Comparison Between Closed Reduction and Percutaneous Fixation with K-Wires and Open Reduction and Internal Fixation in the Treatment of Supracondylar Fracture of the Humerus in Children

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Abstract
A study of (40) cases of supracondylar fracture of humerus in children with class (3) according to Gartland classification were done at Al-Hussein Teaching Hospital in Samawa city at the period from 1/9/2022 to 1/5/2023. A (26) male and (14) female, with mean age ( ), the extension type formed (35) cases, while the flexion type (5) cases. We applied closed reduction and percutaneous pin fixation for (20) cases under general anesthesia and imaging control, while the other (20) cases were treated with open reduction and internal fixation with K-wires. We compared between the two methods (CRPP) and (ORIF) according to Baumann's angle, carrying angle and loss of the motion. All the cases were sent for anteroposterior (AP) and lateral view of the elbow. This study showed that the (CRPP) method is better than the (ORIF) method in the treatment of this fracture. We study the sex, side of limb, the mechanism of fracture and the type of fracture. We followed up the patient at the first week and then every two weeks for three months.

Aims of study:
1-To evaluate the difference between open reduction with internal fixation (ORIF) and closed reduction with percutaneous pinning (CRPP) in treating supracondylar humeral fractures in children. 2-When treating paediatric supracondylar fractures, this research intends to find out if (ORIF) or (CRPP) resulted in smaller changes in Baumann's angle, the carrying angle, loss of mobility, and complications.

Introduction

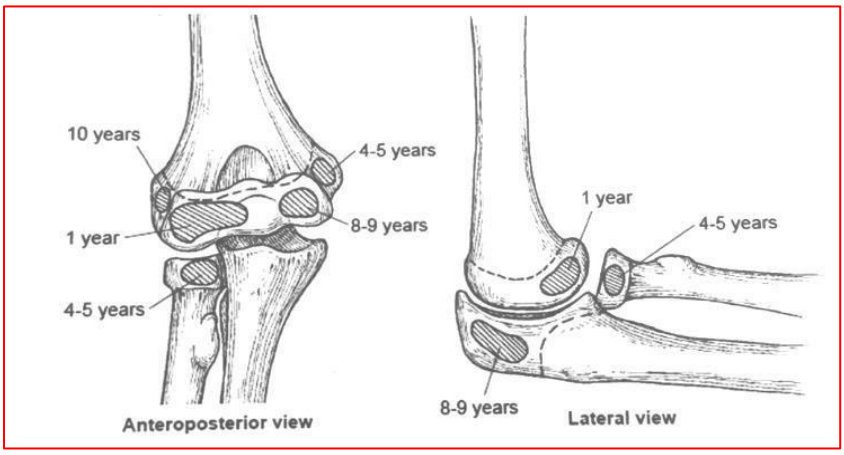
Definition

One sixteenth of all paediatric fractures and two-thirds of all paediatric elbow injuries requiring hospitalisation are supracondylar fractures, making them the most prevalent kind of elbow injury in children. Supracondylar fractures are most common in children aged 6–7.

Anatomy

One synovial joint in the upper limb connects the arm to the forearm; this joint is called the elbow joint. The three bones that make up the forearm—the ulna, the radius, and the humerus—articulate at this position. According to its structural makeup, the elbow joint is a synovial joint. At one year of age, the capitellum is the first to emerge. After the radial head and medial epicondyle start to ossify around four to five years old, the trochlea and olecranon epiphysis start to ossify about eight or nine years old. In most cases, the lateral condyle does not develop until about the age of 10. The supracondylar region is more prone to fractures because it goes through remodelling between the ages of 6 and 7, becoming thinner and having a more slender cortex. Due to its arrangement in two columns joined by thin bone, the distal humerus anatomy is particularly vulnerable to damage.

Understanding the general order and timing of the different ossification centers within elbow provides landmarks for the physician to define anatomy on radiographs and to treatment.

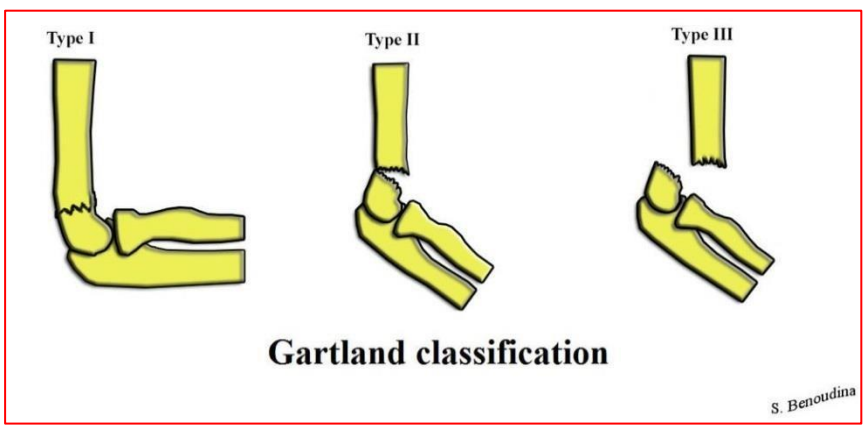


Mechanism of fracture

The most common cause is a fall onto an extended hand, which causes the arm to hyperextend. In almost all instances, the distal piece moves backward. The distal humerus fractures because the olecra acts as a fulcrum and directs the force onto it when the elbow is hyperextended. A fall onto a flexed elbow is a common cause of the uncommon flexion-type supracondylar fracture. The supracondylar region becomes thin and more susceptible to fractures during remodelling that occurs between the ages of 6 and 7.

Classification (Gartland classification)

Type	Description
1	Non-displaced
11	Angulated with intact posterior cortex
11A	Angulation
11B	Angulation with rotation
111	Complete displacement but have perisosteal (medial/lateral) contact
111A	Medial periosteal hinge intact. Distal fragment goes posteromedially
111B	Lateral periosteal hinge intact. Distal fragment goes posterolaterally
1V	Periostial disruption with instability in both flexion and extension

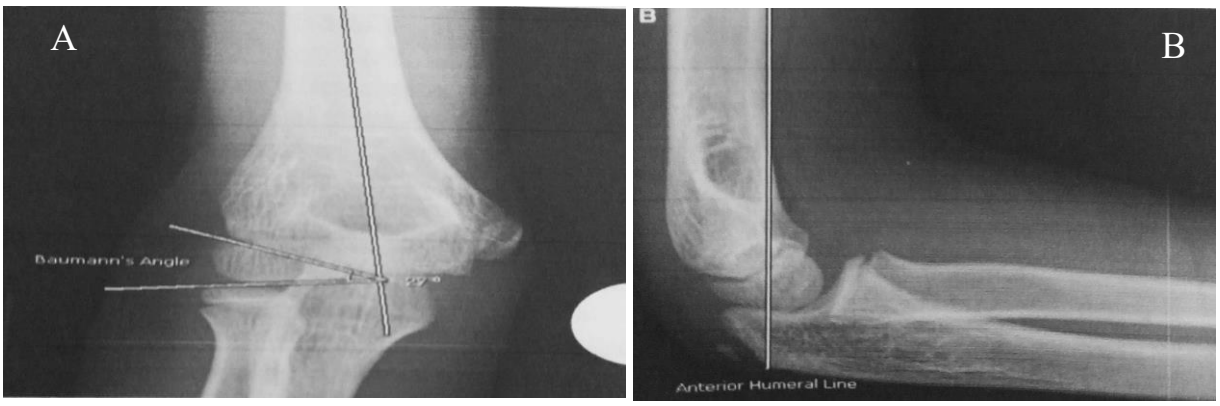


Clinical Presentation

A painful, swelling elbow that the patient is reluctant to move is the clinical manifestation of a supracondylar humerus fracture. Angulated elbow and shorter upper limbs are possible symptoms. Open wounds are seen in up to 30% of these fractures, according to certain data.

Radiological Finding

Radiographs taken of the hurt limb should show the elbow and any other painful or abnormal areas in a lateral and anteroposterior (AP) orientation. As it provides an estimate of the carrying angle—the varus or valgus attitude of the distal humerus and elbow—on the AP view, Baumann's angle is often used for fracture evaluation. The intersection of two lines drawn along the growth plate of the lateral condyle of the elbow and the axis of the humeral shaft creates what is known as Baumann's angle, which typically ranges from 9 to 26 degrees. When the varus deviates from the proximal humerus, the angle widens. In case further comparison is necessary, radiographs of the opposite elbow should be taken.Every person's Baumann angle is different.



a) Baumann's angle is obtained on the anteroposterior radiograph by measuring the angle(between a line perpendicular to the longitudinal axis of the humerus and a line parallel to the growth plate of the capitellum. (b) The anterior humeral line is a vertical line drawn directly on the anterior aspect of the distal humeral shaft that should pass through the mid- portion of the capitellum.

Patients and Methods

In this study (40) patients were collected with the supracondylar fracture of humerus with class (3) according to Gartland classification. They sent for anteroposterior and lateral X-ray. The patient assessed rediologicaly with the Baumann's angle and clinically with carrying angle and loss of motion. Twenty patients underwent closed reduction and fixation with two K-wires under general anesthesia and imaging control. Twelve of these patients treated with the lateral pin fixation and the other eight patients treated with medial – lateral pin fixation. The remaining twenty patients underwent open reduction and internal fixation with two Kwires through posterior approach. We evaluate the age, the sex, the side affected, the type of fracture and mechanism of injury. We followed up the patients at first week then at every two weeks for three months through the assessment of Baumann's angle, carrying angle and loss of motion.

Reduction Maneuver

After the image intensifier verified closed reduction, it was executed. At the outset, hyperextension of the elbow and supination of the forearm were used to provide longitudinal traction. A valgus or varus force was applied to the fracture site to rectify the medial or lateral displacement while the traction was maintained. After that, the distal fragment's posterior displacement was fixed by applying a force to its posterior aspect while the elbow was safely hyperflexed and softly hyperflexed; the image intensifier subsequently verified the reduction. An incision was made at the very top of the medial epicondyle to insert the medial pin. The lateral epicondyle served as the site for the insertion of the lateral pin. The lateral fixation method included inserting two or three pins from the outside of the elbow, going through the lateral cortex, and then engaging the medial cortex while the elbow was hyperflexed. The pins were positioned at the fracture site in either a parallel or divergent pattern, making sure there was enough space between them. Prior to engaging the medial cortex while maintaining hyperflexion of the elbow, the lateral pin was introduced from the lateral cortex for the medial−lateral fixation procedure. The procedure included extending the elbow to ~90°, using the opposite thumb to roll back the ulnar nerve, and inserting the medial pin to engage the lateral cortex while the arm was flexed at ~90°. Those who suffer from varus can try pronating their forearms with a 90-degree bend.

Results

Table (1): Distribution of age and sex groups according to type of fixation

Mean	CRPP	ORIF	P Value
Age Mean±SD	6.8±2.37	6.70±2.36	0.895
1-3 years old	2 (10)	2 (10)	0.942
3-6 years old	6 (30)	7 (35)	

>7 years old	12 (60)	11 (55)	
Sex: Male	12 (60)	14 (70)	0.507
Female	8 (40)	6 (30)	

* represent a significant difference at P <0.05.

Table (2): Comparison of mechanism and Type of Fixation

Groups		Fall		FWP		RTA	
		Yes	No	Yes	No	Yes	No
CRPP	Count	7	13	10	10	7	13
	%	30.4%	76.5%	76.9%	37.0%	87.5%	40.6%
ORIF	Count	16	4	3	17	1	19
	%	69.6%	23.5%	23.1%	63.0%	12.5%	59.4%
Total	Count	23	17	13	27	8	32
	%	57.5%	42.5%	32.5%	67.5%	20.0%	80.0%
P value		0.004*		0.018*		0.018*	

* represent a significant difference at P <0.05.

Table (3): Outcome according to side groups and type of fixation

Groups		Right		Left	
		Yes	No	Yes	No
CRPP	Count	13	7	7	13
	%	46.4%	58.3%	58.3%	46.4%
ORIF	Count	15	5	5	15
	%	53.6%	41.7%	41.7%	53.6%
Total	Count	28	12	12	28
	%	70.0%	30.0%	30.0%	70.0%
P value		0.490		0.490	

* represent a significant difference at P <0.05.

Table (4): Outcome according to Loss of carrying angle criteria and type of fixation

Groups		Loss of carrying angle			
		Exc.	Good	Fair	Poor
CRPP	Count	17	2	0	1
	%	65.4%	25.0%	0.0%	50.0%
ORIF	Count	9	6	4	1
	%	34.6%	75.0%	100.0%	50.0%
Total	Count	26	8	4	2
	%	65.0%	20.0%	10.0%	5.0%
P value		0.037*			

* represent a significant difference at P <0.05.

Table (5): Outcome according to Loss of motion criteria and type of fixation

Groups	Loss of motion

		Exc.	Good	Fair	Poor
CRPP	Count	16	2	1	1
	%	55.2%	28.6%	33.3%	100.0%
ORIF	Count	13	5	2	0
	%	44.8%	71.4%	66.7%	0.0%
Total	Count	29	7	3	1
	%	72.5%	17.5%	7.5%	2.5%
P value		0.403			

* represent a significant difference at P <0.05.

Table (6): Outcome according to Baumann's angle criteria and type of fixation

Groups		Baumann's angle			
		Exc.	Good	Fair	Poor
CRPP	Count	17	2	0	1
	%	65.4%	22.2%	0.0%	100.0%
ORIF	Count	9	7	4	0
	%	34.6%	77.8%	100.0%	0.0%
Total	Count	26	9	4	1
	%	65.0%	22.5%	10.0%	2.5%
P value		0.017*			

* represent a significant difference at P <0.05.

No.	Age (Yrs.)	Sex	Mechanism			Side		Type of fracture	Type of surgery	Loss of carrying angle				Loss of motion				Baumann's angle				P-Value
			Fall	F.W.P	R.T.A	Right	Left			Exc.	Good	Fair	Poor	Exc.	Good	Fair	Poor	Exc.	Good	Fair	Poor	
1	8	M	Yes				Yes	**Extension**														
2	10	F	Yes				Yes	**Extension**														
3	6	F		Yes		Yes		**Extension**														
4	7	M	Yes				Yes	Flexion														
5	9	F	Yes			Yes		**Extension**														
6	8	M	Yes			Yes		**Extension**														
7	5	F	Yes				Yes	**Extension**														
8	5	M		Yes		Yes		**Extension**														
9	8	M	Yes			Yes		Flexion														
10	4	F	Yes			Yes		**Extension**														
11	7	M	Yes				Yes	**Extension**	**CRPP**	**17**	**2**	**0**	**1**	**16**	**2**	**1**	**1**	**17**	**2**	**0**	**1**	
12	10	M		Yes		Yes		**Extension**														
13	3	F	Yes			Yes		**Extension**														
14	6	F	Yes				Yes	**Extension**														
15	9	M	Yes			Yes		**Extension**														
16	4	F	Yes			Yes		Flexion														
17	2	M	Yes			Yes		**Extension**														
18	10	M			Yes	Yes		**Extension**														
19	7	M	Yes			Yes		**Extension**														
20	8	M	Yes				Yes	**Extension**														
21	6	F	Yes			Yes		**Extension**	**ORIF**	**9**	**6**	**4**	**1**	**13**	**5**	**2**	**0**	**9**	**7**	**4**	**0**	
22	9	M		Yes			Yes	**Extension**														

23	5	M	Yes			Yes		**Extension**
24	8	F	Yes			Yes		**Extension**
25	7	M	Yes			Yes		Flexion
26	8	M	Yes			Yes		**Extension**
27	10	M		Yes		Yes		**Extension**
28	5	M	Yes			Yes		**Extension**
29	4	F	Yes				Yes	Flexion
30	7	M	Yes			Yes		**Extension**
31	6	M	Yes			Yes		**Extension**
32	2	M			Yes		Yes	**Extension**
33	4	F	Yes			Yes		**Extension**
34	3	M	Yes			Yes		**Extension**
35	8	M	Yes			Yes		**Extension**
36	7	F	Yes				Yes	**Extension**
37	10	M	Yes			Yes		**Extension**
38	6	M		Yes		Yes		**Extension**
39	9	M	Yes				Yes	**Extension**
40	10	F	Yes			Yes		**Extension**

Table (7): comparison between (CRPP) and (ORIF) methods.

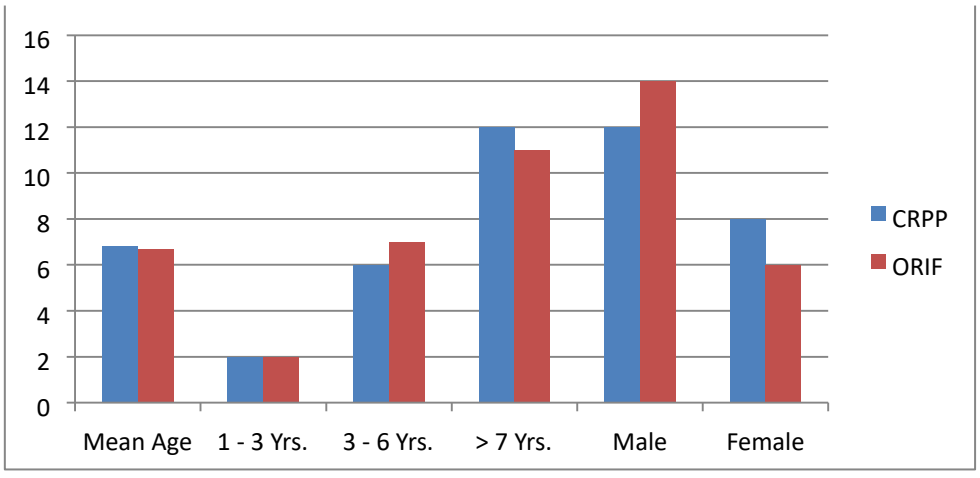


Figure (1): Distribution of age and sex groups according to type of fixation

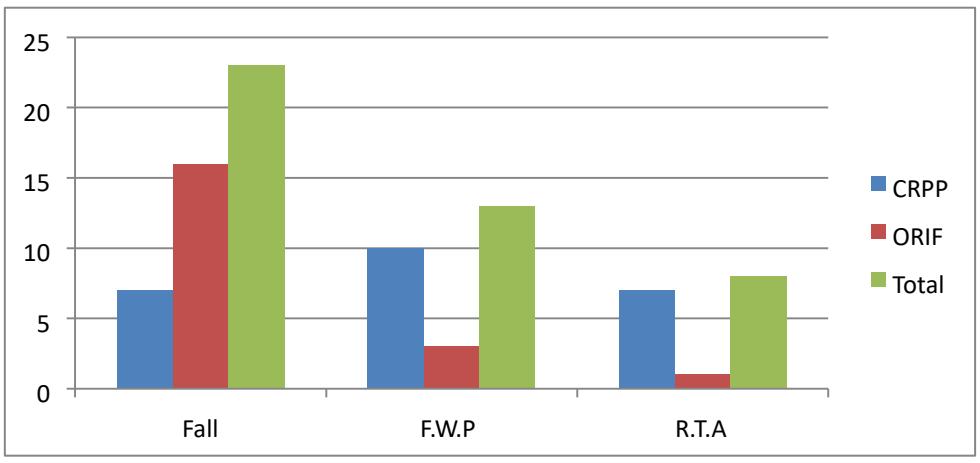


Figure (2): Comparison of mechanism and Type of Fixation

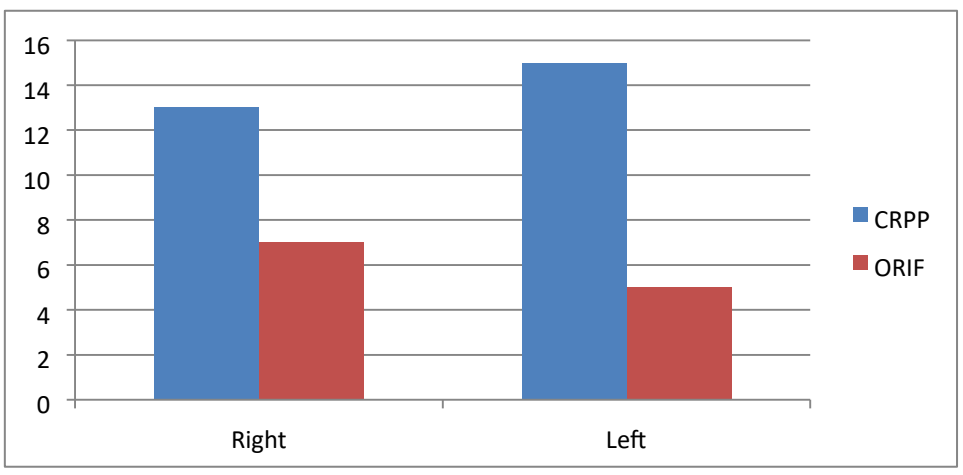


Figure (3): Outcome according to side groups and type of fixation

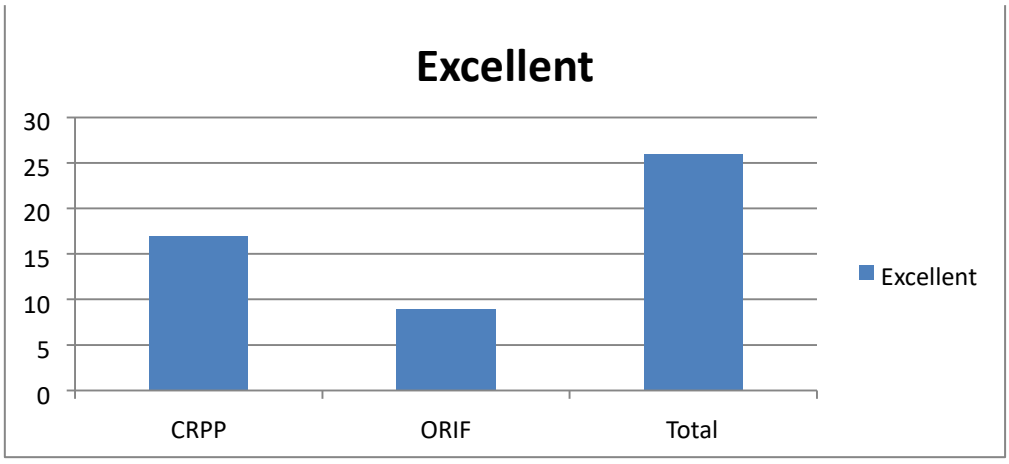


Figure (4): Outcome according to Loss of carrying angle criteria and type of fixation

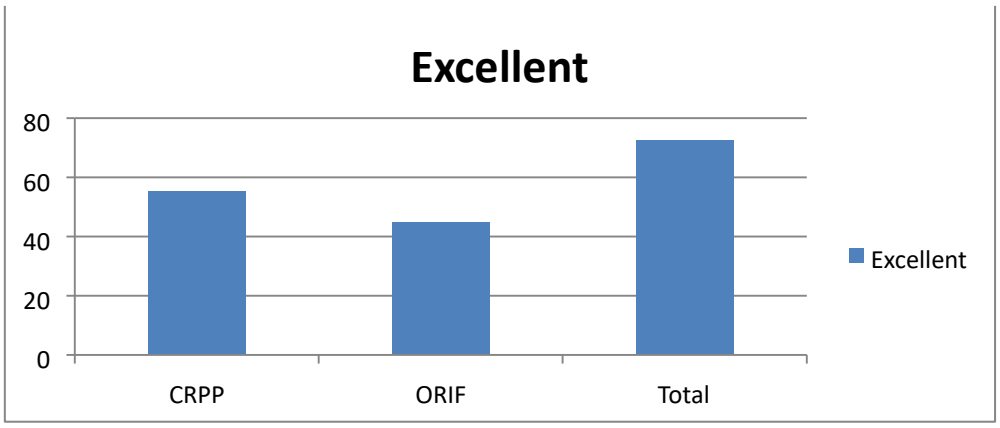


Figure (5): Outcome according to Loss of motion criteria and type of fixation

Discussion

According to Chi-square test we find the following information :

- Regarding the loss of carrying angle and Baumann's angle criteria about 65.4 % were excellent result with the CRPP method, while 34.6 % with the ORIF method, which mean there is a significant result of CRPP better than ORIF method as shown in tables (4) and (6).
- Regarding the loss of motion criteria there is a 55.2 % are excellent results with the CRPP method while 44.8 % with the ORIF method, this indicate also the CRPP method better than ORIF method, so we conclude that the CRPP method is a gold stand method in treatment of supracondylar fracture of humerus in children of class
  (3) Gartland, due to :-
  1- Less trauma and safe .
  2- Least time consuming .
  3- Cost efficient method .
  4- Provide stable fixation .

5- Short hospital stay .
6- Reduce post-operative stiffness.
7- Faster recovery .
8- Excellent results .

But the disadvantage of CRPP method is iatrogenic ulnar nerve injury, which is the most common complication in this method (4) cases in our study in the medial-lateral fixation, while there is only one case with the ORIF method. Most cases like neuropraxia recovered within three months, if persist so we apply electromyographic measurement and treated accordingly.

- There is a significant association between mechanism of injury and result of technique, which means one the trauma is severe leads to more injury to the bone and tissue which ends in poor prognosis, as shown in table (2).
- There is no significant association between age, sex and side of the injury and the result of method of fixation.
- Cubetus varus deformity (Gunstock deformity) this is because coronal rotation or tilting of the distal fragment. The residual medial tilt after reduction is the most important in the varus angulation. In our study there are two cases with CRPP method and one case with ORIF method.
- Pin tract infections : they are superficial and healed after removing pins and administration of oral antibiotics. In our study we find (4) cases with the CRPP method and two cases with the ORIF method.
- Stiffness : it should be start physiotherapy once removing of the pins. In our study there are two cases with the CRPP method and (5) cases with the ORIF method.
- Myositis ossificans : also it should be start physiotherapy at the early time. In our study there are (3) cases with the ORIF method, while no case recorded with the CRPP method.

Conclusions

In contrast to the open procedure, the percutaneous approach is a successful surgical treatment modality due to a large list of benefits, even if the outcomes are approximate. Children with displaced supracondylar fractures may benefit from closed reduction with percutaneous pinning because it shortens their recovery time, decreases the need for physical therapy, and decreases the likelihood of complications. Providing outstanding outcomes. Compared to medial lateral fixation, lateral pin fixation spared the ulnar nerve damage.

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