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Comparison of Lateral Entry and Crossed Entry Pinning for Paediatric Supracondylar Humeral Fractures: Case Series

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A B S T R A C T

Background: Closed reduction and percutaneous pin fixation techniques have been proposed as treatment strategies for displaced supracondylar humeral fractures (SCHFs) in children. Commonly lateral pinning and cross pinning techniques are utilised for fixation. However, controversy exists regarding the selection of the appropriate procedure. ***Methods***: A prospective study with 15 cases of displaced fracture supracondylar humerus, treated by lateral pinning and cross pinning, was conducted between August 2020 and May 2022. Patients were treated with either the lateral entry pin alone or the cross pinning with a combination of lateral entry pin and medial entry pin. Age, gender, fractured side, duration of surgery, postoperative complications, surgical approach, direction of pin application (lateral or cross), and Modified Flynn grading system grade was noted for study outcome. ***Results:*** No difference was found between lateral pinning and crossed pinning groups in terms of the grade of the Modified Flynn grading system and complications like iatrogenic ulnar nerve damage, loss of reduction. ***Conclusions:*** When both techniques were performed carefully, successful clinical results were observed. If the intraoperative instability found, should not hesitate to pin the medial K-wire in order to increase stability.

Keywords: Supracondylar humeral fractures, Pediatric, Pin fixation.

INTRODUCTION

Pediatric supracondylar humerus fractures are the most common fractures that account for more than 50% of fractures around the elbow in children [1]. These injuries are divided into extension and flexion types. The extension type is the most common type [2]. The most widely accepted classification is the Gartland classification [3]. While type I fractures are typically treated non-surgically, some type II and almost all type III fractures usually require surgical intervention [4]. Closed reduction and percutaneous pinning is the universally accepted modality for displaced fractures. Pin configuration has been the focus of many recent research studies on the treatment of displaced fractures [5-7]. There are two common pin fixing techniques: lateral pinning only and cross pinning with medial and lateral pins [8]. Theoretically, cross-entry pins have the advantage of improved mechanical stability of the configuration, however, this technique increases potential injury to the ulnar nerve [9, 10], Lateral entry pins can reduce the mechanical stability of the construct [11] but injury to the ulnar nerve can be avoided. Biomechanical tests have shown that both medial and lateral cross pinning is more advantageous [12, 13]. Nevertheless, the risk of iatrogenic ulnar nerve injury during medial pin placement is high [14]. In this study, it was aimed to analyze the functional outcomes and complications treated with lateral pinning and cross pinning.

METHODS

Pediatric supracondylar humerus fractures are the most common fractures that account for more than 50% of fractures around the elbow in children [1]. These injuries are divided into extension and flexion types. The extension type is the most common type [2]. The most widely accepted classification is the Gartland classification [3]. While type I fractures are typically treated non-surgically, some type II and almost all type III fractures usually require surgical intervention [4]. Closed reduction and percutaneous pinning is the universally accepted modality for displaced fractures. Pin configuration has been the focus of many recent research studies on the treatment of displaced fractures [5-7]. There are two common pin fixing techniques: lateral pinning only and cross pinning with medial and lateral pins [8]. Theoretically, cross-entry pins have the advantage of improved mechanical stability of the configuration, however, this technique increases potential injury to the ulnar nerve [9, 10], Lateral entry pins can reduce the mechanical stability of the construct [11] but injury to the ulnar nerve can be avoided. Biomechanical tests have shown that both medial and lateral cross pinning is more advantageous [12, 13]. Nevertheless, the risk of iatrogenic ulnar nerve injury during medial pin placement is high [14]. In this study, it was aimed to analyze the functional outcomes and complications treated with lateral pinning and cross pinning.

SURGICAL TECHNIQUE

All interventions were performed under general anesthesia. A closed reduction maneuver was performed to all fractures. An anterior approach was performed to patients with preoperative anterior interosseous nerve (median nerve) injury. After reduction, it was stabilized in the reduced position with percutaneous K-wires (k-wires determined according to the patient's age and bone cortex thickness). Two K-wires were placed laterally or one K-wire was placed medially in a mini-open technique along with lateral pin, in case of instability additional k wire was placed, stability assessed by the intraoperative C-arm fluoroscope. After the wires were cut, the ends were bent and left on the skin. After the K-wire dressing, the elbow joint was splinted to be immobilized in neutral rotation and 90° flexion position for three weeks. Postoperative follow-up was made routinely, radiologically, and clinically at the first, second, third, fourth, sixth, eighth, twelfth, twenty-fourth weeks and at the end of the first year. The splint was terminated in the third week. Active movements were encouraged by teaching the child and family without removing the K-wires. In the fourth week, the K-wires were removed. Active-passive movements of the elbow were started. Evaluation of clinical results was made with the modified Flynn grading system at 12 weeks and at the end of the first year [16, 17]. Modified Flynn grading system's criteria include two factors: Cosmetic factor (loss of carrying angle degree) and functional factor (motion loss in degrees). Results were grouped into satisfactory [Excellent (0 to 5) - Good (6 to 10)] / Unsatisfactory [Fair (11 to 15) – Poor (>15)]. The final modified Flynn grade result was noted according to whichever cosmetic or functional factor was worse [18]. The range of motion of the joint was measured with the goniometer. Measurements were made considering passive movements. Restoration of a full range of motion of the elbow was defined as the range of motion of elbow flexion/extension less than 10° as measured by the uninjured elbow [19].

RESULTS

A total of 15 people were included in the study. While 7 of the patients were in the lateral pinning group, 8 of them were in the cross-pinning group. In the study, no difference was observed between the groups in terms of gender. In the study, no statistically significant difference was found between the groups in terms of Modified Flynn grading system. The mean operating time of the study is 25 minutes, with highest time noted in cross pinning group. Complications like pin loosening and superficial infection was noted in one patient in lateral group. No neuropraxia were noted.

Table 1:Mechanism of injury

Type of fixation		**Mechanism of injury**			
		RTA	**Self-fall**	**Sports**	**Total**
	Cross Pinning	3	2	3	8
	Lateral Pinning	1	5	1	7
	Total	4	7	4	15

Table 2: Modified Flynn grading system

Type offixation		**Grading**			**Total**
		Excellent	**Good**	**Poor**	
	Cross Pinning	5	3	0	8
	Lateral Pinning	0	6	1	7
	Total	5	9	1	15

Table 3:

Patient No.	**Age/ Sex**	**Mechanism Of**	**Fracture Type**	**Type Of Fixa**	**Duration Of**	**Modified Flynn Grading System**	**Grading**	**Radiological Finding**	**Complications**

		Injury	**(Gartland)**	**tion**	**Surgery**					**s**			
						Follow Ups	**Loss Of Carrying Angle**	**Loss Of ROM**			**Superficial Infections**	**Ulnar Neuropraxia**	**Pin Loosening**
1	5Y/M	Self fall	II	Cross pinning	20	2,4,6	0	0	Excellent	United	NO	NO	NO
2	6Y/M	Self fall	II	Lateral pin	20	2,4,6	0	0	GOOD	United	NO	NO	NO
3	9Y/F	RTA	II	Cross pinning	28	2,4,6	10	10	GOOD	United	NO	NO	NO
4	4Y/M	Self fall	II	Lateral pinning	32	2,4,6	5	5	GOOD	United	NO	NO	NO
5	9Y/F	Sports	III	Cross pinning	25	2,4,6,	0	0	Excellent	United	NO	NO	NO
6	12Y/M	Self fall	II	Lateral pinning	16	2,4,6	5	5	GOOD	United	NO	NO	NO
7	10Y/F	Self fall	II	Lateral pinning	24	2,4,6	5	5	GOOD	United	NO	NO	NO
8	7Y/M	RTA	III	Cross pinning	26	2,4,6	5	5	GOOD	United	NO	NO	NO
9	6Y/M	Self fall	II	Lateral pinning	28	2,4,6	15	15	Excellent	United	YES	NO	YES
10	5Y/M	Sports	II	Cross pinning	16	2.4.6	10	10	POOR	United	NO	NO	NO
11	9Y/F	Self fall	III	Cross pinning	24	2.4.6	0	0	GOOD	United	NO	NO	NO
12	7Y/M	RTA	III	Cross pinning	26	2,4,6	0	0	Excellent	United	NO	NO	NO
13	6Y/M	Self fall	II	Lateral pinning	28	2,4,6	10	10	GOOD	United	NO	NO	NO

14	9Y/F	RTA	II	Lateral pinning	31	2,4,6	5	5	GOOD	United	NO	NO	NO
15	9Y/F	Sports	III	Cross pinning	52	2,4,6	5	5	GOOD	United	NO	NO	NO

CASE1

7 year male child sustained injury left elbow resulting in left supracondylar humerus fracture fixed with closed reduction and cross pinning

Figure 1:

Figure 2:

CASE 2

4 year old female child with right supracondylar humerus fracture treated with closed reduction with lateral pinning.

Figure 3:

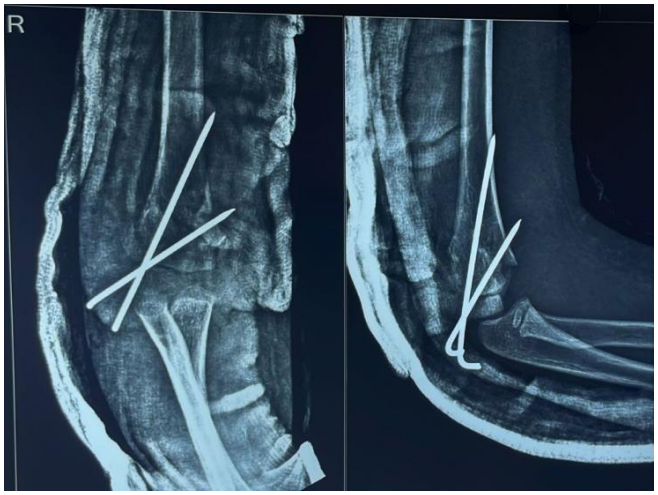

Figure 4:

DISCUSSION

In order to treat displaced SCHF in children successfully, an acceptable reduction must be achieved and maintained while avoiding complications until the fracture heals. There is still debate over the best method for pin fixation. Although there are numerous pinning configurations described in the literature, crossed and lateral entry pinning are the two most often utilized configurations. With a 0–6% incidence rate, there is a considerable chance of iatrogenic ulnar nerve injury during medial pinning in a crossed configuration. On the other hand, the most frequent consequence of inadequate or loss of reduction during treatment is cubitus varus, with an incidence of 3-57%. This is because the lateral pinning technique carries a risk of loss of reduction because it is biomechanically less table. Dorgan's method of crossing pinning from the lateral side was designed to prevent these complications. Although there is a theoretical possibility of ulnar nerve damage, in practice, nerve injury is farless common than with medial-lateral cross pinning. The issue is the lack of evidence from biomechanical studies showing that this method's stability is comparable to that of conventional cross-pinning.

47 patients under went the crossed pinning technique in a study by Kwak-Lee *et al*., [26], and it was reported that none of the patients had iatrogenic ulnar pin terrain. It was asserted that medial pinning was secure when the right procedure was followed. It was also asserted that even though inserting medial pins lengthens procedures, complications do not rise as a result.

In a study by Maity*et al*., [27] comparing lateral and cross pinning on 160 supracondylar fractures found no statistically significant difference in complications between the two groups. This means that using a standard technique won't make a difference in terms of effectiveness orsafety.

In a 2018 meta-analysis, it was recommended that the lateral access technique be used to treat paediatric distal humerus supracondylar fractures due to the potential risks of lateral pinning with only two K-wires and crossed K-pins

with risk of iatrogenic ulnar nerve injury. It was also mentioned that adding a third K-wire laterally could increase the stability of the fracture fixation and that adding an extra K-wire might be an option for surgeons who want to avoid medial pinning. Additionally, it was recommended that surgeons using the cross-entry technique who want a more stable structure take extra precautions to protect the ulnar nerve [11].

The fact that there were less number of patients included in the groups was the drawback. For better outcomes, randomised, prospective studies involving larger groups are required.

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