Outcomes After Close Reduction and Percutaneous Pinning of Gartland Type III & IV Supracondylar Distal Humerus Fracture in Children

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Abstract

Objective: To assess the outcome and complications after close reduction and fixation with k wires of Gartland type III & IV supracondylar fracture of Humerus in children.

Method: This prospective study was done using a non-probability purposive sampling technique between November 2009 to October 2020. 200 children, age between 01 -10 year Gartland III & IV supracondylar fracture of distal humerus presented within 48-hour of the injury were included, and children with neurovascular injury, refracture, skeletal dysplasia, open fractures, and trauma presenting after 2 days were excluded. Maximum three Close attempts were made to reduce the fracture and K-wires were used to fix the supracondylar fracture. Flynn criteria, ROM, Ulno-humeral angle, carrying angle, and Bouman angle were assessed at each follow-up visit. Bone union by hammer et al and complication were evaluated.

Results: There were 133 (66.5%) were boys, and 67 (33.5%) were girls. The mean age of the children was 5.2 ± 3.1years having right side dominance 122 (61%). Gartland type-III fracture was 115 (57.5%), and type IV was 85 (42.5%). Only 03 (1.5%) had transient ulnar nerve palsy while there was no vascular injury. Superficial infection at the pin site was observed in 10 (5%) children and one (0.5%) case of pin migration. Cubitus varus deformity was observed in 03 (1.5%). Although, the operative site has decreased ROM by Baumann angle, and carrying angle, results were excellent (61%) to good (39%) according to Flynn's Criteria.

Conclusion: Closed reduction and pin fixation in Gartland type III & IV supracondylar fractures in children is the preferred option with early pin removal and physiotherapy.

Keywords: Gartland type III & IV, Supracondylar Fracture, Humerus Fracture, Percutaneous Pinning.

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Introduction

Supracondylar distal humerus fractures represent the most common upper limb skeletal injuries in children. The current treatment of choice is closed reduction and percutaneous pin fixation.[1] Displaced supracondylar fractures of the humerus are common pediatric injuries treated by orthopedic surgeons that have a high rate of complications if not reduced and fixed in the optimal position, e.g., neurovascular injuries and residual deformities. Amongst various methods for treating these fractures, closed reduction and percutaneous Pinning have shown satisfactory results.[2] Supracondylar humerus fractures are first classified as either flexion or extension injuries. A flexion supracondylar humerus fracture is called when the distal fracture is either flexed or displaced anteriorly to the proximal shaft of the humerus. More common fractures are the extension-type supracondylar

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humerus fractures in which the distal segment is extended or displaced posteriorly to the proximal shaft of humerus, and these extension type fractures are further classified as follows.[3] Type I fractures are nondisplaced or minimally displaced, Type II fracture is a displaced fragment with an intact posterior cortex, Type III injury is a completely displaced fragment, and Type IV injury in which distal fragment is unstable in both flexion and extension due to the loss of the periosteal attachment with instability in flexion and extension. Previously, open reduction is preferred for type III & IV fractures. complications including neurovascular injury and cubitus varus are mostly associated with type III &IV.[4] After Treating displaced fracture, complications are compartment syndrome leading to Volkmann's ischemic contracture, nerve injury, arterial injury, myositis ossificans, and cubitus varus deformity. Cubitus varus deformity develops after an inadequate reduction of the internally rotated and medial displaced distal segment. Fracture is irreducible after multiple attempts, maybe because of entrapment of soft tissue inside the fracture, e.g., brachialis muscle, joint capsule, and neurovascular bundle. Intraoperative stability criteria depend upon assessing the following: anterior humeral line, Baumann's angle ulnohumeral angle, radiocapitate line, and rotatory movements under image intensifier while keeping an eye on avoiding posterior fat pad sign and fishtail sign.

A scant data is published regarding closed management of Gartland type IV supracondylar fractures. In this study, we will focus on the effectiveness of close reduction and pin fixation in displaced SCH fracture of type III & IV and complications associated with close reduction and pinning e.g pain, restricted ROM, pin site infections, nerve palsy, vascular compromise, and any rotational mal-alignment.[5]

Material and Method

This prospective study was done using a non-probability purposive sampling technique at the Orthopedic Surgery department, King Edward medical university, Mayo hospital, Lahore between November 2009 to October 2020. 200 children, age between 01 -10-year supracondylar Gartland III & IV fracture presented within 48-hour of the injury were included, and children with neurovascular injury, refracture, skeletal dysplasia, open fractures, and trauma presenting after 48 hours were excluded. Ethical approval was obtained from the university, institutional review board. Informed written consent was taken from the parents of the children. All children were treated using close reduction (preferably percutaneous fixation (CRIF) with cross-K-wires with a back-slab above elbow for three weeks. We documented fracture type, compartment syndrome, neurovascular injury, superficial & deep infection, pin migration, Cubitus varus deformity, malalignment, union, and functional outcome were noted. Postoperative children were assessed at immediate, three weeks, six weeks, three months, six months, nine months, and one year. The back slab was removed at three weeks, and physiotherapy was started. Complications including Compartment syndrome, nerve injury, superficial & deep infection, pin migration, Cubitus varus deformity, malalignment was assessed clinically. Bauman angle and Ulno-humeral angle were drawn on a postoperative radiograph at the final visit. Functional outcome and union were assessed using Flynn criteria and Hammer et al. criteria, respectively. K-wires were removed after six weeks. Patients who had postoperative nerve palsy sensory/motor were followed, and an NCS study was done at three months. Data was entered and analyzed using SPSS version 21.0. Quantitative variables like ages, carrying angle was presented as mean ± standard deviation. Qualitative variables like gender, compartment syndrome, nerve injury, pin migration, superficial and deep infection as frequencies and percentages. Chi-square test was applied for the gender and type of the fracture with the union, and a p-value less than <0.05 was taken significantly. All procedures were done in general anesthesia in the supine position. Initially, traction was applied, and then fracture is reduced under the fluoroscopic image. Close reduction internal fixation with 2-3 K-wires has been performed either cross based fixation. 1cm incision was given on the medial epicondyle of the humerus to save the ulnar nerve. A maximum of three reduction attempts were made to reduce the fracture closely. Anterior humeral line, the ulno-humeral angle, was used as a criterion for fracture reduction. Postoperatively, backslap was applied in 70-90 degrees depending upon swelling and vascular status. Postoperative radiographs are used to confirm fracture reduction.

Results

Out of the total 200 children, there were 133 (66.5%) were boys, and 67 (33.5%) were girls. The mean age of the child was 5.2 ± 3.1year. The fractured elbow was the right in 122 (61%) and left in 78 (39%). Gartland type-III fracture was 115 (57.5%), and type IV was 85

(42.5%). The was no case of postoperative compartment syndrome. Only 03(1.5%) had ulnar nerve injury while there was no vascular injury. Three children presented with paresthesia along with the little finger and decrease the power of the little finger. He was observed and closely monitored at 4 months; all of the patients exhibited marked improvements. Superficial infection was observed in 10 (5%) children. There one (0.5%) case of pin migration. Cubitus varus deformity was observed in 03 (1.5%) children of 9.1 degrees while there was no case of mal-rotation.

According to Flynn's criteria, all patients were in excellent and good scores except four non-compliant patients with poor follow-up and physiotherapy. They had an upper limb in flexed attitude due to decrease arc of motion (Table 2). The mean difference between the Baumann angle and the ulno-humeral angle was 8±2 degrees between the operated and healthy sides. The operative site had a decreased range of motion, and a decreased carrying angle was observed (Table 3). As compared to the normal site operated site has a decreased range of motion of 19.5 degrees (p-value 0.02).

Table 1: *Demographic data of supracondylar fracture type III &IV*

Variables	Frequency (200)	Percentage	P-Value
Age in years (Mean)	5.2 ± 3.1		0.04
Gender			0.05
Male	133	66.5	
Female	67	33.5	
Affected side			0.03
Right	122	61	
Left	78	39	
The duration between injury & surgery in days	0.5 ±1.3	-	0.03
Follow-up duration (Mean)	6months	-	0.04
Gartland type			
III	115	57.5	0.03
IV	85	42.5	

Table 2: *Flynn's Criteria for supracondylar fracture of pediatric patients*

Results	Rating	Cosmetic Factor (Loss of Carrying angle in degrees)	Functional Factor (Loss of Motion in degrees)
Satisfactory	Excellent	0-5 (61%)	0-5 (65%)
	Good	6-10 (39%)	6-10 (33%)
	Fair	11-15 (0%)	11-15 (0%)
Unsatisfactory	Poor	>15 (0%)	>15 (02%)

Table 3: *Radiographic criteria and ROM of operated as compared to normal*

Variables	Operated	Normal	P-Value
Boumann Angle	62± 4	70±6	0.04
Ulnohumeral angle	168±6	160±5	0.03
Carrying Angle	15.6± 5.1	10.8±3	0.03
ROM Arc	149±6.5	130± 8	0.02

Discussion

This study evaluated percutaneous Pinning's outcomes in a supracondylar fracture in terms of infection, deformity, and functional ROM. Closed reduction and internal fixation is the preferred choice of surgery in Gartland extension type III and IV. The old school of thought to openly reduce the displaced type IV fractures is on a decreasing trend. This study showed a few complications of pin site infection 5%, decreased range of motion 1.5%, and 1.5% nerve palsy.

Although Open reduction and internal fixation with Pinning is an acceptable treatment options in irreducible, gravely communicated, and old neglected supracondylar fracture of the humerus. The open fixation techniques have higher chances of complications, e.g., surgical site infection and ROM limitation as compared to closed procedures.[6,7,8] This study showed that we could manage all types of fractures initially closely with auspicious outcomes. The risk of the scar and delayed activity can be avoided with a meticulous approach. Apart from the minimally invasive approach, We believe that our results support the fact that first-line use of the CRIF e K-wires is cosmetically and functionally superior in terms of patient satisfaction and functional activity.

2% of the patients showed unsatisfactory results due to decreased range of motion. Non-compliance with physiotherapy and medical therapy is the main reason for poor scores. They were subjected to aggressive physiotherapy protocols, which markedly improved their functional status. In this study, Pins were removed at six weeks as compared to some studies advocating their removal at three weeks. Pin site infection was 5% in this study, while other studies showed a 3% pin site infection.[9] Yuji Tomori compared close reduction with the mini-open technique. It showed ROM 143.8±6.9 with close Pinning, while our study narrated a 149.5 Arc of range of motion. Karamitopoulos stated that migration of pin does not affect the management and treatment of the patient.[10]

Ultimately, all bony fractures heal. In our study, not a

single case of non-union was reported.

Vallila et al. reported complications around 1% of distal humerus fractures in Finland; the risk is too little as compared to the highest number of patients being treated. Ponce et al. explained that simply follow-up radiographs could not reduce complication rates. One to two cases of permanent iatrogenic nerve injuries happened to patients in Noora Tuomilehto study because of the same surgeon's intervention. The number of nerve related complications can be reduced by concentrating on the surgeries at a specialized center or surgeries performed by properly trained surgeons with aequate experience and skill to closely reduce and fix these fractures.[11]

Adequate reduction assessed by intraoperative normalization of radiological parameters along with stable fixation can reduce the incidence of cubitus varus deformity.

This study's limitations include small sample size, retrospective study, unicentred study, no control group was made. A much larger multicentered study is required to delineate close pinning outcomes in Gartland types III and IV. Longer follow-up period studies are required to evaluate the late deformity of the injured elbow.

Conclusion

We prefer Close reduction internal fixation with K-wires in Gartland types III and IV to reduce the complications associated with the open technique. Pin site infection and reduced range of motion are the known complications. Early removal of pins and timely physiotherapy can markedly reduce the adverse effects. In this study, all nerve palsies heal without consequences at 5months of follow-up visits.

Conflict of Interest *None*

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Authors Contribution

MA: Conceptualization of Project
MTJ: Data Collection
FM: Literature Search
AA, MT, OIC: Statistical Analysis
AA: Drafting, Revision
SAQ: Writing of Manuscript