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Original Research Article **Orthopaedic Surgery**

Evaluation of Stiffness in Paediatric Closed Supracondylar Fracture Gartland Type III Treated Open Reduction and Internal Fixation by Cross K-Wire

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Abstract

Background: Supracondylar fractures are a common type of elbow fracture in children, and Gartland type III fractures are the most severe form of this injury. These fractures may be treated with either closed reduction and percutaneous pinning or open reduction and internal fixation using pins. ***Objective:*** To evaluate the outcome of pediatric stiffness in Gartland type III supracondylar fractures using the Flynn's criteria. ***Materials and Methods:*** A Multicentered based prospective study was performed in 250 Beded District Hospital, Chapainawabganj, Rajshahi, Bangladesh, from January 2021 to December 2022. A total of 80 patients with displaced type III extension supracondylar fractures were included, all of whom were treated at two separate facilities in a systematic way. Closed reduction and percutaneous cross-pinning were the major components of treatment at (n = 43). ORIF was the treatment plan (n = 37) for patients. Their stiffness was evaluated over a 6-month follow-up period. ***Result:*** A total of 80 displaced type III extension supracondylar fractures treated primarily closed reduction and percutaneous cross-pinning (n=43), while the other used primarily open reduction and internal fixation (n=37) with two lateral parallel pins (n=11), cross pins (n=11) and two lateral and one medial pin (n =15), 28 patients (75.6%) had an excellent result, six patients (18.9%) had a good result, two patients (4.6%) had a fair result, and one patient (2.7%) had a poor result in the ORIF group. In the CRPF group, 33 (76.7%) patients had an excellent result, seven (16.2%) patients had a good result, two (4.6%) patients had a fair result, and one (2.4%) patient had a poor result. The stability and configuration of the fracture open and closed reduction groups were not statistically significant according to Flynn's criteria (P>0.05). ***Concision:*** This study provides valuable information on the evaluation of pediatric stiffness in Gartland type III supracondylar fractures and highlights the need for careful follow-up to detect and manage any potential stiffness. Although closed reduction did not show any superiority over open reduction, it was suggested as the first treatment choice due to its low morbidity and short hospital stay.

Keywords: Paediatric, Supracondylar Humerus Fracture.

INTRODUCTION

The humeral supracondylar fracture is the second most common fracture in children, accounting for 16.6% of all pediatric fractures [1]. Orthopedic surgeons have technical challenges while treating type-III fractures in the surgical procedure. According to Gartland's criteria, these fractures might be nondisplaced (type I), partially displaced (type II) with the posterior cortex still intact, or entirely displaced (type III) (type III). Malunion, elbow stiffness, iatrogenic neurovascular damage, and compartment syndrome are among potential complications following treatment for completely displaced [2]. While consensus exists over how to highly appreciable type I and type II fractures, type III fractures serve as a source of controversy.

Effective treatments for type III fractures range from closed reduction and cast immobilization to traction using a variety of techniques to open or closed reduction with Kirschner (K-) wire fixation [3]. This

study aims to analyze and evaluate the effects of two methods of treating type III extension fractures (predominantly closed reduction with percutaneous pinning versus predominantly open reduction with pinning) in two different sites. In addition, we examined the efficacy of three distinct pin designs during open surgery and compared them.

MATERIAL AND METHOD

Eighty children with displaced Gartland type III extension fractures were studied, and their treatments ranged from matricentred base standard procedure to another's (primarily open reduction versus primarily closed reduction). Patients' medical histories were reviewed regarding the fracture's site, whether or not an open wound developed, and when surgery was performed. Infection, nerve damage, and compartment syndrome were also noted as postoperative problems (Table 1).

The patients were divided into two groups. All of the patients with displaced Gartland type III fracture (n =37) had been treated with primarily open reduction through a lateral incision (ORIF). Different pin configurations were used according to the stability and configuration of the fractures. Eleven patients had been treated with two lateral, 11 patients with one lateral and one medial, and 15 patients with two lateral and one medial K-wires in the open reduction group. Thirty patients had been treated within 24 hours in this group, and seven patients had been treated 24 hours after the injury.

Table 1: Provides an overview of the two groups' demographics

Variable	Open reduction group (*n*=37)	Closed reduction group (*n*=43)
Age, (range)	5.9	6.5
Sex, M/F	26/11 (70%, 30%)	29/14 (63%, 37%)
Side, R/L	14/23 (38%, 62%)	16/27 (37%, 63%)
Follow-up time (months)	29.5 (19–62)	32.9 (13–63)
Ipsilateral fracture	2 (5.4%)	3 (6.9%)

Closed reduction and two percutaneously implanted cross pins were the primary treatments for all 46 patients with displaced Gartland type III fractures (CRPF). Within 24 hours of injury, 38 people in the closed reduction group had been seen by a doctor. In seven cases, the first closure reduction effort failed, and surgical intervention was delayed until after four to five days of skeletal overhead traction. Open reduction was performed on two patients after a delayed closed reduction attempt failed and on one immediately due to simultaneous brachial artery damage. The research did not include these three patients.

Following surgery, patients in both groups wore lengthy arm casts that flexed at the elbow. In the closed reduction group, all patients were sent home the day following the procedure, whereas the average length of stay for the open reduction group was 3.8 days in the hospital. After 3-4 weeks, pins were removed from both sets of patients. Pins were removed from 11 patients in the open group at week 6 because of poor callus development. After the pin was removed, the patient was urged to move their joints actively.

All injuries were closed except for one patient in the open reduction group. Radial nerve palsy was seen prior to surgery for two individuals in the open reduction group. Both patients with radial palsy who had sural nerve grafting after fracture repair achieved full recoveries within three months. There was a full recovery from all ulnar nerve damage within 12 weeks after surgery. Table 2 summarizes the number of individuals with nerve lesions in each group and their outcomes. After a mean of 29.5 (19-62) months in the open reduction group and 29 (13-70) months in the closed reduction group, patients were contacted for a final radiological and clinical assessment (Fig. 1a–b).

Patients were assessed using Flynn's criteria, which included measuring the humeral-ulnar angle as the carrying angle and measuring the degrees of flexion and extension clinically [4]. Radiological and clinical assessments were compared with a healthy elbow at the most recent follow-up. Statistics The chi-square test was used to analyze the data for both functionality and aesthetics. Mean 95% CI, graphs, and tables were used to summarize the parameters. The level of significance was determined to be $P < 0.05$.

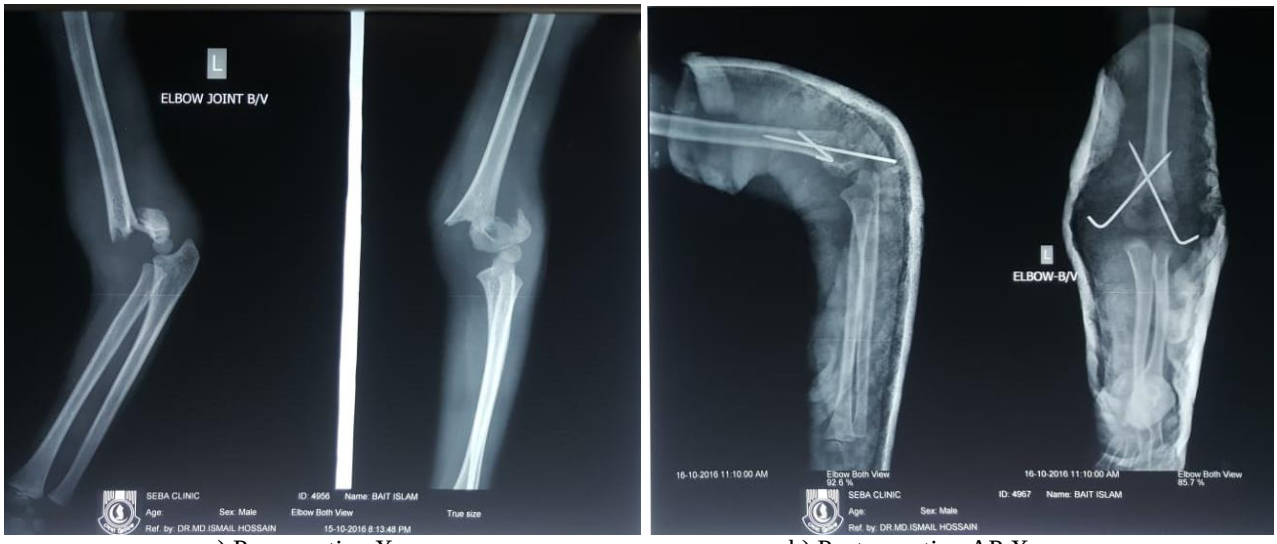
RESULTS

Results in terms of appearance and performance were equivalent across the two groups (Table 3). 28 patients in the ORIF group (75.6%) fared extremely well according to the criteria of Flynn *et al.*, while 6 patients (18.9%), 2 patients (4.6%), and 1 patient (2.7%) fared poorly. There were 33 patients with excellent outcomes (76.7%), 7 with good outcomes (16.2%), 2 with fair outcomes (4.6%), and 1 with a bad outcome (2.4%) in the CRPF group. In the CRPF group, varus angulation was the root of both mediocre and disastrous outcomes. One patient with a poor outcome had a varus angulation of 20 °, while the other two patients with fair outcomes in the ORIF group experienced severe loss of range of motion.

Two open-group patients and three closed-group individuals experienced pin tract infections that

were successfully treated with oral antibiotics. While all 43 patients in the CRPF group had an excellent functional result, just 3 individuals in the ORIF group did so. A preoperative diagnosis of radial palsy necessitated nerve repair in one patient in the ORIF group (two lateral pin fixation groups) who had an unsatisfactory result. One patient had a satisfactory result after surgery due to pin tract, superficial wound infections, and ulnar nerve palsy in the lateral and medical groups, respectively. Functional and aesthetic effects were unaffected by ulnar nerve palsy in the CRPF group. Neither group had a significant loss of fixation among their patients. Neither group had any prior experience with further surgeries.

The ORIF group with two lateral and one medial pin fixation had superior functional and aesthetic outcomes than the two lateral groups and the one lateral and medial group, although the difference was not statistically significant (P > 0.05).



a) Preoperative X-rays b) Postoperative AP X-ray

Fig. 1: Closed reduction and percutaneous pinning for a Type III Gartland fracture

Table 2: Patient outcomes after nerve injury

Variable	Open group	Outcome	Closed group	Outcome
Preoperative				
Ulnar	1 (2.7%)	Satisfactory	-	
Radial	2 (5.4%)	One poor result	-	
Median	-		1 (2.3%)	Satisfactory
A. interossea	-		1 (2.3%)	Satisfactory
Postoperative				
Ulnar	2 (5.4%)	One poor result	4 (9.4%)	All satisfactory

Table 3: Results of two different surgical methods by using the outcome

Open reduction			**Closed reduction**	
Variable	***n***	**%**	***n***	**%**
Excellent	28	75.6	33	76.7
Good	8	21.6	7	16.2
Fair	0	0	2	4.6
Poor	1	2.7	1	2,3
Functional Outcome				
Excellent	34	91.8	43	100
Good	1	2.7	0	0
Fair	2	5.4	0	0
Poor	0	0	0	0

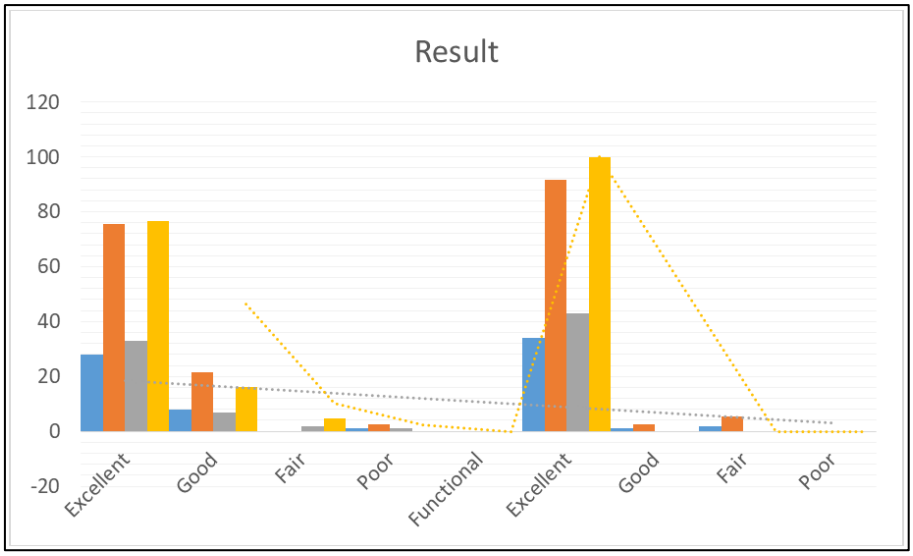


Fig. 2: Comparing the outcomes of two distinct surgical approaches

DISCUSSION

Treating supracondylar fractures primarily aims to restore a fully functioning and aesthetically pleasing limb. A cure for Gartland type III supracondylar fractures has not been found. Proponents of closed reduction with percutaneous pinning argue that it reduces the risk of complications, including infection and functional decline [5]. Also, the duration spent in the hospital is shortened. Opponents of closed treatment argue that displaced fractures are more hard to fix physically and that repetitive manipulations can lead to joint stiffness and myositis ossificans [6].

Most published research has patients who have attempted reduction fail to get together to create open reduction groups. Therefore, the patients with the most challenging patterns were found in the open groups of these investigations. In open groups, the fracture pattern often showed no cortical contact and fully separated periosteum, ruling out the possibility of a closed reduction. These fractures are more difficult to stabilize and have a higher risk of complications [2]. Patients in our open reduction and pinning group were treated predominantly at one facility where the open reduction was performed without a closed reduction attempt. Newer studies also used patients who had undergone successfully closed manipulation to establish their closed groups.

When an acceptable decrease could not be accomplished with closed manipulation, patients were removed from the closed group in these investigations. Seven patients in our research attempted closed reduction but were unsuccessful; only two were removed from the closed group. Five patients had delayed closure reduction performed on them after skeletal overhead traction was applied per the institute's treatment procedure. Due to insufficient closed reduction of the fracture, only two patients required open reduction. We believe these distinctions set apart our studies from that of others [6].

Closed reduction is a good surgical approach for type III supracondylar fractures, which is supported by our findings [7]. About 97% of patients in both groups experienced favorable outcomes in our study. When comparing the two groups on a aesthetic and functional evaluation scale, there were no statistically significant differences. However, it was remarkable that all 43 children who had closed reduction and percutaneous pinning experienced a successful functional result. Both groups saw nearly identical rates of complications. Different pin configurations may account for the increased rate of postoperative ulnar nerve palsy in the closed reduction group (9.7% vs. 5.4%). Eleven patients undergoing open reduction had two lateral pins inserted to protect the ulnar nerve, whereas all patients undergoing closed reduction underwent cross-pinning.

If the closed reduction with cross-pinning is accomplished in a suitable location with secure fixation, it might be considered a highly effective procedure. We believe closed reduction with percutaneous cross-pin fixation is the best first line of defense for type III fractures. Some writers recommend closed reduction with two lateral pins to prevent iatrogenic ulnar nerve damage [8]. Cross-pin configurations, however, have been proven to be more stable than two- lateral pin configurations in biomechanical investigations [9]. Loss of fixation is more likely to occur when two lateral pins are used to treat Gartland type III fractures, as reported by Sankar *et al.*, [10]. Closed reduction with percutaneous pin fixation makes it difficult to assess whether or not the fracture line is stable.

Therefore, we believe that the closed treatment of type III fractures is better suited to a more stiff fixation with a cross-pin configuration, whereas the

closed treatment of type II fractures may be more suited to a two-lateral pin fixation. Cross-pinning increases the risk of ulnar nerve damage; however, it is well-established that hyperextension of the elbow during medial pin insertion reduces this risk [11]. Also, Lyons *et al.,* and Kalanderer *et al.,* have reported that ulnar nerve palsies which developed after surgery mostly recover spontaneously without complication [12].

None of the three pin fixation approaches in the open reduction group produced noticeably different aesthetic or functional results (P>0.05). There was no ulnar nerve palsy in the group that received two lateral pins, but one patient in each of the other two groups experienced this problem (one lateral and one medial, two laterals and one medial). It is important to stress that the findings of open reduction via a lateral approach are just as good as those of closed reduction with percutaneous fixation. Surgeons who lack experience with closed reduction and percutaneous fixation should opt instead for open reduction through a lateral route because it is a well-known and successful operation.

It's a backup plan in case of technological issues. Open surgery is preferred after one or two tries at a closed reduction because to the risk of damaging the epiphysis by repeated manipulations. Most authors argue that two lateral pins are sufficient for stabilizing unstable supracondylar humeral fractures without endangering the ulnar nerve [18, 19]. According to the biomechanical study by Larson *et al.,* the most stable pin design against torsional stresses is two lateral and one medial pin arrangement and medial comminution considerably reduce fracture stability. When there is comminution of the medial cortex, and two lateral or cross pins are not enough to ensure stability, a third pin fixation may be necessary [13].

If the distal fragment is large enough for two lateral pin fixations, we believe that the initial fixation in open surgery should be with two K-wires from the side; after the wires have been placed, the fracture line's stability can be evaluated by flexing, and extending the elbow and gently rotating it during the procedure. Maintaining anatomical alignment of the fracture pieces is indicative of successful fixing. In case the pieces shift, one K-wire inserted from the medial side is recommended. If the distal fragment is tiny, a configuration with one lateral and one medial pin may be preferable; after evaluating stability, a third lateral pin can be added if necessary.

CONCLUSION

The outcomes of open reduction and internal fixation for type III supracondylar fractures are similar to those of closed reduction and pinning. Hence this treatment option may be safely considered an acceptable secondary option. Closed reduction fails; the surgeon may opt for open reduction or skeletal tension and delayed percutaneous fixation.

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