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MANAGEMENT OF DISPLACED SUPRACONDYLAR HUMERUS FRACTURES IN CHILDREN BY CLOSED REDUCTION AND PRECUTANEOUS PINNING

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Gartland type III supracondylar humerus fracture, open reduction close reduction, internal fixation and two lateral K-wire fixation

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Abstract

INTRODUCTION: *Supracondylar fractures of the humerus are the leading cause of hospital admissions for fractures in children, particularly during the first decade of life. Managing Gartland type III fractures is complex and still debated. Various treatment approaches—including closed reduction, closed pinning, traction, and open reduction with internal fixation—are used, each carrying risks such as malalignment, nerve damage, altered carrying angle, restricted extension, and infection.*

OBJECTIVE: *To determine the functional outcome of close reduction and percutaneous pinning in displaced supracondylar humerus fracture in children.*

STUDY DESIGN: *Descriptive Cross-sectional study.*

STUDY SETTING: *Study was conducted at Department of Orthopedics, Liaquat National Hospital, Karachi.*

DURATION OF STUDY: *Six months after approval from **21-08-2024** till **21-05-2025**.*

SUBJECTS AND METHODS: *Patients were followed from August 2024, there data was collected and added in the study after approval of synopsis (Dated: 31st January 2025). Data was prospectively collected from patients after taking a verbal consent. 114 patients who met the diagnostic criteria were included. Quantitative data was presented as simple descriptive statistics giving mean and standard deviation and qualitative variables was presented as frequency and percentages. Effect modifiers were controlled through stratification. Post stratification chi square test was applied taking p-value of ≤0.05 as significant.*

RESULTS: *A total of 114 patients were included in this study. Mean age, duration of surgery and duration of injury in our study was 8.21±1.24 years, 5.51±2.99 hours and 14.8±7.44 hours. 59 (51.8%) and 55 (48.2%) were male and female. Acceptable outcome showed that out of 114 patients, 91 (79.8%) and 23 (20.2%) had and did not have acceptable outcome.*

CONCLUSION: *We conclude that these fractures need to be managed aggressively and reduction, internal fixation with percutaneous pinning is a good and safe method of treatment in displaced supracondylar fractures of humerus in children.*

INTRODUCTION

Supracondylar humerus fractures (SHFs) are the most common elbow injury in children, account for 55% to 80% of all childhood fractures [1,2]. According to Gartland staging, SHFs can be split into three categories [3], extension or flexion type, depending on the distal fragment's displacement direction. [4] Approximately 97-99% of supracondylar humerus fractures are extension-type. [5], Management of displaced supracondylar fractures of humerus have always presented a challenge, their correct management is important because they can cause catastrophic complications. [1,5]

Closed reduction and percutaneous pinning (CRPP) is the classic surgical procedure for the treatment of SHF in children [3]. According to a previous study, CRPP was used in up to 18% of postoperative fracture re-displacements. [6] A plausible reason for this could be because the pull-out resistance can be over 50% lost during intraoperative pin repositioning, which is always required even with fluoroscopic guidance. [7] Simultaneous multiple pin repositioning will increases radiation exposure as well as the potential of neurovascular injury. [8]

Muslu O et al 2023, [9] found according to the Flynn criteria, 92 patients had excellent functional results (92%), seven patients had good results (7%), and one patient had fair results (1%). Regarding cosmetic results, 91 patients had excellent results (91%), six patients had good results (6%), and three patients had fair results (3%).

Treatment of these fractures is challenging due to the complex and difficult-to-understand anatomy of the elbow. The physician's experience and knowledge are associated with positive treatment results and reduced complication rates. They should be considered because they are frequently seen and cause complications such as accompanying neurovascular injuries, the possibility of developing compartment syndrome, decreased joint range of motion, and sagittal-coronal plane deformities [9, 10]. Modern techniques for treating supracondylar humeral fractures in children have significantly reduced the rates of mal-union and compartment syndrome.

This study aims to evaluate the functional outcome of percutaneous pinning and close reduction in children with displaced supracondylar humerus fractures. The results will be valuable information for clinicians managing pediatric fracture cases.

OBJECTIVE:

To determine the functional outcome of close reduction and percutaneous pinning in displaced supracondylar humerus fracture in children.

OPERATIONAL DEFINITION

DISPLACED SUPRACONDYLAR HUMERUS FRACTURE: Type II to type IV on Gartland's classification or flexion type variety

FUNCTIONAL OUTCOME: It was determined according to the Flynn's criteria as follows. Assessed clinically by measuring angles with goniometer. Loss of carrying and motion was assessed clinically by measuring angles with goniometer.

Flynn's criteria		
Functional Outcome	Cosmetic factor carrying angle loss (degrees)	Functional factor movement loss (degrees)
Excellent	$0\text{-}5^0$	$0\text{-}5^0$
Good	$5\text{-}10^0$	$5\text{-}10^0$
Fair	$10\text{-}15^0$	$10\text{-}15^0$
Poor	$>15^0$	$>15^0$

Good and Excellent outcome was considered as acceptable outcome.

METHODS AND MATERIALS

STUDY DESIGN: Descriptive cross sectional study.

STUDY SETTING: Study was conducted at Department of Orthopedics, Liaquat National Hospital, Karachi.

DURATION OF STUDY: Six months after approval from **21-08-2024** till **21-05-2025**.

SAMPLE SIZE: Sample size calculation is based on previous study by using WHO sample size calculator. Muslu O et al 2023 [9] reported that 92% patients had excellent and 6% good results outcome. Therefore **114** children of supracondylar humerus displaced fractures will be recruited to achieve target functional outcome within 5% margin of error with confidence level 95%.

SAMPLING TECHNIQUE: Non-probability consecutive sampling.

SAMPLE SELECTION:

➢INCLUSION CRITERIA:

- Children having age range from 02-12 years.
- Either gender.
- ASA Status I and II
- Children having closed Type II, III & IV supracondylar fractures of humerus on xrays
- Patients visiting within three days of injury

➢EXCLUSION CRITERIA:

- Patients having vascular injury.
- Patients having open fracture.
- Patients having associated systematic injury.
- Patients with traumatic brain injury.

DATA COLLECTION PROCEDURE:

This study was initiated after approval of synopsis from CPSP and Hospital ethic committee. Patients were followed from August 2024, there data was collected and added in the study after approval of synopsis (Dated: 31st January 2025). Children having displaced Type II, III and type IV supracondylar fractures of humerus admitted from the Outpatient clinic or the Emergency department having underwent close reduction and percutaneous pinning for their respective fractures, as per inclusion and exclusion criteria, after taking informed consent from the patient attendants regarding inclusion in the study, All the cases included were treated by consultant surgeons with over five years of post-fellowship experience with standard surgical technique and management .

Would include patients who have underwent closed reduction percutaneous pinning for supracondylar fractures in the year 2023-24 since January to achieve sample size , all the details are pre recorded in the Hospital record system which shall be gathered , assessment of functionality was done by calling the patient for follow-up in OPD, patients included would have their assessment of functionality according to Flynn's criteria done at least 3 months post surgery along with radiographic assessment that is done routinely of supracondylar fractures post surgery. All the data was recorded on pre-designed proforma. Demographic characteristics, duration of fracture injury, acceptable range of motion was gathered in the performa.

DATA ANALYSIS PROCEDURE:

Data analysis was done on statistical software packages (SPSS 19). Demographic and clinical characteristics was summarized in terms of frequency and percentage for categorical / qualitative variables like gender, mode of injury, site and acceptable functional outcome (Only Excellent and good). Normality of continuous variables was assessed by Shapiro Wilks test. Continuous variables like age, duration of fracture and surgery was analyzed using mean and standard deviation for normally distributed data and Median and IQR was reported for Non-Normal distributed data. Stratification was done with regards to age, gender, mode of injury, site and duration of fracture to control the effect modifiers. Chi square test or Fisher exact test (if expected count <5) was applied for post stratification analysis. P-value ≤ 0.05 was taken as significant.

RESULT:

A total of 114 patients who presented with supracondylar humerus fracture at Department of Orthopedics, Liaquat National Hospital, Karachi who

met the inclusion and exclusion criteria were included in this study.

Out of 114 patients minimum age of the patient was 2 while maximum age of the patients was 12 years. Mean age in our study was 5.21 years with the standard deviation of ±1.24. Whereas, mean duration of surgery and duration of injury in our study was 5.51±2.99 hours and 14.8±7.44 hours. As shown in Table 1.

Frequency distribution of acceptable outcome showed that out of 114 patients, 91 (79.8%) and 23 (20.2%) had and did not have acceptable outcome respectively. As presented in Figure 1.

Frequency distribution of age showed that out of 114 patients, 44 (38.6%) and 70 (61.4%) were in age group 2-7 years and 8-12 years respectively. As presented in Figure 2.

Frequency distribution of gender showed that out of 114 patients, 59 (51.8%) and 55 (48.2%) were male and female respectively. As presented in Figure 3.

Frequency distribution of duration of injury showed that out of 114 patients, 55 (48.2%) and 59 (51.8%) had duration of injury for ≤ 12 hours and > 12 hours respectively. As presented in Figure 4.

Frequency distribution of duration of surgery showed that out of 114 patients, 37 (32.5%) and 77 (67.5%) had duration of surgery for ≤ 2 hours and > 2 hours respectively. As presented in Figure 5.

Frequency distribution of site showed that out of 114 patients, 51 (44.7%), 58 (50.9%) and 05 (4.4%) had injury on the right, left and both sides respectively. As presented in Figure 6.

Frequency distribution of mode of injury showed that out of 114 patients, 21 (18.4%), 52 (45.6%) and 41 (36%) had injury dur to fall from height, slip and road traffic accident respectively. As presented in Figure 7.

Stratification for age with respect to acceptable outcome showed that 37 (84.1%) and 07 (15.9%) had and did not have acceptable outcome in age group 2-7 years respectively. Whereas, 54 (77.1%), 16 (22.9%) had and did not have acceptable outcome in age group 8-12 years respectively. P-value was 0.36. As presented in Table 2.

Stratification for gender with respect to acceptable outcome showed that 46 (78%) and 13 (22%) had and did not have acceptable outcome in male group respectively. Whereas, 45 (81.8%) and 10 (18.2%) had and did not have acceptable outcome in female group respectively. P-value was 0.60. As presented in Table 3.

Stratification for duration of injury with respect to acceptable outcome showed that 44 (80%) and 11 (20%) had and did not have acceptable outcome in duration of injury ≤ 12 hours respectively. Whereas, 47 (79.7%) and 12 (20.3%) had and did not have acceptable outcome in duration of injury > 12 hours respectively. P-value was 0.96. As presented in Table 4.

Stratification for duration of surgery with respect to acceptable outcome showed that 29 (78.4%) and 08 (21.6%) had and did not have acceptable outcome in duration of surgery ≤ 2 hours respectively. Whereas, 62 (80.5%) and 15 (19.5%) had and did not have acceptable outcome in duration of surgery > 4 hours respectively. P-value was 0.79. As presented in Table 5.

Stratification for site of injury with respect to acceptable outcome showed that 34 (66.7%) and 17 (33.3%) had and did not have acceptable outcome in right sided injury respectively. Whereas, 52 (89.7%) and 06 (10.3%) had and did not have acceptable outcome in left sided injury respectively. Moreover, 05 (100%) and 00 (00%) had and did not have acceptable outcome in both sided injury respectively. P-value was 0.79. As presented in Table 6.

Stratification for mode of injury with respect to acceptable outcome showed that 15 (71.4%) and 06 (28.6%) had and did not have acceptable outcome in fall from height respectively. Whereas, 41 (78.8%) and 11 (21.2%) had and did not have acceptable outcome in slip injury respectively. Moreover, 35 (85.4%) and 06 (14.6%) had and did not have acceptable outcome in RTA injury respectively. P-value was 0.42. As presented in Table 7.

TABLE-1
DESCRIPTIVE STATISTICS
n=114

VARIABLE	MEAN ± SD	STANDARD DEVIATION	MIN-MAX
AGE (YEARS)	5.21	±1.24	2-12
DURATION OF SURGERY (HOURS)	5.51	±2.99	3-9
DURATION OF INJURY (HOURS)	14.8	±7.44	3-24

FIGURE-1
ACCEPTABLE OUTCOME n=114

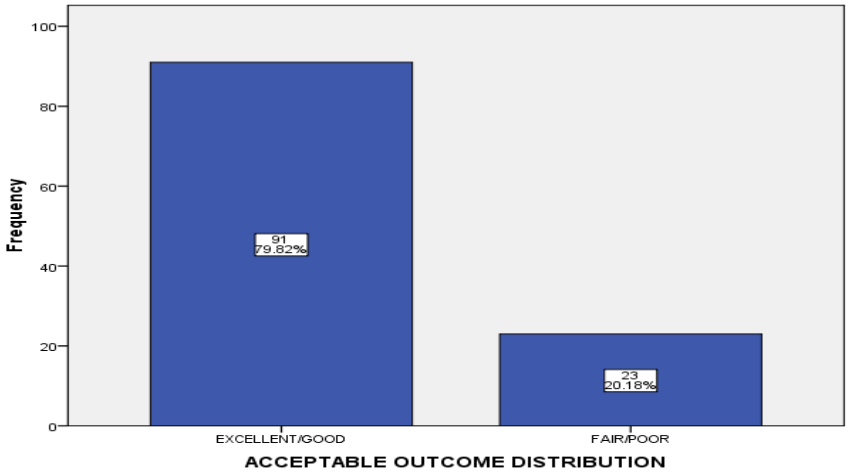

FIGURE-2
AGE DISTRIBUTION n=114

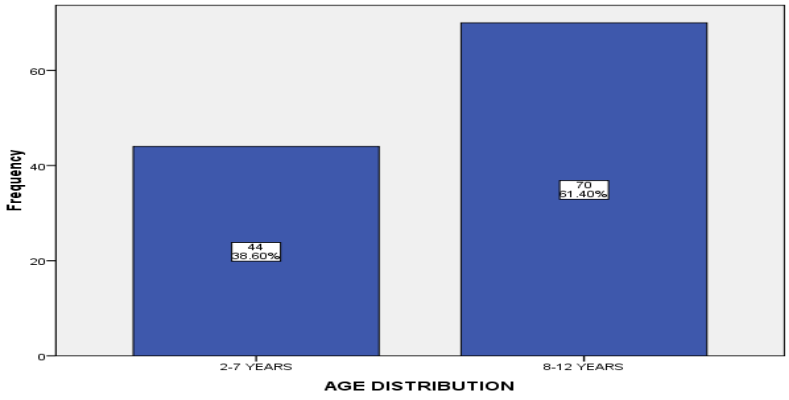

FIGURE-3
GENDER DISTRIBUTION n=114

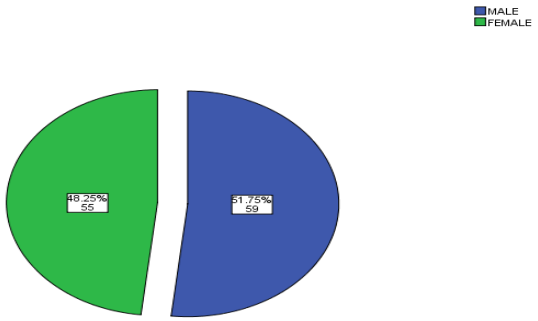

FIGURE-4
DURATION OF FRACTURE DISTRIBUTION
n=114

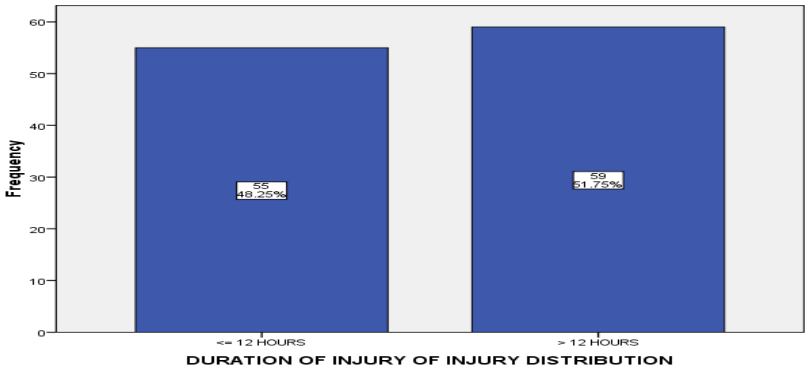

FIGURE-5
DURATION OF SURGERY DISTRIBUTION n=114

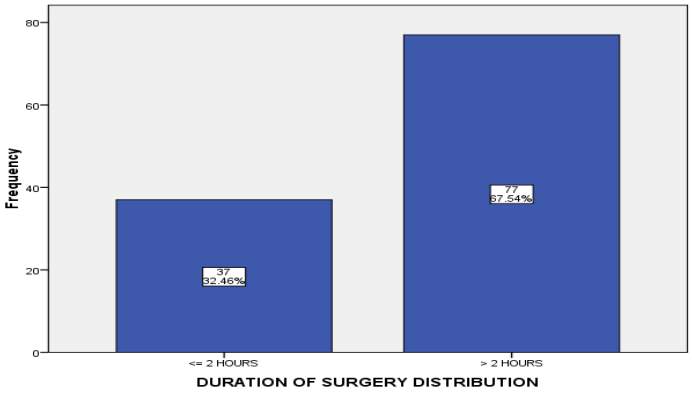

FIGURE-6
SITE DISTRIBUTION n=114

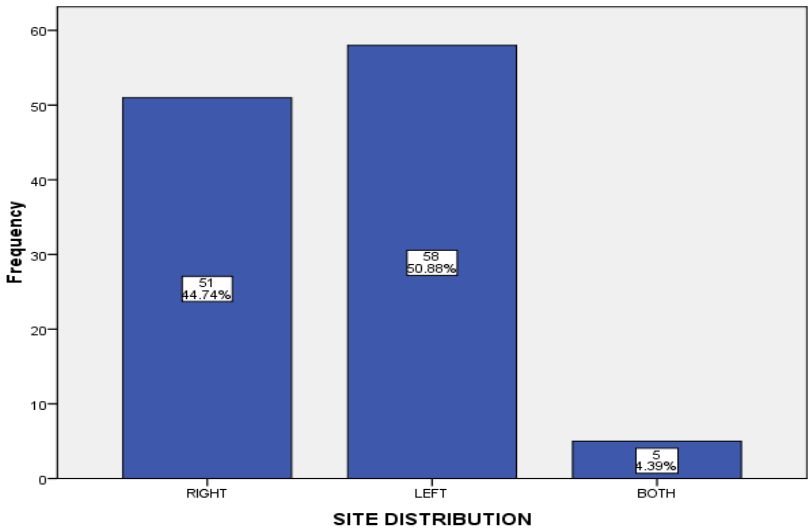

FIGURE-7
MODE OF INJURY DISTRIBUTION n=114

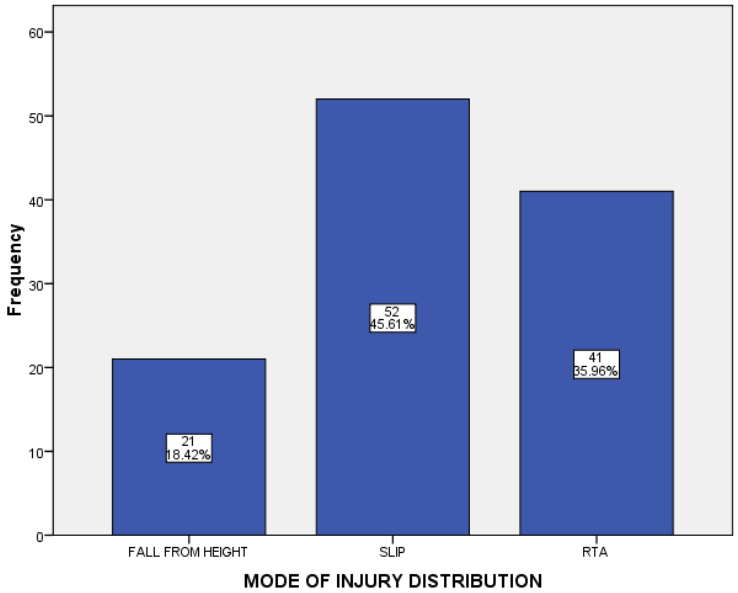

TABLE-2
ACCEPTABLE OUTCOME ACCORDING TO AGE
n=114

AGE (YEARS)	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
02-07	37 (84.1%)	07 (15.9%)	44 (100%)
08-12	54 (77.1%)	16 (22.9%)	70 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.36		

TABLE-3
ACCEPTABLE OUTCOME ACCORDING TO GENDER
n=114

GENDER	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
MALE	46 (78%)	13 (22%)	59 (100%)
FEMALE	45 (81.8%)	10 (18.2%)	55 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.60		

TABLE-4
ACCEPTABLE OUTCOME ACCORDING TO DURATION OF FRACTURE
n=114

DURATION OF FRACTURE (HOURS)	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
≤ 12	44 (80%)	11 (20%)	55 (100%)
> 12	47 (79.7%)	12 (20.3%)	59 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.96		

TABLE-5
ACCEPTABLE OUTCOME ACCORDING TO DURATION OF SURGERY
n=114

DURATION OF SURGERY (HOURS)	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
≤ 2	29 (78.4%)	08 (21.6%)	37 (100%)
> 2	62 (80.5%)	15 (19.5%)	77 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.79		

TABLE-6
ACCEPTABLE OUTCOME ACCORDING TO SITE
n=114

SITE	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
LEFT	34 (66.7%)	17 (33.3%)	51 (100%)

RIGHT	52 (89.7%)	06 (10.3%)	58 (100%)
BOTH	05 (100%)	00 (00%)	05 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.01		

TABLE-7
ACCEPTABLE OUTCOME ACCORDING TO MODE OF INJURY
n=114

MODE OF INJURY	ACCEPTABLE OUTCOME		TOTAL
	EXCELLENT/GOOD	FAIR/POOR	
FALL FROM HEIGHT	15 (71.4%)	06 (28.6%)	21 (100%)
SLIP	41 (78.8%)	11 (21.2%)	52 (100%)
RTA	35 (85.4%)	06 (14.6%)	41 (100%)
TOTAL	91 (79.8%)	23 (20.2%)	114 (100%)
P-VALUE	0.42		

DISCUSSION

Supracondylar humerus fractures are among the most common childhood injuries, accounting for approximately 60% of elbow fractures in children. The primary treatment goal is to restore both function and cosmetic appearance of the arm. There is no universally accepted approach for managing Gartland type III fractures, though closed reduction with percutaneous pinning is currently the most widely used method. Despite its popularity, this technique fails in about 15% of cases and may lead to issues like inadequate reduction or wire misplacement in 1–7% of patients. Advocates of this method highlight its lower risk of complications, such as infection and movement loss, along with shorter hospital stays. In contrast, supporters of open reduction and internal fixation emphasize the importance of achieving anatomical alignment, particularly in complex or irreducible fractures where the bone fragments lack cortical contact and the periosteum is completely disrupted, making closed reduction unfeasible.

Our study included a total of 114 patients. Mean age, duration of surgery and duration of injury in our study was 8.21±1.24 years, 5.51±2.99 hours and 14.8±7.44 hours. 59 (51.8%) and 55 (48.2%) were male and female. Acceptable outcome showed that out of 114 patients, 91 (79.8%) and 23 (20.2%) had and did not have acceptable outcome.

In one study, a total of sixty consecutive children aged between 2 and 12 years, with displaced supracondylar humerus fractures (Gartland Type II and III), were evaluated using anteroposterior and lateral radiographs. The average age of participants was 7.7 years, with the youngest being 2 years old and the oldest 12. Functional outcomes showed that 46 patients (76.7%) had excellent results, 10 (10%) had good outcomes, 3 (5%) had fair, and 1 patient (1.7%) had a poor outcome. In terms of cosmetic results, 47 patients (78.3%) achieved excellent outcomes, 9 (15%) were rated as good, 3 (5%) as fair, and 1 patient (1.7%) had a poor result.[11]

In another study, thirty patients with Gartland type III supracondylar humerus fractures were managed using the Campbell posterior approach. The group consisted of 18 males and 12 females, with an average age of 6.5 years (ranging from 2 to 13 years). Patients with vascular compromise were excluded from the study. All fractures were treated with open reduction

and stabilized using two crossed Kirschner wires. Postoperative evaluation was conducted using Flynn's criteria, focusing on deformity, range of motion, and pain. The results showed that 16 patients (53.4%) had excellent outcomes, 6 (20%) had good outcomes, 5 (16.6%) had fair results, and 3 patients (10%) experienced poor outcomes.[12]

In a separate study, the average age of participants was 7.02 ± 2.25 years. Among patients with loss of carrying angle, 72% achieved excellent outcomes and 28% had good results. The average loss in elbow flexion and extension was 8.38° ± 3.10 and 7.26° ± 3.22, respectively. In the group treated with medial-lateral crossed K-wire fixation, 72% of patients had excellent outcomes and 28% had good outcomes—findings that were comparable to those observed in the group treated with two lateral K-wires. Iatrogenic ulnar nerve injury occurred in 4% of patients in the medial-lateral crossed K-wire group, while no nerve injuries were reported in the two lateral K-wire group. However, with a p-value of 0.312, this difference was not statistically significant, indicating no meaningful difference in the risk of ulnar nerve injury between the two fixation methods.[13]

In another study involving seventy-five children with type III supracondylar humerus fractures, open reduction and internal fixation using crossed K-wires was performed following unsuccessful closed reduction. Patients were monitored every two weeks for the first two months, followed by monthly follow-ups for six months. Outcomes were evaluated using Flynn's criteria. The study included 47 male and 28 female patients, with the left arm affected in 52 cases and the right in 23. The average age was 6.7 years, ranging from 3 to 12 years. Overall, 70 patients (93.3%) achieved excellent or good results, while 5 patients (6.7%) had fair or poor outcomes.[14]

A quasi-experimental study was conducted involving children aged 5 to 12 years who presented with supracondylar humerus fractures within one week of injury. The outcomes were evaluated using Flynn's criteria. Among the 79 participants, 50 (63.3%) were boys and 29 (36.7%) were girls, with an average age of 7.36 ± 1.68 years. Functional and cosmetic results showed that 58 patients (73.4%) had excellent outcomes, 14 (17.7%) had good, 5 (6.4%) had fair, and 2 (2.5%) had poor outcomes. The findings indicated that open reduction and internal fixation provided favorable functional outcomes, making it a preferred treatment approach for these fractures.[15]

CONCLUSIONS

We conclude that these fractures need to be managed aggressively and reduction, internal fixation with percutaneous pinning is a good and safe method of treatment in displaced supracondylar fractures of humerus in children. This approach minimizes the chances of an inaccurate reduction and subsequent deformity. Chances of ulnar nerve injury are minimized as the nerve is visualized throughout the length of incision. The approach is particularly useful when per-operative imaging facilities are not available.

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