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Original Research Article

Surgical management of pediatric supracondylar humerus fractures with percutaneous pinning: A prospective study

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Abstract

Background and Objectives: Supracondylar fractures of humerus is a common injury in children accounting to 60% of the fractures around the elbow. The management of displaced supracondylar fracture of the humerus is one of the most challenging, since it requires accurate reduction and internal fixation to prevent complications. Conservative treatment results in malunion. Open reduction and internal fixation is more invasive and recovery is prolonged. Closed reduction and percutaneous pinning is preferred method of treatment for displaced supracondylar fracture of humerus in children. The objectives of this study is to report the results of closed reduction and internal fixation with percutaneous k wires in the displaced Gartland type 2 and type 3, supracondylar fracture humerus in children.

Materials and Methods: A prospective clinical study conducted at the Department of Orthopaedic Surgery, Vijayanagar Institute of Medical Sciences, Ballari. from August 2020 to August 2022. This study consists of 30 cases of displaced supracondylar fracture humerus treated by closed reduction and internal fixation with k wires. The cases were selected according to inclusion and exclusion criteria. The final results were evaluated according to Flynn *et al*. criteria.

Results: In our study based on Flynn *et al*. criteria, the following results were made. Of the 30 cases, 21 patients obtained excellent results, 5 patients had good results, 3 patients had fair results, that is 29 patients had satisfactory results and one patient had poor result, that is unsatisfactory result. The results were comparable to other studies.

Conclusion: It can be concluded from the present study that closed reduction and internal fixation with percutaneous k wires, for displaced supracondylar fracture humerus in children gives good anatomical reduction, stable fixation and good functional outcome with minimum complication.

Keywords: Closed reduction, internal fixation, percutaneous, k wire, displaced supracondylar fracture humerus in children

Introduction

Supracondylar fractures of humerus are the most common paediatric elbow fractures, accounting 60% of the fractures around the elbow in children [1]. The rate of occurrence increases steadily in the first five years of life to peak at 5-7 years of age [2]. The high incidence of residual deformity and the potential for neurovascular complications make supracondylar humerus fractures a serious injury [3]. The management of displaced supracondylar fracture of the humerus is one of the most difficult of the many fractures seen in children [4]. Pitfalls in the management occur frequently and continue to trouble the doctor caring for these patients, especially with respect to displaced supracondylar fractures [5]. If the

ISSN 2515-8260 Volume 09, Issue 07, 2022

fracture is not treated properly it may give rise to many complications like volkmann's ischemic contracture, neurovascular injury, skin slough, myositis ossificans, elbow stiffness and malunion. There is no controversy about management of the nondisplaced fractures. But many methods have been proposed for the treatment of displaced supracondylar fractures of the humerus in children, such as closed reduction and plaster of paris slab application, skin traction, overhead skeletal traction, open reduction and internal fixation, and closed reduction and percutaneous pin fixation [6]. The displaced supracondylar fractures of humerus are difficult to be reduced and equally difficult to maintain the reduction. cubitus varus deformity is the most common problem seen after malunion of supracondylar humeral fractures. It causes a cosmetic deformity and barely affecting the range of motion.

Closed reduction with plaster of paris slab immobilization has traditionally been recommended for displaced supracondylar fractures, but loss of reduction and necessity of repeated manipulation is likely to go for malunion producing varus or valgus deformity of elbow and elbow stiffness [7]. Traction (skin or skeletal), which has also been used for many years, has been shown to be safe and reliable, but it has the drawback of requiring a long stay in the hospital.

Open reduction and internal fixation have generally been reserved for specific indications mainly for an open fracture, a fracture requiring vascular exploration, or an irreducible fracture. Due to high chances of elbow stiffness Recent studies have shown good functional results with closed reduction and percutaneous fixation using 'K' wires and is the most commonly accepted treatment of displaced supracondylar fractures of the humerus in children.

Materials and Methods

This is an observational prospective study, consisting of 30 cases of fresh supracondylar fractures of humerus in children aged less than 14 years, which were treated by closed reduction and stabilized by percutaneous Kirschner’s wires. This study was conducted at Vijayanagar institute of medical sciences, Ballari, between August 2020 to August 2022.

Inclusion criteria

1. Both sexes.
2. Age less than 14 years.
3. Children with unstable displaced Gartland type II and type III fractures.

Exclusion criteria

1. Age more than 14 years.
2. Un displaced Gartland type 1 fractures.
3. Compound, comminuted fractures.
4. Those who had previous attempt of manipulation.

All the patients selected for this study were admitted in VIMS Hospital and a detailed history and examination of the patient was done according to the protocol. The required information was recorded in the proforma prepared. The patient’s radiograph was taken in Antero-

posterior and lateral views. The diagnosis was established by clinical and radiological examination.
In this study, supracondylar fracture of humerus was classified according to Gartland's classification.
Type I: Un displaced Supracondylar fracture of humerus.
Type II: Displaced Supracondylar fracture with intact posterior cortex.
Type III: Displaced Supracondylar fracture with no cortical contact.
a) Posteromedial.
b) Posteromedial.

All patients were taken for elective or emergency surgery as soon as possible after necessary routine investigations and radiographic preoperative work-up. Patient's attendants were explained about the nature of the injury, its possible complications and about the need for the surgery and complications of surgery. Written and informed consent was obtained from the parents of the children before surgery. All patients were started on prophylactic antibiotic therapy. Intra venous antibiotics were used. It was administered according to body weight of the children, prior to induction of anaesthesia and continued post- operatively for 3 days and oral antibiotics were given for further 4 days.

Surgical procedure

Anaesthesia: General Anaesthesia.

Operative technique: Under general anaesthesia the patient was placed in the supine position on the operating table. The image intensifier machine was used on the operating table. Painting and draping was done.
Technique of closed reduction and internal fixation: Traction along the longitudinal axis with elbow in extension and supination were given. At the same time counter traction was given by an assistant by holding proximal portion of arm. Medial or lateral displacements were corrected by valgus or varus forces respectively. After that, posterior displacement and angulation was corrected by flexing the elbow and applying posteriorly directed force from anterior aspect of proximal fragment and anteriorly directed force from posterior aspect of distal fragment. Reduction was confirmed under image intensifier in two views: Antero-posterior view or Jone's view and Lateral view.
After confirming satisfactory alignment, reduction was maintained by percutaneous k-wire fixation. Above elbow posterior pop splint in 90° elbow flexion of forearm was applied.

Introduction of K-wires

K-wires of about 1.2mm to 2.0mm were used. Either 2 crisscross K-wires were used, one from medial epicondyle and one from lateral epicondyle or 2 lateral K-wires were used. After achieving satisfactory reduction, K-wires were introduced with the help of a drill, both K-wires were placed percutaneously. Medial pin entry was from tip of the medial epicondyle and lateral pin was introduced from the center of the lateral condyle. Both pins were directed 40° to the humeral shaft in sagittal plane and 10° posteriorly. K-wire placement was checked in image intensifier in Antero posterior and lateral views. And precautions were taken to engage both cortices to cross above the fracture site and not to cross the olecranon fossa after K-wires are placed, the adequacy and stability of the reduction was checked under image intensification. The pins were bent to prevent migration and cut 1 outside the skin to allow removal in the outpatient clinic without anaesthesia and Sterile dressing was applied.

ISSN 2515-8260 Volume 09, Issue 07, 2022

Postoperatively, the extremity was placed in well-padded posterior splint with the elbow flexed only 90° and patient was shifted to the ward after recovery from anaesthesia.

Post-operative management

- Operated limb was kept elevated on a drip-stand.
- Patient was encouraged to move fingers.
- A careful observation for any neurovascular deficit was observed at regular intervals.
- Appropriate antibiotics and analgesics were used.
- At 2nd post-operative day, check dressing was done and condition of the operative wound or pin site were noted.
- Check x rays in AP & lateral views were taken.
- Patients were discharged on 3rd or 4th post-operative day with oral antibiotics.

Follow up

These patients were reviewed on 12th postoperative day on outpatient basis for suture removal. K-wires were removed at 4 weeks post-operatively after X-Ray confirmation of satisfactory callus formation.

- Pop splint was discarded at the same time and patient was encouraged to do active elbow flexion extension and supination-pronation exercises.
- Patients were advised to avoid massage and passive stretching and not to lift heavy weights till 12 weeks post-operatively.
- Follow up was done on O.P.D. basis at 3rd, 6th & 12th week post operatively.

The follow up was done by clinical and radiological evaluation, and results were assessed based on:

1) Pain.
2) Swelling.
3) Tenderness at fracture site.
4) Movements of the elbow.
5) Carrying angle of the elbow compared with normal elbow.
6) Union of the fracture.

Functional results

The final results were evaluated by Flynn's criteria [7]. The results were graded as excellent, good, fair and poor according to loss of range of motion and loss of carrying angle.

Case 1

Pre-operative Radiographs **Immediate Post-Operative Radiographs**

ISSN 2515-8260 Volume 09, Issue 07, 2022



At 4 weeks follow up **At 6 months follow up**



Range of Motion at final follow up

Case 2


Pre-Operative Radiographs **Immediate Post-Operative Radiographs**

ISSN 2515-8260 Volume 09, Issue 07, 2022

At 4 weeks follow up **At 6 months follow up**

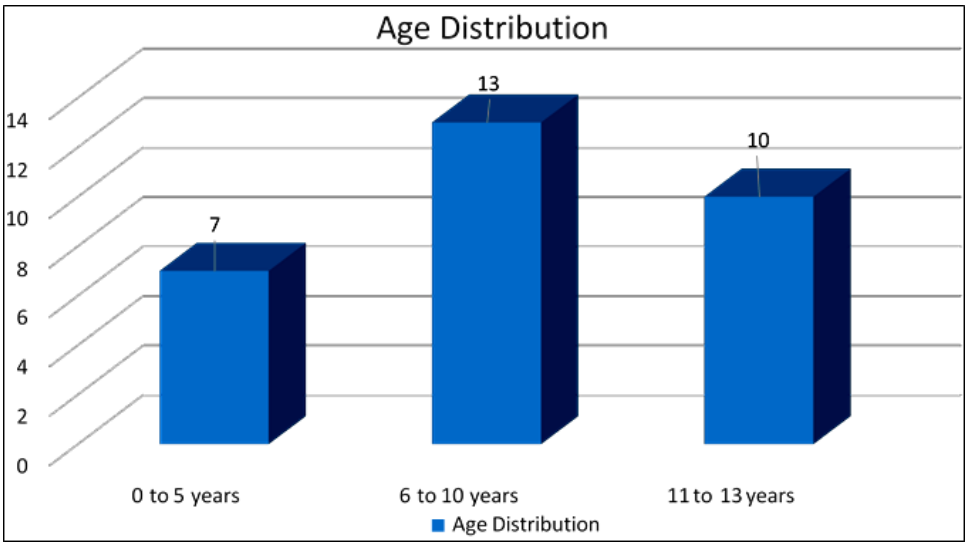
Range of motion at final follow up

Results

This is a descriptive study, conducted on 30 patients with closed displaced supracondylar fractures were treated by closed reduction and percutaneous fixation with Kirschner wires and follow up done at 4 weeks, 12 weeks and 24 weeks post-operatively.

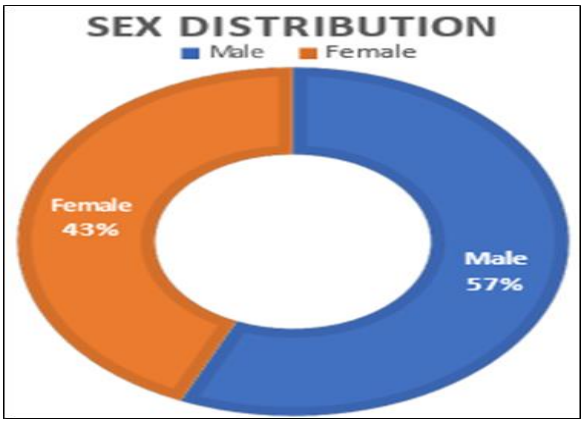
The following observations were made from the data collected during this study.

Age distribution

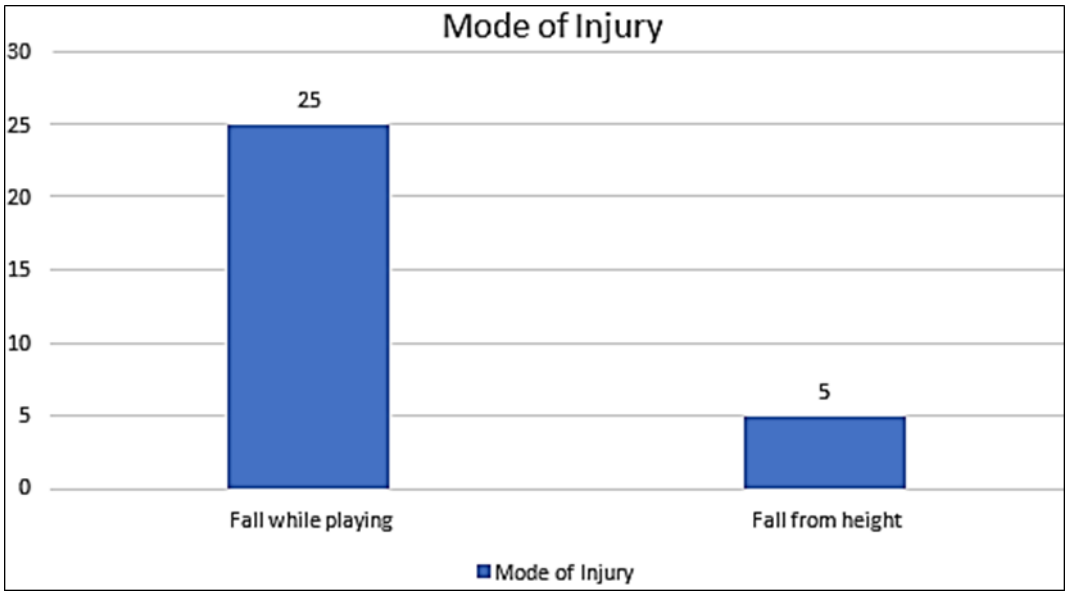


ISSN 2515-8260 Volume 09, Issue 07, 2022

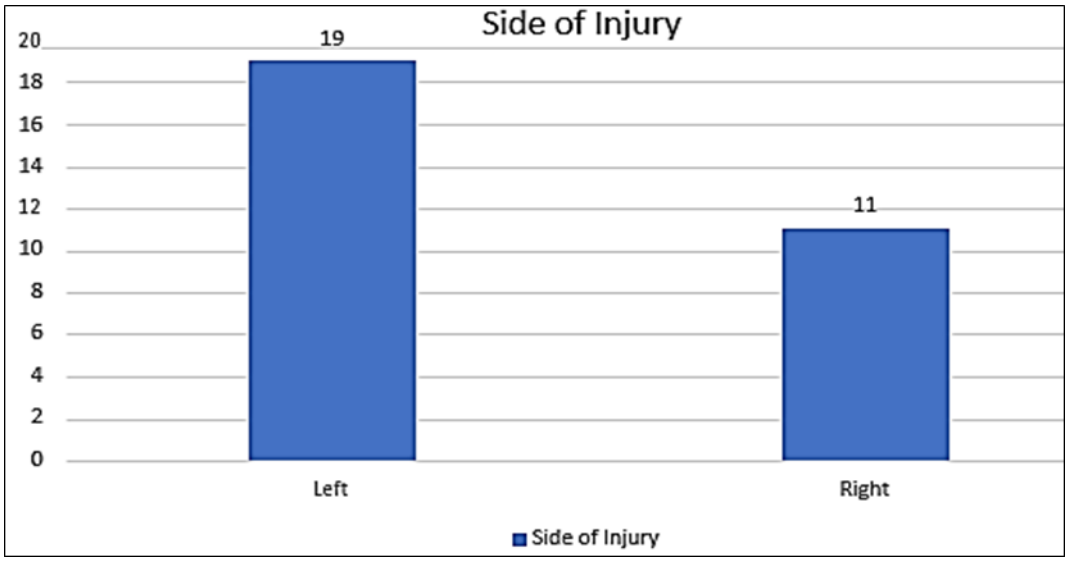
Sex distribution



Mode of Injury

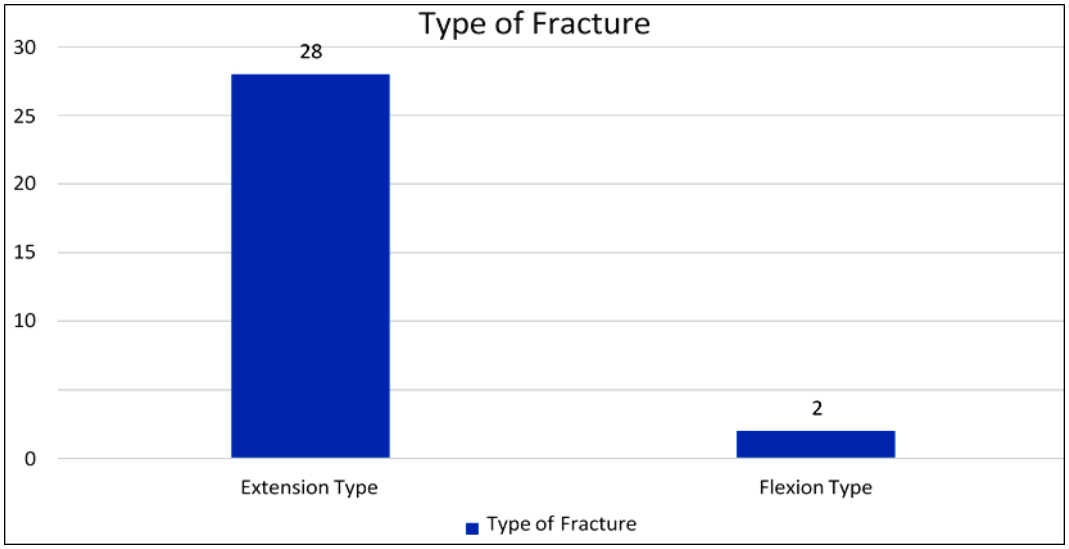


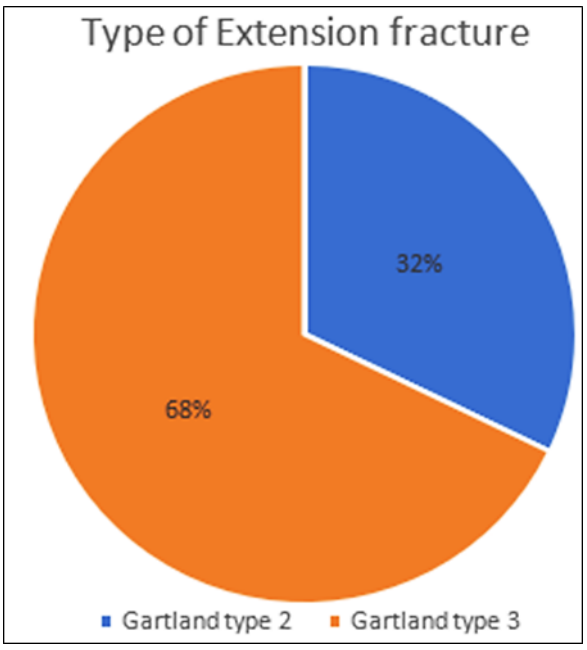
Side of Injury

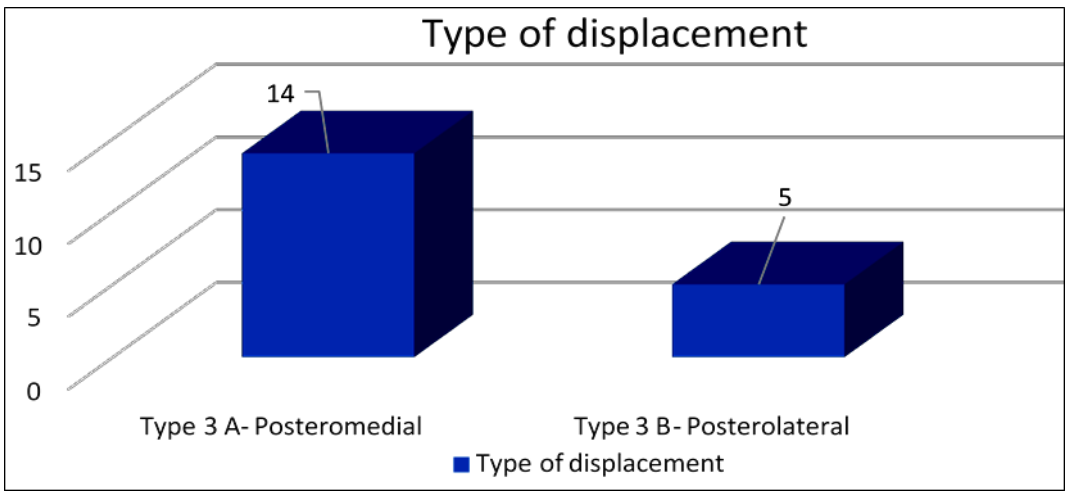


ISSN 2515-8260 Volume 09, Issue 07, 2022

Type of Fracture

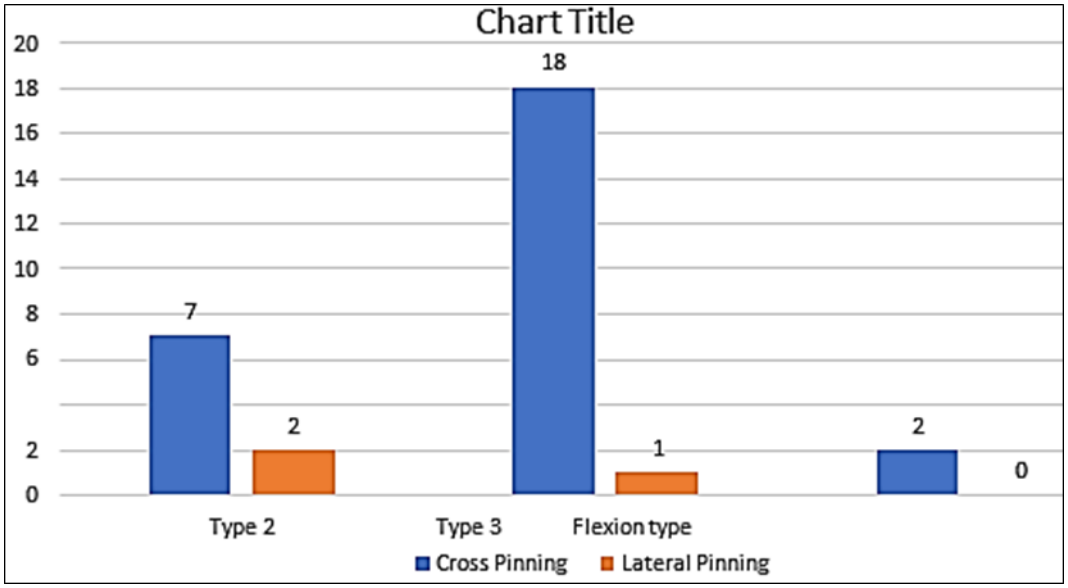






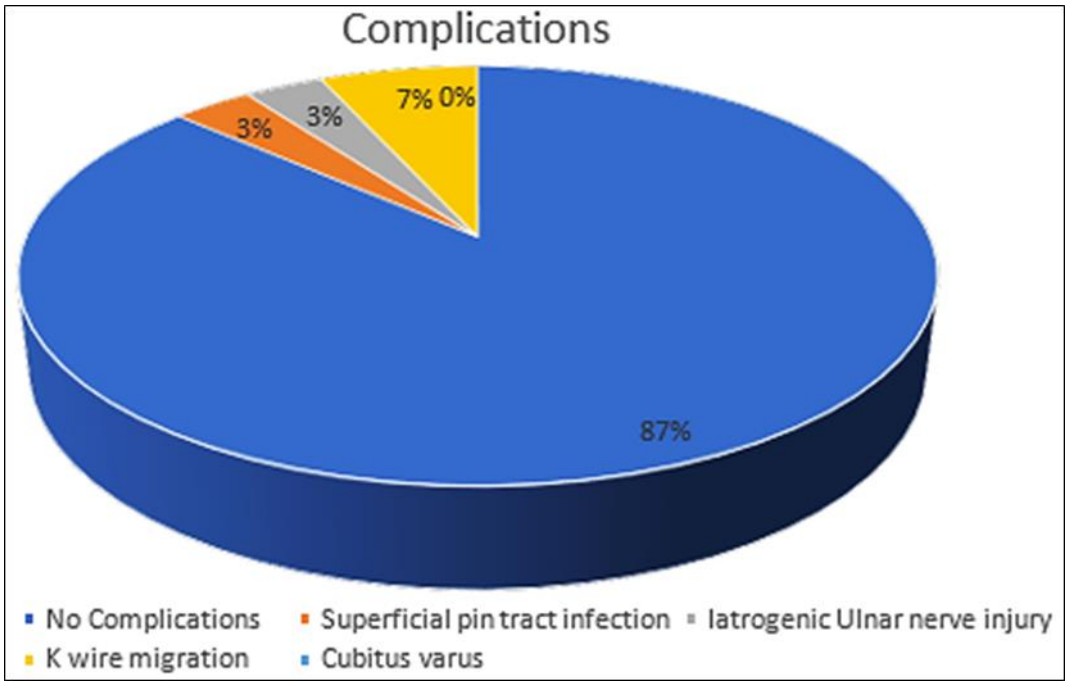
ISSN 2515-8260 Volume 09, Issue 07, 2022

Pinning method



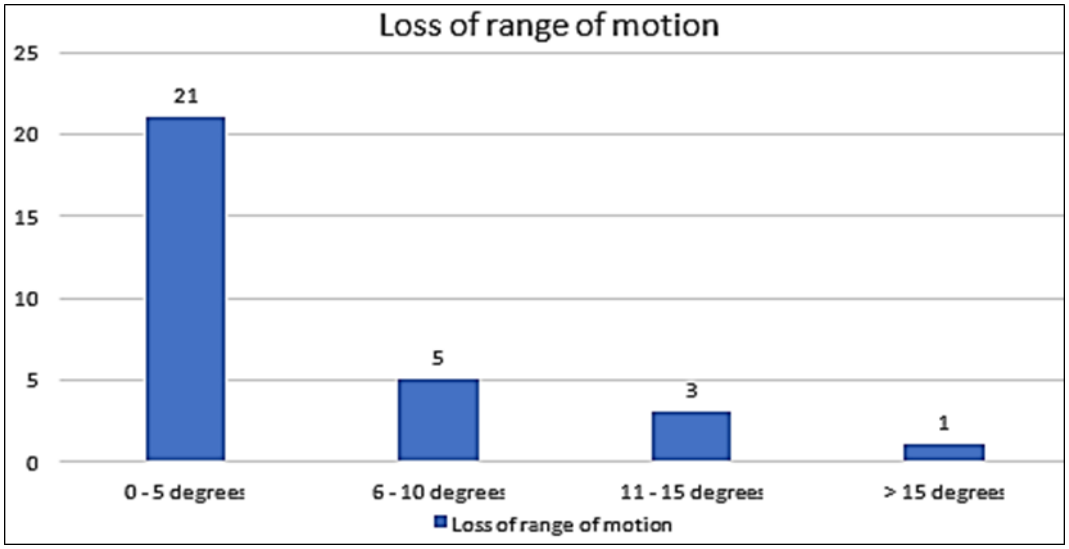
Complications

Complications	No. of patients	Percentage
Superficial pin tract infection	1	3
Iatrogenic Ulnar nerve injury	1	3
K wire migration	2	7
Cubitus varus	0	0

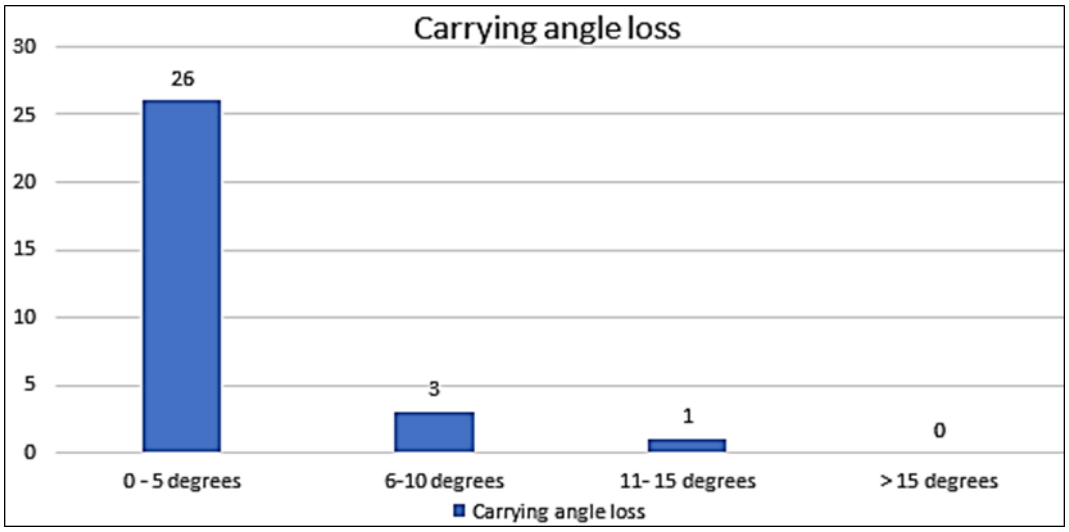


ISSN 2515-8260 Volume 09, Issue 07, 2022

Loss of range of motion



Carrying angle loss

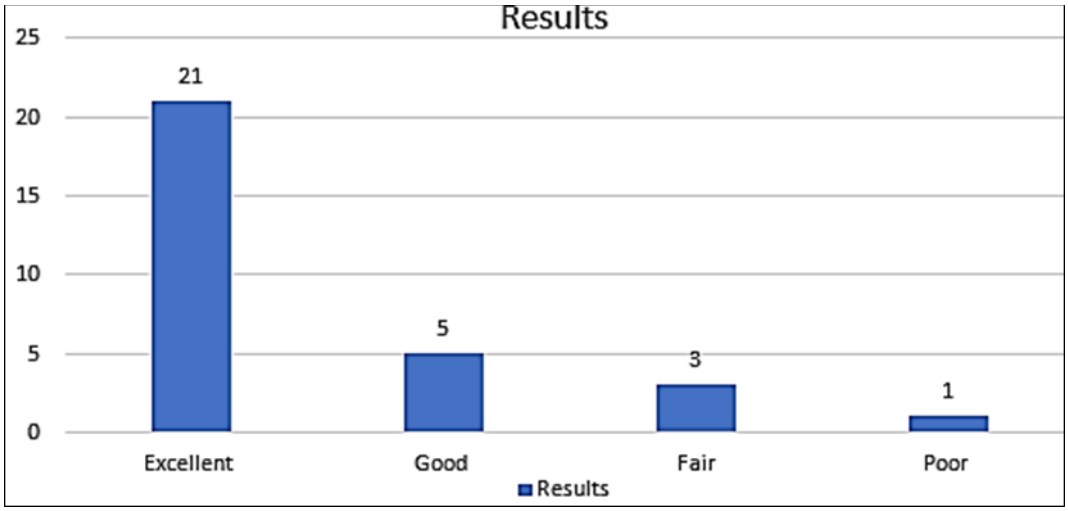


Results

Flynn's Grading system

Result	Rating	Cosmetic Factor: Carrying angle loss (in degrees)	Functional factor: Motion loss (in degrees)
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
	Fair	11-15	11-15
Unsatisfactory	Poor	>15	>15

ISSN 2515-8260 Volume 09, Issue 07, 2022



Discussion

A supracondylar fracture of the humerus is one of the most common injuries in children. The management of displaced supracondylar humerus fracture is one of the most difficult of the many fractures seen in children.

The aims of the treatment of supracondylar fractures are to achieve functionally and cosmetically satisfactory results and to avoid complications. Assuring a low cost and decreasing the hospitalization period are very important for both surgeons and patient's parents.

In this study, 30 children of Type II and Type III supracondylar fracture of humerus were treated with closed reduction and percutaneous K-wire pinning. The purpose of this study was to evaluate the efficacy of closed reduction and per cutaneous pinning and to access of carrying angle, loss of range of motion and to find out the complications encountered with this modality of treatment.

Supracondylar fractures occurred most frequently in children between 5 and l0 years of age as reported in other studies. In this Present study the average age was 8.3years, which is similar to other studies [8].

Authors	Average Age (in years)
D Ambrosia (1972) [9]	7
Fowls & Kassab (1974) [10]	7.2
Andrew J W (1978) [11]	6.6
Kurer & Regan (1990) [12]	8
Present Study	8.3

In this present study, 17 (56.6%) were male patients and 13 (43.3%) were female patients, which is same as other studies, showing a male preponderance.

Authors	Male (in %)	Female (in %)
Wilkins KE *et al.*, (1990) [13]	62.8	37.2
Pirone AM *et al.*, (1988) [6]	52	48
Aronson DD *et al.*, (1987) [14]	75	25
Present Study	56.6	43.3

In this study, 19 (63.3%) had left sided injury and 11 (36.6%) of them had right Sided injury, the non-dominant extremity is most commonly affected. The other series of study mentioned

ISSN 2515-8260 Volume 09, Issue 07, 2022

below also show a preponderance to left sided fractures.

Authors	Right (in %)	Left (in %)
Wilkins KE *et al*., (2010) [8]	60.88	39.2
Mazda K *et al*., (2001) [15]	56	44
Aronson DD *et al*., (1987) [14]	65	35
Flynn JC *et al*., (1974) [16]	66.7	33.3
Present Study	63.3	36.6

The major cause of fracture in our study was fall while playing i.e. In 25 patients (83.3%) and 5 patients had history of fall from height, which is similar to other studies.
In Edward E Palmar *et al*., [17] series of 78 patients with supracondylar fractures 69 patients sustained injury due to fall while playing. Farnsworth CL *et al*., [18] 29 (82.9%) patients had fall from height and 6 (17.1%) had fall while playing, which is similar to other studies.
In the present study, based on the Gartland's classification, 9 (32.1%) patients had Type II fracture and 19 (67.8%) of them had Type 3 fracture, comparable to other studies.

Study	Type 2	Type 3
Zamzam *et al*., (2009) [19]	37.9	62.03
Zhong *et al*., (2009) [20]	35	64.95
Present study	32.2	67.8

In the present study, 1 patient developed pin tract infection, which healed with oral antibiotic therapy. 2 patient developed k-wire back out. 1 patient had iatrogenic ulnar nerve palsy. 1 patient had complete loss of carrying angle. No cubitus varus deformity in any case.

Authors	Ulnar Nerve Palsy (%)	Pin Tract Infection (%)	Cubitus Varus (%)
Pirone *et al*., (1988) [7]	0	1	14
Kumar R *et al*., (2000) [21]	0	18.5	0
Devkota P *et al*., (2008) [22]	6.8	7.8	0
Srivastava *et al*., (2000) [23]	2	14	0
Karapinar *et al*., (2005) [24]	3.3	6.6	1.6
Present Study	3.3	1.1	0

In the present study, of the 30 cases, 21 (70%) patients had limitation of flexion b/w 0-5°, 5 (16.6%) patients b/w 6-10°, 3(10%) patient b/w 11-15° and 1 patient (3.3%) had >15o loss of flexion. The average loss of flexion was 5.5o in the present study.
The mean loss of range of motion was 7.8o in the study conducted by Nacht JL. *et al*., [25]
In the present study, at the final follow up, 26 patients (86.66%) had carrying angle loss less than 5°, 3 patients (10%) of them had loss of carrying angle b/w 6-10°, 1(3.33%) of them had loss >10°. Mean loss of carrying angle is 3^{o}.

Authors	Carrying Angle loss (in degrees)
Nacht JL *et al*., (1983) [25]	5.8
Flypp JC *et al*., (1974) [16]	6.2
Present Study	3

In the present study, the clinical and functional outcome grading was measured as per the Flynn *et al*., criteria; of the 30 cases, 29 patients (96.66%) had satisfactory results, of which 21 patients (70%) observed excellent results, 5 patients (16.6%) had good results and 3 patients (10%) had Fair results. 1 patient (3.33%) had Poor results that is Unsatisfactory as per Flynn *et al*., criteria.
The Clinical outcome is Compared between others study as given below:

Treatment	Author	Total no.	Excellent	Good	Fair	Poor
Percutaneous K wire fixation	Pirone *et al*., (1988) [6]	96	78%	16%	1%	5%
Percutaneous K wire fixation	Flynn *et al*., (1974) [16]	52	80%	14%	4%	4%
Closed Reduction and Percutaneous K wire fixation	Present study	30	70%	16.6%	10%	3.3%

The present study results are comparable with the other studies.
The clinical and functional outcome of the present study compare favourably with those of other previously reported methods of treatment of the displaced supracondylar fractures of the humerus in children. In conclusion, recent studies have showed closed reduction and percutaneous fixation using 'K' wires is the most commonly accepted treatment of displaced supracondylar fractures of the humerus in children.

Conclusion

Supracondylar fracture of humerus is one of the commonest fractures in childhood.

- Common in 6-10 years age group.
- Incidence is higher in boys.
- Left sided injury is more common than right side.
- Due to the frequent occurrence of complications a detailed neurovascular examination is a must in all cases.
- Anatomical reduction is the key to obtaining good results, which can be achieved by closed reduction and percutaneous pinning.
- It does not expose the patient to an undue risk of infection and elbow stiffness unlike open reduction and internal fixation.
- It reduces the length of hospital stay, thus reduces the cost of treatment.
- With the fracture stabilized by pins, an elbow with severe swelling can be extended beyond 90°, thus vascular compromise is avoided.
- Hence from our study, we conclude that closed reduction and percutaneous k-wire fixation under C-arm guidance is a simple, cheap and effective method of treatment of displaced supracondylar fracture (type II and type III) humerus in children with excellent functional and cosmetic results and relatively fewer complications.

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ISSN 2515-8260 Volume 09, Issue 07, 2022

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