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Functional and Radiological Outcome in Displaced Supracondylar Humerus Fracture in Children Treated with Closed Reduction and Lateral or Cross Pinning- A Retrospective Study

Vishal Ashokraj Pushkarna[1*] and Kelvinkumar Bhagvanjibhai Sureja[1]

[1]Department of Orthopaedics, Gujarat Adani Institute of Medical Sciences, Bhuj, District Kutch, Gujarat, India.

Authors' contributions

This work was carried out in collaboration between both authors. Author VAP designed the study, performed the statistical analysis, wrote the protocol with contribution of author KBS and wrote the first draft of the manuscript. Author KBS managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Supracondylar Humerus Fracture (SCHF) is frequently encountered in pediatric age group and nearly three fourth of all upper extremity fractures. Most commonly used technique for surgical treatment in the displaced SCHF in children is closed reduction and stabilization with percutaneous pins.

Aim: This retrospective study was conducted to find out the outcome and safety of percutaneous pinning techniques which includes lateral pinning and cross pinning in terms of functional and radiological outcome and to see the associated complications with this method of fixation.

Materials and Methods: This retrospective study comprising of 26 cases of displaced supracondylar fracture, treated with lateral or cross pinning was carried out at Orthopedics Department, Gujarat Adani Institute of Medical Sciences and G.K General Hospital, Bhuj from May 2019 to April 2020. The inclusion criteria were: a) Gartland extension type II, III, b) age below 12 years, c) presented to OPD/Emergency within 72 hours of injury, d) closed and gustilo grade I

**Corresponding author: Email: vishalpusshkarna@hotmail.com;*

open fractures, Patients with: a) Extension Type I of fractures, b) flexion type injuries, c) except Gustilo grade 1 open fracture d) age more than 12 year e) pervious history of fractures or nerve injury around the elbow, were excluded from the study. Postoperative immobilization was with an above elbow back splint and an arm sling. Flynn's score was used to measure outcome.

Results: Out of the 26 patients, 18 were male and 8 were female. The children were aged 2 years to 12 years with a median age of 8.07 years. Out of all cases, 3 cases were treated by two lateral k-wires while 19 were treated by 3 lateral k-wires while only four cases were treated with cross pinning. According Flynn's criteria; satisfactory functional results in our study were 54% of cases had excellent results, 38% had good results and 8% had a fair result. 42% of cases had excellent cosmetic results were 54% of cases had good results and 4% had a fair result.

Conclusion: In our study, we found that anatomical reduction and intra- operative stability will dictate the type of configuration to be used in SCHF.

Keywords: Fracture; loss of reduction; supracondylar humerus; pin configuration.

1. INTRODUCTION

Supracondylar Humerus Fracture (SCHF) is frequently encountered in pediatric age group and nearly three fourth of all upper extremity fractures [1,2,3]. According to the direction of distal fragment, in children's supracondylar humerus fractures is divided into extension type 97.8% and flexion type 2.2% [2]. Gartland's classification is used to describe this fracture and it is based on displacement in coronal plane radiographs. Type I: Undisplaced fractures or minimally displaced fracture with intact anterior humeral line. Type II hinged fractures with the posterior cortex intact, and Type III completely displaced fractures, breach in the posterior cortex [3]. Later, Leitch et al., Added type IV, describing multidirectional instability [4].

Most commonly used technique for surgical treatment in the displaced SCHF (type II, III, IV) in children is closed reduction and stabilization with percutaneous pins [5]. First described by Casiano in 1960 [6]. The most commonly used configuration of pinning are medial, lateral crossed pinning and only lateral pinning. Biomechanically, a crossed pin configuration (one medial and one lateral) provides increased stability, but carries the risk of iatrogenic ulnar nerve injury during insertion of the medial pin [7,8]. Conversely, lateral pin fixation avoids the danger of iatrogenic ulnar nerve injury, but has been proven to be mechanically less stable compared to crossed pin configuration [8,9]. There are studies which have proven that lateral-only fixation is good enough for maintaining reduction while simultaneously avoiding injury to the ulnar nerve [10-13] but biomechanically less stable if not used in the proper configuration. Still, there is controversy regarding choice of pinning configuration and based primarily on the surgeon's preference.

This retrospective study was conducted to find out the outcome and safety of percutaneous pinning techniques which includes lateral pinning and cross pinning in terms of functional and radiological outcome the management of displaced supracondylar humerus fractures in children and to see the associated complications with this method of fixation.

2. MATERIALS AND METHODS

This retrospective study comprising of 26 cases of displaced supracondylar humerus fracture, treated with lateral or cross pinning was carried out at Orthopedics Department, Gujarat Adani Institute of Medical Sciences and G.K General Hospital, Bhuj from May 2019 to April 2020.

The inclusion criteria were: a) Gartland extension type II, III, b) age below 12 years, c) presented to OPD/Emergency within 72 hours of injury, d) closed and gustilo grade I open fractures, while patients with: a) Extension Type I of fractures, b) flexion type injuries, c) except Gustilo grade 1 open fracture d) age more than 12 year e) pervious history of fractures or nerve injury around the elbow, were excluded from the study.

All the necessary preoperative work-up was done in the form of thorough clinical and radiological examination. The fractures were classified as per the Gartland's classification system. In the operating room, closed reduction was done, under general anesthesia.

Transcutaneous pin fixation was then performed and directed with image intensifiers. When satisfactory reduction had been achieved, then fixation was done by two or three lateral or cross pinning with one lateral and one medial depending upon the testing post reduction and

the fracture stability intraoperatively with K-wires of 1.8- or 2. 0-mm size. If preoperatively and/or intra operatively if we found medial comminution than we have chosen to do cross pinning in such cases because according to literature cross pinning is more stable construct than lateral pinning [14]. Patients in which cross pinning technique was used in such cases medial pin was inserted with small incision over medial epicondyle and in order to prevent ulnar nerve injury, elbow was kept in less flexion around 45 to 60 degrees and wire was placed over the epicondyle, anterior to ulnar groove. At least one lateral pin was passed from capitulum to increase the purchase of k-wire. Vascularity of distal limb were also checked at this point. The pins were bent and cut off outside the skin and a well-padded, above-elbow, back-slab was applied and vascularity of the distal part of limb checked again.

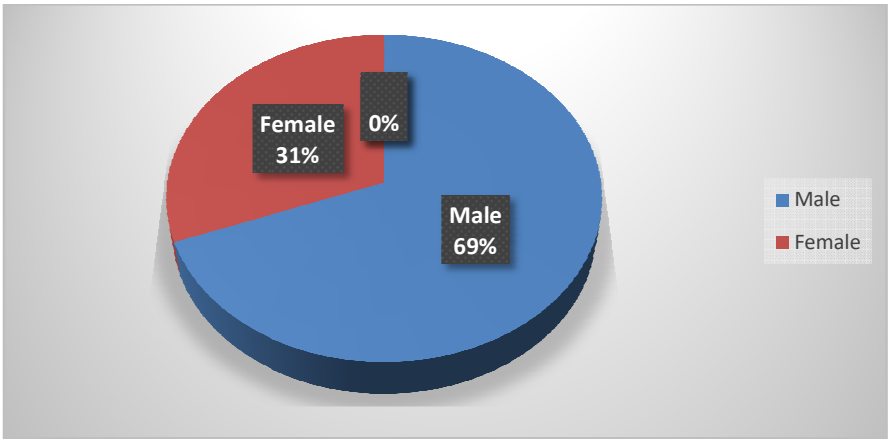
2.1 Postoperative Care and Rehabilitation

The patient was carefully observed for 24-48 hours with proper limb elevation and then discharged in above elbow POP back slab. The follow-up was done as follows: 5th day and 12th day to inspect pin tract infection and swelling; and 4th and 6th week follow-up to assess radiological union and infection or pin loosening. K-wire and plaster slab were removed at 6th week and physiotherapy were started. Subsequent follow up is around the 8th week to see the progress of rehabilitation and any other complications; and the final follow-up on the 3 months post-operatively to see the result of the study. The results were analyzed using the Flynn criteria [7]. These criteria are divided into two components, the functional and the cosmetic component and both are further sub-divided as excellent, good, fair and poor at an interval of five degrees.

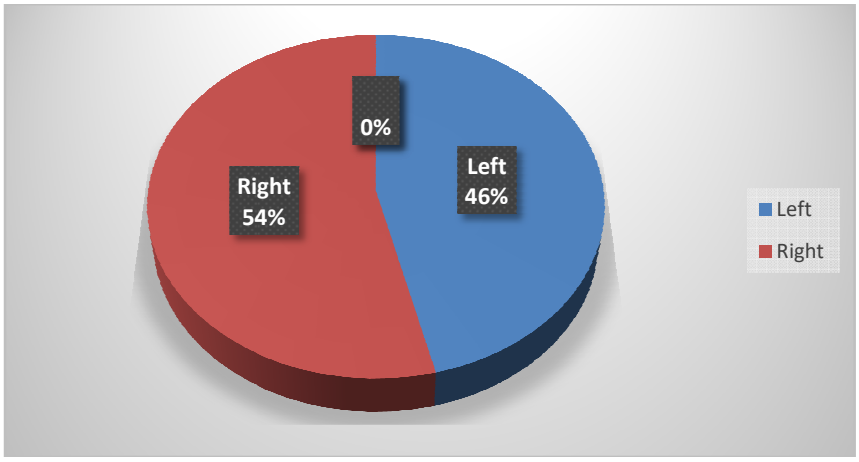
3. RESULTS

Out of the 26 patients, 18 (69.3%) were male and 8 (30.7%) were female (Graph 1). The children were aged 2 years to 12 years with a median age of 8.07 years (Table 1). There were 12 left sided and 14 right-sided fractures (Graph 2). 20 children had an injury while playing and 6 had a fall from a height. Out of 26 patients one patient having gustilo type I fracture. The extension type II were 7 and 19 were of extension type III. (Graph 3). Out of all cases, 3 cases were treated by two lateral k-wires while 19 were treated by 3 lateral k-wires while only four cases were treated with cross pinning (Table 2). Two of the fractures required open reduction. There were no cases of vascular or nerve injuries, pre-operatively. During follow-up, none had a secondary displacement of wires and loss of reduction. Post-operatively, no patient had a pin track infection or pin migration. Postoperatively, in one case median nerve injury was noted which recovered in 5 weeks. Callus formation was seen in all patients at the 4th week postoperative follow up before removing the K-wires. No case of nonunion was seen. Results were analyzed using Flynn's criteria [7].

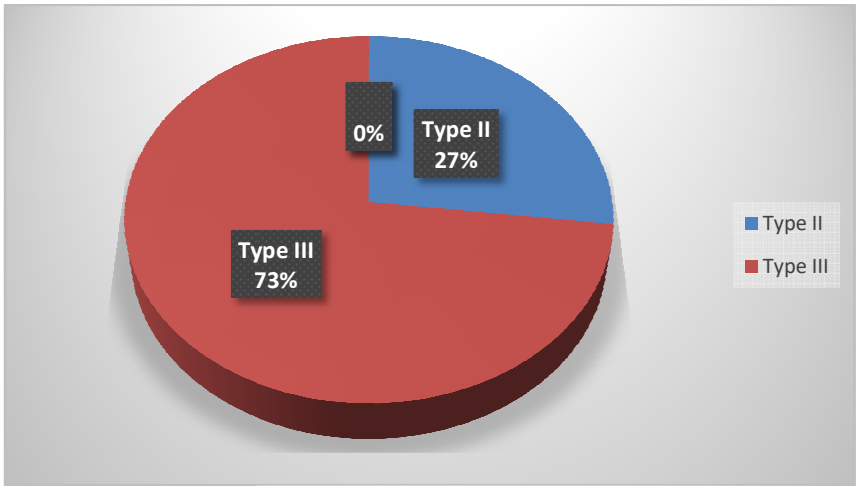
According Flynn's criteria; satisfactory functional results in our study were 54% of cases had excellent results, 38% had good results and 8% had a fair result. 42% of cases had excellent cosmetic results while 54% of cases had good results and only 4% hada fair resultt. (Tables 4, 5, 6, 7, 8).



Graph 1. Gender wise distribution of patients



Graph 2. Distribution according to site involved



Graph 3. Distribution of patients according to type of fracture

Table 1. Distribution of patients as per age

Age	0-5 years	6-10 years	More than 10 years but less than 12 years	Total
Male	2	10	6	18
Female	2	5	1	8

Table 2. According to method of fixation

Approach	Numbers	Percentage
Lateral 2 pin	3	11.5%
Lateral 3 pin	19	73%
Cross Pinning (medial and lateral pinning)	4	15.5%

Table 3. According to fracture type pinning method

Type of fracture	2 Lateral pins	3 Lateral pins	Cross pinning	Total
Type II	3	4	0	7
Type III	0	15	4	19
Total	3	19	4	

Table 4. Assessment of treatment outcome according to Flynn criteria

Results		Cosmetic factor: Loss of carrying angle (degrees)	Functional factor: Loss of motion (degrees)
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
	Fair	11-15	11-15
Unsatisfactory	Poor	>15	>15

Table 5. Functional result: Range of Motion (ROM)

Results	Rating	Functional factor: loss of motion (degrees)	Outcome of patients	Percentage (n=26)
Satisfactory	Excellent	0-5	14	54%
	Good	6-10	10	38%
	Fair	11-15	2	8%
Unsatisfactory	Poor	>15	0	0

Table 6. Functional result according to pin configuration: Range of Motion (ROM)

	Lateral 2 pin	Lateral 3 pin	Cross pinning
Excellent	1	11	2
Good	2	6	2
Fair	0	2	0

Table 7. Cosmetic results

Results	Rating	Cosmetic factor: Loss of carrying angle (degrees)	Outcome in patients	Percentage (n=26)
Satisfactory	Excellent	0-5	11	42%
	Good	6-10	14	54%
	Fair	11-15	1	4%
Unsatisfactory	Poor	>15	0	0

Table 8. Cosmetic result according to pin configuration

	Lateral 2 pin	Lateral 3 pin	Cross pinning
Excellent	1	8	2
Good	2	10	2
Fair	0	1	0

Fig. 1. Pre-operative x-ray

Fig. 2. Immediate post-operative x-ray

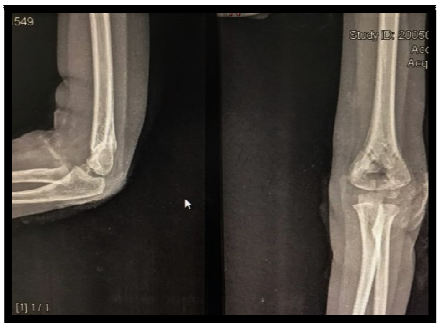


Fig. 3. 3 months post-operative x-ray

Fig. 4. Clinical picture

4. DISCUSSION

The success of the treatment of displaced supracondylar fractures of the humerus in children depends on good reduction, intra-op stability achieved with a k-wires, maintenance of the reduction until fracture healing with avoidance of complications. Controversy persists regarding the optimal pin fixation technique. It involves the use of two or three lateral pins which are placed in either a parallel or a divergent pattern and cross pinning where one pin is inserted from the medial side [15].There is a significant risk of iatrogenic ulnar nerve injury

during medial pinning in crossed configuration with an incidence rate of 0-6% [16]. Whereas, in lateral pinning technique, there is a chance of loss of reduction due to biomechanically less stable, and most common complication of poor or loss of reduction during treatment is cubitus varus with an incidence of 3-57% [16]. Chakraborty et al. and Balakumar and Madhuri found crossed (medial/lateral) pinning to be superior than two parallel lateral pin Fixations [17,18]. However, many studies have reinforced the observation that both lateral-entry pin fixation and crossed pin configuration are effective in the management of Type III Gartland supracondylar fractures in children.

Sankar et al. studied the loss of pin fixation in supracondylar humerus fractures. He concluded in all cases; loss of fixation was due to technical errors that were identified during intraoperative fluoroscopic images [19]. All these errors could have been prevented with proper reduction and fixation technique. Three types of pin-fixation errors were identified as: (1) failure to achieve bicortical fixation with two pins or more, (2) failure to engage both fragments with two pins or more, and (3) failure to achieve adequate pin separation (>2 mm) at the fracture site.

Govindasamy et al. did a retrospective study on Cross pinning versus lateral pinning in supracondylar fracture in children and concluded that both fixation techniques were good in terms of stability, function and cosmetic outcome [20]. The problem with cross pinning was iatrogenic ulnar nerve injury due to medial pinning which was 11%. So lateral pinning is a reliably safe method and provides adequate stability in displaced supracondylar fractures.

In the current concept of Bloom et al, they reported that three lateral pins were biomechanically equivalent to two cross pins; but that the cross pins provided more stable fixation than the two lateral pins [14].

In our study on a total number of 26 cases, two lateral pins were used in 3 cases, 19 cases 3 lateral pins were used, and 4 cases cross pinning was done. The mode of injury was mostly fall while playing. In one case median nerve injury was reported, in 3 lateral pinning configuration post operatively, which was recovered. The choice of the pin configuration was based on the intraoperative stability using continues fluoroscopic examination after pin fixation and the severity of the elbow swelling.

Few limitations of this study were sample size, which is less and secondly, short term follow-up.

5. CONCLUSION

In our study, we found that anatomical reduction and intra- operative stability will dictate the type of configuration to be used in SCHF. For most of the type II fractures 2 or 3 lateral pin configuration works best and in type 3 at least three lateral pin configuration gives stability to the fracture and maintained the reduction till fracture unites. We found that if there is a comminution of the medial wall or unstable SCHF cross pinning will give better results compared to only lateral pinning and the only downside is the chances of iatrogenic ulnar nerve injury. Still in our study there was no significant difference in patient outcomes in between cross pins and lateral pin entry in terms of functional and radiological outcome, union and other surgical complication.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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