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Original Research Article

Outcome of treatment of gartland type lll supracondylar humerus fractures in children by closed reduction and percutaneous pinning vs. open reduction and internal fixation by K-wires

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ABSTRACT

Background: Extension fractures are more common than flexion fractures, and were classified into three subgroups by Gartland: type I, with no displacement; type II, with moderate displacement and intact posterior cortex and type III, with complete displacement. According to many authors, the ideal treatment for type 3 supracondylar humerus fractures is closed reduction and percutaneous pinning.
Methods: This study was conducted in the department of orthopaedics, Rajendra institute of medical sciences, Ranchi during the period from December 2020 to December 2022. Both male and female patients were included in the study. Implant used are K wires of various diameter ranging from 1.5 to 2 mm.
Results: The results with CRPCP are better than ORIF method as far as range of motion of elbow is concerned. Baumann angle were also comparable in both the groups.
Conclusions: In our study, in the ORIF group, the ROM of the elbow treated improved with time. There was improvement in the range of motion at the 6-months follow-up as compared to the 3-months follow-up.

Keywords: Gartland classification, Supracondylar, Baumann angle, Flynn's criteria

INTRODUCTION

Supracondylar humerus fractures are most common fracture around elbow in children.[1] Incidence is more in patients less than 10 years and decreases as the age advances.[2-4] These fractures comprise 55% to 75% of elbow fractures and approximately 3% of all fractures in children.[1,5] It was mostly seen in boys.[6] The aim of treatment of supracondylar fracture of humerus in children is to achieve normal range of motion (ROM) of elbow along with cosmetic acceptance of upper limb.[7,8] Late presentation is defined as roughly more than 2 days after injury.[9] Extension fractures are more common than flexion fractures, and were classified into three subgroups by Gartland : type I, with no displacement; type II, with moderate displacement and intact posterior cortex and type III, with complete displacement.[7,10] Extension type is caused by fall on the outstretched hand with elbow joint in hyperextension, thus pushing the distal fragment posteriorly.[11] The results of some studies have suggested that closed reduction with two lateral pins was an effective method associated with avoidance of iatrogenic ulnar nerve injuries.[12-14] However, biomechanical studies have definitively demonstrated that the cross-pin configuration is more stable than the two lateral pin configuration.[14-16] The results of a study by Zionts et al indicated that the most stable K-wire composition was a cross-pin configuration with two K-wires used at medial and lateral locations.[15]

Gartland type 3 and some displaced type 2 needs operative management.

According to many authors, the ideal treatment for type 3 supracondylar humerus fractures is closed reduction and percutaneous pinning.[3,17,18] Traditionally, open reduction had been reserved for cases in which closed reduction failed, displacement recurred or vascular complications occurred during the closed attempt[19]. Additionally, sometimes displaced fractures cannot be reduced using the closed method. Brachialis muscle entrapment at the fracture site, for example, is the most common cause of blocked reduction, as the distal spike of the proximal fragment is driven through the substance of the muscle.[20-22] In supracondylar humerus fractures, open surgical intervention can be achieved via anterior, posterior, medial, lateral or postero-medial approaches.[3,7,8,11,22-26] The posterior approach provides effective surgical access by exposing both cortices directly, although it is thought that the posterior approach can cause loss of joint movement.[23-25] Proponents of the anterior approach states that it provided for excellent exposure of the fracture site and had the advantage of not adding surgical injury to the posterior structure.[20,24] Some authors prefer to let the fracture malunite and later on perform a corrective osteotomy to avoid myositis ossificans and stiffness.[27] Theoretically, the fracture should be left alone until solid union occurs and the patient regains full range of motion of the elbow to full extension, and then corrective osteotomy is planned.[28]

METHODS

This study was conducted in the department of orthopaedics, Rajendra institute of medical sciences, Ranchi during the period from December 2020 to December 2022. Both male and female patients were included in the study. This is a prospective study with follow-up at 2, 4, 8, 12, and 24 weeks and finally at 1 year. Average follow-up was 1 year.

Inclusion criteria

Inclusion criteria for current study were; closed Gartland type 3 fractures, both extension and flexion type and age 4-16 years.

Exclusion criteria

Inclusion criteria for current study were; age >16 years, Gartland type I-II fractures, metabolic bone disease, ipsilateral upper extremity fracture, compound fractures, nerve or vessel injuries, fractures with intercondylar extension and patients with compartment syndrome.

Implants

K wires of various diameter ranging from 1.5 to 2 mm. All the patients were initially assessed in the emergency of RIMS, Ranchi. They were given first aid in the form of analgesia, splint immobilization, and other resuscitation measures. Examinations of the neurological and vascular status of the limb was done. Anteroposterior and lateral radiographs of the elbow were done and the Baumann angle was measured.

Preoperative advice

Every patient was evaluated for swelling and bruising at the fracture site and visible deformity of the elbow. Closed reduction was attempted under IV sedation to prevent neurovascular compromise due to existing deformity and to convert a severely displaced fracture to a lesser displaced or a reduced configuration. A posterior above elbow slab was applied. Check X-rays done to assess reduction. Neuro vascular examination of the involved limb was done. In Gartland type 1 and undisplaced type 2 fractures conservative management with above elbow cast is done. In displaced supracondylar fractures of humerus in children operative treatment is suitable.

Operative technique

22 cases were operated by closed reduction and percutaneous pinning method (group 1) under short general anaesthesia and the other 18 by ORIF and pinning method (group 2) under general anaesthesia with intubation. Group 1: Supine position, no tourniquet was applied, under c-arm in supine position, closed reduction was done and elbow hyperflexed with forearm pronated to maintain reduction. Fracture was fixed with either 2 k wires one from each condyle with an angle of 30 to 40 degrees with humeral shaft and 10 degree posteriorly or with 2 k wires from lateral condyle. Position of k wires confirmed by c arm and remaining portion of k wire was cut and bent to avoid migration. Antiseptic dressing with posterior plaster splint given in 90 degree flexion. Group 2: Lateral position. Tourniquet was used in all patients. At the elbow region, a skin excision was made beginning from 5 cm proximal and extending to 1–2 cm distal to the olecranon via a posterior approach. The distal humerus was exposed through the medial and lateral aspects of the triceps muscle. Also Open reduction using a posterior approach with midline triceps split can be performed. Then, the fracture fragments were anatomically reduced with crossed K-wires and checked under c-arm for reduction and stability. In some patients, more than one K-wire was inserted laterally for better stability. In some cases it was tried to bury K-wires under the skin as this reduces the chance of infection[29] and these buried K-wires were removed at 12 weeks after the fracture consolidated. Skin sutures were removed on post-surgical day 12. Most patients were managed with one lateral and one medial K wire through respective epicondyles. After 3 weeks of immobilization active range of motion was started. K wires and plaster were removed in the outpatient (OPD) clinic by four weeks when radiological union was confirmed. Elbow Range of motion exercises were started after removing the POP slab. At 12 weeks, the range of motion and carrying angle were measured with a goniometer and graded according to Flynn's criteria.[30,31]

Statistical analysis

Excel software and Microsoft words was used to analyse the data. Percentage was calculated for qualitative data.

RESULTS

In our study maximum number of patients 16 (40%) belong to age group 8-10 years follwed by 4-7 years group (25%) followed by 17.5% each in 11-13 years and 14-16 years group.

Table 1: Age wise distribution of patients.

Age (years)	N	%
4-7	10	25
8-10	16	40
11-13	7	17.5
14-16	7	17.5
Total	40	100

Table 2: Distribution of patients according to mode of injury.

Mode of injury	N	%
Fall from bicycle	7	17.5
Fall from Tree	5	12.5
Fall during playing	20	50
Road traffic accidents	8	20
Total	40	100

Table 3: Distribution of patients according to post operative complications.

Post operative complications	Closed reduction group	Open reduction group
Pin track infection	1	2
K-wire displacement	1	0
Ulnar nerve injury	1	0
Mal union	1	0

Total 50% patients were admitted following trauma due to fall while playing, road traffic accidents being second culprit (20%), followed by fall from bicycle (17.5%). Follow up was done at 2nd week, 4th week, 8th week and 12th week. Signs of union was seen by 8th week. Post op carrying angle was normal at each follow up and there was no loss of reduction. ROM was started by 4th week and was measured at 12th week. Outcome according to Flynn's criteria was evaluated after 12th week. Outcome according to Flynn's criteria was excellent in 20 cases of CRPCP group and 15 cases of ORIF with K-wire group and good in 2 cases of CRPCP group and 2 cases of ORIF with K-wire group and fair in 1 case of ORIF with K-wire group.

Figure 1: Pre op X-ray of supracondylar fracture of case 1. Gartland type 3.

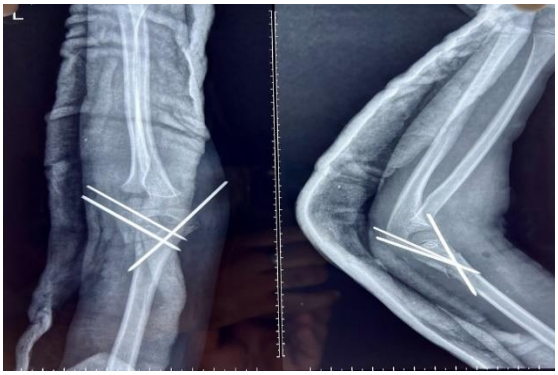

Figure 2: Post-op x-ray of case 1 . K- wires should have been bent otherwise fixation is good.

Figure 3: Pre op X-ray of case -2 gartland type 3 fracture.

In our study functional range of motion was found to be better in patients treated by CRPCP compared to ORIF group as seen in table 7 and 8. Pin track infection was seen in 1 case of CRPCP group while in 2 cases of ORIF group. 1 case was suffering from ulnar nerve injury and 1 case of malunion was noted in CRPCP group. 1 case of K-wire displacement was also noted in CRPCP group. Pre-op and post-op Baumann angle was comparable in both groups, ROM was better in CRPCP group, there was more loss of ROM in ORIF group. Time of union was also more in ORIF group.

Table 4: Flynn's criteria.

Flynn's criteria			
Result	**Rating**	**Cosmetic factor (carrying angle loss) (degrees)**	**Functional factor (motion loss) (degrees)**
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
Unsatisfactory	Fair	10-15	10-15
	Poor	Over 15	Over 15

Table 5: Assessments at follow-up.

Variables	Follow up			
	2nd week	**4th week**	**8th week**	**12th week**
Union	No	No	Yes	Yes
Loss of reduction (Baumann's angle and AHL)	No	No	No	No
Carrying angle	Normal	Normal	Normal	Normal
ROM	NA	Started	Continued	Measured
Flynn's criteria	NA	NA	NA	Evaluated

Table 6: Outcomes according to Flynn's criteria in both groups.

Groups	Excellent	Good	Fair	Poor
CRPCP	20	2	0	0
ORIF & K-wire	15	2	1	0

Table 7: Functional range of motion in CRPCP group.

Number of patients in CRPCP group	Flexion (Degrees)	Extension (Degrees)	Arc of Motion (Degrees)
2	125	30 Lag	95
3	130	15 Lag	115
4	130	0	130
4	140	15 Lag	125
5	145	05	140
4	130	15 Lag	115

Table 8: Functional range of motion in ORIF with K-wire group.

Number of patients in ORIF + K-wire group	Flexion (Degrees)	Extension (Degrees)	Extension (Degrees)
3	145	5 Lag	140
3	130	40 Lag	90
3	105	20 Lag	85
4	130	5 Lag	125
5	125	35	90

Table 9: Outcome of study.

Variables	CRPCP	ORIF + K-wire
Pre-op. Baumann angle (degrees)	(6-9)	(6-9)
Post-op. Baumann angle (degrees)	(10-16)	(10-16)
Carrying angle at end of study (degrees)	(6-9)	(6-10)
ROM at end of study (degrees)	(130-145)	(120-145)
Loss of ROM (degrees)	(0-10)	(0-15)
Time of union (weeks)	5-7	6-8

Figure 4: Post op X-ray of case 2; cross k- wire fixation (2 lateral and 1 medial k-wires).

DISCUSSION

Our study included 40 cases of displaced supracondylar fractures of humerus in children which were divided in 2 groups-one treated with closed reduction and percutaneous pinning under c arm and other by open reduction and internal fixation with K- wire. Operation time in CRPCP group was 15 to 30 min and in ORIF with K-wire group was 45-70 min and the hospitalisation time was 1-2 days in CRPCP group and 1-2 weeks in ORIF group. The results with CRPCP are better than ORIF method as far as range of motion of elbow is concerned. Baumann angle were also comparable in both the groups. In Edward et al series 69 out of 78 patients sustained injury by fall and Fransworth reported 70% injury by fall.[32-35] Pin tract infection with pin loosening occurred in 3 cases which is comparable to Mostafavi study.[16] Pin tract infection necessitated earlier removal of K-wires (at 2 weeks). Infection was treated with antibiotics and regular dressing. According to Cramer et al., percentage of pin track infection was 6% in group A and 7% in group B.[36] We had one ulnar nerve injury, it was probably due to overstretching of nerve while putting K wire, but patient recovered in 6 months. The displaced fragment can damage nearby structures leading to artery transection, thrombosis, or reduced arterial flow causing Volkmann's ischemic contracture.[37] We found that more time for union was required in group managed with open reduction than in those managed with closed reduction and percutaneous pinning. Early union achieved with CRPCP than with ORIF was due to preservation of fracture hematoma and conservation of soft tissue attachment of bone. According to Flynn's criteria, 22 patients of CRPCP group and 17 patients of ORIF group had satisfactory results and 1 case of ORIF had unsatisfactory result. The most common complication of supracondylar fractures of the humerus is malunion leading to cubitus varus deformity.[12] This deformity does not improve with remodelling.[9] In our study no patient had this deformity. In our study, in the ORIF group, the ROM of the the elbow treated improved with time. There was improvement in the range of motion at the 6-months follow-up as compared to the 3-months follow-up. The initial decrease in ROM may be due to the posterior approach, which gives appropriate exposure but causes scarring of posterior soft tissue and increased elbow stiffness.[34] Kazımoğlu et al reported that outcomes of closed reductions had no superiority over open reductions in their study, which compared closed surgery and open reduction via the lateral approach in Gartland extension type III supracondylar fractures.[35] Ozkoc et al found that the cosmetic outcome did not differ between both groups and we got similar results in our study.[8]

Kumar et al treated 44 patients with open reduction and pinning and found that 95% had a satisfactory outcome.[38] Cramer et al found that open reduction itself does not appear to cause stiffness and decrease strength.[39] Ababneh et al concluded that the best results were achieved by closed reduction and pinning as judged by the highest incidence of excellent results and the lowest incidence of poor results.[40] Aktekin et al found that patients treated with closed reduction and pinning had better function and a greater range of movement of the elbow.[41] Pirone et al suggested that open reduction increased the risk of stiffness.[42,43] We have to take into account that these worse results are because open reduction in those studies was performed after a closed reduction attempt, meaning that the open reduction group was made up of patients with a more difficult pattern of fractures. Same thing happened in our study and similar results came.

Limitations

Study consisted of small numbers of participants. Larger sample size would amplify the results and clearly demarcate the superiority between the two approaches. No control group was taken into consideration. Short follow-up was also one of the limitations. Another limitation is the inclusion of different approaches in the open reduction group.

CONCLUSION

Treatment of choice for displaced supracondylar fracture humerus in children is closed reduction and percutaneous pinning except in conditions where open reduction is required. These are-failed attempts at closed reduction, open fracture, neurovascular compromise, late presented fractures, centers with no C arm facility. Complications with CRPCP with K-wire fixation are neurovascular injury, skin problems, compartment syndrome, and cubitus varus. Advantages of closed reduction and percutaneous pinning are-easy to obtain reduction under C-arm, less surgical trauma to tissues, less hospital stay, less need of IV antibiotics, less post operative stiffness, no ugly scar mark, cost effective. In conclusion, good reductions were obtained using the open reduction technique via a posterior approach without transection of the triceps muscle. However, the incision scar formation after open surgery remains problematic from a cosmetic point of view. We recommend starting with a closed reduction technique unless some special circumstances are present; if an

anatomical reduction cannot be obtained after one or two closed attempts, an open reduction should be performed because repetitive manipulations could result in joint stiffness and transient neuropraxia.

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