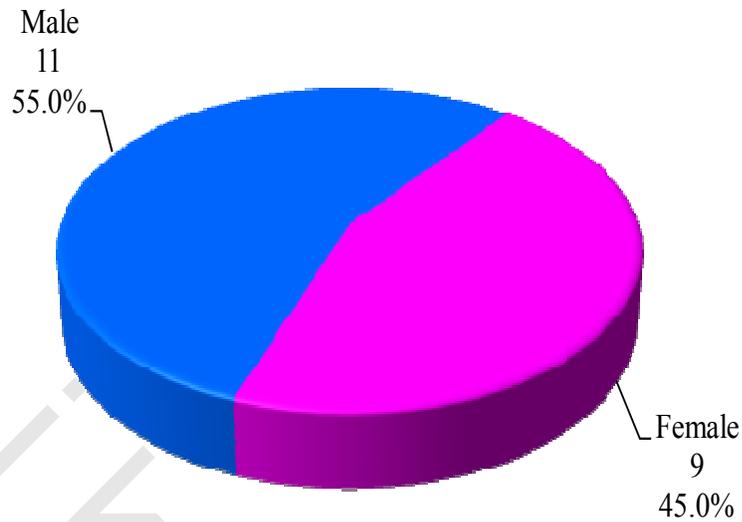


Figure (29): Distribution of the studied cases according to sex

3. Side affected

Of the studied group, the right side was affected in 7 patients (35%), and the left side was affected in 13 patients (65%) (**Fig.30**)

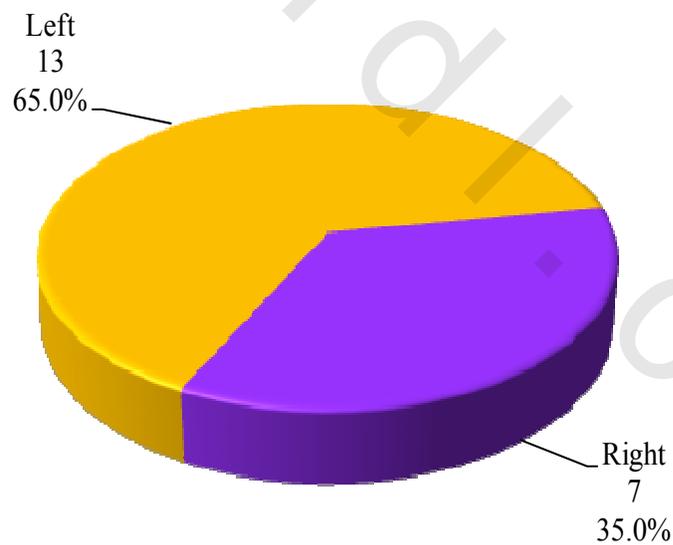


Figure (30): Distribution of the studied cases according to side affected

4. Dominant hand:

Of the studied group 12 children (60%) were left handed and 8 children were right handed.

5. Type of fracture:

All patients included in the study were extension type Garlands grade III.

6. Mechanism of injury

All patients included in the study were involved in indirect trauma i.e.; fall on outstretched hand.

7. Time lapse before surgery

The time lapses before surgery ranged from 0 to 4 days with mean of 2.11 ± 1.0 (Table II, fig.31)

Table (II): Distribution of the studied cases according to time lapse before surgery

Time lapse before surgery (days)	No	%
0	1	5.0
1	6	30.0
2	8	40.0
3	2	10.0
4	3	15.0
Total	20	100.0
Min. – Max.	1.0 – 4.0	
Mean \pm SD.	2.11 ± 1.05	
Median	2.0	

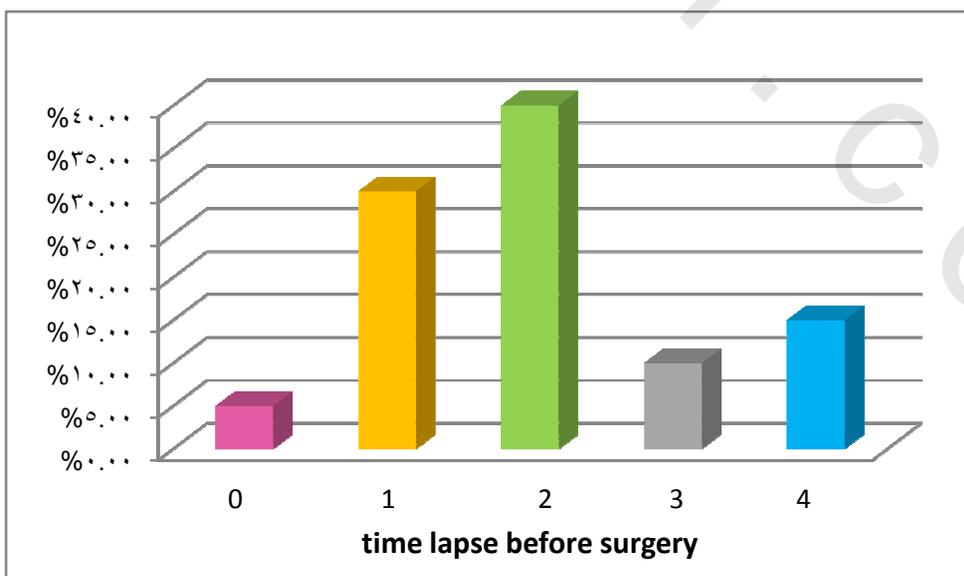


Figure (31): Distribution of the studied cases according to lag to surgery

8. Distal circulation:

19 children (95%) had a good distal pulse and capillary filling and one child (5%) had a weak distal pulsation with good capillary filling.

9. Skin condition:

6 children (30%) had echimosis of the elbow and elbow swelling, 10 children (50%) had only elbow swelling and 4 children (20%) had good skin condition. **(Fig.32)**

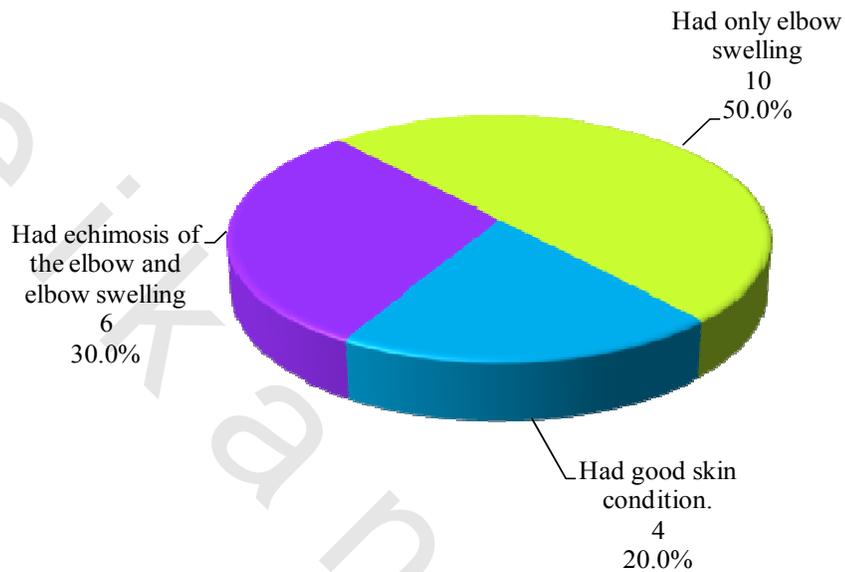


Figure (32): Distribution of the studied cases according to skin condition

METHODS

Each patient was submitted to thorough personal, clinical, and radiological examination.

Data were collected according to the following sheet:

a) History:

- Name.
- Age.
- Gender.
- Residence.
- Date of trauma.
- Mechanism of trauma.
- Previous treatment.
- Time lag to surgery.

b) Clinical examination:

- Side affected.
- Associated skin and soft tissue injury.
- Neurovascular injuries.

c) Radiological examination:

Anteroposterior and lateral views to determine the type of the fracture whether extension or flexion type, and which grade is the fracture whether grade I, II or III.

Surgical technique:

1) Anaesthesia:

The operation was performed under general anaesthesia. All children received intravenous antibiotic 30 minutes prior to the skin incision.

2) Patient positioning:

A standard operating table was used. The child was placed in lateral decubitus with the injured side upwards. The arm is flexed to 90, internally rotated and resting on arm support.

3) Patient preparation:

The limb was exsanguinated by elevating it for 3 to 5 minutes and then a tourniquet was applied as high up on the arm as possible. The hand, forearm, elbow and the upper arm are draped leaving only the affected elbow and the upper arm.

4) Incision and exposure:

A longitudinal incision on the posterior aspect of the elbow was made. Beginning 5 cm above the olecranon in the midline. Just above the tip of the olecranon the incision is curved laterally so that it runs down the lateral side of the process. To complete the incision, curve it medially again so that it overlies the middle of the subcutaneous surface of the ulna. A full-thickness fasciocutaneous flap was elevated laterally and medially, preserving the subcutaneous arterial plexus and the cutaneous nerves. **(Fig.33)**



Figure (33) skin incision

The deep fascia is incised in the midline. The ulnar nerve was palpated as it lies in the bony groove on the back of the medial epicondyle. The fascia overlying the nerve was dissected bluntly to expose it. The ulnar nerve was dissected proximally, where it is easily found medial to the triceps, and followed. It should be identified and protected at all times. **(Fig.34)**



Figure (34) identification of the ulnar nerve

The triceps muscle was then cut in a reversed v shaped. The flap was distally based and should extend to the outer part of the humeral condyles in order to allow an adequate approach and to allow exposure of the olecranon fat pad, the olecranon fossa and the posterior aspect of the distal humerus. Sufficient tendon tissue at both sides of the flap must be preserved to obtain a good repair. **(Fig.35)**



Figure (35) triceps muscle flap

By using periosteal elevators, any remaining insertion of the triceps muscle is reflected medially and laterally from the posterior aspect of the humerus. The posterior elbow capsule is opened from medial to lateral (to protect the ulnar nerve), and the dissection is carried across the entire posterior humerus; blunt dissection through the fracture hematoma with the gloved finger was continued anteriorly to expose the distal aspect of the proximal fragment to be certain that no tissue has been trapped within the fracture.

5) Reduction and fixation of the fracture:

The fragments were reduced anatomically by gentle manipulation or by a bone lever and fixed with percutaneously placed crossed K-wires from the epicondyles engaging the far cortex. (Fig.36)



Figure (36) Fixation of the fracture

6) Closure of the wound:

Closure of the triceps aponeurosis was meticulously performed in two layers using nonabsorbable sutures. The elbow was always tested by putting it through a full range of motion before skin closure. The K-wires are allowed to protrude through the skin. They are bent, protected by gauze, and incorporated into the cast. (Fig.37 a & b)



a



b

Figure (37) a: Closure of the triceps muscle, b. closure of the skin.

7) Early post-operative management:

Postoperative management consisted of immobilization in above elbow cast for 4 weeks. The patient and the parents were warned against vigorous activities.

8) Follow-up:

All children were seen each 2 weeks. In the first visit the sutures were removed and a new above elbow plaster cast was done. X-ray was done every 4 weeks to assess union. Plaster was removed after 4 weeks and K-wires were removed after radiological healing of the fracture, and child parents were instructed to start elbow mobilization.

The follow up period of 20 patients involved in the study ranged from 6 to 10 months with an average of 8 months.

Assessment of the result:

All children were assessed radiologically and clinically as follow:

A. Radiologically:

- i. Baumann's angle was measured on AP x-rays and it represented an angle that made physal line of the lateral condyle of the humerus with the longitudinal axis in post operative x-rays and at the end of the follow up compared to the other side.
- ii. Humerotrochlear angle was measured on the lateral x-ray which consisted of longitudinal line of diaphysis of the humerus with the axial line of the condyle in post operative x-rays and at the end of the follow up compared to the other side.
- iii. AHL (anterior humeral line) was measured on the lateral x-ray and represented a longitudinal line which runs from the edge of the humeral diaphysis and normally passes through the middle third of the humerus capitulum in post operative x-rays and at the end of the follow up compared to the other side.

B. Clinically:

The patients will be followed clinically for:

- Nerve injury.
- Vascular injury.
- Infection.
- Cubitus varus.

Flynn's criteria are used to determine the success of treatment, which included the measurement of the degree of carrying angle, flexion and extension. (Table III)

Table (III): Flynn's criteria

Results		Loss of motion °	Loss of carrying angle °
Satisfactory	Excellent	0-5°	0-5°
	Good	6-10°	6-10°
Unsatisfactory	Fair	11-15°	11-15°
	Poor	>15°	>15°

Statistical Analysis:

The data was collected and entered into the personal computer. Statistical analysis was done using Statistical Package for Social Sciences (SPSS/version 15) software.

The statistical tests used were:

A. Descriptive statistics

1. Arithmetic mean (\bar{X}):

Was calculated as follows:

$$\bar{X} = \frac{\sum x}{n}$$

Where: \bar{X} = arithmetic mean

$\sum x$ = sum of observations

n = number of observations

2. Standard deviation (SD):

Was calculated as follows:

$$SD = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

Where: $\sum x^2$ = sum of squared observations.

$(\sum x)^2$ = square of the sum of observations.

n = number of observations.

B. Significance tools:

1. "t" test:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

$$S_p^2 = \frac{S_1^2(n_1 - 1) + S_2^2(n_2 - 1)}{n_1 + n_2 - 2}$$

Methods

Where: S_p^2 = Pooled variance.

S_1^2 = Variance of sample (1).

S_2^2 = Variance of sample (2).

n_1 = Size of sample (1).

n_2 = Size of sample (2).

X_1 = Mean of sample (1).

X_2 = Mean of sample (2).

S_1 = Standard deviation of sample (1).

S_2 = Standard deviation of sample (2).

2. Chi-square (X^2):

For comparison between distributions of patients according to different items of study using this formula for calculation:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

O = Observed results

E = Expected results

$(O - E)^2$ = difference squared

Where $E = \frac{\text{Total row} \times \text{total column}}{\text{Grand total}}$

P is significant if < 0.05

3. Fisher's Exact test:

Was also used for comparison of categorical data, using this formula for calculation:

$$P = \frac{t1 \times t2 \times t3 \times t4}{X \times x1 \times x2 \times x3 \times x4}$$

t1 and **t2** are rows' totals,

t3 and **t4** are columns' totals

X is total number of subjects

x1, x2, x3 and **x4** are 4 frequencies

RESULTS

According to Flynn's criteria the results were excellent in 3 children (15%) good in 10 (50%), faire in 4 (20%), and poor in 3 (15%). (Table VI, fig.38)

The excellent and good results were considered satisfactory while faire and poor results were considered unsatisfactory.

Table (VI): Distribution of the studied cases according to result

Out come	Number	Percent
Satisfactory	13	65.0
Excellent	3	15.0
Good	10	50.0
Unsatisfactory	7	35.0
Fair	4	20.0
Poor	3	15.0
Total	20	100.0

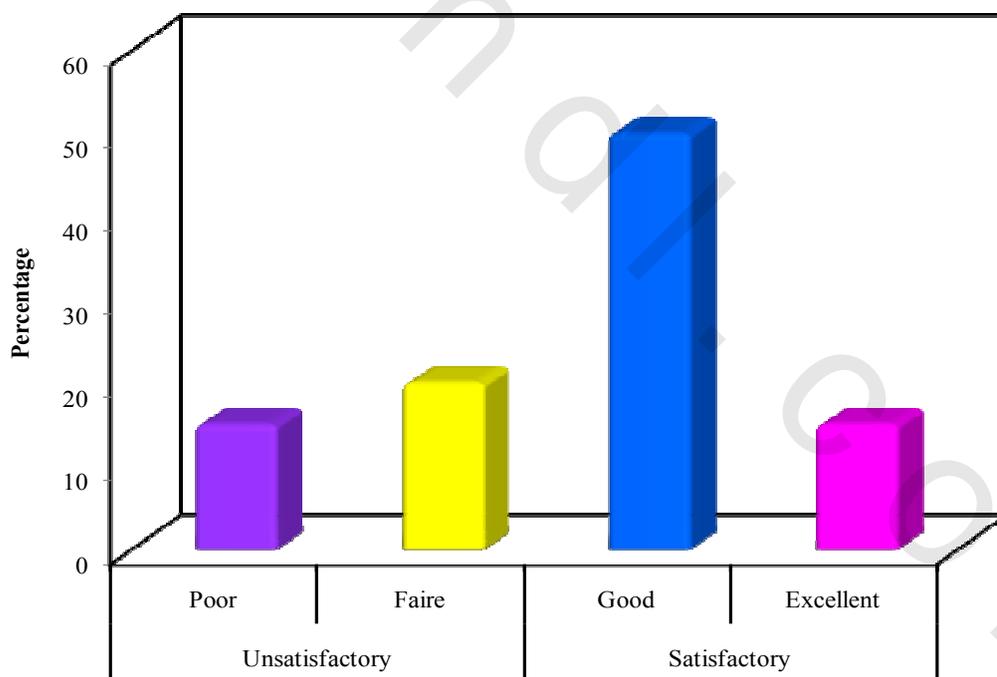


Figure (38): Distribution of the studied cases according to result

Results

A. Clinical result:

1. Operation time :

The operation time as calculated from skin to skin ranged from 30 to 70 minutes with a Mean of 51.5 ± 14.24 .(Table V)

Table (V): Distribution of the studied cases according to operation time

Operation time(minutes)	Number	Percent
<50 minute	10	50.0
≥ 50 minute	10	50.0
Total	20	100.0
Min. – Max.	30.0 – 75.0	
Mean \pm SD.	51.5 ± 14.24	
Median	47.50	

2. Healing time:

The healing time ranged between 5 and 8 weeks as seen radiologically and clinically with a mean of 6.35 ± 0.88 . (Table VI)

Table (VI): Distribution of the studied cases according to heal time

Healing time(weeks)	Number	Percent
<6 weeks	12	60.0
≥ 6 weeks	8	40.0
Total	20	100.0
Min. – Max.	5.0 – 8.0	
Mean \pm SD.	6.35 ± 0.88	
Median	6.0	

3. Range of motion of the elbow after removal of the cast:

Two children (10%) had a loss of 6°-10°, while 8 children (40%) had loss of 11°-15°, and 8 children had a loss of >15°. With a mean of 20.10 ± 5.41. (**Table VII**)

Table (VII): Distribution of the studied cases according to loss of ROM after removal of the cast

Loss of range of motion	Number	Percent
0°-5°	0	0
6°-10°	0	0
11°-15°	4	40
>15°	16	60
Min. – Max.	13.0 – 32.0	
Mean ± SD.	20.10 ± 5.41	
Median	19.0	

4. Range of motion of the elbow after the end of follow up.

Three children (30%) had a loss of range of motion of 0°-5°, on the other hand 11 children (11%) had a loss of 6°-10°, while 1 child (5%) had a loss of 11°-15°, and 2 children (2%) had a loss of >15° with a mean of 9.30 ± 3.53. (**Table VIII**)

Table (VIII): Distribution of the studied cases according to loss of ROM after after the end of follow up.

Loss of range of motion	Number	Percent
0°-5°	3	15
6°-10°	11	55
11°-15°	4	20
>15°	2	10
Min. – Max.	5.0 – 17.0	
Mean ± SD.	9.30 ± 3.53	
Median	9.0	

5. Loss of Carrying angle at the end of the follow up:

Radiological assessment of the carrying angle revealed that 3 children (15%) had a loss of carrying angle of 0°-5° compared to the normal side, while 11 children (55%) had a loss of carrying angle of 6°-10°, on the other hand 3 children (15%) had a loss of carrying angle of 11°-15° and 3 children (15%) had a loss of carrying angle of >15°. With a mean of 11.10 ± 6.80. (Table IX)

Table (IX): Distribution of the studied cases according to loss of carrying angle at the end of the follow up.

Loss of carrying angel °	Number	Percent
0°-5°	3	15.0
6°-10°	11	55.0
11°-15°	3	15.0
>15°	3	15.0
Total	20	100.0
Min. – Max.	3.0 – 30.0	
Mean ± SD.	11.10 ± 6.80	
Median	9.0	

6. Deformities at final follow up:

Three children (15%) had cubitus varus deformity at the end of the follow up while 17 children (85%) did not have a deformity.

7. Nerve injury:

None of the children included in this study had any iatrogenic nerve injury.

8. Post operative infection:

Six children (30%) had no infection, while 13 children (65%) had pin tract infection that improved after removal of the wires, and 1 child (5%) had superficial skin infection.

Table (X)

Table (X): Distribution of the studied cases according to infection after removal of the cast

Infection	Number	Percent
No infection	13	65.0
Pin tract infection	5	25.0
Superficial infection	2	10.0
Total	20	100.0

B. Radiological result:

1. Immediate post-operative :

a. Baumann's angle:

On the AP x-ray view 8 children (40%) had an angle of 76°-80°, on the other hand 12 children (60%) had an angle >80°. With mean of 83.90 ± 6.54 . (Table XI)

Table (XI): Distribution of the studied cases according to Baumann's angle immediately post-operative

Baumann's angle °	Affected side		Normal side	
	Number	Percent	Number	Percent
<65°	0	0	0	0
66°-70°	0	0.0	3	15.0
71°-75°	0	0.0	13	65.0
76°-80°	8	40.0	4	20.0
>80°	12	60.0	0	0
Total	20	100.0	20	100.0
Min. – Max.	76.0 – 100.0		68.0 – 78.0	
Mean ± SD.	83.90 ± 6.54		73.30 ± 2.74	
Median	84.50		73.50	

b. Frontal humeral line:

On the lateral x-ray view 6 children (30%) had the frontal humeral line passing in front of the anterior third of the capitulum of the humerus, while 8 children (40%) had it passing through the anterior third, still 4 children (20%) had it passing through the middle third, and 2 children (10%) had it passing through the posterior third. (Table XII)

(Table XII): Distribution of the studied cases according to frontal humeral line immediately post-operative.

Frontal humeral line	Affected side		Normal side	
	Number	Percent	Number	Percent
Passes in front of the anterior third	6	30.0	0	0
Passes through anterior third	8	40.0	3	15.0
Passes through middle third	4	20.0	17	85.0
Passes through posterior third	2	10.0	0	0
Total	20	100.0	20	100.0

c. Humerotrochlear angle:

In the AP x-ray view 3 children (15%) had the humerotrochlear angle less than 25°, 3 children (15%) had an angle of 26°-30°, but 4 children (20%) had an angle of 31°-35°, while 8 children (40%) had an angle of 36°-40°, and 2 children had it more than 40°. With a mean of 28.95 ± 4.32. (Table XIII)

Table (XIII): Distribution of the studied cases according to humerotrochlear angle immediately post- operative

Humerotrochlear angle°	Affected side		Normal side	
	Number	percent	number	percent
<25°	4	20.0	0	0
26°-30°	10	50.0	0	0
31°-35°	5	25.0	0	0
36°-40°	1	5.0	20	100
>40°	0	0.0	0	0
Total	20	100.0	20	100.0
Min. – Max.	22.0 – 36.0		37.0 – 40.0	
Mean ± SD.	28.95 ± 4.32		39.0 ± 0.97	
Median	29.0		39.0	

d. Purchase of the k-wires:

Four children (20%) had loose wires while 16 children (80%) had good purchased wires. (Table XIV)

Table (XIV): Distribution of studied cases according purchase of the k-wires

Purchase of the k-wires	No	%
Loose	4	20.0
Good	16	80.0
Total	20	100.0

2. Radiological results at the end of the follow up:

a. Baumann's angle:

In the AP x-ray view 1 child (%) had an angle of 71°-75°, yet 7 children (35%) had an angle of 76°-80°, and 12 children (60%) had an angle >80°. With a mean of 84.20 ± 8.06. (Table XV)

Table (XV): Distribution of the studied cases according to Baumann angle at the end of the follow up

Baumann's angle °	Affected side		Normal side	
	Number	Percent	Number	Percent
<65°	0	0.0	0	0.0
66°-70°	0	0.0	3	15.0
71°-75°	1	5.0	13	65.0
76°-80°	7	35.0	4	20.0
>80°	12	60.0	0	0.0
Total	20	100.0	20	100.0
Min. – Max.	72.0 – 105.0		68.0 – 78.0	
Mean ± SD.	84.20 ± 8.06		73.30 ± 2.74	
Median	83.50		73.50	

b. Frontal humeral line:

In the lateral x-ray view 3 children (15%) had the frontal humeral line passing in front of the anterior third of the capitulum of the humerus ,yet 9 children (45%) had it passing through the anterior third, while 7 children (35%) had it passing through the middle third, and 1 child (10%) had it passing through the posterior third. (Table XVI)

Table (XVI): Distribution of the studied cases according to frontal humeral line at the end of follow up.

Frontal humeral line	Affected side		Normal side	
	Number	Percent	Number	Percent
Passes in front of the anterior third	3	15.0	0	0
Passes through anterior third	9	45.0	3	15.0
Passes through middle third	7	35.0	17	85.0
Passes through posterior third	1	5.0	0	0
Total	20	100.0	20	100.0

Results

c. Humerotrochlear angle:

In the lateral x-ray view 3 children (15%) had the humerotrochlear angle less than 25°, while 5 children (25%) had an angle of 26°-30°, on the other hand 7 children (35%) had an angle of 31°-35°, while 5 children (25%) had an angle of 36°-40°. With a mean of 31.25 ± 4.58 . (Table XVII)

Table (XVII): Distribution of the studied cases according to humerotrochlear angle after the end of follow up

Humerotrochlear angle ^o	Affected side		Normal side	
	Number	percent	number	percent
<25°	3	15.0	0	0.0
26°-30°	5	25.0	0	0.0
31°-35°	7	35.0	0	0.0
36°-40°	5	25.0	20	100.0
>40°	0	0.0	0	0.0
Total	20	100.0	20	100.0
Min. – Max.	23.0 – 39.0		37.0 – 40.0	
Mean ± SD.	31.25 ± 4.58		39.0 ± 0.97	
Median	31.50		39.0	

Factors that may affect the final score

1. Age:

The mean age of the patients that achieved an excellent outcome was 3.67 ± 0.58 years. The mean age of those patients who got a good outcome was 6.40 ± 3.16 years. The mean age of those patients who got a fair result was 5.13 ± 3.97 years, whereas the mean age of those patients who got poor results was 7.33 ± 4.04 years. This difference of means was statistically insignificant. (Table XVIII).

Table (XVIII): Relation between result with age (years)

	Excellent (n =3)		Good (n =10)		Fair (n =4)		Poor (n = 3)		Test of sig.	p
	No.	%	No.	%	No	%	No.	%		
Age (years)										
≤ 4	3	15	4	20	3	15	0	0.0	$\chi^2=7.400$	MC _P =0.084
> 4	0	0.0	6	30	1	15	3	15		
Min. – Max.	3.0 - 4.0		3.50 - 12.0		2.50 - 11.0		5.0 - 12.0		$^{KW}\chi^2=4.854$	p=0.183
Mean ± SD.	3.67 ± 0.58		6.40 ± 3.16		5.13 ± 3.97		7.33 ± 4.04			
Median	4.0		5.50		3.50		5.0			

2. Gender:

There was no statistically significant relation between children's' gender and the final score, (table XIX).

Table (XIX): Relation between results with sex

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		χ^2	MC _p
	No.	%	No.	%	No.	%	No.	%		
Sex										
Male	2	10.0	2	10.0	5	15.0	2	10.0	0.811	1.000
Female	1	5.0	2	10.0	5	15.0	1	5.0		

Results

3. Side affected:

There was no statistically significant relation between side affected and the final score, (table XX).

Table (XX): Relation between results with the side affected

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		MC _p
	No.	%	No.	%	No.	%	No.	%	
Side									
Right	1	5.0	2	10.0	6	30.0	2	10.0	0.466
Left	2	10.0	2	10.0	4	20.0	1	5.0	

4. Operative time:

There was no statistically significant relation between the operative time and the final score, (table XXI).

Table (XXI): Relation between results with operation time

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		Test of sig.	p
	No.	%	No.	%	No.	%	No.	%		
Operation time										
<50	2	10.0	3	15.0	4	20.0	1	5.0	$\chi^2=2.067$	0.630
≥50	1	5.0	1	5.0	6	30.0	2	10.0		
Min. – Max.	30.0 – 60.0		35.0 – 50.0		35.0 -75.0		45.0 – 55.0		F=1.461	0.220
Mean ± SD.	45.0 ± 15.0		41.25 ± 6.29		57.50 ± 16.03		51.67 ± 5.77			
Median	45.0		40.0		62.0		55.0			

Results

5. Healing time:

There was no statistically significant relation between the healing time and the final results. (Table XXII)

Table (XXII): Relation between result with heal time

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		Test of sig.	p
	No.	%	No.	%	No.	%	No.	%		
Heal time (weeks)										
<6	1	5.0	2	10.0	6	30.0	3	15.0	$\chi^2 = 3.056$	0.473
≥6	2	10.0	2	10.0	4	20.0	0	0.0		
Min. – Max.	5.0 – 7.0		5.0 – 7.0		5.0 – 8.0		6.0 – 6.0		F= 0.243	0.865
Mean ± SD.	6.33 ± 1.15		6.25 ± 0.96		6.50 ± 0.97		6.0 ± 0.0			
Median	7.0		6.50		6.0		6.0			

6. Time elapsed before surgery

There was statistically significant relation between the time lapsed before surgery and the final outcome, as short trauma-surgery interval gave more satisfactory final result. P=0.01 (Table XXIII)

Table (XXIII): Relation between results with time elapsed before surgery

	Poor (n = 3)	Fair (n =4)	Good (n =10)	Excellent (n =3)	$\text{KW} \chi^2$	p
Lag to surgery (days)						
Min. – Max.	4.0 – 4.0	2.0 – 3.0	1.0 – 3.0	1.0 – 1.0	11.379*	0.010*
Mean ± SD.	4.0 ± 0.0	2.25 ± 0.50	1.70 ± 0.67	1.0 ± 0.0		
Median	4.0	2.0	2.0	1.0		

*: Statistically significant at $p \leq 0.05$

Results

7. Purchase of the k-wires

There was statistically significant relation between positions of the k-wires and the final results as the fractures fixed with a good purchased wires gave more satisfactory results. $P=0.004$ (Table XXIV)

Table (XXIV): Relation between results with purchase of the k-wires

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		χ^2	MC p
	No.	%	No.	%	No.	%	No.	%		
Purchase of the k-wires										
Loose	3	150.0	1	5.0	0	0.0	0	0.0	11.293*	0.004*
Good	0	0.0	3	15.0	10	50.0	3	15.0		

*: Statistically significant at $p \leq 0.05$

8. Baumann's angle

There was statistically significant relation between degree of Baumann angle at the end of the follow up and the final results as there is a high percent of excellent and good results when it was $76-85^\circ$. On the other hand there was a high incidence of fair and poor results with Baumann angle $<75^\circ$. $P<0.001$ (Table XXV)

Table (XXV): Relation between result and affected Baumann's angle at the end of the follow up

	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		Test of sig.	p
	No.	%	No.	%	No.	%	No.	%		
Baumann angle(degree)										
$71^\circ - 75^\circ$	0	0.0	0	0.0	1	10.0	0	0.0	$\chi^2=8.268$	MC p=0.169
$76^\circ - 80^\circ$	0	0.0	1	5.0	3	15.0	3	15.0		
$>80^\circ$	3	15.0	3	15.0	6	30.0	0	0.0		
Min. – Max.	96.0 – 105.0		78.0 – 87.0		72.0 – 88.0		76.0 – 78.0			
Mean \pm SD.	99.67 \pm 4.73		84.0 \pm 4.08		81.80 \pm 4.80		77.0 \pm 1.0		F=16.318*	$<0.001^*$
Median	98.0		85.50		82.50		77.0			

*: Statistically significant at $p \leq 0.05$

9. Frontal humeral line

There was statistically significant relation between the position of the frontal humeral line as it passed through the humeral capitulum at the end of the follow up with the final results. There was a high percent of excellent and good results when it passed through the anterior and middle third. On the other hand there was high incidence in fair and poor results when it passed anterior to the humeral capitulum or through the posterior third. $P < 0.001$. (Table XXVI)

Table (XXVI): Relation between results and position of the frontal humeral line at the end of follow up

frontal humeral line position	Poor (n = 3)		Fair (n =4)		Good (n =10)		Excellent (n =3)		χ^2	MC p
	No.	%	No.	%	No.	%	No.	%		
In front of the anterior third	3	15.0	0	0.0	0	0.0	0	0.0	18.90*	0.001*
Through the anterior third	0	0.0	2	10.0	7	35.0	0	0.0		
Through the middle third	0	0.0	1	5.0	3	15.0	3	15.0		
Through the posterior third	0	0.0	1	5.0	0	0.0	0	0.0		

*: Statistically significant at $p \leq 0.05$

10. Humerotrochlear angle

There was statistically significant relation between degree of humerotrochlear angle at the end of the follow up and the final results as there is significant increase in excellent and good results when it was 30°-40°. On the other hand there was significant increase in fair and poor results with humerotrochlear $< 30^\circ$ $P < .001$. Table (XXVII)

Table (XXVII): Relation between results and humerotrochlear angle at the end of the follow up

Humerotrochlear angle °	Poor (n = 3)	Fair (n =4)	Good (n =10)	Excellent (n =3)	F	p
Min. – Max.	23.0 – 24.0	27.0 – 32.0	30.0 – 36.0	37.0 – 39.0		
Mean ± SD.	23.67±0.58	29.0± 2.16	32.50± 2.3	37.67± 1.2	26.889*	<0.001*
Median	24.0	28.50	32.0	37.0		

*: Statistically significant at $p \leq 0.05$

COMPLICATIONS

1. Limitation of the elbow motion

Elbow range of motion was partially limited in 6 children (30%), It was due cutting of the triceps muscle, Weakening of muscle strength, scarring of posterior soft tissues and retraction of the posterior located scare. That led to increase elbow stiffness in the presence of already scarred anterior soft tissues.

2. Infection

Two children of our study group had superficial wound infection 7 days after the surgery. This might be advocated to the bad skin condition preoperatively. It was improved with broad spectrum antibiotics and daily dressing for 10 days. While 5 children had pin tract infection which improved after removal of the k-wires and daily dressing for 7 days.

3. Cubitus varus

Three children of our study group had cubitus varus deformity with a loss ranged between (10° - 15°) which caused by epiphyseal growth arrest or improper fixation and loose k-wires which was a technical fault.

4. Ugly Scar

Five children (25%) included in our study had contracted posterior scar that was cosmetically not accepted. They refused to have any cosmetic surgery at the time.

CASE PRESENTATION

Case (1):

A 3.5 years old right handed male child sustained a fall on outstretched hand; he had a grade III extension type supracondylar fracture of the right humerus associated with weak radial pulse and sluggish capillary filling. Open reduction and percutaneous internal fixation of the fracture was done through posterior approach by k-wires. The fracture was fixed 3 hours after initial trauma. The radial pulse returned to normal after reduction and internal fixation with good capillary filling. An above elbow plaster cast was done. Immediate post-operative x-ray showed anatomical reduction. The fracture was united both clinically and radiologically after 4 weeks and the cast was removed. The child was encouraged to start active range of motion. The final outcome was graded as **excellent** according to the evaluation scoring system. (Fig.39-42)



a



b

Figure (39): Plain x-ray (a) AP view (b) lateral view preoperative

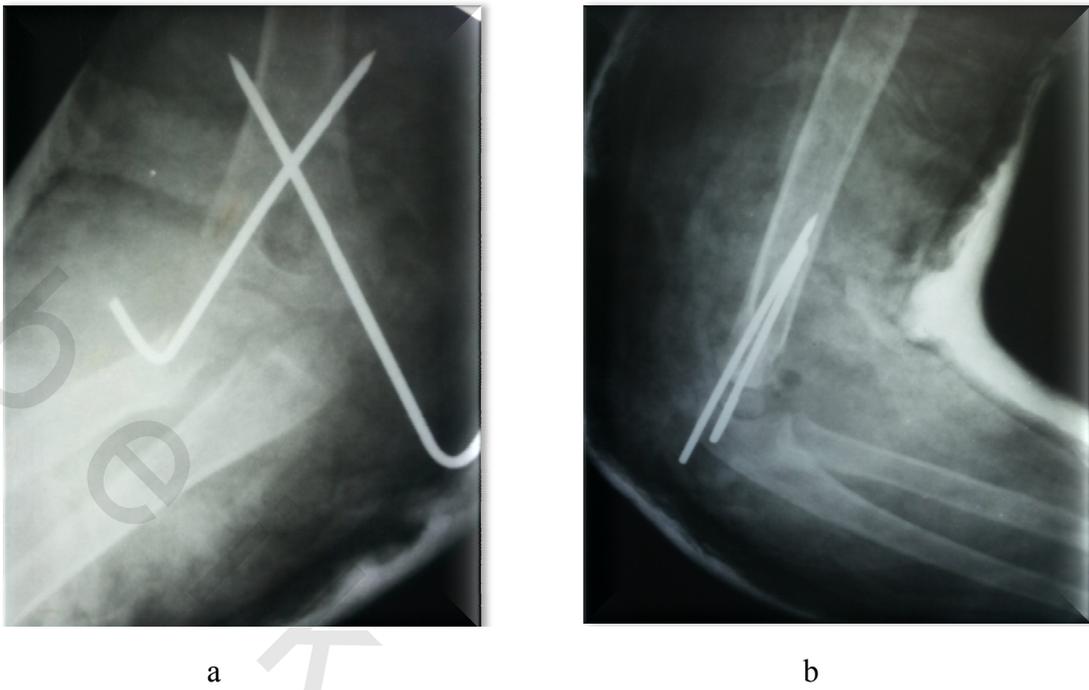


Figure (40): Plain x-ray (a) AP view (b) lateral view immediate postoperative



Figure (41): Plain x-ray (a) AP view (b) lateral view at the end of follow up



a



b

Figure (42): (a) loss of carrying angle (b) loss of elbow flexion at the end of follow up

Results

Case (2):

A 4 years old right handed boy sustained a fall on outstretched hand; he had a grade III extension type supracondylar fracture of the left humerus. Open reduction and percutaneous internal fixation of the fracture was done through posterior approach by k-wires. The fracture was fixed 2 days after the initial trauma. An above elbow plaster cast was done. Immediate post-operative x-ray showed acceptable reduction. The fracture was united both clinically and radiologically after 4 weeks and the cast was removed. The child was encouraged to start active range of motion. At The final follow up he had a loss of last 7° of flexion and 7° loss of carrying angle and graded as **good** according to the evaluation scoring system. (Fig.43-46)

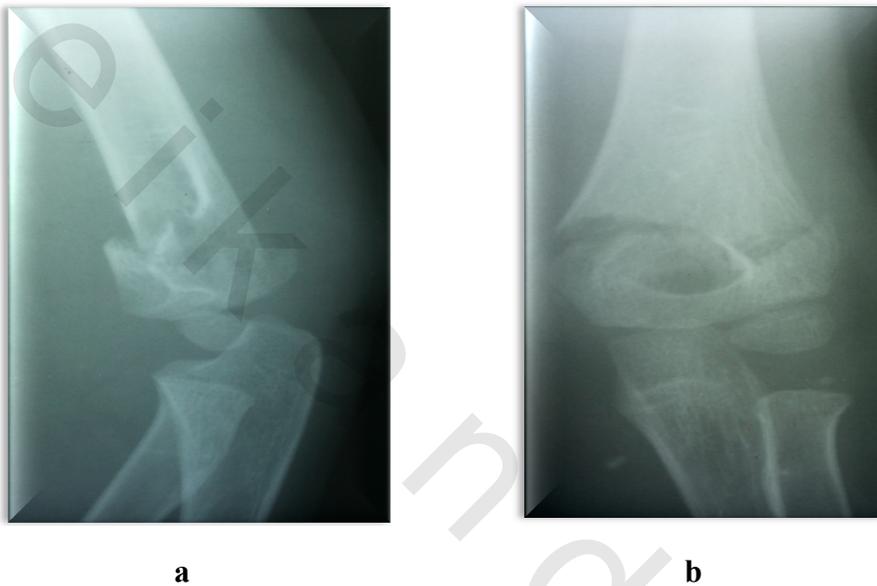


Figure (43): Plain x-ray (a) AP view (b) lateral view preoperative

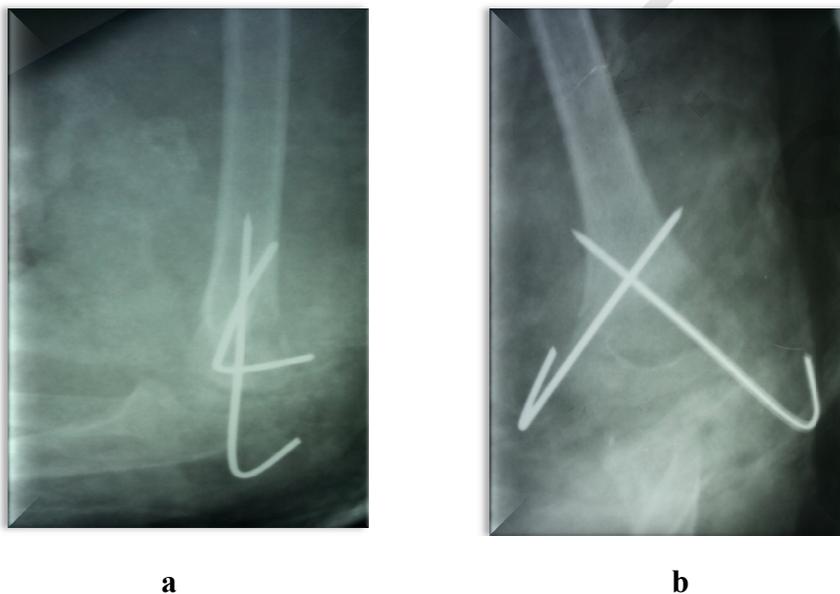


Figure (44): Plain x-ray (a) AP view (b) lateral view immediate postoperative



a



b

Figure (45): Plain x-ray (a) AP view (b) lateral view at the end of follow up



a



b

Figure (46): (a) loss of carrying angle (b) loss of elbow flexion at the end of follow up

Case (3):

A 6 years old right handed boy sustained a fall on outstretched hand; he had a grade III extension type supracondylar fracture of the left humerus. Open reduction and percutaneous internal fixation of the fracture was done through posterior approach by k-wires. The fracture was fixed 4 days after the initial trauma. An above elbow plaster cast was done. Immediate post-operative x-ray showed acceptable reduction. The fracture was united both clinically and radiologically after 6 weeks and the cast was removed. The child was encouraged to start active range of motion. At The final follow up he had a loss of last 14° of flexion and 11° loss of carrying angle and graded as **faire** according to the evaluation scoring system. (Fig.47-50)

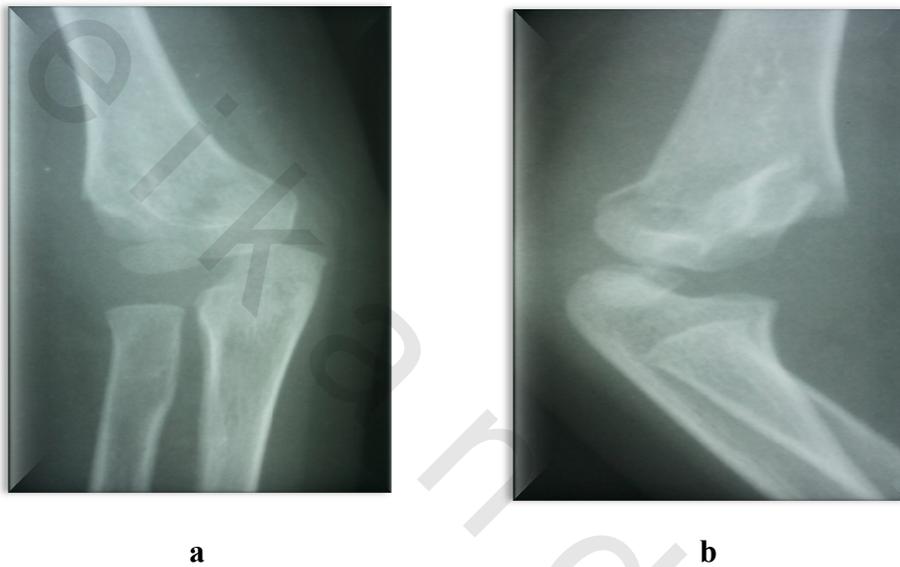


Figure (47): Plain x-ray (a) AP view (b) lateral view preoperative

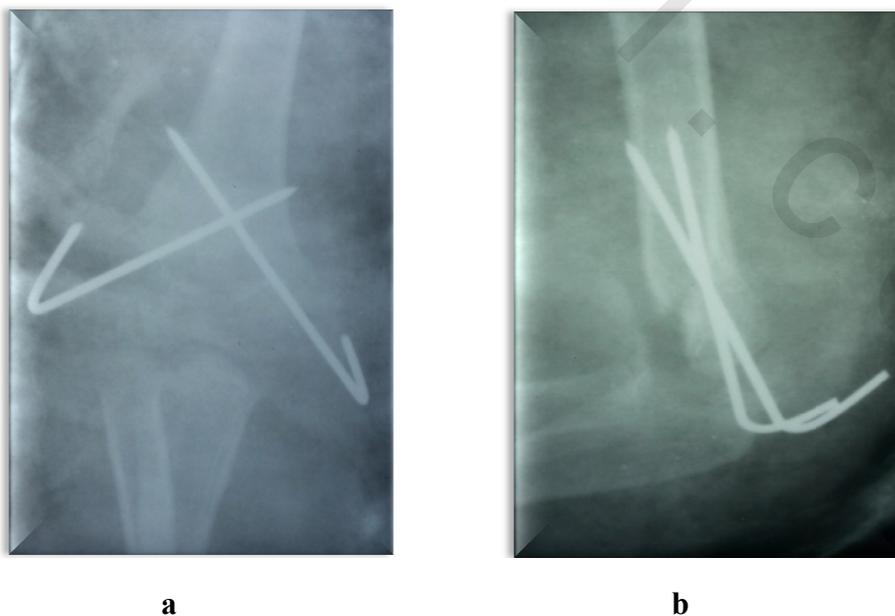


Figure (48): Plain x-ray (a) AP view (b) lateral view immediate postoperative



a



b

Figure (49): Plain x-ray (a) AP view (b) lateral view at the end of follow up



a



b

Figure (50): (a) loss of carrying angle (b) loss of elbow flexion at the end of follow up

Case (4):

An 8 years old right handed girl sustained a fall on outstretched hand; she had a grade III extension type supracondylar fracture of the left humerus. Open reduction and percutaneous internal fixation of the fracture was done through posterior approach by k-wires. The fracture was fixed 6 days after the initial trauma due to bad skin condition. An above elbow plaster cast was done. Immediate post-operative x-ray showed anterior angulation. The fracture was united both clinically and radiologically after 6 weeks and the cast was removed. The child was encouraged to start active range of motion. At The final follow up she had a loss of last 16° of flexion and 20° loss of carrying angle and graded as **poor** according to the evaluation scoring system. (Fig.51-54)



Figure (51): Plain x-ray (a) AP view (b) lateral view preoperative

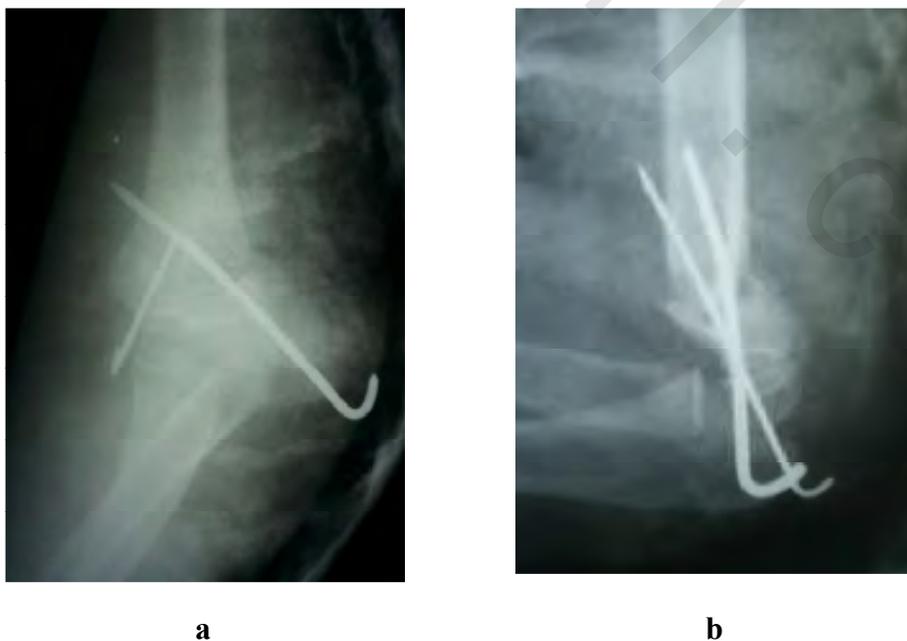


Figure (52): Plain x-ray (a) AP view (b) lateral view immediate postoperative



Figure (53): Plain x-ray (a) AP view (b) lateral view at the end of follow up

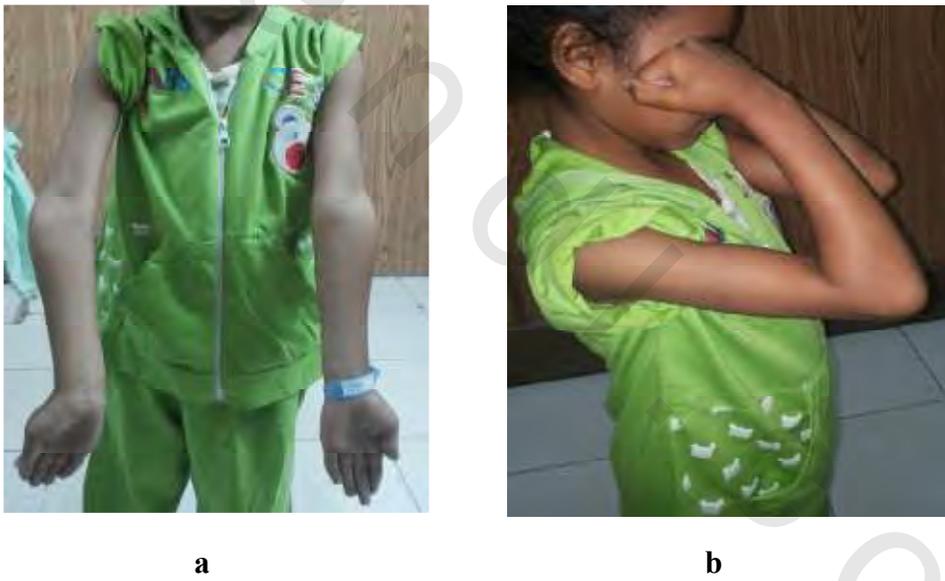


Figure (54): (a) loss of carrying angle (b) loss of elbow flexion at the end of follow up