

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 369-375
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<https://www.orthopaper.com>
Received: 01-06-2023
Accepted: 08-07-2023

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Posterior Intra-focal wiring for extension type supracondylar humeral fractures in children

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DOI: <https://doi.org/10.22271/ortho.2023.v9.i3e.3448>

Abstract

Background: Supracondylar fractures of the humerus in children continue to possess treatment challenges for the surgeon. The aim of this work was to assess the outcome of posterior intra-focal pinning for extension-type supracondylar fractures of the humerus in children.

Methods: This study was carried out on 21 children with clinical criteria of supracondylar fracture of the humerus. All patients were treated by closed reduction and internal fixation with posterior intra-focal pinning from posterior cortex and one or two lateral Kirschner wires.

Results: According to Gartland classification all cases were extension type, 15 of them were type II (71%), 6 were type III (29%), operative time range was (30-90) minutes, the follow up period was 6 months average. According to Flynn's criteria, 11 patients had excellent results, 7 patients had good results, 2 patients had fair results and 1 patient had poor results. Patients were rapidly mobilized after pin removal (3 - 6) weeks. Only one patient had hyperextension. Two patients had cubitus varus. Approximately three-quarters of the patients (71.4%) had no complications.

Conclusions: Treatment of supracondylar fractures of the humerus in children by closed reduction and internal fixation with posterior intra-focal pinning is a stable method of fixation with complete ulnar nerve protection.

Keywords: Intra-focal wiring, supracondylar, humeral fractures, Flynn's criteria

Introduction

50% to 70% of paediatric elbow fractures are humeral supracondylar fractures, which generally affect children between the ages of 3 and 10. The afflicted arm is often the non-dominant arm. Because of the olecranon and coronoid fossas, which are present posteriorly and anteriorly, the narrow supracondylar area is susceptible to fracture^[1].

A metaphyseal injuries known as a supracondylar fracture is usually always found in children less than 10 years old with an immature skeleton^[2]. Gartland classified supracondylar humeral fractures in children into 3 types: Type I: undisplaced fractures, type II: displaced fractures with intact posterior cortex, and type III: displaced fractures with no cortical contact^[3].

Type I: un-displaced fractures, type IIA: angulated fractures with intact posterior cortex and no rotation, type IIB: angulated fractures with intact posterior cortex and rotational deformities, and type III: displaced fractures with no cortical contact were the modifications made by Wilkins to this classification to accommodate rotational deformities^[4]. Depending on the pattern of fractures and the mode of damage, these fractures might be classified as flexion or extension injuries. 98% to 99% of injuries are extension-type injuries, which are frequently brought on by falling onto an out-stretched hand with the elbow fully extended^[5].

Regarding displaced supracondylar fractured humerus in childhood, closed reduction and percutaneous pinning is well-established as the optimal surgical technique^[6].

The best pin configurations remain controversial despite the fact that the available evidence consistently indicates that two or three K-wires are sufficient to ensure stable fixing of the fracture. There are lateral pins merely, two lateral pins paired with one medial pin, and medial and lateral crossing pins as options. It is possible to implant lateral pins in a divergent, parallel, or convergent direction.

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The crossed-pin method is recommended as the best therapy in current textbooks and research, with the exception of cases where the ulnar nerve or the medial epicondyle can't be felt. [6-8].

The frequency of ulnar nerve injuries in many series ranges from 0- 15%. These injuries are either traumatic or iatrogenic. Iatrogenic ulnar nerve deficits often result from a pain impinging on the nerve. The main risk with crossed pinning is injury to the ulnar nerve by a medial pin [9]. It is stated that the posterior intra-focal pin approach has a number of benefits. The posterior approach is reasonably secure and keeps you away from the vital elbow components. It stays away from the medial pathway and potential ulnar nerve harm. The technique would enable vascular exploration because it spares the medial side's skin and because the block to extension would stop the vascular repair from being stretched [10].

This study's objective was to evaluate the results of posterior intra-focal pinning for paediatric extension-type supracondylar humeral fractures.

Patients and Methods

This work was performed on 21 individuals aged from three to 13 years old, with clinical criteria of skeletal immaturity and Gartland types II & III supracondylar fractures. Tanta University's and El-Helal Hospital's ethics boards gave their consent before the study was carried out. The relatives of the patients provided signed, fully informed permission.

The criteria for exclusion were prior fractures of the humerus, open fractures, and flexion-type supra-condylar fractures, Gartland type I and type IV and fractures with neurovascular insult.

All instances were extension types based on the Gartland categorization, 15 instances were type II cases, and six instances were type III cases.

All cases were subjected to: personal data, complaints, A medical history (including the date of the event, the side that was injured, how it was caused, and any allergies) and physical evaluation (looking for deformity, edema, pain, movements, neurovascular conditions, skin conditions, and other traumas on the afflicted side).

Methods of radiological assessment: For all individuals, standard lateral and AP plain X-ray images of the elbows and forearms that were afflicted were taken.

All displacement supracondylar fracturing had to be admitted, and for patients with weak radial pulsation, vascular consultation was performed while the damaged elbows was

kept immobilized in a splint that maintained the elbow in flexion of 70 to 90 degrees. We administered analgesics. Closed-reduction and posterior intra-focal pin internal fixation were used for treating all of the participants. Each individual underwent general anaesthesia for their procedures, and prophylactic antibiotics (50 mg/kg cephalosporin) were given to them 30 minutes prior to surgeries.

Postoperative care: Regularly, vital signs were taken into account. At the afflicted limb, a neurovascular evaluation was performed. Twice per day for two days, IV antibiotics (50 mg/kg individual dosage) was administered. When necessary, proper analgesia was administered. To verify the placement of the wires, check X-rays were taken on the first postoperative day. Following 1-2 days, the participants had been released from the hospital.

Follow up

The frequency of follow-up visits was weekly for the first six weeks, afterwards monthly, and each visit included a radiographic examination. Following between 3 and 5 weeks, the splint was eliminated, and elbow mobilisation began. K-wires were taken out between 3 and 6 weeks. The follow-up duration was between three and nine months.

Flynn's criteria for grading [11]

Based on Flynn's rating standards, which include both loss of extension and flexion (functional) as well as loss of carrying angle (cosmetic), the findings of the present research were graded. When holding out both arms at the sides with the palms directed forward, you would typically have a carrying angle of between 5 and 15 degrees. This is the elbow's "carrying angle" in its natural position. Loss of carrying angle occurs when the upper arm does not line properly with the forearm when the arm is in extension, and the palm is supinated. The following scale rates how much the arm's line diverges from the forearm: (Table 1).

Cosmetic component: When contrasted to the normal side, the results are poor ($>15^\circ$), fair ($10^\circ-15^\circ$), good ($5^\circ-10^\circ$), and excellent ($0^\circ-5^\circ$).

Functional component: Based on Flynn's standards, losses of flexion and extension values are excellent ($0^\circ-5^\circ$), good ($5^\circ-10^\circ$), fair ($10^\circ-15^\circ$), and poor ($>15^\circ$) if contrasted to the normal side.

Table 1: Flynn's criteria to evaluate outcome of treatment

Results	Rating	Carrying angle loss	Flexion Loss	Extension loss	Outcome
Satisfactory	Excellent	0-<5	0-<5	0-<5	The lower of the ratings is the overall rating.
	Good	5 to <10	5 to <10	5 to <10	
	Fair	10 to 15	10 to 15	10 to 15	
Unsatisfactory	Poor	>15	>15	>15	

Statistical analysis

SPSS version 28 (IBM, Armonk, New York, United States) was used for data administration and statistical analysis. The Shapiro-Wilk test and methods for direct visualization of data were used to determine the normality of the quantitative information. Quantitative parameters were reported as a median and range in accordance with normality. Numbers and percentages were used to represent a categorical set of data. Utilizing the Mann-Whitney U test for quantitative

information, outcomes were compared between quantitative data sets. In order to compare categorical data, Fisher's exact test was used. Every statistical test has two sides. P values less than 0.05 were considered significant.

Results

The mean age was 5 years 6 months ranging from (3-13) years, 12 participants were females (58%), and 9 participants were males (42%). 15 cases having their fractures in left side

(71%) and 6 cases having their fractures in right side (29%). 17 participants having their fractures because of falling on outstretched hand (FOOH) (81%) and 4 participants having their fracture because of falling from height (FFH) (19%). based on classification of Gartland all instances were extension-type, 15 of instances were type II (71%) and 6 instances were type III (29%).12 patients (57%) were

operated upon in the first 6 hours after trauma, 9 patients were operated upon 6-48 hours after trauma with mean 10.05 hours. 2 patients had diabetes mellitus (9.5%), 5 patients had anaemia (23.8%), 1 patient had epilepsy (4.76%), 1 patient had hepatitis c virus (4.76%) and rest of patients had no associated diseases (57.1%). Table 2.

Table 2: Demographic data, side affected, mode of trauma, Gartland classification, time from injury to surgery /hours and associated diseases of the studied cases

		n=21	%
Age/years	Mean	5.57	
	Median (Min-Max)	5	(3.0-13.0)
	<5	10	48%
	≥5	11	52%
Sex	Female	12	58%
	Male	9	42%
Side	Left	15	71%
	Right	6	29%
Mode of trauma	Falling on outstretched hand	17	81%
	Falling from height	4	19%
Gartland classification	II	15	71%
	III	6	29%
Time from injury to surgery /hours	Mean	10.05	
	Median (Min-Max)	6 (5-48)	57.0%
	≤6	12	
	>6	9	43.0%
Associated disease	None	12	57.1
	Anemia	5	23.8
	DM	2	9.5
	Epilepsy	1	4.8
	HCV Ab + ve	1	4.8

Data are presented as mean, median (IQR) or number (%). DM: diabetes mellites. HCV: Hepatitis C virus. Ab: antibody.

Half of the patients (52.4%) reported an excellent outcome. One-third reported good (33.3%). Only two patients reported fair outcomes, and one reported poor outcome. Most patients showed excellent grade (71.4%), followed by 19% good. Only one patient showed fair grade, another one showed good

grade. Most patients showed excellent rating (81%), followed by 14.3% good. Only one patient showed fair grade. Most patients showed excellent grade (71.4%), followed by 23.8% good. Only one patient showed fair grade. Table 3.

Table 3: Outcome, carrying angle, extension and flexion loss grade of the studied patients

	Poor n (%)	Fair n (%)	Good n (%)	Excellent n (%)
Outcome	1 (4.8)	2 (9.5)	7 (33.3)	11 (52.4)
Carrying angle loss	1 (4.8)	1 (4.8)	4 (19)	15 (71.4)
Extension loss	---	1 (4.8)	3 (14.3)	17 (81)
Flexion loss	---	1 (4.8)	5 (23.8)	15 (71.4)

Data are presented as number (%).

Radiological union appeared in 10 patients by 3rd week, three patients by 4th week, three patients by 5th week and in five patients by 6th week. The median Bauman’s angle change was 2, ranging from 0-7. The median AHL loss was 0, ranging from 0-15. The median carrying angle loss was 3, ranging from 0 – 12. The median extension loss was 3, ranging from 0 – 12. The median flexion loss was 4, ranging

from 0 – 17. Three-quarters of the patients (71.4%) had two pins, while one-quarter (28.6%) had three pins. Three patients reported pin tract infection (14.3%). Only one patient had hyperextension. Two patients had cubitus varus. Approximately three-quarters of the patients (71.4%) had no complications. Table 4.

Table 4: Time of radiological union in weeks, Baumann’s angle change and AHL loss, number of pins and complications in the studied patients

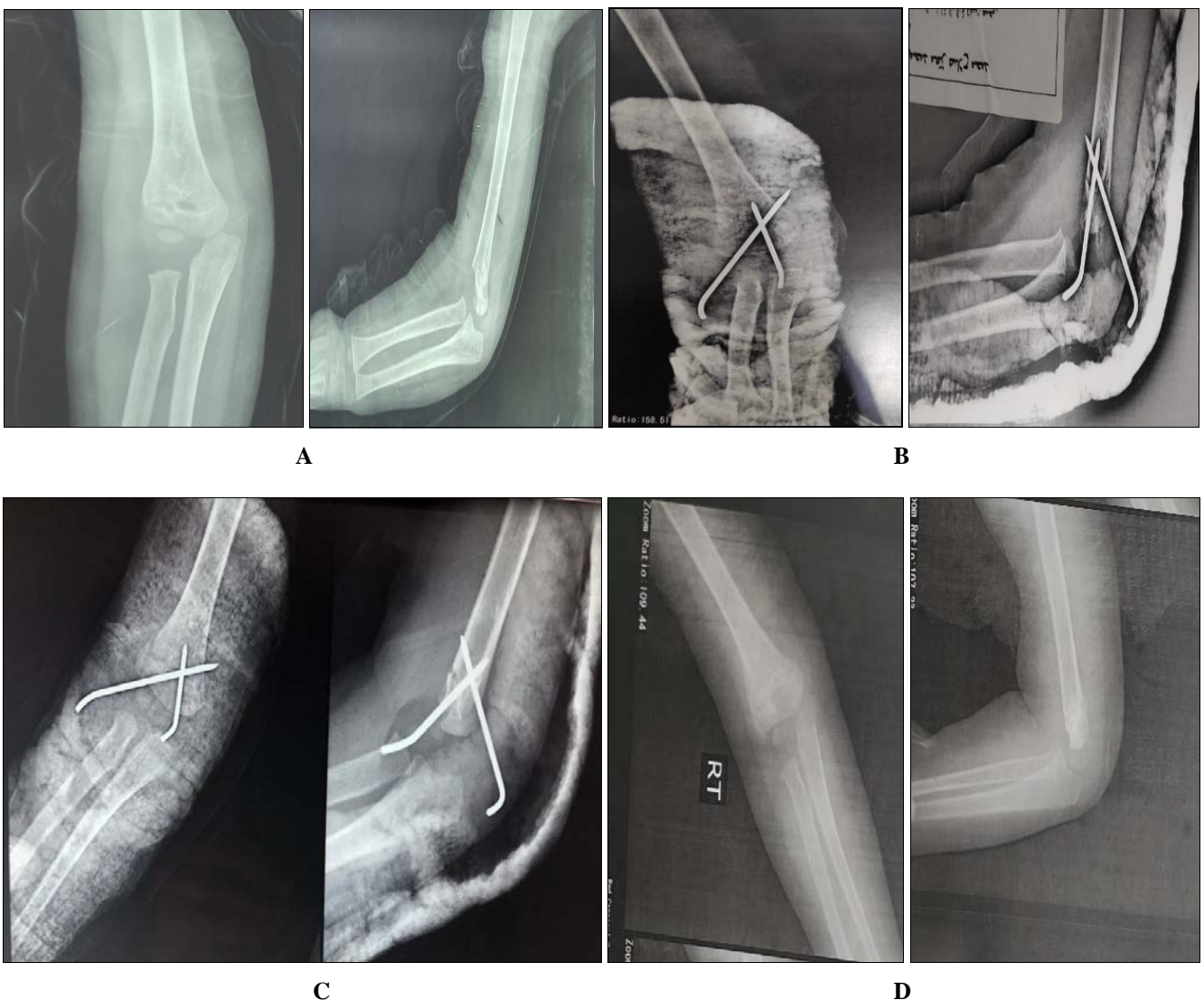
Time of radiological union in weeks		n=21	%
3 weeks		10	48.0
4 weeks		3	14.0
5 weeks		3	14.0
6 weeks		5	24.0
Baumann’s angle change		2 (0 - 7)	
AHL loss		0 (0 - 15)	
Number of pins	Two	15	71.4
	Three	6	28.6
Complications	Hyperextension	1	4.8
	Cubitus Varus	2	9.5
	Pin tract infection	3	14.3
	No complications	15	71.4

Data are presented as number (%) or median (IQR). AHL: anterior humeral line.

Case 1:

Male patient 4 years old. Fall on outstretched hand. Supracondylar fracture humerus, right elbow, extension type,

Gartland type 2. Managed by closed reduction and 1 posterior intra-facal pin and 1 lateral pin. Graded as an excellent result. Figure 1



Functional outcome

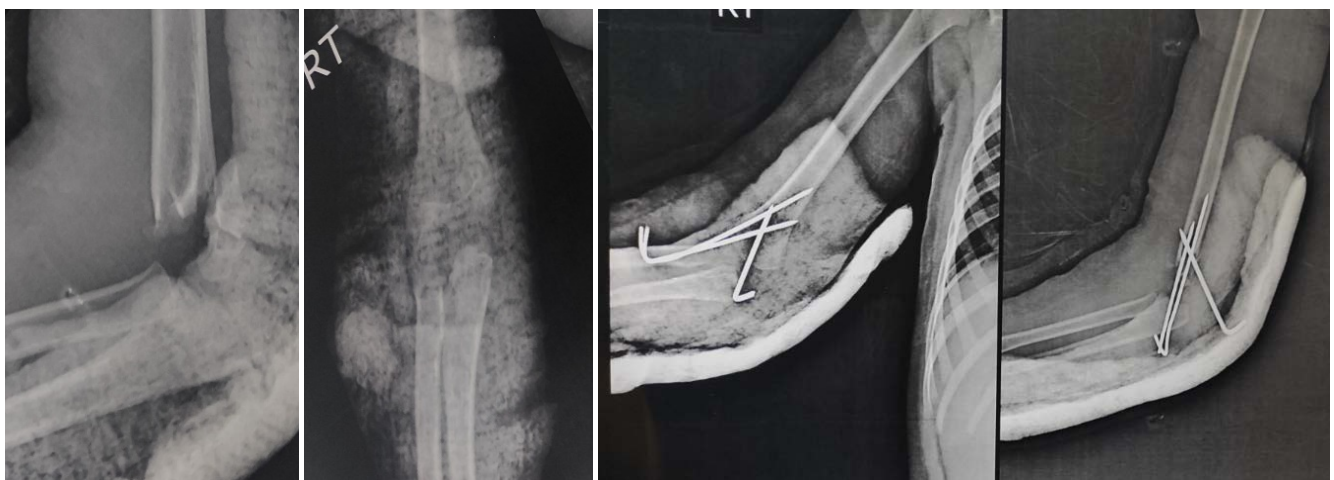


Fig 1: Case 1 (A): Pre reduction x-ray AP and Lateral views, (B): Immediate postoperative x-ray AP and lateral views, (C): 2 weeks follow up x-ray AP and lateral views and (D): 6 weeks follow up x-ray AP and lateral view

Case 2

Female patient 3 years old. Fall on outstretched hand. Supracondylar fracture humerus, right elbow, extension type,

Gartland type 3. Managed by closed reduction and posterior intrafocal pin and 2 lateral k wire fixation. Graded as an excellent result. Figure 2.



(A)

(B)

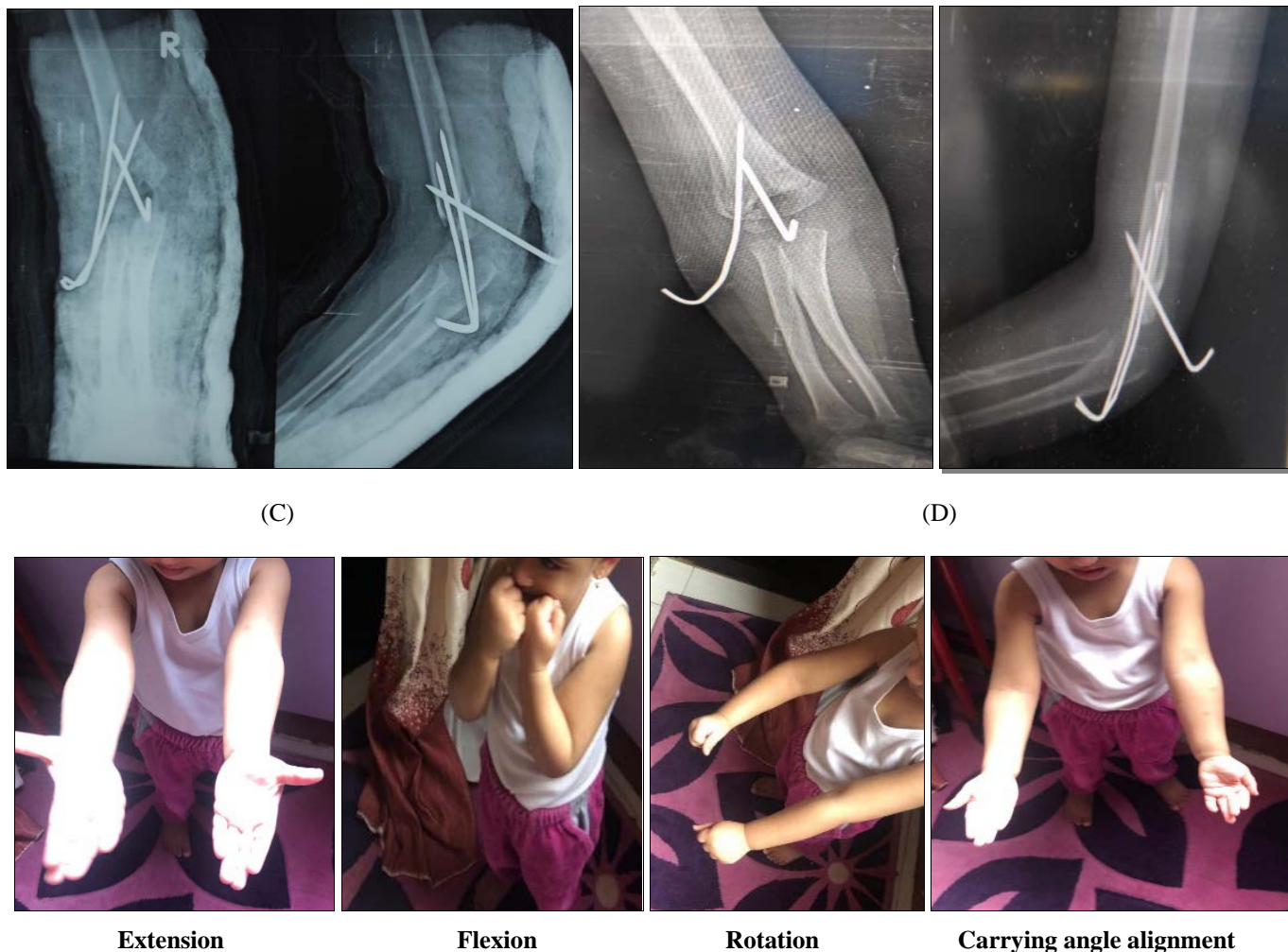


Fig 2: Case 2: (A) Pre reduction x-ray AP and Lateral views, (B): Immediate postoperative x-ray AP and lateral views, (C): 2 weeks follow up x-ray AP and lateral views, (D): 4 weeks follow up x-ray AP and lateral views before and after removal of one lateral k wire and (E): Functional outcome

Discussion

Surgery's primary objective in treating pediatric supracondylar the humeral fractures is the secure development of a construct strong enough to prevent axial rotation, hyperflexion, and extension of the distal fragment, hence preventing the postoperative deformities, that has been estimated to be as high as 17% [12].

In this research, the mean age of the patient was 5 years and 6 months, with a range of 3 to 13 years, 12 female participants (58%) and 9 male participants (42%), 17 individuals who sustained fractures as a result of falling on an outstretched hand (81%) and four individuals who sustained fractures as an originate from falling from height (19%), and a range of 5 to 48 hours between the injury and surgery.

All instances were extension-type based on the Gartland classifications, and 15 of the instances were type II (71%), while six instances were type III (29%). Flynn's criterion showed that 11 individuals had great outcomes, 7 had acceptable results, 2 had medium results, and 1 had poor outcomes. Following the removal of the pins, participants were quickly mobilized (3 to 6 weeks), and the usual follow-up time was 6 months. Due to improper reduction, there were two individuals who had a carrying-angle decrease of at least 10° compared to the opposing elbow. Cubitus varus deformity may occur if carrying angle is lost by more than 10 degrees. Not just for aesthetic reasons, but also to prevent potential delayed posterolateral rotatory instability of the elbow, the cubitus varus might require to be repaired.

Participants receiving care using the posterior intra-focal pinning approach were not reported to have had any iatrogenic neurovascular damage throughout this investigation. Other issues, such as a pin-tract infection, were managed by cleaning the pin site by removing wires, crusts, and repeated dressings with a local antibiotics spray and oral antibiotics (Amoxicillin-clavulanic acid), which helped the patient recover at the next check-up. On the most recent clinical evaluation, neither Volkmann ischemic contracture nor compartment syndrome were found.

Numerous investigations produced outcomes that were equivalent to those of this research, as reported by Fahmy *et al.*, [10] and the outcomes were evaluated using Flynn's standards. There were 21 excellent, 5 good, and 1 bad result in the single-wire category. Two individuals were unfollowable and lost. There were 32 excellent, two good, and three bad outcomes in the two-wire category. Three were not found during follow-up. They came to the conclusion that the intact posterior periosteal hinge may be employed effectively in a clinical setting and provide outcomes that are comparable to those of other pinning methods.

Retrospective reviews of 93 kids who had crossed pinning for Gartland type III supracondylar humerus fractures were conducted by Kao, Hsuan-Kai *et al.* [11]. Results were evaluated using the elbow's range of motion and radiographic parameters such the Baumann angle, the lateral humero-capitellar angle, and the anterior humeral line (AHL) location. They came to the conclusion that one additional posterior

intra-focal pin may help with reduction of fractures and improve fixation stability when crossing pinning is used.

The stiffest fixation, according to Marsland, Daniel, Stephen M. Belkoff *et al.* [13], was given by crossing pins (2.4 N m/degree), then followed by diverging lateral pins (1.9 N m/degree) and the posterior intra-focal pin (1.9 N m/degree), although none of the variations was statistically significant. Peak torque was similar among fixations, but the trend revealed that crossing pins (34.6 N m) were the strongest, followed by divergent lateral pins (30.3 N m), and finally posterior intra-focal pin fixation (26.1 N m). They came to the conclusion that the resistance to internal rotation of posterior intra-focal pin fixation is on par with that of crossed medial and lateral pins and divergent lateral entrance pins.

According to Lu *et al.*'s analysis [14] using the Flynn assessment criteria, 116 children (90.6% of all patients) had excellent outcomes, 11 (8.6%) had good outcomes, and 1 (0.8%) had fair results. The course of therapy revealed no infection, no ischemic muscle atrophy, and no nerve injury. They came to the conclusion that manipulative reduction and lateral percutaneous K-wire fixation of supracondylar humeral fractures in young patients with minor wounds is stable, dependable, and simple to be operated, safe, efficient, and inexpensive.

Limitations: The sample size was relatively small. Larger study with enough power is needed for further assessment of this technique of fixation. postoperative follow up was not very long relatively. Also, each subtype group of fixation technique needs further separate assessment.

Conclusions

If properly applied, closed reduction and internal fixation with posterior intra-focal pinning is a reliable type of fixation that completely protects the ulnar nerve in the management of supracondylar fractures of the humerus in children in the age range (3-13 years).

Financial support and sponsorship: Nil

Conflict of Interest: Nil

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How to Cite This Article

Khattab IS, Khalil AE, Mejahed AA, Elgebaly OA. Posterior Intra-focal wiring for extension type supracondylar humeral fractures in children. *International Journal of Orthopaedics Sciences*. 2023;9(3):369-375.

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