One-year follow up of pediatric supracondylar humerus fractures with bone fragments

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Research article

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Abstract

Background The aim of this study is to evaluate the clinical and imaging outcome of pediatric supracondylar humerus fractures with bone fragments on X ray film after closed reduction and percutaneous pin fixation.

Methods A retrospective review of 12 children with fragments on image after closed reduction treatment for displaced humeral supracondylar fractures (Gartland III). Primary radiographic assessment included the outcome of the fragments, post-operative Baumann angle, Carrying angle and loss of reduction. The clinical outcome included elbow range of motion, Flynn grade and other complications.

Results Totally there were 460 cases of pediatric supracondylar humerus fractures (2-14 years old) treated in our center from January 2015 to January 2018, and 12 (2.6%) of the patients with bone fragments on postoperative X ray film were included. All 12 patients had bone fragments union or absorbed at 1 year after operation with good radiographic and clinical outcome. The mean Baumann angle was $15.5 \pm 4.3^\circ$, and the mean Carrying angle was $11.2 \pm 2.8^\circ$. All patients had a normal elbow range of motion, 10 patients obtained an excellent result, and 2 patients were good According to Flynn criteria.

Conclusions We have good results for closed reduction and percutaneous pin fixation treatments in 12 pediatric supracondylar humerus fractures with bone fragments. The fragments were mainly absorbed or union to humerus in one year after surgery.

Introduction

Supracondylar humerus fractures are the most common pediatric elbow fracture in children [1]. The current preferred treatment for displaced fracture is closed reduction with percutaneous pin fixation (CRPP) [2–3]. however, complications like iatrogenic nerve palsy, loss of reduction, cubitus varus deformity, pin tract infection and restricted range of motion (ROM) still can't be completely avoided [4–5]. In case of fracture with bone fragments, it is not easy to get an anatomical reduction for the fragments in closed procedure. These fragments showed on X ray film will make the parents worry about the treatment and the prognosis.

The aim of this study was to evaluate the clinical and imaging outcome of pediatric supracondylar humerus fractures with bone fragments after closed reduction and percutaneous pin fixation.

From 2015 to 2018, we have performed surgery in 460 children with supracondylar humerus fractures, of which 12(2.6%) children had unsatisfactory bone fragments on postoperative X ray film. The details of the patients' general data and clinical results are presented here.

Patients And Methods

Based on the diagnosis card index at our department during the period from January 2015 to January 2018, we searched the files of patients diagnosed as supracondylar fractures with bone fragments on postoperative X ray film. Finally, 12 patients were enrolled in the study.

All children with supracondylar humerus fractures were assessed for vascular and neurological status and received emergency operation within two days. Anteroposterior and lateral radiographs were performed before and after operation.

Surgical techniques were standardized in terms of pin location, pin size and the position of the elbow for pin placement. Surgery was performed by a senior pediatric orthopedic surgeon who was well trained in this technique. General anesthesia was used for all patients. Closed reduction was performed and confirmed by the X ray image intensifier, with three pins inserted from lateral side. The pins were bent and cut off to prevent migration and allow removal in the outpatient clinic.

Postoperatively, the extremity was placed in a well-padded splint with the elbow flexed to 60–80°. For all patients, immediate postoperative radiographs were taken to determine the maintenance of the reduction. Patients were followed up at least for 1 year, and in the fourth week, the splint and pins were removed without anesthesia.

During follow-up in the outpatient department, all patients were assessed both clinically and radiologically, which included measurement of Carrying angle, Baumann angle, fragments healing, loss of reduction and range of motion. Complications including neurovascular status, infection and compartment syndrome were documented. Clinical evaluation was graded as excellent, good, fair and poor, according to the criteria of Flynn. The final clinical and radiological outcome was assessed at the time 1 year after surgery.

Results

A total of 12 patients (9 boys and 3 girls) were included in the present study, with an average age of 6.1 years (2–9 years). All fractures were extension type classified as Gartland III, with 7 patients involving the left side, and 5 on the right side. No patient had any other associated fractures or open fractures. The common injury mechanism was falling on an outstretched hand. There was no brachial artery injury, and only one child had a median nerve injury with an unsatisfactory thumb opposition and recovered 1 months later after surgery.

Closed reduction and percutaneous pins fixation surgery was performed under general anesthesia within two days. Patients were followed up at least 1 years at 1, 4, 8, 12, and 24 weeks and 1 year after surgery. The mean follow-up time was 20.4 months (12 to 40 months). There was no compartment syndrome or a complication of infections, while only one patient suffered from pin tract irritation and relieved after removal of the pins. No patient had a forearm rotational deformity, elbow extension dysfunction or a major loss of reduction that needed reoperation. All patients had a good outcome of elbow flexion, with a

mean flexion of 136.6°(130° to 145°). According to Flynn criteria, 10 patients obtained an excellent result, and 2 patients were good (Table 1).

Table 1
Demographic data and outcome of the 12 children
with supracondylar humerus fracture

Characteristics	n = 12
Mean age, years ^a	6.1 ± 1.9
Sex, Male/Female ^b	9/3
Side, Left/Right ^b	7/5
Follow-up time, years ^a	20.4 ± 10.6
Post-operation carrying angle ^a	11.2 ± 2.8
Post-operation Baumann angle ^a	15.5 ± 4.3
Flynn grading	
Excellent ^b	10
Good ^b	2
Infections ^b	0
Loss of reduction ^b	0
a Values are given as the mean and SD	
b Values are given as the number of patients	

Anteroposterior and lateral radiographs analysis (Syngo Imaging V31, Siemens AG Medical Solutions, Germany) revealed that the mean post-operative Baumann angle was 15.5° (10 to 24°) and the mean carrying angle was 11.2° (6 to 15°).

The fragments all “disappeared” on X ray film in 1 year after surgery, whether absorbed or fused to the humerus. 8 patients mainly had a result of the fragments absorbed (Fig. 1), and 4 patients obtained radiographic bone fragments fusion to the humerus at 1 year after surgery (Fig. 2).

Discussion

Supracondylar humerus fractures are common fractures in children. The standard treatment for displaced supracondylar fractures of the humerus is closed reduction and percutaneous pin fixation. For

closed reduction, the surgery's experience is very important [6]. Saarinen, A.J[7] reported that there is a significant difference in outcome of surgical treatment for supracondylar humerus fractures between the surgical specialties. In the process of closed reduction, the small bone fragments usually are not easy to get an anatomical reduction especially for those less experienced surgeons. These bone fragments will be presented on the postoperative X ray film and cause the parents' worries. From January 2015 to January 2018, there were 460 cases of pediatric supracondylar humerus fractures treated in our center, and 12 (2.6%) patients who received CRPP treatment had bone fragments on postoperative X ray film. Patients treated with open surgery didn't have any unsatisfactory fragments on postoperative X ray film, for it could be well managed during the operation.

Mostly, the supracondylar humerus fractures are extension type and occurring as a result of fall on an outstretched hand [8]. Patients with supracondylar humerus fractures enrolled in our study were all extension fracture classified as Gartland type III. The bone fragments on X ray film all lay anterior to the humerus, without bone fragments on posterior side. It may be related to the mechanism of injury or the procedure of reduction, but exact mechanism is still unclear. In our study, all the bone fragments were very close to the humerus on X ray film. It might mean that there was still some periosteum connected between the fragments and humerus, which would be beneficial to the union of the fragments. While we had no evidence to prove it due to the closed reduction procedure.

Although complications of supracondylar fractures are common in the pediatric population, the long-term outcome and function is good if the fracture is appropriately diagnosed and treated [9]. Many of the associated complications either are self-limited or are amenable to functional repair with surgical intervention. In our study, the small fragments on X ray film after CRPP treatment all "disappeared", either be absorbed or fusion to humerus. But we didn't think all the fragments left after operation would disappear, in case of infection, unsatisfactory pins fixation or lose of reduction, there might be a problem. For the large fragments or free fragments far away from humerus, we also preferred open surgery for an anatomical reduction. While, how to define the size of "small fragment" or totally free fragment usually depended on the surgeons, which was also a limitation of our study. A computed tomography (CT) scan may be helpful for the accurate assessment of the fragments' size, but whether there is such a need remains to be discussed.

For those severely displaced supracondylar fractures, there is still a difference in opinion among authors whether utilizing closed reduction or open reduction procedure [10]. Open reduction with percutaneous pinning is an accepted treatment for severely displaced, irreducible fractures of the distal humerus [11–12], which also has several complications like infection, ROM limitation and scarring [13]. There is no research to prove that whether we should have an open procedure for supracondylar humerus fracture with such small fracture anterior to the humerus. In our study, the small fragments left after closed reduction is not an indication for open surgery, which may be absorbed or healing. But more research is needed to support it.

Other limitations of our study were the small number of cases and a short follow-up period. In addition, this study was retrospective. Therefore, we could not draw any firm conclusions. A large, prospective study is needed.

Conclusions

Based on our study, the small bone fragments on X ray film after closed reduction for supracondylar humerus fracture mostly will be absorbed or union in one year, which may depend on the size of fracture, periosteal connection and complications affecting bone healing. Further extensive studies are needed to confirm the findings of our study.

Abbreviations

CRPP

closed reduction with percutaneous pin fixation; ROM:range of motion

Declarations

Ethics approval and consent to participate

This study was approved by the Human and Ethics Committee for Medical Research at Sichuan University in accordance with the Declaration of Helsinki. Written informed consent was obtained from parents of all individual participants included in the study.

Consent for publication

Written informed consent for publication was obtained from parents of all pediatric participants.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Authors:

LY wrote the first draft of the manuscript, completed the analysis and interpretation of data for the work; PYY and LL put forward the idea and completed the data collection and patients' follow up. XYT performed the clinical practice and final approval of the version to be published. All authors reviewed the manuscript for important intellectual content and approved the final version to be published.

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Figures

Figure 1

Radiographic of a patient with left supracondylar humerus fracture Gartland type 3 who received a close reduction and percutaneous pins fixation procedure. a, b: Preoperative radiographs; c: postoperative radiograph demonstrated a fragment anterior to the humerus; d: radiograph at 6 weeks after surgery; e: radiograph at 6 months showing a partial absorption of the fragment; f: radiograph at 1 year follow up, there was no fragment any more, which mainly was absorbed.

Figure 2

Radiographic outcome of a patient with left supracondylar humerus fracture Gartland type 3 who received a close reduction and percutaneous pins fixation procedure. a: preoperative radiograph; b: postoperative radiograph demonstrated a fragment anterior to the humerus; c: radiograph at 1 year follow up, the fragment mainly fused to humerus.