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Original Article

Comparison of the Functional Outcomes of Close Reduction Percutaneous Pinning Versus Open Reduction Internal Fixation with Pinningin Children with Gartland Type III Supracondylar Fracture of Humerus

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ABSTRACT

Objective: To compare the functional outcomes of close reduction percutaneous pinning versus open reduction internal fixation with pinning in children with Gartland type-III supracondylar fracture of the humerus.

Study Design: Quasi-experimental study

Place and Duration of the Study: Department of Orthopaedic Surgery, Jinnah Postgraduate Medical Center, Karachi Pakistan, from Sep 2019 to Aug 2020.

Methodology: A total of 98 patients aged of 2 to 15 years, of either gender, with Gartland type III supracondylar fracture were included in the study. By blocked randomization, patients were randomly assigned into two groups (49 each), Group-A (CRPP) and Group-B (ORIF). All of the patients were prospectively followed up after six months, assessed for the functional outcome according to Flynn's criteria, and classified as satisfactory and unsatisfactory based on functional and cosmetic factors.

Results: The mean age in our study population was 8.2±3.4 years and 7.1±2.3 years in ORIF and CRPP Groups, respectively. The right arm was shown to be more commonly involved than the left arm in our population demographics, and RTA was determined to be the most frequent cause of supracondylar fractures. Functional outcomes were satisfactory for 68 individuals (69.4%), out of which 40(40.8%) belonged to the ORIF Group, and 28(28.6%) belonged to the CRPP Group, respectively.

Conclusion: It is to be concluded that a significant difference was noted in terms of satisfactory outcomes between CRPP versus ORIF in the treatment of supracondylar fracture of humerus in children and that ORIF can be considered a valid first-line treatment for Type III supracondylar humeral fractures in the pediatric population.

Keywords: Closed reduction, CRPP, ORIF Fractures, Gartland classification, Humerus, ORIF, Open reduction.

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INTRODUCTION

The fracture of the distal end of the humerus just above the epicondyles is called the supracondylar fracture.[1] Supracondylar fracture of the humerus is very common in children. It makes up about 60% of elbow fractures and 13%-15% of all bone fractures in children.[2] Supracondylar fracture has two types, called flexion and extension types. About 97- 99% of cases are of the extension type. Moreover, the non-dominant arm is more commonly affected.[3-4] As with other paediatric trauma, these fractures occur mostly in warm weather due to increased sports activity during summers.[5] The modified Gartland classification system describes fracture displacement and guides treatment for all supracondylar fractures.[6] Different configurations have been used to treat displaced supracondylar fractures of the humerus, such as closed reduction with percutaneous Kirschner wires or open reduction and internal fixation with Kirshner wires in different configurations.[7] The definitive management of these fractures still needs to be made public.[8] Closed Reduction And Percutaneous Pinning (CRPP) is the preferable treatment for displaced supracondylar fractures. Open Reduction Internal Fixation with pinning (ORIF) is made when closed reduction fails, or there is a pulseless hand after reduction.[9] ORIF allows manipulation of the fracture with direct visualization and a reduced risk of neurovascular complications.[10]

Our study compares the functional outcome of CRPP versus ORIF with pinning in children with Gartland type III supracondylar fracture of the humerus. Local literature on this subject needs to be updated. In contrast to international literature, our population's sociodemographic and nutritional status differs from theirs. We hypothesized that the functional outcome of the surgical procedure (ORIF/CRPP) would not be associated with the aetiology of injury, the age of fracture, patient's gender and age group. This study will aid surgeons in selecting the approp-

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riate surgical method for reducing pediatric supracondylar fracture of the humerus according to the demographics.

METHODOLOGY

The quasi-experimental study was conducted at the Department of Orthopaedic Surgery, JPMC, Karachi Pakistan, from September 2019 to August 2020 after receiving ethical approval from the Institutional Review Board (Ref No. 73055). The sample size was calculated using the WHO software, keeping the frequency of satisfactory functional outcome in CRPP as 90% and in ORIF with pinning as 70%,[9] at a 95% confidence level and 80% power.

Inclusion Criteria: Children of either gender, with aged 2-15 years with Gartland type III supracondylar fracture were included in the study. Patients presenting to both the Out Patient Department and the Emergency Room with a fractured age ranging from 1 to 7 days were included in the study.

Exclusion Criteria: Children of age less than one year and more than 15 years with Gartland type-III supracondylar fracture were not included in this study. Patients presenting with Gartland type-I and II fractures, open fractures, associated ipsilateral fracture of the radius, associated neurovascular damage, compartment syndrome, and age of fracture greater than seven days were excluded from the study. Patients lost to follow-up and with associated congenital defects were also excluded from the study.

Ninety-eight patients met our inclusion criteria, which were then randomly assorted into two groups (49 each) via blocked randomization, the CRPP Group and the ORIF Group, with a random number table generated using Microsoft Excel. Data regarding age, gender, height, weight, BMI, mechanism of trauma, side involved, fracture duration, surgery, and functional outcome was recorded on a structured proforma.

The patients and their guardians were informed about their prognosis and the types of treatment offered. All the patients were enrolled after obtaining informed consent from the parents. The patients and their guardians were informed that they held the right to withdraw from the trial if necessary. All surgeries used a standardized pin location and pin size (weight 20kg, size 2mm). Both operations were performed under general anaesthesia with intraoperative monitoring via C-arm. Patients were kept supine, and the fractured limb was put on a radiolucent side Table.

In CRPP, closed reduction was performed, and reduction was maintained using adhesive tape. To commence, longitudinal traction was administered without keeping the elbow in hyperextension and the forearm supinated. The initial step in correcting the bone displacement was providing either a varus or a valgus force at the fracture site while maintaining traction. After that, the posterior displacement of the distal fragment was rectified by applying a force on the posterior aspect with the forearm in pronation and elbow in acute flexion. This reduction was evaluated under the C-arm. After the reduction had been achieved to the surgeon's satisfaction, fixation was done with two crossed 1.5 or 2mm K-wires. In the first step of the procedure, a K-wire was inserted to par-tially stabilize the fracture by engaging the medial cortex. After that, the patient's elbow was gently extended to a position that was 90^{o} while the ulnar nerve was maintained in its groove. After that, the lateral cortex was reinforced by a second K-wire inserted through the medial epicondyle.

In ORIF, a longitudinal incision was given 1cm anterior to the medial epicondyle of the humerus. The ulnar nerve was saved by retraction. The fracture site was exposed and cleaned carefully. After exposing the distal fragment, about 5–10mm of common flexor muscle attachment were lifted from the distal fragment in order to visualize the fracture line. After the fracture had been satisfactorily reduced, it was stabilized by fixing it with two crossed K-wires of 1.5 or 2mm, and then the stability was assessed. The K wires were then cut and bent and left outside the skin. The raised common flexor origin was fixed by taking a suture around the K-wire. An absorbable sub-cuticular suture was used to seal the incision, and a POP slab was applied.

The patients were discharged and followed in our outpatient department. Splint and wires were removed at third-week post-operatively, and range of motion exercises was initiated. X-rays were performed during the third and sixth week post-operatively and then at the third and sixth month of follow-up. In the sixth month of follow-up, patients were assessed for functional outcomes according to Flynn's criteria, which includes a cosmetic factor (loss of carrying angle) and a functional factor (loss of motion in degrees). Results of Flynn's criteria were graded as satisfactory and unsatisfactory based on functional and cosmetic factors.

Data were analyzed using Statistical Package for the social sciences (SPSS) version 23:00. Mean±SD was calculated for all the quantitative variables. In addition, frequency and percentage were computed for all the qualitative variables. The results were analyzed

using the Pearson-Chi square test/ Fischer's exact test and t-test. The *p*-value of ≤0.05 was considered significant.

RESULTS

Based on the type of treatment, 98 patients in total were split into two groups for this study: Group-A (ORIF) and Group-B (CRPP). There were 49 patients in each of the study groups. The average age of patients in Group-A was 8.2±3.4 years, while the average age in group B was 7.1±2.3 years. There were 98 patients in total, and 38 of them were female (Table-I).

Table-I: Descriptive Statistics of the Treatment Groups (n=98)

Variables	ORIF-Group (n=49)	CRPP-Group (n=49)
Age(years)	8.2±3.4	7.1±2.3
Height(cm)	127.2±21.3	122.8±13.9
Weight(kgs)	26.8±11.1	24.4±6.6
BMI a(kg/m2)	16.0±1.9	15.8±1.8
Age of fracture (days)	3.1±1.8	3.5±1.5
Duration of surgery (min)	67.8±15.1	30.0±2.7
Gender		
Male	27(55.1%)	33(67.3%)
Female	22(44.9%)	-
Side affected		
Right	27(55.1%)	30(61.2%)
Left	22(44.9%)	19(38.8%)
Mechanism of trauma		
Fall	13(26.5%)	24(49%)
RTA b	36(73.5%)	25(51%)

a Body Mass Index b Road Traffic Accident

In total, 68 individuals (69.4%) were found to have a functional outcome that was considered satisfactory. The difference between the two groups is statistically significant, as the first group, Group-A, had a satisfactory functional outcome in 40(81.6%) of their patients. In contrast, the second group, Group-B, only had a satisfactory functional outcome in 28(57.1%) of their patients, indicating that Group-A had a higher proportion of patients with a satisfactory functional outcome than Group-B. In Group-A, 26 patients (92.9%) aged 2 to 7 years were found to have a satisfactory functional outcome. In Group-B, only 12 patients (75%) in the age category of 2-7 years had a satisfactory functional outcome. The difference between the two groups was statistically significant. According to Flynn's criteria, 21(95.5%) females in Group-A had satisfactory functional outcomes. In contrast, only 12(5%) of the females in Group-B had satisfactory functional outcomes, and the difference between the two groups was statistically significant. In comparison, 35(87.5%) of the patients in Group-A and 23(56.1%) of the patients in group B had an age of fracture spanning from day 1 to 5, with the difference between the two groups being statistically significant. 32(88.9%) patients who came with RTA in Group-A were found to have a satisfactory functional outcome in contrast to 13(52%) patients in Group-B. The difference between these two groups was statistically significant (Table-II).

Table-II: Stratification with respect to Flynn's criteria (n=98)

Variable	Flynn's criteria		*p*-value
	Satisfactory n(%)	Unsatisfactory n(%)	
Functional outcome			
ORIF	40(81.6%)	9(18.4%)	0.009a
CRPP	28(57.1%)	21(42.9%)	
Age Group (years) ORIF			
2-7 years	26(92.9%)	2(7.1%)	0.02b
>7 years	14(66.7%)	7(33.3%)	
Age Group (years) CRPP			
2-7 years	12(75%)	4(25%)	0.07a
>7 years	16(48.5%)	17(51.5%)	
Gender (ORIF)			
Male	19(70.4%)	8(29.6%)	0.03b
Female	21(95.5%)	1(4.5%)	
Gender (CRPP)			
Male	16(48.5%)	17(51.5%)	0.07a
Female	12(75%)	4(25%)	
Age of fracture (days)			
ORIF			
1-5 days	35(87.5%)	5(12.5%)	0.04b
>5 days	5(55.6%)	4(44.4%)	
CRPP			
1-5 days	23(56.1%)	18(43.9%)	1.000b
>5 days	5(62.5%)	3(37.5%)	
Mechanism of trauma			
ORIF			
RTA	32(88.9%)	4(11.1%)	0.04b
Fall	8(61.5%)	5(38.5 %)	
CRPP			
RTA	13(52%)	12(48%)	0.45a
Fall	15(62.5%)	9(37.5%)	

a Pearson Chi Square, b Fischer's exact test

DISCUSSION

The most prevalent kind of fractures in children needing surgery occur in the supracondylar region of the humerus.[11] Supracondylar fracture of the humerus in children occurs at the level of the olecranon fossa, which is the point at which the medial and lateral columns begin to flatten.[12] Gartland characterized the extension-type supracondylar fracture by displacement. Type I injuries are non-displaced or minimally displaced and may have a seemingly normal radiograph with an elevated anterior and posterior fat pad.

In type II injuries, there is a displacement, but the posterior cortex and the posterior periosteal hinge are still intact. Disruption of the anterior and posterior cortices characterizes Type III injuries. Therefore, completely displaced.[13] Supracondylar fractures in the paediatric population have an infamous reputation due to their grave complications.[14] No single surgical treatment works for type III supracondylar fracture. The most commonly used treatment for Gartland Type III supracondylar fracture is closed reduction and percutaneous pinning; open reduction is used when the closed reduction procedure has failed. According to the available literature, CRPP may be more advantageous over ORIF. However, a direct comparison of these two distinct treatment modalities has only been carried out in a limited number of investigations.[15,16]

Flynn's criteria is a widely established method for evaluating the outcomes of supracondylar fractures of the humerus, which combines functional variables, such as range of motion and cosmetic elements, with alterations in carrying angle (Table-III).

Table-III: Flynn's Criteria for Grading Functional and Cosmetic Outcome of Supracondylar Humerus Fractures in Children (n=98)

Rating	Cosmetic Factor: Carrying Angle (°)	Functional Factor: Motion Loss (°)
Satisfactory		
Excellent	0-5	0-5
Good	6-10	6-10
Fair	11-15	11-15
Unsatisfactory		
Poor	>15	>15

Abousaleh *et al.* and Shrestha *et al.* reported an increase in patients with satisfactory functional outcomes when treated with CRPP.[9,17] In contrast, in our study, the overall functional outcome according to Flynn's criteria was determined to be satisfactory for 42(82%) and 28(57%) ORIF and CRPP patients, respectively and unsatisfactory for 9(18%) and 21(43%) patients, respectively, with a *p*-value that was statistically significant (0.009) (Figure).

Prior studies, to the best of our knowledge, indicated that CRPP was superior to ORIF for type III supracondylar fractures of the humerus. However, this study demonstrates that ORIF results in more patients with satisfactory functional outcomes. Tarallo *et al.* stated that open reduction is not associated with an increased risk of sequelae such as fibrosis and stiffness, painful scarring, pin tract infections, or nerve damage.[18]

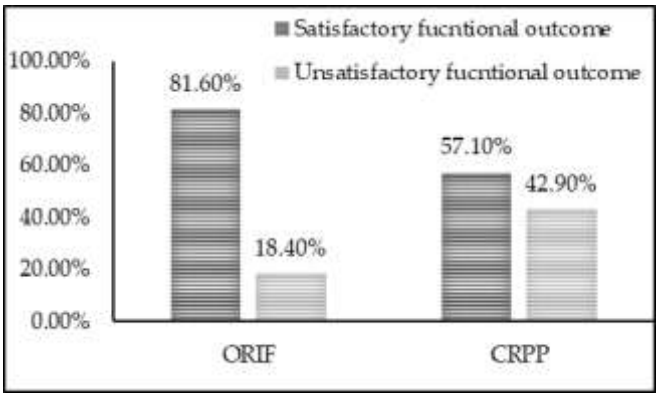

Figure: Comparison of Satisfactory and Unsatisfactory Functional Outcomes between ORIF and CRPP in the Supracondylar fractures of Humerus

Approximately two-thirds of the patients in our study attributed supracondylar fractures to RTA. Our study demonstrates a marginally superior functional outcome in patients treated with ORIF following (*p*-value 0.04). Prompt emergency care may explain why ORIF is associated with more RTA patients with satisfactory functional outcomes. The possible limitations of our study are the relatively shorter follow-up time of six months and the small sample of 49 patients in each treatment group. These facts could be implicated in the reason for generalising our study findings.

CONCLUSION

It can be concluded that open reduction and internal fixation (ORIF) is superior to closed reduction and percutaneous pinning for type III supracondylar fractures (CRPP) of the humerus in the paediatric population. Therefore, open reduction and internal fixation (ORIF) can be considered a valid first-line treatment for Type III supracondylar humeral fractures in females aged 2 to 7 years, presenting within five days of fracture with RTA as the aetiology of the paediatric supracondylar fracture of the humerus.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

PA & KMK: Conception, study design, approval of the final version to be published.

REK & SS: Data acquisition, data analysis, data interpretation, approval of the final version to be published.

RK & A: Critical review, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of

any part of the work are appropriately investigated and resolved.

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