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Original Research Article

A Prospective Study of the Functional and Cosmetic Outcome of Supra Condylar Fractures of Humerus in Children Treated by Percutaneous Pinning and ORIF with Kirschner Wires

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Abstract: In the first decade of life, supracondylar fractures are common skeletal injuries comprising of 15% of all paediatric skeletal injuries. Injuries in boys are more common and the left or the non-dominant side gets injured more often. This prospective study done for a period of 3 years compares the functional and cosmetic outcomes of 35 cases of supracondylar fractures treated in the age group of 2 years to 12 years, by closed reduction and percutaneous pinning and by ORIF. We concluded that closed reduction with percutaneous pinning had the advantages of better cosmetic results, are less expensive, having fewer days of hospitalization and with quicker union time. Even from the functional outcome view point and pre and post-operative complication rates, closed reduction percutaneous pinning fared far better over ORIF. Rates of malunion are also higher in the ORIF group.
Keywords: Closed reduction percutaneous pinning, ORIF, supracondylar fractures, paediatric fractures, Flynns' Criteria

INTRODUCTION:

Supracondylar fracture of humerus is the most common fracture in the children under 7 years of age, comprising of 15% of all paediatric fractures. This fracture is common in the first decade of life due to causes like ligamentous laxity and anatomical structure of humerus tube (shaft) to flat transformation at lower end of humerus. Its incidence decreases with age**.** It comprises about 55% to 75% of fractures around elbow in children. Boys have a higher incidence than the girls. It is more common in left side or the non-dominant side.

There are two types of supracondylar fractures [3].

1. Extension type -- 97%
2. Flexion type -- 3%

Various modes of treatment are:-

1. Closed reduction and casting.
2. Percutaneous Pinning.
3. Open reduction and internal fixation.

The early complications of supracondylar fractures include vascular and nerve injuries and the late complications include Volkmann's ischaemic contracture, Myositis ossificans, Cubitus varus or valgus deformity, Tardy ulnar nerve palsy.

Supracondylar fractures of humerus need to be handled carefully to avoid drastic short term complications and vexing long term complications. The complications can be prevented by early and appropriate intervention [16]. This can be achieved only by proper anatomical reduction and maintenance of reduction either by percutaneous pinning or ORIF.

MATERIALS AND METHODS:

This prospective study was carried out from September 2013 to August 2016, at the Department of Orthopaedics, Sree Balaji Medical College, Chromepet, and Chennai. The cases were included in the study, depending on the following inclusion and exclusion criterias.

Inclusion criteria:

1. GARTLAND'S type II and III supracondylar fractures [11].
2. Patient in the age group 2 to 12 years of age. Closed fractures.

Exclusion criteria:

1. GARTLAND'S type I [11].
2. Open supracondylar fractures.
3. Patients with nerve or vascular injury.

4. Fractures with compartmental syndrome.

All the patients were planned for surgery as early as anaesthetic fitness was obtained. Early intervention gives best results. But there were some restrictions.

Criteria for percutaneous pinning:

1. Patients who came within 3 days of injury.
2. Without gross oedema of elbow.
3. Without any contraindications for immediate surgery like LRI, and other anaesthetic contraindications.

Criteria for ORIF:

1. Patients who came 3 days after injury but not later than 7 days, in whom percutaneous pinning was deemed difficult.
2. Patients with gross oedema of elbow.
3. Patients in whom percutaneous pinning failed and required to be proceeded with ORIF in the same anaesthetic sitting.
4. Patients who have to wait for few days for anesthetic fitness for surgery.

CLOSED PINNING TECHNIQUE:

Under general anesthesia or supraclavicular block, with patient in supine position, the elbow was prepared and draped. Correction of medical or lateral translation was done by applying a translatory force with varus or valgus movement in the coronal plane to the distal fragment. After the position was confirmed by C-arm, we proceeded to correct rotatory deformity by supinating or pronating the forearm. Important to understand is that for correcting posteromedial rotation, supination is required and for correcting posterolateral rotation, pronation is required. Correction is checked with C-arm. After achieving this, elbow is kept flexed to maintain rotatory stability. Correction of posterior displacement or angulation is done by lifting the distal fragment anteriorly with the help of surgeons thumb placed over the olecranon process. The elbow then is further flexed to tighten the posterior periosteal hinge. The forearm is then pronated to lock the fracture fragments. By antro-posterior, lateral and Jones view the position of reduction is confirmed by C-arm. The 2 smooth 'K'-wires with trocar point size 1.2mm to 2mm diameter are chosen. Either 2 lateral pins or 1 lateral and 1 medial pin is used and both should engage the cortex on the far side. Pins are passed in such a way that they cross proximal to the fracture at an angle of about 30 degrees to the humeral shaft. The lateral pin is inserted first. A second lateral pin is temporarily placed to achieve better stability, prior to inserting the medial pin. Avoid directing the pin too far anterior or posterior. It is important to note that without hyper flexion, the ulnar nerve can get impaled. Medial and lateral pin insertion provides for better stabilization rather than using 2 lateral pins may not permit full elbow extension, thus preventing fall assessment of carrying angle. After C-arm confirmation again, 'K'-wires are cut and bent. Sterile dressings are done and an above elbow slab applied with 70 to 90 degrees of flexion. Post operatively the arm is kept in elevation and looked for neuro-circulatory compromise. IV antibiotics and analgesics started prior to surgery are continued for 3 days. Post operatively, by the third day or as the patients pain tolerance may permit, active elbow mobilization is encouraged. Periodic sterile dressing changes were done on 3rd, 7th and 12th, post op days. The patient were reviewed weekly for the first month and fortnightly for the next two months and monthly for the next 3 months, totally for a period of 6 months. K-wires were removed under LA at the end of 4 weeks.

ORIF TECHNIQUE:

For cases requiring ORIF, under suitable anesthesia, with patient in prone position, after prep and drape of elbow, a posterior midline incision is made. Under the deep fascia, triceps muscle is reached; the ulnar nerve is identified and isolated. A triceps splitting technique with apex facing proximally and retracted distally. The fracture site is then visualized. Fragments are then aligned in position and are held with reduction clamps. The fracture fragments are then secured by 2 criss cross K wires following the same principles as outlined for the closed K wire pinning. After confirming the stability of the fracture site and confirming their position under the c-arm, wound is closed in layers over a DT. Sterile dressings are applied and an AE posterior slab applied in 70 to 90 degrees of flexion. Post op management is same as that outlined for percutaneous pinning, except that the DT is removed at 48hrs and active exercises of elbow encouraged by the 5thpost operative day or as early as the patient's pain tolerance permits. Alternate SR is done on the 12th and the 14th post op days respectively.

INSTRUMENTS USED FOR PERCUTANEOUS PINNING AND ORIF

PERCUTANEOUS PINNING

STEP WISE ILLUSTRATION

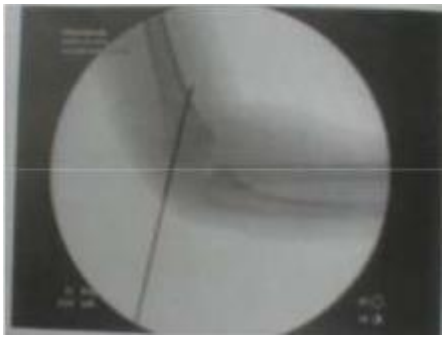
LATERAL TRANSLATION CORRECTED

ROTATION DEFORMITY CORRECTED

CORRECTION OF POSTERIOR DISPLACEMENT

ELBOW IN FULL FLEXION

LATERAL PINNING



C-ARM IMAGES

OPEN REDUCTION

INTERNAL FIXATION

STEP WISE ILLUSTRATION

POSTERIOR MID LINE INCISION

ULNAR NERVE ISOLATED

FRACTURE REDUCED

LATERAL PINNING

MEDIAL PINNING

WOUND CLOSED

The following criteria were used:

1. Regaining the function of elbow.
2. Avoiding Cubitus varus deformity.
3. Early mobilization.
4. Avoiding stiffness of elbow.
5. Surgical scar.

The cases were analysed as per the following criteria:

1. Age.
2. Sex.
3. Mode of injury.
4. Side of upper limb involved.
5. Time interval between injury and surgery.
6. Type of fracture- Extension or Flexion type.
7. Nature of surgery done – closed pinning or ORIF.
8. Post-operative complication.
9. Hospital stays in days.
10. No. of days in which bony union was achieved.
11. Mobilization and timing of K wire removal.

POST OPERATIVE PEROID:

The patients were reviewed every week for the first month and then fortnightly for next 2 months and then every month for the next 3 months, totaling a period of 6 months.

The results were graded using the **FLYNNS' CRITERIA [16].**

Table for Flynns' Criteria

	Cosmetic factor	**Functional factor**
Results	**(loss of carrying angle in degrees)**	**(loss of motion in degrees)**
Excellent	0 - 5	0 – 5
Good	6 - 10	6 - 10
Fair	11 - 15	11 – 15
Poor	> 15	> 15

RESULTS:

Age group distribution:

Age group varied from 2 to 12 years. Maximum percentage of patients belonged to the 6 to 8 age group

Age group in years	No. of cases	Percentage
2 - 4	3	8.6%
5 - 6	5	14.3%
6 - 8	12	34.3%
8 - 10	9	25.7%
10 - 12	6	17.1%
Total	35	100%

Sex ratio:

There was a predominance of male children in the ratio of 60:40. This is probably because male children are involved more in outdoor activities and rough games than female children, who in turn prefer indoor games.

Sex	No. of patients	Percentage
Male	21	60%
Female	14	40%
Total	35	100%

Mode of injury:

Fall from height (i.e tree, walls) was the most common etiology. Fall from the cycle was the second most common cause, and Road traffic accident comes the third cause.

Mechanism of Injury	**No. of patients**	**Percentage**
Fall from height	23	65.7%
Fall from cycle	7	20%
Road traffic accident	5	14.3%
Total	35	100%

Side of elbow involved:

28 patients (i.e 80 %) had injury in the left humerus and only 7 patients (20%) had injury to the right side humerus.

SIDE	**Number of Cases:**	**Percentage**
Right	7	20%
Left	28	80%

Time interval between injury and surgery:

82.86% of the patients were taken up for surgery within 24 hours either closed pinning or ORIF[18]. Unless and other wise there were any contraindication like lower respiratory tract infection or specific anaesthetic contraindications, immediate fixation was done.

Time of surgery	**No. of Patients**	**Percentage**
Within 24 hours	29	82.86%
After 24 hours	6	17.14%

Type of fracture:

94.29% of the cases were of Extension type. Extension type of supracondylar fractures far outnumbered flexion type of injuries. The only two case of flexion type had an etiology of fall from height with flexed elbow and landing on the elbow.

Type of injury	**No. of Patients**	**Percentage**
Extension type	33	94.29%
Flexion type	2	5.71%

Nature of surgery done:

Nature of surgery		Total
ORIF No.: (%)	Closed Pinning No.: (%)	35
17(48.57%)	18(51.43%)	

Post-operative complications:

- Four patients (11.42%) developed ulnar nerve neurapraxia, which recovered completely within 5 weeks with physiotherapy.
- Six patients (17.14%) had pin site infection, which settled with IV antibiotics for 7 days.
- Two patients (5.71%) had pinned loosening and backing out.
- Acceptable malunion (posteromedial displacement of upto 10^{o}) occurred in 1 patient (2.86%) in the ORIF group and 4 patients (11.43%) in the closed pinning group.

Neurovascular Complication (ulnar nerve)		Volkmann's Contraction		Cubitus varus deformity		Infection		Pin loosening		Malunion		Non Union	
ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning	ORIF	Closed pinning
4	0	0	0	0	0	6	0	2	0	1	4	0	0

Hospital stay:

The hospital stay of 25 patients (71.42%) was less than a week, 8 patients (22.86%) were discharged between 8 and 14 days and the remaining 2 patients (5.72%) were discharged between 15 and 18 days.

No. of days	No. of patients		Percentage	
	ORIF	Closed pinning	ORIF	Closed pinning
< 7 days	8	17	47.05%	94.44%
8 – 14 days	7	1	41.18%	5.56%
15 – 18 days	2	0	12.77%	0%
TOTAL	17	18	100%	100%

Bony union:

Bony union was checked by taking serial x-rays every week in the first month and then once in 2 weeks thereafter. Union was assessed by radiological and clinical parameters.

No. of weeks for Union	**No. of Patient**		**Percentage**	
	ORIF	**Closed pinning**	**ORIF**	**Closed pinning**
4	1	12	5.88 %	66.67 %
5	5	4	29.41 %	22.22 %
6	11	2	64.71%	11.11%
TOTAL	17	18	100%	100%

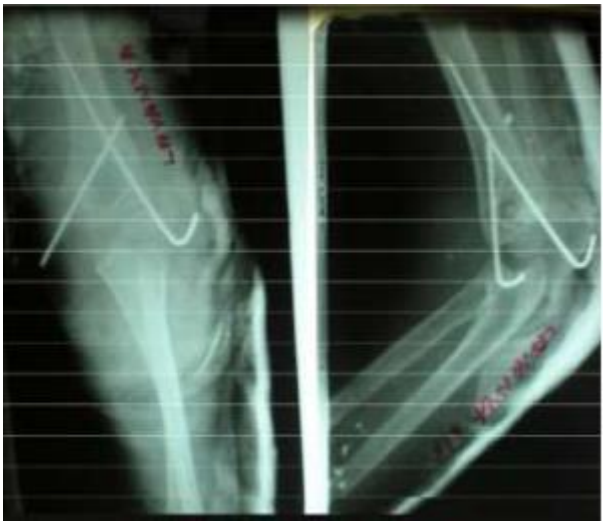
MOBILISATION AND REMOVAL OF K-WIRES:

Out of 8 cases treated by percutaneous pinning, the mobilisation was started between 3 to 5 days with K-wire in situ, while the mobilisation was started between 5 and 10 days with K-wire in situ for the other patients who were treated by ORIF(17 cases).

The sutures were removed on 14thpost operative day for the patients treated by ORIF. K-wires were removed either at the end of 3rd week (for patient aged below 6 years) and by the end of 4th week for patients aged above 6 years.

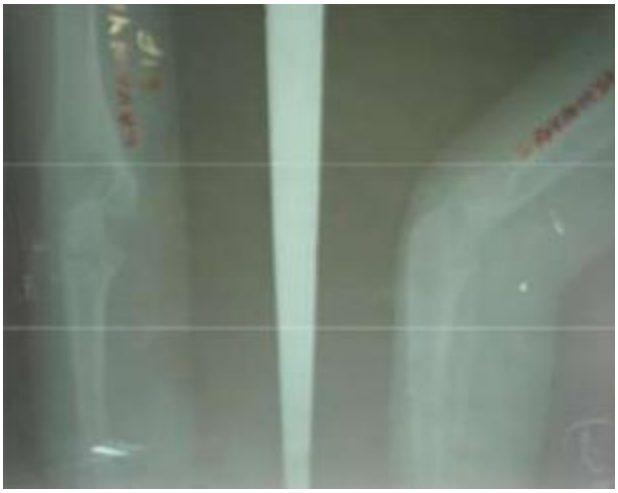
CASE ILLUSTRATION -1
PERCUTANEOUS PINNING

PRE – OP



POST – OP

3 WEEKS POST OP

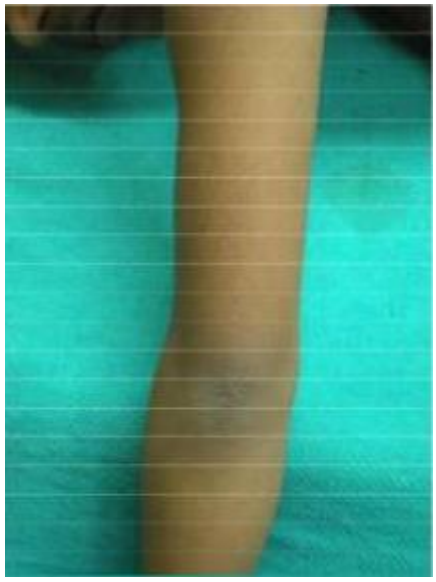


6 MONTHS FOLLOW UP

CASE ILLUSTRATION- 1
PERCUTANEOUS PINNING 6 MONTHS FOLLOW UP

FULL EXTENSION NO VARUS OR VALGUS

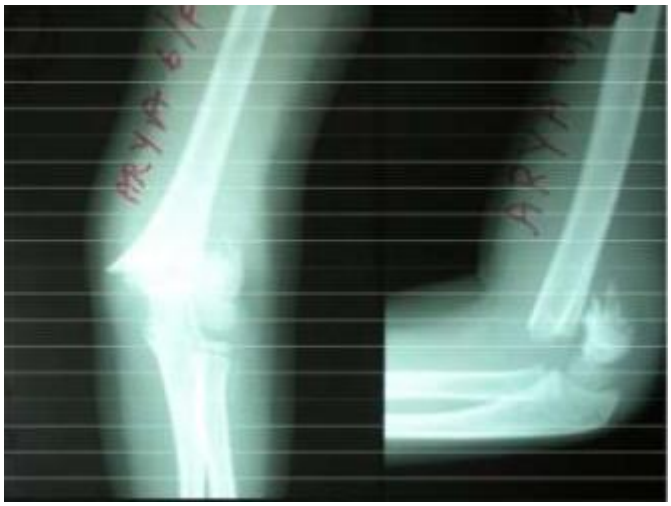
FULL FLEXION



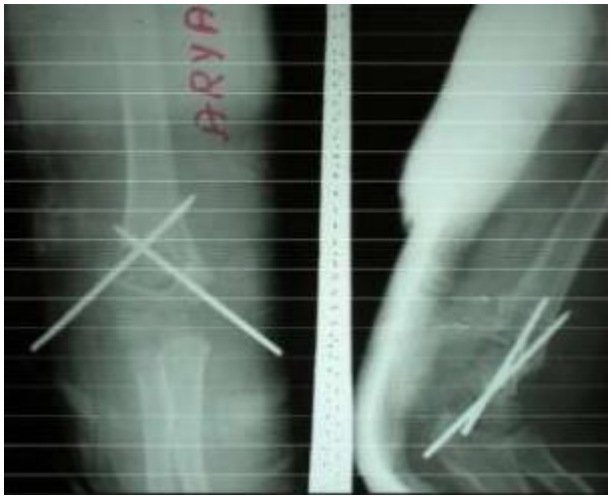
POSTERIORLY NO SCAR

SMALL SCAR OVER ENTRY POINT OF K- WIRE

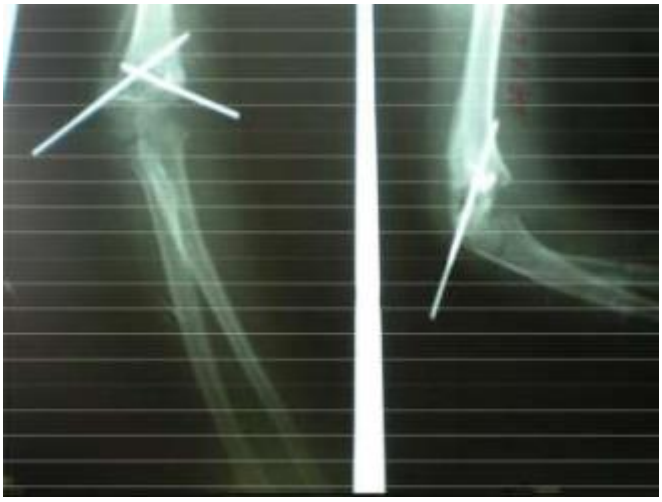
CASE ILLUSTRATION-2
PERCUTANEOUS PINNING



PRE-OP



POST-OP



3 WEEKS POST-OP

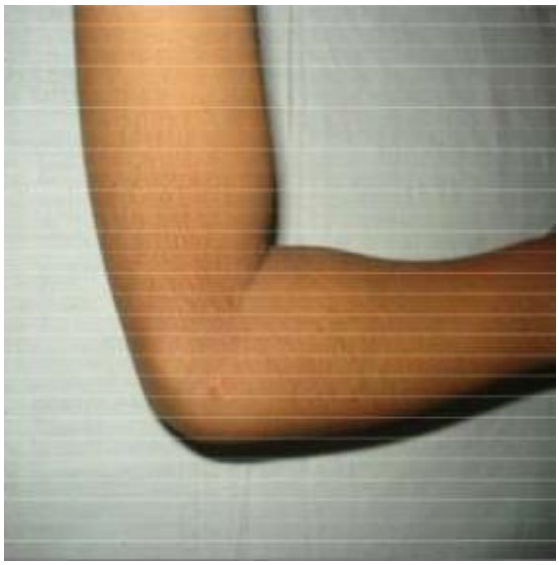
6 MONTHS FOLLOW UP

CASE ILLUSTRATION -2
PERCUTANEOUS PINNING 6 MONTHS FOLLOW UP

FULL EXTENSION
NO VARUS OR VALGUS

FULL FLEXION

POSTERIORLY NO SCAR



SMALL SCAR OVER ENTRY POINT OF K-WIRE

CASE ILLUSTRATION - 3
OPEN REDUCTION AND INTERNAL FIXATION

PRE – OP

POST- OP

3 WEEKS POST – OP

6 MONTHS FOLLOW UP

CASE ILLUSTRATION - 3
ORIF 6MONTHS FOLLOW UP

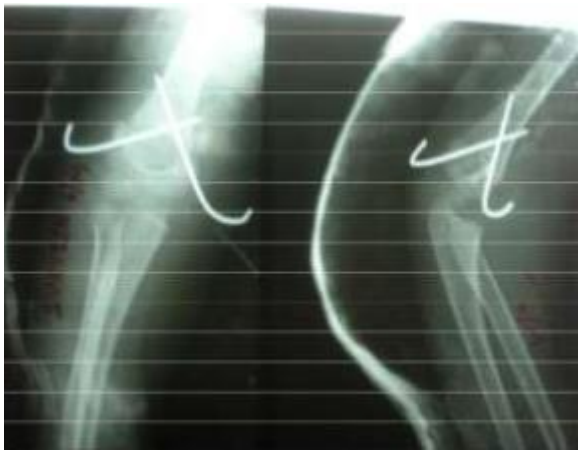
FULL EXTENSION NO VARUS OR VALGUS

FULL FLEXION

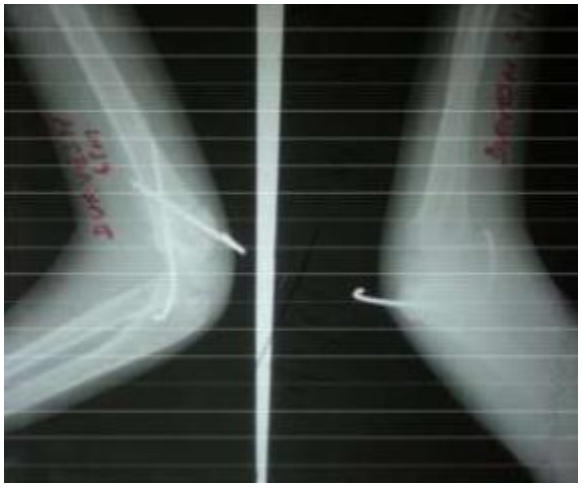
POSTERIOR LARGE SCAR

CASE ILLUSTRATION – 4
OPEN REDUCTION AND INTERNAL FIXATION

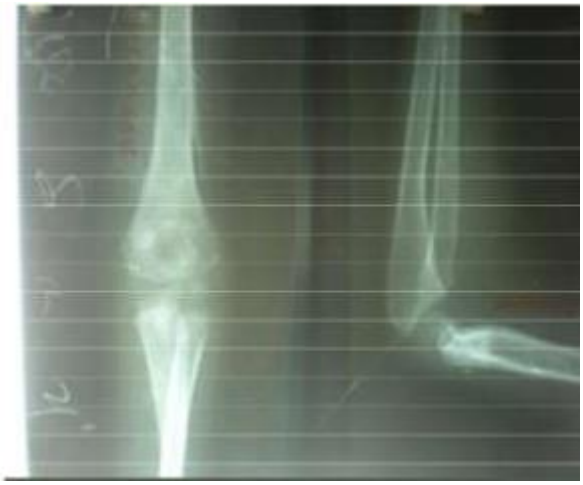
PRE – OP



POST – OP



3 WEEKS POST – OP



6 MONTHS FOLLOW UP

CASE ILLUSTRATION- 4
ORIF 6 MONTHS FOLLOW UP

FULL EXTENSION NO VARUS OR VALGUS

FULL FLEXION

POSTERIOR LARGE SCAR

DISCUSSION:

- All the relevant data were analysed.
- The fracture was more in the age group of 6 – 8 yrs. Peak incidence for the supracondylar fractures of humerus is 6.7 yrs.
- Boys had higher incidence compared to the girls in the ratio of 60:40. This
- This incidence was similar to that study conducted by Celiker *et al.;* [28].
- Though the mechanism of injury is fall on outstretched hand, the common mode of injury was fall from height like wall, trees, etc. (65.7%)
- Left elbow or the non-dominant side was more involved (80%) than the right or dominant side. (20%)
- About 60% of patients were operated within 24 hours of injury and the rest were operated within 3 days.
- Extension types were 33 patients (94.29%) of our study and only two patients (5.71%) were of flexion type. This inference correlates with the study by Cekanauskas *et al.;* [29]. Of the extension type, 28 patients (84.84%) were of type III and 5 patients (15.15%) were of Type II.
- About 94.44% of the patients who were treated by percutaneous pinning were discharged within 7 days, but only 47.05% of the patients who were treated by ORIF were discharged within the same period.
- In about 66.67 % of the patients treated by percutaneous pinning, fracture united in 4 weeks and in only 5.88% of the patients treated by ORIF did so in the same time. 29.41% and 22.22% of the patients from ORIF and closed pinning groups had union in 4 weeks. 64.71% of the patients treated by ORIF had union by the 6^{th} week. Only11.11% of patient of the closed pinning group showed union delayed upto the 6^{th} week.
- All the patients were graded as per the **FLYNN CRITERIA**. In our study, all the patients treated by both means either ORIF or closed reduction and percutaneous pinning had an excellent result, with mean loss of carrying angle of 3.8^{o} and mean loss of flexion by 4.2^{o}.

- In our study, 4 patients developed ulnar nerve neuropraxia post operatively, which recovered completely in 5 weeks, following physiotherapy. Six more patients had a pin site infection, which settled with IV antibiotics for 1 week. Acceptable malunion (postero medial displacement within 10º was observed for 1 patient in the ORIF group and in 4 patients in the closed pinning group.

Mercer Rang said "Pity the young surgeon whose first case is a fracture around elbow" [15]. Proper training is needed to adopt recent advances by young surgeons to deal with these challenges. Though this statement is for the young surgeons, even experienced surgeons sometimes have difficulty in treating supracondylar fractures. Supracondylar fracture of humerus in children are still difficult to handle because of the age group involved, the neurovascular structures and difficulty in achieving and then maintaining anatomical reduction by closed means.

To obtain a perfect result after a supracondylar fracture of the humerus, an accurate anatomical reduction is needed. It is essential to minimize additional trauma to the already traumatized joint and periarticular tissues [16]. This is more in ORIF, though it may also happen if repeated attempts at closed reduction are made in percutaneous pinning. It is therefore advisable that if a couple of trials of closed reduction fail, it is best to proceed with open ORIF.

Fracture healing is slightly delayed in cases treated by ORIF, due to further stripping of periosteum per operatively, in addition to that which had happened during the injury. This iatrogenic damage to the periosteum is not there in percutaneous pinning. The best treatment for supracondylar fracture of the humerus must provide an excellent functional result and an elbow of normal cosmetic appearance with minimal risk to the patient. Either of the procedures ORIF or percutaneous pinning has their merits and demerits.

CRITERIA	**ORIF**	**PERCUTANEOUS PINNING**
Surgical Expense	More	Less
Stay in hospital	More	Less
Mobilisation	Late	Early
Cosmetic	Big scar	No scar
appearance		
Union	Late	Early
Technical difficulty	Less	More
Surgical time	More	Less
Chance of infection	More	Less
Soft tissue damage	More	Less

From the functional stand point, limitation of flexion of the elbow is considered more disabling than the extension. Next impairment comes the change in carrying angle, which may result in tardy ulnar nerve palsy. The patient may develop Cubitus varus deformity, which disturbs the patient cosmetically. More over the patient treated by ORIF may have a large scar in addition to that.

It is generally agreed that accurate reduction is not necessary for an excellent functional result because of the great remodeling power in younger children. But it is also true that the cosmetic end results of such a treatment are often poor and are therefore not acceptable. Union is never a problem in treating supracondylar fracture of humerus in the paediatric age group, but the problems to be kept in mind are-

1. Early neurovascular injury
2. Long term complications like Volkmann's ischemic contracture, Myositis ossificans, Cubitus varus or valgus deformity and tardy ulnar nerve palsy. Of all these complications, Cubitus varus is by far the most common complication.

Kaewpornsawan's study [20] states that both treatments gave good results. Closed reduction should be performed first and, if it fails, then open reduction can be performed. This will produce good results in the hands of an experienced surgeon.

CONCLUSION:

Though both the procedures, either ORIF or percutaneous pinning, gave excellent results functionally. We conclude that closed reduction percutaneous pinning is a superior option for supracondylar fractures of humerus for the following simple reasons:

1. The cosmetic results are always better.
2. They are cost effective.
3. Hospital stay is less.
4. Complications are fewer and rare.
5. Union was earlier.

But not all supracondylar fractures budge to the reduction manoeuvers and have to be opened up for ORIF, in order not to accept anatomical mal-reduction which in variably gives poor cosmetic results and lands up with Cubitus varus or tardy ulnar palsy making a future surgery almost inevitable. The earlier the intervention, closed reduction is possible and percutaneous pinning is satisfactorily achieved. This is by far more satisfying as far as functional and cosmetic outcomes are concerned.

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