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"Functional and Radiological Outcome of Closed Reduction and Percutaneous Pinning Of Supracondylar Fracture of Humerus In Children Aged 5 To 15 Years: A Prospective Interventional Study"

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Abstract:-
Background:-*Supracondylar fractures of the humerus are common in paediatric ageand needs adequate treatment to prevent complications like cubitusvarus/ valgus, elbow stiffness, neurovascular damages, compartment syndromeand Volkmann's ischaemic contracture.This study aimed to evaluate the clinical and radiologicaloutcomes and complications following close reduction and crossed percutaneous pinningoftype II & III (modified Gartland classification) supracondylar fractures of humerus in children (5-15 years age).*
Methods:- :-*This prospective interventional study was conducted in Department of Orthopaedics at a tertiary referral hospital of western Rajasthan from June 2018 to November 2019. Study was done on 50children aged 5-15 years with supracondylar fracture of the humerus selected, who were managed byclosed reduction and percutaneous pinning (crossed).The minimum duration of follow up was 6 month. After assessing fracture union with serial radiographs, range of motion, carrying angle,final outcomes were evaluated by Modified Flynn's criteria.*
Results:-*Most of the supracondylar fractures of the humerus cases were between 5-7 years of age, According to modified Flynn criteria, most cases showed excellent results (73.33%), 13.33% cases showed good results, 8.89% cases showed fair results and 4.44% cases showed poor results. Two cases (4.4 %) had pin tract superficial infection. No other complications were recorded.*
Conclusion:-*Closed reduction and crossed percutaneous pinning under C-arm guidance is an effective management technique of type II and type III Gartland supracondylar fractures of the humerus in children.*
Key words:-*Supracondylar fracture, closed reduction, percutaneous pinning, humerus*

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I. Introduction

Supracondylar fractures of the humerus contribute 13% to 16.6% of all paediatric fractures and account for around 60-80% of all elbow injuries.Extension type is most common type of supracondylar fracture[1]. 98% of supracondylar fractures of the humerus are extension type and rest are flexion type. The modified Gartland system is most often used for classification of the supracondylar humeral fractures in children[2].

Supracondylar fracture of the humerus is common injury in children and needs adequate treatment to prevent complications like cubitusvarus or cubitus valgus, elbow stiffness, neurovascular damages and compartment syndrome[3,4]. There is no uniformity of opinion concerning the ideal method of treatment of displaced supracondylar fractures of humerus.Various methods of treatment for supracondylar fractures of humerusinclude closed reduction and immobilization with cast[5-8], skeletal traction with various methods[9-10], closed reduction with percutaneous pinning[11-12] and lastly open reduction and internal fixation by Kirschner (K) wires[13-14]. The recent most acceptable treatment option for type II & III(modified Gartland classification) supracondylar fracture of the humerus is closed reduction and percutaneous pinning. The closed reduction and crossed percutaneous pinning in supracondylar fracture of the humerus in children provide best skeletal stability with minimal soft tissue damage and loss of reduction, although there ispossible risk of iatrogenic ulnar nerve injury.

Aim:-The purpose of the study wasto evaluate the clinical and radiological outcomes and complications of type II & III (modified Gartland classification) supracondylar fracture of the humerus following close reduction and crossed percutaneous pinning in children aged 5 – 15 years

II. Materials and Methods

This prospective interventional study was conducted in Department of Orthopaedics at a tertiary referral hospital of western Rajasthan from June 2018 to November 2019. This study was conducted on 50 patientsselected consecutively who were received as a preferred method of closed reduction and percutaneous pinning for supracondylar fracture of the humerus.

Inclusion criteria:-

1. Children of either gender age 5 years to 15 years.
2. Closed fracture of supracondylar of the humerus of less than 1 week old.
3. Type II and type IIImodified Gartlandfracture of supracondylar humerus.

Exclusion criteria:-

1. Fractures with other skeletal fractures of same limb.
2. Fractures associated with vascular, neurological and compartment syndrome.

Demographic data of patients were recorded on admission and through history and clinical examination. The preoperative, operative and post operative details were obtained and recorded in predesigned semi structured Performa.Written informed consent to participate in this study was obtained from all subjects prior to inclusion in the study.The patients were instructed at discharge time and contacted by telephonefor attending a follow-up visit.In present study all fracture classified as per modified Gartland classification.Gartland classification (modified):-

- Type 1 – nondisplaced (Fat pad present)
- Type 2 – a posterior bony hinge remains intact with angulation.
- Type 3 – completely displaced with no meaningful cortical continuity but periosteum is usually intact.
- Type 4 – a displaced fracture that is unstable in both extension and flexion (a controversial category) .

Operative procedure:- With all aseptic precaution, limb was painted with povidone iodine 10% solution and draped with sterile sheets. Fracture was reduced by applying longitudinal traction, keeping elbow extended, and manipulation of displaced fracture fragment done with thumbs & fingers to correct lateral tilt, medial impaction, or posterior displacement then elbow was flexed up to 90 to 100 degrees. Reduction was checked in AP and lateral view with an image intensifier. A lateral pin was inserted across the fracture site and engaged the medial cortex. After the lateral pin insertion, the elbow is extended to 45 degrees of flexion and identified the medial epicondyle and ulnar nerve. A medial pin was inserted across the fracture site to engage the lateral cortex. After successful reduction and insertion of K-wires, all K- wires were cut outside the skin and their ends were bent. Radial pulse was checked at the end of operation. Sterile dressing was done& pop slab was applied above elbow keeping the elbow flexed at 90°-100°. All patients were discharged postoperatively.

Followup Protocol:- All patients were instructed to attend OPD at 1 week, 3-4 weeks, 6 weeks, 12 weeks and 6 months after operation.At 3 weeks POP Slab wasremoved and x-ray AP & lateral views of operated elbow were taken. If fracture United,K-wires were removed& gentle elbow mobilization exercises werestarted under supervision of Physiotherapist. The minimum duration of follow up of each case was 6 month. After assessing fracture union with serial radiographs, range of motion, carrying angle and final outcomes were evaluated by Modified Flynn's criteria[15].

50 cases were included in this study, out of which 5 cases were lost to final follow up. Therefore final follow up was done on 45 cases.

III. Results

A total of 45 patients with type II and type III Gartland supracondylar fractures of the humerus treated with closed reduction and crossed pinning, were available for assessment.The mean age of case was 7 years (Range 5years to 13 years). 29 patients were male and remaining 16 were female. 28 cases were of Left side and 17 cases were of Right side out of 45 cases. Majority of cases (82.22%) were injured due to fall on the ground and 8 cases (17.78%) were injured due to road side accident. There were 35 cases (77.78%) ofGartland type III and 10 cases (22.22%) of Gartland type II. All 45 cases (100%) were extension type of injury. Not a single case of flexion type of injury was recorded in our study.35 cases (77.78%) had posteromedially displacement. Most of cases (68.89%)were admitted within 48 hours (1-2 days) after injury in hospital and most of themwere operated same day or next day.The average hospital stay were 4.18 days (Range 1 day to 10 days).

Radiological Outcomes:-The mean time of pin duration was 3.31 weeks. The mean duration of radiological bony union was 6.38 ± 0.9 weeks (Range 6 weeks to 8 weeks).The mean loss of carrying angle (humeroulnarangle) was $5.88^0 \pm 0.8^0$.

Clinical Outcomes:-The clinical outcome grading was measured as per the Flynn et al[15]criteria for grading outcomes as shown in Table 2.Excellent results were seen in 33 cases (73.33%), Good results in 6 cases(13.33%) and Fair results in 4 cases(8.89%).Poor results were seen in only 2 cases (4.44%). The average loss of motion was (4.56^0)

According to Flynn et al criteria 43 cases (95.56%) had satisfactory results and only 2 cases (4.44%) observed Poor results (Unsatisfactory outcome).

Table 1:- Demographic characteristics of study subjects

	AGE(YEARS)	NO. OF PATIENTS	PERCENTAGE (%)
Age (in years)	5-7	31	68.89
	8-10	8	17.78
	11-13	6	13.33
	14-15	0	0.00
Gender	Male	29	64.44
	Female	16	35.56
Mode of injury	FALL IN THE GROUND	37	82.22
	ROAD SIDE ACCIDENT	8	17.78
Type of injury	EXTENSION	45	100.00
	FLEXION	0	0.00
Affected side	LEFT	28	62.22
	RIGHT	17	37.78
Type of fracture	GARTELAND TYPE II	10	22.22
	GARTELAND TYPE III	35	77.78
Displacement	POSTEROMEDIALLY	35	77.78
	POSTEROLATERALLY	10	22.22
Time from injury to surgery (days)	≤1	8	17.78
	2-4	25	55.55
	5-7	12	26.66

	DURATION (WEEKS)	NO. OF PATIENTS	PERCENTAGE (%)
Time to radiological bony union (weeks)	6	31	68.89
	7	11	24.44
	8	3	6.67
Duration of hospital stay (days)	1-2	5	11.11
	3-4	24	53.33
	5-6	11	24.44
	7-8	3	6.67
	9-10	2	4.44
Pin duration (weeks)	3	31	68.89
	4	14	31.11
	6	0	0.00

Table 2: Outcome according to Flynn's criteria

Result	Cosmetic factor			Functional factor		
	Loss of carrying angle	No of patients	Percentage	Loss of motion	No of patients	Percentage
Excellent	$0\text{-}5^0$	33	73.33	$0\text{-}5^0$	33	73.33
Good	$6\text{-}10^0$	6	13.33	$6\text{-}10^0$	6	13.33
Fair	$11\text{-}15^0$	4	8.89	$11\text{-}15^0$	4	8.89
Poor	$>15^0$	2	4.44	$>15^0$	2	4.44
Total		45	100.00		45	100.00

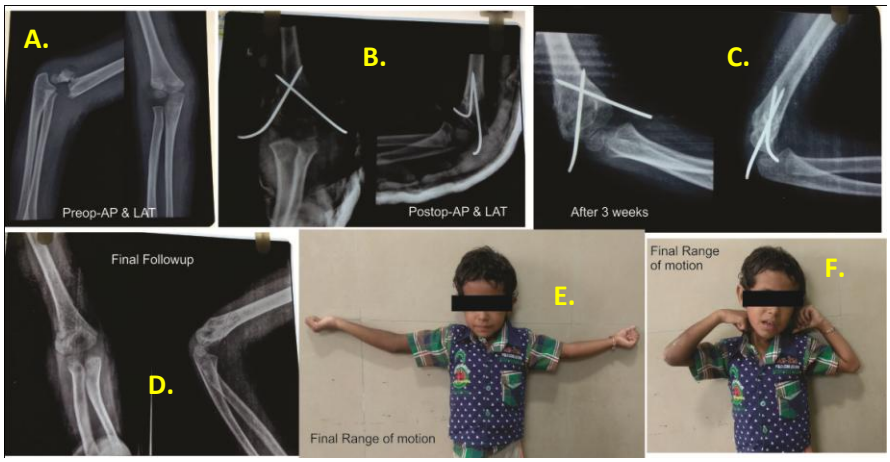

FIGURE 1 :CLINICAL PHOTOGRAPHS OF A CASE

A.Preoperative AP and Lateral view, B. Postoperative AP and Lateral view, C.After3weeks AP and Lateral view, D.After 6months, E&F.Final range of motion.

Complications:-2 cases (4.4%) had pin tract superficial infection. No case with iatrogenic nerve injury was observed in our study. No type of rotational deformity was found in this study.

IV. Discussion

Supracondylar fractures of the humerus are common in children.The treatment of supracondylar humeral fractures in children has been the subject of much discussion and dispute for many years. Although the extensive literature on this fracture describes many methods of treatment, both conservative and operative.The success key in the treatment of displaced Gartland paediatric supracondylar fracture of the humerus is to adequately achieve an acceptable stable reduction safely and maintain it until the fracture is healed.The closed reduction and percutaneous pinning in supracondylar fracture of humerus in children provide adequate skeletal stability with minimal soft tissue damage and loss of reduction. Recently, this is preferable method to manage the supracondylar fracture of the humerus in children.A percutaneous pinning (crossed design) is more stable than lateral pinning alone as reported in the biomechanical studies[16,17]. In present study, duration of radiological union in majority of cases (68.89%) was 6 weeks. The mean duration of radiological bony union was 6.38 weeks, which is similar to other workers, Yadagiri SR et al (2015)[18](6 weeks); Kiran et al(2015)[19](5 weeks); Musa M et al (2009)[20](6 weeks);Biradar RK et al (2016)[21](6 weeks), . In present study, in majority of cases (73.33%), loss of motion (flexion/extension) was $0^0\text{-}5^0$. The average loss of motion was 4.56^0,which is similar to other studies, MajGenV P et al (2016)[22](66.7%); Kiran et al(2015)[19](79.54%);Khurram B. et al (2005)[23](69.76%); Govindasamy R et al (2016)[24](78%),Shiva Naik R. et al (2016)[25](74.29%) .In present study, in majority of (73.33%), loss of carrying angle was $1^0\text{-}5^0$. Mean loss of carrying angle was 5.88^0, which is similar to other studies, Khurram B. et al (2005)[23](79.06%); Kiran et al(2015)[19](84.09%); Shiva Naik R. et al (2016)[25](82.9%).According to Flynn et al[15] criteria 43 cases (95.56%) had satisfactory results and 2 cases (4.44%) observed Poor results that is Unsatisfactory results, which is quite comparable to other workers, Roshan SD et al(2016)[26](100%); Pirone et al (1998)[27](94.79%); Flynn et al (1974)[15](98.04%); Shiva Naik R. et al(2016)[25](88.57%). In present study, 2 cases (4.4 %) out of 45 cases had pin tract superficial infection, which is similar toBiradar RK et al (2016)[21](3.5%). No iatrogenic ulnar nrerveinjuey was observed and no other rotational deformities were recorded in present study, which is quite comparable to Shim et al study[28].

V. Conclusion

Closed reduction and percutaneous pinning(crossed) for the treatment of type II & type III (modified Gartland classification) supracondylar fracture of the humerus in children is functionally and cosmetically acceptable. This method is efficient, safe and cost effective method with low rate of complications. It provides stable fixation to achieve good functional & cosmetically acceptable outcomes with minimal complications and a possibility of iatrogenic ulnar nerve damage postoperatively.

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