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Closed reduction and percutaneous pinning for paediatric proximal humeral fractures

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Abstract
Introduction: Proximal humeral fracture pattern varies based on the mechanism of injury and the patient's age at the time of the injury. The purpose of this study was to prove short-term clinical and radiographic results of closed reduction and percutaneous pinning in displaced proximal humeral fractures in pediatric patients.
Materials and Methods: We conducted this prospective study in Govt. Bone and Joint Hospital Barzulla an associated Hospital of Govt. Medical College Srinagar. A total of 18 paediatric patients with proximal humeral fractures were enrolled in this study between July 2019 and June 2022. The mean age of the study population was 10.98 (range 7-15) years.
Results: Average time to union was 5 and a half week with a range from 4 and a half to 6 and a half weeks. Average time to pin removal was 5 (range 4-6) weeks.
As per Constant- Murley scoring criteria 13 (72.22%) patients were excellent, 3 (16.67%) were good and 2 (11.11%) were fair. Among 18 patients, 16 (88.89%) had no pain at the end of the follow-up. 13 (72.22%) patients had active flexion above 150^0. There were 15 patients with full muscle strength. In this study superficial wound infection was seen in 3 (16.67%) patients which subsided with oral antibiotics. In 1 (5.56%) patient of stiffness physiotherapy was done and achieved good result. 14 (77.78%) patients showed no complications.
Conclusion: Closed reduction and percutaneous pinning gives more stability for the severely displaced proximal humeral fractures with rotational or angular instability in paediatric population.

Keywords: proximal humeral fracture, closed reduction, percutaneous pinning

Introduction
Proximal humeral fracture pattern varies based on the mechanism of injury and the patient's age at the time of the injury. Proximal humeral fractures in children are not common. Studies estimate that these fractures constitute approximately 2% of all pediatric fractures and 3% to 6.7% of all physeal fractures [1], with a peak incidence between 11 and 15 years of age [2].
Fractures of proximal humerus, including fracture of the epiphysis, and surgical neck, have huge remodeling potential because of longitudinal humeral growth, which accounts for 80% of humeral growth [3]. Proximal humeral fractures are classified by their anatomic location, displacement, and angulation. Proximal humeral fractures are commonly diagnosed according to the Salter Harris classification scheme. Most of these fractures are either non displaced Salter Harris I fractures, or displaced Salter Harris II fractures. It is extremely rare to see a Salter Harris III or IV proximal humeral fracture.
Treatment of proximal humeral fractures is rarely debatable. The traditional teaching is that non-operative treatment is expected to give satisfactory results with return to full function and complete anatomic remodeling [4]. However, in older children with less growth remaining, severely displaced fractures may need operative treatment to restore anatomic alignment and maximize shoulder motion [5-9]. A variety of stabilization techniques have been described for the surgical management of pediatric proximal humerus fractures, including Kirschner wires [6, 7, 10-13], screws [7], and intramedullary nails [6, 8, 14-16].

Despite preliminary reports on the use of percutaneous pins and intramedullary nails for pediatric proximal humeral fractures, a paucity of literature exists comparing the safety and efficacy of the two treatment techniques [7, 8, 11, 17].

In this study we use closed reduction and percutaneous pinning for the management of proximal humeral fractures. Although closed reduction and percutaneous pinning give satisfactory result in displaced proximal humeral fracture in pediatric population. Yet it has complications as pin tract infection, migration of pin and osteomyelitis [18]. The aim of this study was to prove short-term clinical and radiographic results of closed reduction and percutaneous pinning in proximal humeral fractures in pediatric population.

Materials and Methods

We conducted this prospective study in Govt. Bone and Joint Hospital Barzulla an associated Hospital of Govt. Medical College Srinagar. A total of 18 paediatric patients with proximal humeral fractures were enrolled in this study between July 2019 and June 2022. The mean age of the study population was 10.98 (range 7-15) years (Table 1).

Table 1: Demography of patients

Parameters		No. of patients	Percentage
Gender	Male	11	61.11
	Female	7	38.89
Mode of trauma	Fall	10	55.56
	Road accidents	6	33.33
	Others	2	11.11
Side	Right	6	33.33
	Left	12	66.67

All the enrolled patients fulfilled inclusion criteria and were treated with closed reduction and percutaneous pinning.

Inclusion criteria:

- Age >7 and <15 years.
- Closed displaced fractures of the proximal humerus.
- Absence of associated neurovascular injuries.

Exclusion criteria

- Associated neurovascular injuries.
- Hematological or rheumatological diseases.
- Presence of infection.
- Polytraumatized patients, compound fractures and pathological fractures.

Operative technique

Systemic broad-spectrum intravenous antibiotics were given an hour before the operation. Surgery was done under general anesthesia for all patients with muscle relaxant to facilitate reduction. The patient was positioned as far laterally on the table as possible with lateral thorax support to prevent the patient from being pulled off the operating table. The head was immobilized in a head holder. The involved extremity was draped to allow free mobility for reduction maneuvers, fixation, and radiographic imaging. Image intensification was positioned to allow complete visualization of the proximal humerus and glenohumeral joint in two orthogonal planes. Once the reduction was done K-wire was introduced. After the first pin was placed, multiplanar fluoroscopic views were obtained to confirm appropriate alignment and implant placement. Following this one or two additional pins were placed. After satisfactory k wire position antiseptic dressing was done and arm chest bandage was applied.

Follow-up

All patients were followed every week in first month and every 2-3 weeks for 3 months. The active range of motion was started at 1-2 weeks postoperatively, depending on stability of osteosynthesis and bone quality. Pins were removed between 4-6 weeks according to the union. The sling was discontinued by 8-12 weeks depending upon fracture stability. The patients were examined clinically and radiologically and were assessed for range of motion and bony union and complications. The patients with shoulder stiffness were given physiotherapy for 1 week to 15 days.

Results

Average time to union was 5 and a half week with a range from 4 and a half to 6 and a half weeks. Average time to pin removal was 5 (range 4-6) weeks.

As per Constant- Murley scoring criteria 13 (72.22%) patients were excellent, 3 (16.67%) were good and 2 (11.11%) were fair (Table 2). Among 18 patients, 16 (88.89%) had no pain at the end of the follow-up. 13 (72.22%) patients had active flexion above 150^0. There were 15 patients with full muscle strength. In this study superficial wound infection was seen in 3 (16.67%) patients which subsided with oral antibiotics. In 1 (5.56%) patient of stiffness physiotherapy was done and achieved good result. 14 (77.78%) patients showed no complications.

Table 2: Complications and results as per Constant-Murley Scoring criteria

Complications		No. of patients	Percentage
No complication		14	77.78
Superficial wound infection		3	16.6
Stiffness		1	5.56
Constant-Murley Scoring	Excellent	13	72.22
	Good	3	16.67
	Fair	2	11.11
	Poor	0	0

Discussion

Although most pediatric proximal humeral fractures can be successfully treated non-operatively, however multiple authors recommend surgical stabilization in older patients with highly displaced fractures [6, 7, 19, 20]. The results of this study demonstrate that leaving pins exposed after surgical treatment of pediatric proximal humeral fractures is safe and confers greater cost savings than burying the pins or using intramedullary fixation. Our sensitivity analysis demonstrated that these findings remained true despite employing a wide range of probable infection rates and treatment costs.

In this study the mean age was 10.98 (range 7 to 15) years. 11 (61.11%) patients were males and 7 (38.89%) were female patients and the same age was detected in a study conducted by Shore *et al*. [21].

All cases were treated by closed reduction and percutaneous pinning technique and short -term follow up after the operation was done to assess the outcome.

Concerning analysis of Constant-Murley Score and patients' outcome; the pain score consisted of 15 points. At the end of the follow up period 16 (88.89%) patients had no pain and 2 (11.11%) patients had mild pain.

The ability of the patients to do daily work, engage in recreational activity and sleep with a total score of 10 points, 16 (88.89%) patients had the ability to fulfill all the activities and were able to use the hand at specific level in painless manner with a total score of 10 points. 2 (11.11%) patients showed some restricted activity, while none of the patients had disturbed sleep pattern. Regarding range of motion, the average normal forward flexion in this series (as measured on the intact shoulder joint of each patient) was 170˚ (ranged from 150˚ to 180˚). While the average normal abduction (as measured on the intact shoulder joint of each patient) was 175˚ (ranged from 150˚ to 180˚). 13 (72.22%) patients had active flexion above 150º and 5 (27.78%) patients had active flexion from 121º to 150º. All the studied group (18 patients) could do full active external rotation according to constant-Murley Shoulder Score (100%).

Power was examined by comparing muscle resistance of both shoulders at 90º of abduction. There were 15 (83.33%) patients with full muscle strength and 3 (16.67%) patients with mild muscle weakness.

Concerning the outcome of the current study, in this study 14 (77.78%) cases had no complication, 1 (5.56%) cases had stiffness and 3 (16.60%) cases had superficial wound infection. The cases with superficial wound infection did not necessitate early removal of K-wires. All of them were treated with oral antibiotics. All of them achieved excellent results. Physiotherapy was done for the one case of stiffness, who achieved excellent result.

This good to excellent outcome was in agreement with Popkin *et al*. [1] who demonstrated that in pediatric patients with proximal humeral fractures, the potential for remodeling is great; therefore, most of these fractures can be successfully treated non-surgically. Traditionally, nonsurgical management of pediatric proximal humerus fractures produced well to excellent results in all pediatric age groups.

Simultaneously in a study of 43 patients with proximal humeral fractures (10 treated non-surgically, 33 treated surgically) conducted by Cruz *et al*. [18] found no complications at a mean follow-up of 39 months, with excellent Constant Scores reported in those with non-displaced and displaced fracture patterns and attributed this because of the remodeling potential of the humerus in young patients with proximal humeral fractures, treatment outcomes are generally good to excellent. Additionally in a systematic review of pediatric proximal humeral fractures; Pahlavan *et al*. [5] reported excellent overall outcomes; most patients were able to return to activity with no restrictions, no residual loss of function, and no major complications.

Conclusion

Closed reduction and percutaneous pinning gives more stability for the severely displaced proximal humeral fractures with rotational or angular instability in paediatric population.

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Author's Contribution

Not available

Conflict of Interest

Not available

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