

Research article**The two-year evaluation of physal injury and motion limitation of forearm after open reduction and intramedullary fixation by transphyseal pin in children with forearm both bone fracture, in Razi Hospital during 2015-16****Hanon Sadoni, Saeed Tabatabaei,****Mohammad Fakoor, Mojgan Seifi and Fariborz Pakpour***

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ABSTRACT

Introduction: Avoiding the growth plate damage and restore the normal range of motion are important after surgical treatment of fractures in children. The purpose of this study is evaluation of physal injury and motion limitation of forearm after open reduction and intramedullary fixation by transphyseal pin in children with forearm both bone fracture.

Materials and Methods: This prospective study was done on medical records and radiographs of 48 pediatric patients with unstable forearm fractures who had been treated with transphyseal intramedullary nails in Razi hospital in Ahvaz in 2015-16. At final follow-up, the functional outcomes were evaluated according to Quick DASH scale and the range of motion of forearm and wrist was compared with contralateral normal arm. Radiologically, the physal injury was measured.

Results: The mean age was 9.78 ± 3.01 years (range 5 to 16 years) and mean follow-up was 14.53 ± 6.49 months (range 6.57 to 24.57 months). The clinical and functional results were excellent in all patients, except one case that did not refer for pin removal on the predicted time. Loss of forearm rotation was not observed in any patient and there was no difference in the range of motion of forearm and wrist between arms. Radiologically, there was no evidence of physal injury in all patients.

Conclusion: Transphyseal intramedullary nailing is a simple, safe and effective technique for pediatric forearm both bone fractures, crossing the pin from radius and ulnar physis had no detrimental effect on the physis such as physal arrest or bar formation.

Keywords: Forearm fracture, Growth-plate, Intramedullary nailing, Children

INTRODUCTION

Forearm fractures are common injuries, constituting 41.1% of pediatric fractures (1, 2). Diaphyseal radius and ulna fractures are the most common reasons for pediatric need for orthopedic cares. These fractures are regarded difficult injuries due to their difficult treatment and risk of complications (3). It has been estimated that diaphyseal fractures of both forearm bones comprise 5.4% of all fractures in children aged <16 years and 26% of fractures of the long bones of upper limb (1, 4). The most

common mechanism of this fracture is falling on an outstretched hand (5). The aim of management of these patients is obtaining an appropriate alignment, which allows the functional range of motion and is associated with the least amount of complications (6, 7). Given the high potential for bone regeneration in children (8), the majority of these fractures can be successfully treated with closed reduction and casting (2, 9). However, re-displacement during casting and increased angulation and

rotational deformity can lead to the permanent loss of range of motion of the forearm (10, 11). Therefore, there is a greater tendency toward surgical treatments to provide better care for patients (12). Common surgical indications of forearm both bone fracture include open fractures, non-reducible fractures with closed reduction, unstable fractures, pathological fractures and fractures with significantly malunion (9, 12). Pediatric surgical methods include open reduction internal fixation (ORIF) with plate and screw and closed reduction with mini-open and intramedullary K-wire or percutaneous pinning Rush rods or flexible nails (1). Today, fixation with intra medullary nails is the most common method used for unstable forearm fractures in children due to its less invasive nature and lower risk of periprosthetic fractures (13, 14). In this regard, previous studies have yielded positive results (15-17). Compared to fixation with plate, intra medullary nails have several advantages, including improved cosmetic results, reduced soft tissue injury, less surgical time, ease of removal of the implants and rapid return to activity after implant removal (5, 14). Juxtaepiphyseal fractures are more potent for remodeling. Distal third Fractures lead to more deformity, compared to fracture in the middle third and proximal third (18). Growth plate injury is one of the problematic issues in pediatric traumatology, leading to various degrees of limb deformity and difference in length of limbs due to the arrest of growth plate. Therefore, it is crucial to avoid injury in growth plate during surgery (19). Nevertheless, manipulation of growth plate is inevitable in some cases. In this context, having an accurate knowledge about the degradation process of growth plate in the damaged area in bone surgeries is of paramount importance (20). Given the high prevalence of forearm bone fracture in children and importance of avoiding damage to growth plate and functional deficiencies in children, this study aimed to evaluate the physal damage due to surgery and motion limitation of forearm after open reduction and intramedullary fixation by transphyseal pin in children with forearm both bones fracture.

MATERIALS AND METHODS

This prospective study was conducted on children aged 5-16 years with forearm both bones fracture, who referred to Razi Hospital of Ahvaz, Iran during 2015-2016. After taking the history of the patients, they were examined and referred to do necessary radiography. Moreover, demographic and clinical characteristics of the patients, specifications of fractures, time of surgery, complications of surgery and duration of follow-up of patients were evaluated and recorded.

Patients Selection

All patients with forearm fracture were included in this study according to surgical indications. The exclusion criteria were Monteggia fracture, Galeazzi, Greenstick, intra-articular and pathologic fractures. Surgical indications were open fractures, fractures with impending compartment syndrome, irreducible fractures and unstable fractures. In addition, A3 forearm fracture.

Surgical Procedures

After induction of anesthesia the limb was put on hand table. Skin and subcutaneous tissues were incised and the fracture site was exposed. After exposing the fracture site, an intramedullary nail in proportion to the diameter of bone medulla (in 1.5, 2 and 3 mm sizes) was entered into the proximal ulnar physis through retrograde fashion using a drill. The fracture was reduced and the pin advanced to distal fragment. In the next step the radius was exposed using Henry approach. Then, a pin with an appropriate size in proportion to the diameter of bone medulla was selected and entered toward radius distal fragment and crossed distal radial physis. After that, the pin was advanced to exit the wrist while the wrist was in flexed position. In the next step radial fracture was reduced and the pin was advanced to proximal radial metaphysis. After obtaining suitable fixation the distal end of the pin was cut and put under the skin.

Outcomes of Surgery

Results of surgery were assessed for all of the patients during a follow-up period using radiological and clinical findings. In the last follow up, clinical results were categorized by Price et al. system (21), and range of motion of

elbow and wrist was compared with a normal hand (Table 1).According to radiological assessment, ulna length discrepancy and its variance were measured for the analysis of early growth arrest.In this study, healing of fractures was defined as bridging of callus of at least three cortices season from the lateral and anteroposterior radiograph. Healing after four

months is defined as delayed union, and after 6 months as nonunion. Functional results were assessed after surgery based on Quick DASH questionnaire.

Data analysis was performed with SPSS version 22 using descriptive statistics (mean, standard deviation, frequency and percentage).

Table 1. Evaluation of clinical results according to the classification system by Price et al. (21)

Loss of forearm rotation	Symptoms	Results
<15°	No problem after strenuous activity	Excellent
15°–30°	Mild complaints after strenuous activity	Good
31°–90°	Mild complaints after daily activities	Fair
>90°	All the other results	Poor

RESULTS

In the present study, seven female (14.6%) and 41 male (85.4%) patients with mean age of 9.87±3.01 years (5-16 years) participated and evaluated. Characteristics related to the forearm fracture of the patients are fully stated in Table 2. Mean follow-up duration for patients after the surgery was 14.53±6.49 months (duration of 6.57-24.57 months). The pins were removed after 4 weeks and the splint continued for more 2 weeks. Radiographic results indicated that all fractures healed appropriately with no delay (mean duration of eight weeks, period of 6-12 weeks). In addition, all fractures in radiography were healed in a good position (Figure 1).

Results of Quick DASH questionnaire for elbow and wrist demonstrated that the performance of all of the patients was excellent and all of the participants achieved the best score in this questionnaire (Score= 11). Only grade of one case was good due to delayed pin removal.

Table 2. Results of Quick DASH questionnaire

Patients (n)	Grade
47	Excellent
1	Good

Moreover, all of the patients could go back to their previous physical activities. Only one case scored 33 (medium) in the questionnaire and had medium forearm performance due to delayed pin removal.

Loss of forearm rotation, loss of pronation and supination and loss of flexion and extension were observed in none of the patients. In addition, range of motion of wrist and elbow were excellent in all of the subjects and no significant difference was observed between these elbows and healthy elbows. Only one participant (2.08%) had slight pain in the surgical site due to delayed pin removal.

Complications after surgery, including nerve palsy, pin tract infections,compartment syndrome, re-fracture, delayed union, malunion, arthritis of physal arrest or bar formation were not observed in any patients.

Table 3. Characteristics of fractures in evaluated patients

Fracture characteristics		Frequency (%)
Mechanism of fracture	Motorcycle accident	10 (20.8%)
	Falling during playing and exercising	31 (64.6%)
	Bicycle incident	7 (14.6%)
Position of fracture	Right	27 (56.3)
	Left	21 (43.7)
Fixed bone	Radius	9 (18.8%)
	Ulna	4 (8.3%)
	Radius and ulna	35 (72.9%)

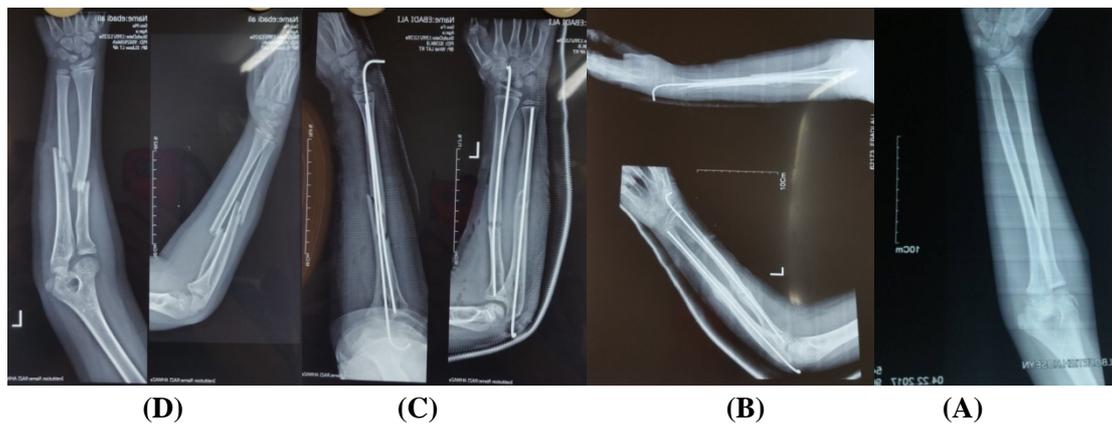


Figure 2. Samples of fractures before and after surgery A) Before surgery, B) One day after surgery and fixation with intramedullary nail, C) 4 weeks after surgery, D) one year after surgery and complete recovery.

DISCUSSION

Special characteristic of pediatric fractures is probability of physal injury. Therefore, prevention of damage to the growth plate is important (19). Therefore, the present study was performed to evaluate the amount of physal damage and limitations in range of motion for fractures of both radius and ulna bones in children. Evaluation of function and performance of forearm after surgery indicated that none of the patients had problems in performing daily activities. In a study by Reinhardt et al. (2008), loss of forearm rotation was seen in none of the patients with fracture in forearm going under surgery with intramedullary nail (18). These results are in line with our findings. In another study by Kose et al. (2008), treatment results of unstable ulna and radius fractures in children were assessed using intramedullary k-wire technique, indicating that clinical and functional results, including the range of motion of elbow, wrist and forearm, were excellent in all of the patients (22). These results are also in congruence with the results of the present research. Lee et al. (2013) demonstrated no significant difference in range of motion of elbow and wrist of the surgical treated forearm and healthy hand after treatment of ulna distal fracture in children through fixation with transphyseal pin (19). Results obtained by Ali et al. (2010) in evaluation of functional results after the surgery of forearm both bones fracture with intramedullary nail indicated that except for one patient all of the patients regained their complete range of motion in forearm and elbow (10). In a study by Martus

et al. (2013), it was indicated that treatment of diaphyseal fractures of forearm in children with intramedullary nail was good and excellent in 91% of patients (15). In the present study, physal damage was not observed in the patients treated with transphyseal intramedullary nail surgery. In a study by Lee et al. (2013), distal radius fractures using transphyseal approach. Results were indicative of physal destruction in 4.7% of the subjects. However, based on radiological observation, no evidence was found to confirm permanent physal damage in their patients (19). Risk of growth retardation depends on type of pin, size of pin, the angle in which the pin passes and duration of penetration (23, 24). In the current research, results of treatment of forearm both bone fractures through fixation with intramedullary nail indicated that the amount of complications was equal to zero and implant removal was routinely performed for all of the patients. Furthermore, no complications due to the removal of implant were reported. Similar to the present research, results obtained by Shah et al. (2010) were indicative of no delayed union of the fracture and non-union and other complications for patients who underwent intramedullary nail procedure (1). In a study by Reinhardt et al. (2008), complications due to surgical treatment of forearm fracture with intramedullary nail were observed in 21% of the patients (18). Martus et al. (2013) expressed that complications caused by treatment of diaphyseal fracture of forearm in children with intramedullary nail were observed in 17% of the patients (15). Difference in the amount of complications of the surgery might be due to

difference in surgical techniques or demographic characteristics of patients and their injuries. Moreover, sample size and quality of surgery might be involved in this regard.

CONCLUSION

According to the results of the current research, technique of open reduction and internal fixation with trans physeal intramedullary pins for forearm both bone fractures in children is a favorable method with no physeal damage. In addition, these techniques lead to full recovery of range of motion of elbow and wrist. Therefore, this simple method can be used to treat forearm both bone fractures in children as a safe and effective method. However, it is noteworthy that longer duration of follow-ups is required for more assessment of the patient. In addition, conducting similar results needs the application of several centers and an equal protocol to increase the reliability of results.

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