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Percutaneous Pinning Treatment for Pediatric Proximal Humeral Fracture

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The rationale behind reduction and percutaneous pinning of proximal humeral fractures is a more rapid return of normal active and passive range of motion, improved patient comfort, and easier care of the patient. This study is to prove short-term clinical and radiographic results of closed reduction and percutaneous pinning in displaced proximal humeral fractures in pediatric by k-wire.An interventional Study included 18 patients with mean age (11.8) years with closed proximal humeral fracture at Zagazig University Hospital. Surgery was done under general anesthesia for all patients with muscle relaxant to facilitated reduction. All patients were treated by closed reduction and percutaneous pinning under image intensifier using Kirschner-wires. Radiographs were taken immediate after surgery. Passive range of motion and pendulum exercises was begun depending on stability of osteosynthesis and bone quality from 3rd weeks.All patients were followed every week in first month and every 3 w for 3 months.The age of the patients ranged from (8 -15) with the mean± SD was 11.88 ± 2.08. According to NEER classification 15 patient had grade 4 (83.3%), 2 cases had grade 3 (11.1%) and 1 case had grade 2 (5.6%). The union time mean was 5.11 ± 0.67weeks with minimum of 4 weeks and maximum6 weeks. Majority of studied group 10 cases had union at 5 weeks (55.6%), 5 cases had union in 6 weeks (27.7%), and 3 cases had union in 4 weeks (16.7%). Complicated cases significantly with Neer grade 3 and 2 and with associated injuries but non-complicated cases significantly associated with excellent constant score.Closed reduction and percutaneous pinning are effective in stabilizing severely displaced proximal humeral fractures in pediatric with achievement of satisfactory results.This study advocate non-operative treatment where possible, especially in younger children.

Keywords: Humeral Fracture, Percutaneous Pinning, NEER classification and Kirschner-wires.

INTRODUCTION

Proximal humeral physeal fractures are most commonly classified according to the type of physeal injury or the amount of displacement, or both. Generally, infants and small children with proximal humeral physeal injuries have Salter-Harris type I fracture, whereas older children and adolescents have Salter-Harris type II injuries (Wattset al.2018). The rationale behind reduction and percutaneous pinning of proximal humeral fractures is a more rapid return of normal active and passive range of motion, improved patient comfort, and easier care of the patient. There is a minimally increased, but acceptable, risk of infection. This approach is more acceptable than leaving the fracture unreduced and risking a decrease in shoulder range of motion with secondary shoulder pain (Markel et al.1994). A Kirschner wire (also called a K-wire) is a thin wire that can be used to stabilize bone fragments. These wires can be drilled through the bone to hold the fragments in place. They can be placed

percutaneously or can be buried beneath the skin. K-wires used to be used more commonly when traction was a common treatment for certain types of fractures (Kobayashi and Fukasa-wa, 2014).

The most frequent complications in pediatric population are claimed to be angulation and shortening. Neurologic injuries have been reported to occur with proximal humerus fractures including the brachial plexus, mainly the axillary nerve, from fracture dislocation. Most of these injuries are neurapraxias that recover within 4-6 months (Visser et al.2000; Steinmann and Moran,2001). Patients presenting after dislocation or fracture, signs of trauma will be evident on physical exam. Nevertheless, patients may not report muscle weakness or paresthesia due to the presence of acute pain and limited range of motion (Ellefsenet al.1994). Injury to the axillary artery occurs secondary to fractures of the proximal humerus and is the most common vascular injury seen in these fractures. Angiography should be performed to confirm the diagnosis and to establish the exact location and nature of the injury. Arterial repair should be performed without delay and, coordinated with appropriate orthopaedic fracture repair (Brian et al. 2009 ; Williams and Wong, 2010). Children with humerusvarus have a significant decrease in the humeral neck shaft angle and shortening. Malunion from insufficient treatment of displaced fractures can be disabling problem. However, in some cases surgical management is needed to properly realign the humerus (Hohlochet al.2017). Shoulder stiffness remains one of the most common complications after a proximal humerul fractures. Patients who began a therapy program fewer than 2 weeks from the date of injury demonstrated significantly better results (forward elevation, external rotation, pain level) than did the patients who began therapy more than 2 weeks after injury (Chae et al. 2019). Thus, the purpose of this study is to prove short-term clinical and radiographic results of closed reduction and percutaneous pinning in displaced proximal humeral fractures in pediatric by k-wire.

MATERIALS AND METHODS

An interventional study included 18 patients percutaneous pinning proximal humeral fracture. Patients were enrolled from Orthopedic Department, Zagazig University Hospitals between November 2019 and June 2020 at Zagazig university hospital by closed reduction and percutaneous pinning by k-wire. An approval was obtained from Institutional Review Board (IRB) Zagazig University and written informed consents were obtained from all patients.

Inclusion criteria:

Age of children between (8 -15 years) with closed displaced fractures of the proximal humerus and minimal skin compromise of the injured shoulder. The patient could tolerate general anesthesia. There was absence of associated neurovascular injuries.Growth cartilage visible on standard radiographs.

Exclusion criteria:

Fracture dislocation, associated neurovascular injuries, neglected cases, failed previous fixation and need for open reduction, hematological or rheumatological diseases, presence of infection, pathological fractures, absence of growth cartilage on standard radiographs, polytraumatized patients and compound fractures.

Clinical examination:

Patients were examined for any systemic diseases as diabetes mellitus. To test the integrity of sensation around the shoulder, prick each dermatome lightly with a pin, asking the patient if he feels the pinprick. Then prick the opposite side. Again, ask the patient if the sensations in the two shoulders are similar or dissimilar. Vascular examination included examination of peripheral pulsation (radial and brachial pulsations) for absent or unequal pulsation. Antero-posterior view of plain x-ray for the affected shoulder. Laboratory investigations: including: CBC, random blood sugar and renal function test. U shap slab and armpouch-sling for fracture limb was done to stabilize fracture and reduce pain.

Operational procedures:

All patients were treated by closed reduction and percutaneous pinning under image intensifier using Kirschner-wires (1.8, 2.0mm). Systemic broad-spectrum intravenous antibiotic was given an hour before the operation. Surgery was done under general anesthesia for all patients with muscle relaxant to facilitated reduction. The involved extremity is draped to allow free mobility for reduction maneuvers, fixation, and radiographic imaging. Additional k-wire are inserted from distal to proximal through the lateral cortex for more stability of the reduced fracture mainly in grade 4 fractures. Closed reduction maneuvers are performed. Once an adequate

closed reduction has been achieved, the fracture is fixed with percutaneous smooth K-wires.The angle of insertion of the each k-wire through the cortex should be as close to 45 degrees as possible, but one should avoid having the k-wire slip off the humeral cortex,care must be taken to have each k-wire enter above insertion of deltoid muscle in order to avoid injury to radial nerve. A multiplanar fluoroscopic views are obtained to confirm appropriate alignment and implant placement of pins.

Postoperative care and follow up:

All patients were given analgesics and immobilized their arm pouch with cuff and collar sling. Radiographs were taken immediate after surgery. From the third week, passive ranges of motion and pendulum exercises were begun depending on stability of osteosynthesis and bone quality.All patients were followed every week in first month and every 3 weeks for 3 months.according to union occur pins were removed after 4-6 weeks.

Statistical analysis:

Data were analyzed using the SPSS version 20.0 (Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± SD and Qualitative as frequency and percentage. Independent samples t-test of significance was used. Chi-square (x2) test was used to compare between two qualitative parameters. The p-value was considered significant at <0.05 and <0.001 was considered as highly significant. P-value >0.05 was considered insignificant.

RESULTS

The attainable results showed that, age of the patients ranged from (8 -15) with the mean± SD was 11.88 ± 2.08 **(Fig. 1)**. According to NEER classification 15 patient had grade 4 (83.3%), 2 cases had grade 3 (11.1%) and 1 case had grade 2 (5.6%) **(Fig. 2).**

The union time mean was 5.11 ± 0.67weeks with minimum of 4 weeks and maximum6 weeks**.** Majority of studied group 10 cases had union at 5 weeks (55.6%), 5 cases had union in 6 weeks (27.7%), and 3 cases had union in 4 weeks (16.7%)**(Table1)**.

Regarding relation between outcome and complication, 12 cases had no complication (66.7%), 3 cases had stiffness (2 cases loss of abduction above 150º and 1cases limitation of internal rotation and flexion) (16.7%), 2 cases had superficial infection (11.1%) and 1 case had loss of reduction (5.6%). 2 cases of superficial infectiondid not necessity early removal of K-wires. All of them were treated with oral antibiotics.

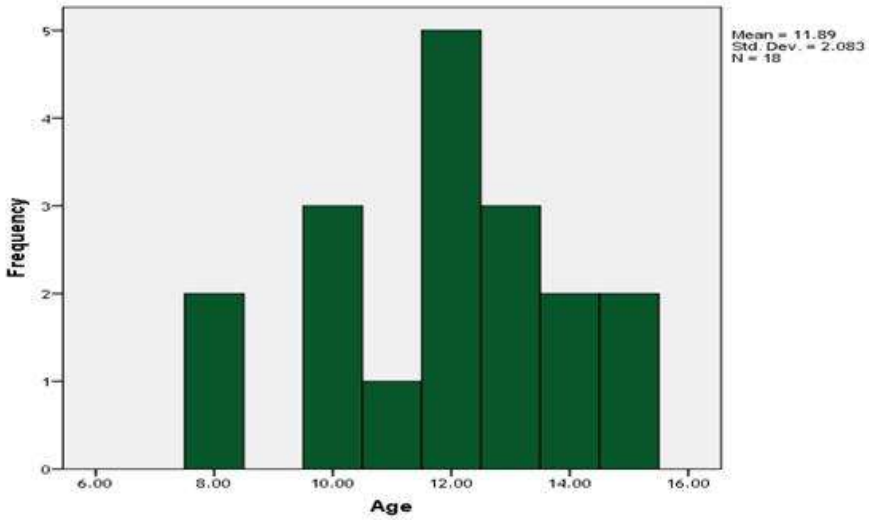

Figure 1: Age distribution among the studied group

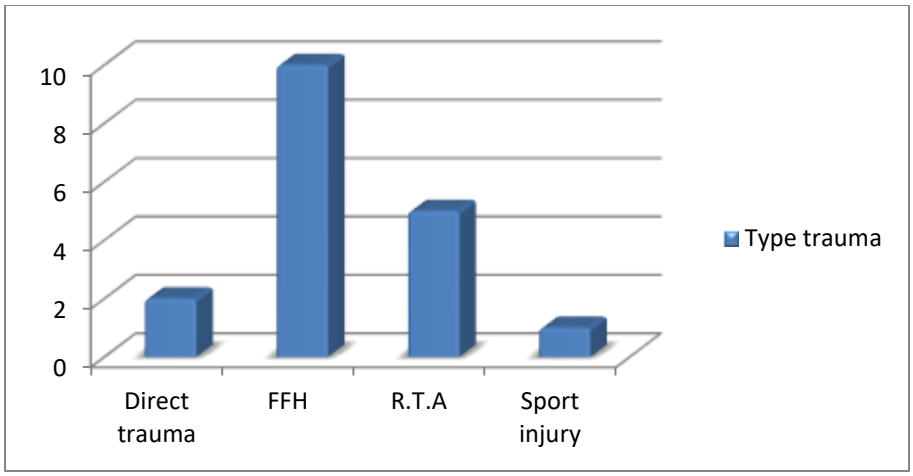

Figure 2: Type of trauma distribution among the studied group

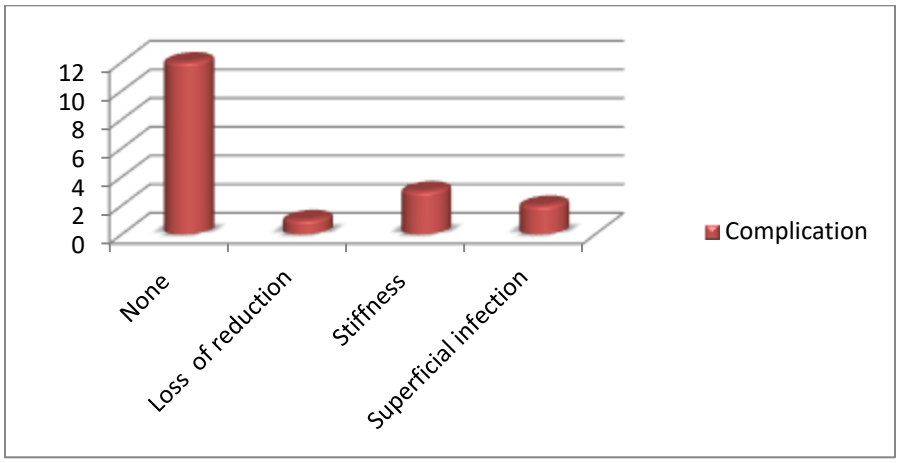

Figure 3: Complication d distribution among the studied group

Table 1: Duration of union distribution among studied group

Duration of union			
Mean± SD		5.11±0.676	
Median (Range)		5.0 (4-6)	
		N	%
Duration of union	4 week	3	16.7
	5 week	10	55.6
	6 week	5	27.7
	Total	18	100.0

Table 2 : Relation between outcome and complication

			Complicated	Non	t/ X^2	P
Age			11.83±1.83	11.91±2.27	-0.078	0.93
Sex	Female	N	1	3		
		%	16.7%	25.0%		
	Male	N	5	9	0.16	0.68
		%	83.3%	75.0%		
Side	Left	N	3	5		
		%	50.0%	41.7%		
	Right	N	3	7	0.112	0.73
		%	50.0%	58.3%		
Neer classification	Grade 2	N	1	0		
		%	16.7%	0.0%		
	Grade 3	N	2	0	7.2	0.027*
		%	33.3%	0.0%		
	Grade 4	N	3	12		
		%	50.0%	100.0%		
Associated injuries	No	N	3	12		
		%	50.0	100.0	4.21	0.04*
	Yes	N	3	0		
		%	50.0	0.0		
Pain	None	N	4	10		
		%	66.7%	83.3%		
	Mild	N	2	2	0.64	0.42
		%	33.3%	16.7%		
Total	Excellent	N	3	12		
		%	50.0%	100.0%		
	Good	N	3	0	7.2	0.007*
		%	50.0%	0.0%		
Total		N	6	12		
		%	100.0%	100.0%		

All of them achieved excellent results. 3 cases of stiffness physiotherapy was done, 2 of them achieved good result and 1 of them achieved excellent result.1 case of loss of reduction treated by k- wire removal and arm sling stabilizer **(**Table 2 & Fig. 3).

DISCUSSION

Proximal humeral fractures are mostly seen in children experiencing frequent falls whilst running or from a height while adolescents usually present such fractures after a sporting accident or direct trauma to the arm. Males are affected more often than females with prevalence in the non-dominant arm (Hohlochet al.2017). Proximal humeral fractures involving the epiphysis are more likely to displace in comparison to metaphyseal proximal humeral fractures. This anatomical area is important as 80% of longitudinal growth of the arm occurs at the physis of the proximal humerus; a fact that explains the great potential for remodelling in young pediatric (Chae et al.,2019).

In most pediatric and adolescent age groups, boys are 3-4 times more likely than girls to sustain a proximal humeral fracture. Two classic traumatic mechanisms are thought to be responsible for this injury in children and adolescents. The first is direct trauma from either a fall directly onto the shoulder or a blunt force or strike. The blow is typically to the posterior shoulder and results in an injury to the metaphysis, physis, and/or epiphysis. The second mechanism is an indirect fall onto an outstretched hand, with the arm abducted and externally rotated (Popkinet al.2015). Surgical fixation has traditionally been recommended in proximal humeral fractures when closed reduction is unsatisfactory due to interposed long head of biceps tendon, deltoid muscle or capsule and in cases of nerve or artery injuries (Hannonenet al.2019).

The management of fractures that are more displaced continues to be debated and the current literature proposes several different approaches. Most centers advocate a surgical approach with techniques including closed reduction with internal fixation or open reduction with internal fixation (ORIF). Fixation is achieved with the use of elastic stable intramedullary nails (ESIN) or K-

irschnerwires (K- wires) which can be buried or left exposed (Wang et al. 2014). Plate and screw fixation are rarely justified; however, many surgeons recommend the elastic stable intramedullary nailing (ESIN) technique because it is stable enough and safe regarding the surrounding soft tissues. This technique is reported to have no increased association to skin irritation or infections and the bone healing is effective and the functional outcome appears to be good (Canaveseet al.2014).

This clinical study included 18 children with proximal humeral fracture. The present study is aimed to prove short-term clinical and radiographic results of closed reduction and percutaneous pinning in displaced proximal humeral fractures in pediatric by k-wire. Our results revealed that the mean age was 11.8 year. These findings are agree with Hannonen et al., (2019) who investigates that the number of affected group of girls and boys with a proximal humerus fracture were 177 and 123, respectively. Their mean age was 10.2 years at the time of fracture. Also, Shore, et al. (2015) who included 84 patients in their retrospective study the age of the studied group was (13.8 ± 2.25) years.

There were 17cases without associated injury, and 1 case associated with lateral condyle fracture of humerus in same side which treated by closed reduction and percutaneous pinning. This results are agree with Pandya et al. (2010) who revealed that the most common mechanism of injury in children was a backward fall onto an outstretched arm and adolescents usually present from sporting accidents, involving a direct impact to the arm or falls during sport. Similarly, Chae et al. (2019) who reported that the injuries from falls (70%), sports-related injuries (5%), non-accidental injury (2.4%), pathological fracture in a patient with global developmental delay and suspected disuse osteoporosis (2.4%).

The union time mean was 5.11 weeks. Majority of studied group 10 cases had union at 5 weeks (55.6%), 5 cases had union in 6 weeks (27.7%), and 3 cases had union in 4 weeks (16.7%). This finding concur Chae, et al. (2019) who recorded that the overall mean time of union from the date of injury was 21.8 days with a range (9 to 78) days.

Our study showed 12 cases had no complication (66.7%), 3 cases had stiffness (16.7%), 2 cases had superficial infection (11.1%) and 1 case had loss of reduction (5.6%). Thisoutcomes in agreement with Popkin et al. (2015) who concluded that in pediatric patientswith proximal humeral fractures, the potential for remodeling is great; therefore, most of these fractures can be successfully treated non-surgically. So, nonsurgical management of pediatric proximal humerus fractures has produced well to excellent results in all pediatric age groups. However, Hannonen et al.(2019) who reported that 10 cases, who were primarily treated non-operatively, had to be surgically fixed later because of re-displacement.

CONCLUSION

Closed reduction and percutaneous pinning are effective in stabilizing severely displaced proximal humeral fractures in pediatric with achievement of satisfactory results. This study advocate non-operative treatment where possible, especially in younger children.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

All authors read and approved the final version.

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