Orthopaedics & Traumatology: Surgery & Research xxx (2016) xxx–xxx

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Original article

Treatment of pediatric forearm midshaft fractures: Is there a difference between types of orthopedic surgeon?

D. Lu [a], Z. Lin [b], J.-D. Zhang [a], H. Chen [a], L.-J. Sun [a,*]

[a] *Department of Orthopaedic Surgery, Second Affiliated Hospital & Yuying Children's Hospital of Wenzhou Medical University, 325000 Wenzhou, Zhejiang, China*
[b] *Department of Orthopaedic Surgery, Wenzhou Central Hospital, 325000 Wenzhou, Zhejiang, China*

ARTICLE INFO

Article history:
Received 28 August 2016
Accepted 7 November 2016

Keywords:
Children
Forearm midshaft fractures
Surgical management
Titanium elastic nails
Functional outcome

ABSTRACT

Purpose of the study: The objective of this study was to compare the clinical and radiological outcomes of pediatric forearm midshaft fractures treated operatively with titanium elastic nails (TENs) by pediatric orthopedists and non-pediatric orthopedists.
Material and methods: We conducted a prospective cohort study of 88 children of forearm midshaft fractures, who were randomized to operative stabilization either by pediatric orthopedists (Group A, 44 cases) or by non-pediatric orthopedists (Group B, 44 cases) from April 2013 to February 2014. At baseline, the groups were comparable with respect to age, sex, AO classification, injured side and interval from injury to surgery. We collected data on operative and radiation time, open reduction rate, length of hospitalization, bone union time, return to full physical activity time, complications, and measured clinical results using the Children's Hospital of Philadelphia (CHOP) Forearm Fracture Fixation Outcome Classification.
Results: The mean follow-up period was 15.8 ± 3.3 months for Group A and 15.2 ± 4.2 months for Group B ($P = 0.491$). No significant difference existed in time to union ($P = 0.282$), the overall complication rate ($P = 0.750$), return to activity time ($P = 0.408$), and clinical outcomes according to CHOP classification ($P = 0.908$) between the two groups. However, the mean operating time and radiation time was significantly longer in Group B than in Group A ($P = 0.001$ and $P = 0.001$, respectively). In addition, there was a trend for patients of Group B to have a higher rate of open reduction ($P = 0.035$).
Discussions: Our results indicated that children forearm midshaft fractures treated surgically by pediatric orthopedists offered potential advantages including a shorter operating time and radiation time, a lower rate of open reduction. However, both pediatric and non-pediatric orthopedists had achieved satisfactory clinical results in treatment of these injuries.
Level of evidence: Level II prospective randomized study.

1. Introduction

Forearm fractures are common injuries in the pediatric population. They represent approximately 3 to 6% of all children's fractures and about 30% of all upper extremity fractures [1]. Approximately 18% of pediatric forearm fractures occur in the middle third [1]. Surgical treatment is necessary for the irreducible or unstable forearm midshaft fractures [2,3]. The traditional internal fixation methods include open reduction and internal fixation with plate and screw fixation, which often can obtain satisfactory results [4,5]. In recent years, titanium elastic nails (TENs) as a minimally invasive technique has become increasingly popular among orthopedists [2,4,6–8].

With more young doctors and medical students giving up their career due to the relatively poor income and working environments [9,10], the great shortage of pediatric orthopedists becomes a serious problem. As a result, in some hospitals, only non-pediatric orthopedists are available to treat these injuries. Although pediatric orthopedists and non-pediatric orthopedists both report their good surgical results of treating forearm shaft fractures, no studies have confirmed whether the therapeutic effect is different in the two types of orthopedic surgeons.

This study was designed to compare the clinical and radiographic results of pediatric forearm midshaft fractures treated surgically by pediatric orthopedists and non-pediatric orthopedists. The hypotheses were that ulnar and radius fractures in

* Corresponding author. Department of Orthopaedic Surgery, Second Affiliated Hospital & Yuying Children' Hospital of Wenzhou Medical College, 109, Xueyuanxi Road, Wenzhou 325000, China.
E-mail address: sunlj797110@163.com (L.-J. Sun).

http://dx.doi.org/10.1016/j.otsr.2016.11.008
1877-0568/

Table 1
Demographics data and clinical characteristics.

Demographics data	Group A ($n=44$)	Group B ($n=44$)	P
Mean age (years)	8.9 ± 2.2	9.0 ± 2.3	0.835
Gender (M/F, n)	34:10	36:8	0.597
AO class (22-D/4.1:22-D/5.1, n)	22:22	25:19	0.521
Fracture side (left:right, n)	7:37	11:33	0.290
Injury to surgery time (d)	1.0 ± 0.5	1.0 ± 0.5	1

AO class: AO classification of pediatric long-bone fractures.

children managed surgically by pediatric orthopedists had fewer complications and more satisfactory functional outcomes versus by non-pediatric orthopedists.

2. Materials and methods

2.1. Study population and study design

We conducted a two-center clinical trial. This prospective study was approved by the Committee of Medical Ethics and the institutional review boards of the authors' institutions. TENs were only performed if fracture alignment after closed reduction and cast immobilization was unacceptable. Form April 2013 to February 2014, a total of 88 children with forearm shaft fractures were treated surgically with TENs by pediatric orthopedists (Group A, 44 cases) or by non-pediatric orthopedists (Group B, 44 cases) in two hospitals respectively.

The patient demographics and fracture characteristics are shown in Table 1. The inclusion criteria were:

- age 5–12 years;
- unilateral midshaft both-bone forearm fracture;
- angulations of > 10 degrees after attempted closed reduction;
- malrotation of > 45 degrees (5–9 years) or malrotation of > 30 degrees (>10 years) after attempted closed reduction;
- huge displacement (>10 mm) after attempted closed reduction;
- no preoperative neurovascular injury;
- fresh closed fractures (within seven days from injury);
- at least 12 months of clinical and radiographic follow-up.

The following patients were excluded:

- ipsilateral or contralateral upper limb fractures and/or dislocation;
- pathological fractures;
- open fractures;
- comminuted forearm shaft fractures;
- associated with nerve or vascular injury requiring repair;
- combined with vital organs damage;
- metabolic bone disease;
- previous ipsilateral upper limb surgery;
- metaphyseo-diaphyseal junction fracture;
- radial head fracture;
- Monteggia and Galeazzi fractures.

There was no significant difference in the preoperative variables between the two groups.

2.2. Surgical procedures and postoperative management

All operations were performed by the two groups of surgeons. They all used the TENs produced by the same company (Synthes Paoli, PA, USA). The operative techniques applied in both groups were the same and similar to that previously described in the literature [6,11]. Appropriate antibiotic (Flucloxacillin 60 mg/kg) prophylaxis was only administered within half-hour before the surgery. Under general anesthesia, the patient was in a supine position on a standard radiolucent table. If the reduction was considered acceptable, two TENs were placed in a retrograde fashion through radius and in an antegrade fashion through the ulna respectively.

In general, the first bone to be fixed was the radius that was easiest to reduce. For the radius, the cortex at the point on the radial aspect of the distal metaphysis, 2 cm proximal to the physis was opened with a drill 1 mm larger than the size of the chosen nail. For the ulna, it was preferable to insert the pin through the proximal end, below the olecranon apophysis, through an incision on the lateral side in relation to the anconeus. The nails were attached to a T-handle and were inserted into the holes gently and rotationally. Closed reduction by manipulative traction was performed under fluoroscopic control. The skin incisions were sutured.

If failed attempts of closed reduction with closed manipulation were made for three times, open reduction with small approach was performed. After the open reduction was successful, we also used TENs to stabilize the fracture.

Postoperative treatments in both groups were the same. In all cases, full above elbow plaster cast was applied for 2 to 4 weeks after the injury in order to control pain.

2.3. Data collection and outcomes measurement

The patients were asked for follow-up at the 1st, 2nd and 4th weeks postoperatively and once a month thereafter. The total follow-up period ranged from 12 to 24 months for Group A and Group B. Demographic and preoperative data collected on the patients included age, gender, AO classification, injured side and interval from injury to surgery. Preoperative and postoperative radiographs were also examined. Preoperative radiographs were used to determine AO classification. At each postoperative follow-up visit, radiographs (anteroposterior [AP] and lateral images) were specifically analyzed by the operative surgeons and a radiologist. Outcome data collected also included operative and radiation time, the rate of open reduction, length of hospitalization, bone union time, return to full physical activity time and complications. For data collection, the operative time was defined as the time from the skin incision to skin closure. Fluoroscopy time was obtained from the fluoroscopy logger. Union was defined as the absence of pain and the presence of bridging callus in three of the four cortices seen on the AP and lateral radiographic views of the bone. Delayed union was defined as incomplete consolidation at 90 days as described by Schmittenbecher et al. [12]. Incomplete healing by 6 months was considered a nonunion [8]. The range of rotation of the forearm was measured with the elbow flexed at 90 degrees and the arm adducted using a goniometer. The postoperative complications were assessed according to a modification of the Clavien-Dindo classification of surgical complications [13,14], namely, Grade I: complications were a deviation from a routine postoperative course without intervention; Grade II: complications resolved after outpatient management, pharmacologic treatment, or with close observation; Grade III: complications required inpatient care or reoperation; Grade IV: complications were limb threatening, life threatening or resulted in a permanent deficit; Grade V: death. Minor complications were considered Grade I and II complications. Major complications were considered Grade III, IV, V complications. At the last visit, the clinical results were assessed using Children's Hospital of Philadelphia (CHOP) Forearm Fracture Fixation Outcome Classification described by Flynn et al. [2]. An excellent result was noted if motion was full (<10 degrees loss of motion – supination and/or pronation) and no complications occurred. A fair result was < 30 degrees loss of motion

Please cite this article in press as: Lu D, et al. Treatment of pediatric forearm midshaft fractures: Is there a difference between types of orthopedic surgeon? Orthop Traumatol Surg Res (2016), http://dx.doi.org/10.1016/j.otsr.2016.11.008