

The Outcome of Closed Reduction and Total Lateral Entry Crossed Pin Fixation of Unstable Type III Pediatric Supracondylar Humerus Fractures

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Abstract

Background: Supracondylar humerus fracture is the most common elbow fracture in children. While closed reduction and percutaneous pinning is the standard treatment method, the ideal pin arrangement is controversial.

Objectives: The current study aimed at evaluating the outcome of the closed lateral cross-pinning to treat displaced supracondylar humeral fractures. Patients and method: After closed parallel lateral pin fixation, reduction was unstable in 35 patients, who underwent cross-pinning from lateral entry point. The mean follow-up period was 6 months and all patients were evaluated for the loss of reduction, iatrogenic ulnar nerve injury, and elbow range of motion.

Results: The mean age of the patients was 7 years. All fractures were type III according to the Gartland classification. There was no case of reduction loss or iatrogenic ulnar nerve injury. Elbow range of motion was full. Two patients had malreduction.

Conclusions: Although medial and lateral cross-pinning has the highest stability of pinning techniques, the risk of iatrogenic ulnar nerve injury is significant. Total lateral entry cross-pin fixation method of pediatric supracondylar humerus fractures has similar results to the conventional cross-pin methods regarding the fixation stability, but with lower ulnar nerve injury cases.

Keywords: Ulnar Nerve, Supracondylar Fracture, Closed Pinning, Cross-Pinning

1. Introduction

Supracondylar humerus fracture is the most common elbow fracture in children (1, 2). Although Kirschner wire fixation is the most widely accepted fixation method, there is wide disagreement about the ideal pin configuration (1-5). The classic method involves medial/lateral cross-pinning in which 1 pin is inserted from lateral side and another one from medial side. Previous Studies showed that the crossed medial and lateral pins can increase fixation stability (6, 7). However, there is well established evidence that insertion of medial pin is associated with increased rate of iatrogenic ulnar nerve injury (2, 8). Bronwyn L. Slobogean et al. in a systematic review showed that compared with the lateral pinning alone, medial/lateral cross-pinning had an increased iatrogenic ulnar nerve injury of 1 in every 28 treated patients (9).

Insertion of 2 or 3 parallel or divergent lateral entry K-wires is a good alternative to prevent iatrogenic ulnar nerve injury. This configuration can protect the ulnar nerve, but the method is thought to be biomechanically less stable than the cross-pin configuration (10, 11).

In fracture patterns that are more proximal to the olecranon fossa, placement of sufficiently divergent and more than 2 lateral pins maybe impossible, necessitating a cross-pin for enough fixation. Another indication for cross-pin is high medial comminution with significant varus instability that may not allow sufficient lateral pin fixation (7).

The current study aimed at evaluating the outcome of the closed lateral cross-pinning technique to treat displaced supracondylar humeral fractures that require cross-pinning.

2. Methods

In a retrospective study from June 2008 to July 2106, the data of 35 surgically treated pediatric supracondylar humerus fracture were collected. Initially, the fixation was performed by 2 lateral divergent or parallel pins, but the fixation construct was unstable when examined by varus stress under the C-arm image intensifier. Despite adding the 3rd lateral pin, the fixation was yet unstable in all cases. Subsequently, another pin was inserted from proxi-

mal/lateral to distal/medial under C-arm image intensifier control.

Information about the patient's age, body mass index (BMI), injury to surgery interval, preoperative and iatrogenic nerve injury, fracture type according to the Gartland classification, duration of follow-up, ultimate elbow range of motion, limb alignment, and pin configuration was collected. Statistical analysis was performed using IBM SPSS version 19 software.

2.1. Technique

Under general anesthesia, the patient was placed in the supine position with the affected arm on a radiolucent arm table. After sterile prepping and draping, the fracture reduction was maintained in a standard manner as described by Mubarak and Davids (12). After reduction, fixation was performed by 2 lateral 1.5-mm smooth pins. Then the stability of fixation was evaluated by C-arm image intensifier. When fixation was unstable on varus stress, a 3rd lateral pin was added and the stability of fixation was rechecked. If fixation was unstable after insertion of the 3rd pin, the 4th pin was inserted from lateral/proximal to distal/medial direction under image control. **Figure 1** shows preoperative and postoperative X-rays of an 8-year-old male after total lateral entry cross-pin fixation. When the fracture was securely fixed, pins were cut out of skin and a long arm cast splint was applied. The postoperative X-ray was performed 5 days after surgery out of splint to evaluate the loss of reduction. Another anteroposterior (AP) and lateral X-ray of elbow was performed 3 to 4 weeks postoperatively and, then, pins were removed. Patients were followed-up for at least 6 months and the elbow range of motion and upper limb alignment were evaluated.

3. Results

The mean age of the patients was 7 years (4 - 11). There were 19 males and 16 females. The mean BMI was 23 (19 - 32). The mechanism of injury was falling on an outstretched hand.

All fractures were type III, according to the Gartland classification, and had posterior displacement (extension type). There was not any preoperative or iatrogenic ulnar nerve dysfunction, but 3 patients had anterior interosseous nerve injury before reduction and all of them improved by the final follow-up. The mean interval from injury to surgery was 36 hours (12 - 120 hours). At the time of final follow up, 2 patients had cubitus varus, 1 of them also had 20 degree limited flexion. The mean follow-up period was 12 months (6 - 23 months). Heterotopic bone formation was not observed in the cases. The elbow range of motion was similar to that of intact contralateral side.

4. Discussion

Although closed reduction and percutaneous pinning is the most widely accepted treatment of displaced supracondylar humerus fractures in children, there is still controversy on the optimal arrangement of the K-wires regarding the fixation stability and iatrogenic ulnar nerve injury (1-3, 13, 14). Biomechanical studies demonstrated better stability of a cross-pin design over a lateral only parallel pin configuration (7, 15). Kocher et al. and Kumar et al. in a prospective, randomized, controlled study demonstrated that lateral pin fixation, compared with medial/lateral pinning has similar functional and radiological outcomes, and nearly equal mechanical stability without increased risk of iatrogenic ulnar nerve injury (14, 16). The systematic review by Carmen et al., indicated that medial and lateral cross-pinning construct is the most stable configuration, but care should be taken to avoid iatrogenic ulnar nerve injury (7). Dekker, in a systematic review and meta-analysis, showed no significant difference between the 2 methods regarding the loss of reduction and iatrogenic ulnar nerve injury (17). Jia-Guo Zhao et al., in a meta-analysis showed that the cross-pinning fixation had significant risk of iatrogenic ulnar nerve injury than the lateral pinning technique (18).

In the current study, proximally located pediatric supracondylar humerus fractures and medially comminuted fractures were unstable after 2 lateral pin fixation. After insertion of the 3rd lateral pin, only 13 of 48 unstable fixations got enough stability. The other 35 patients underwent cross-pinning from lateral/proximal to medial/distal direction. Optimal placement of lateral pins alone with at least 2 mm of divergence at fracture site maybe difficult in proximally located and/or medially comminuted fractures (19, 20). Ulnar nerve injury can be a catastrophic complication of pinning of pediatric supracondylar fracture, thus any efforts should be made to avoid it. There are several ways to avoid iatrogenic ulnar nerve injury, including making small medial incision over the medial epicondyle or manipulating the ulnar nerve by a finger to place it away from the pin, while putting the elbow in a semi-extended position (21). Lateral pinning is not free of risk and may lead to iatrogenic median nerve injury (9). In this series, there was no loss of reduction or iatrogenic ulnar nerve injury. Inserting the pin from proximal/lateral to distal/medial direction can theoretically lead to iatrogenic ulnar nerve injury when the pin exits the medial cortex. To avoid the ulnar nerve injury, the passage of the pin should be toward the anterior cortex and accurately controlled by image intensifier. The 2 patients with cubitus varus had malreduction that was not detected because of poor quality of radiographic images in a cast splint. Twelve

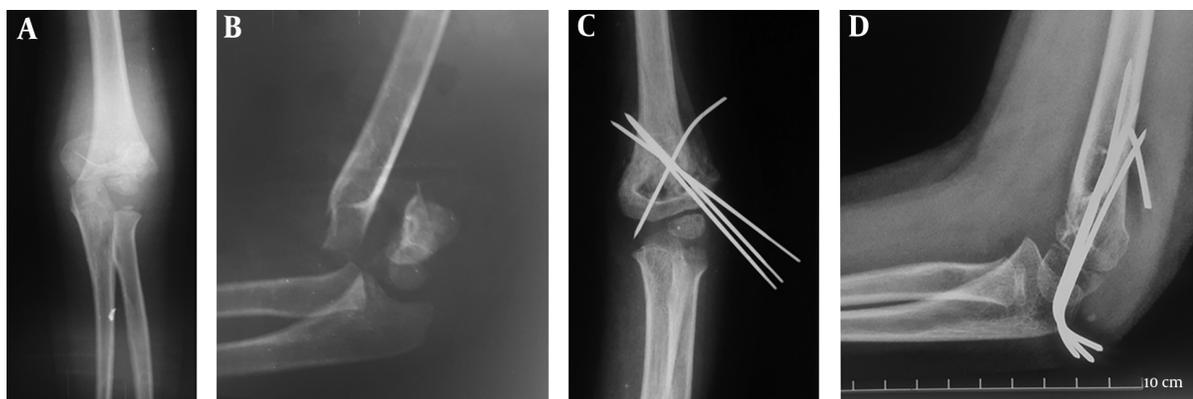


Figure 1. A, Preoperative AP X-Ray; B, Preoperative Lateral X-Ray; C, Postoperative AP X-Ray; D, Postoperative Lateral X-Ray

months after fracture, 1 of the patients underwent corrective osteotomy to correct deformity and increase the limited elbow flexion. It is strongly recommended to evaluate the quality of reduction by high quality X-rays. If there is any doubt about the acceptable reduction, the radiographs should be obtained out of the cast splint. Nowadays, the X-rays are routinely taken out of the splint in all patients. In the case of unacceptable alignment, because of ignorable remodeling potential here, especially in older children, repeated closed reduction or if necessary open reduction is strongly recommended.

In the current study, the average interval between fracture and surgery was 36 hours (12 - 120), but the outcome was not affected by delayed surgery. The current study results were similar to those of Khabiri et al. who showed, in a retrospective outcome study, that more than 24 hours delay in surgery does not influence the outcome (22).

4.1. Conclusions

Results of the total lateral entry cross-pin fixation method of pediatric supracondylar humerus fractures were similar to those of the conventional cross-pin fixation methods regarding the fixation stability, but with much lower ulnar nerve injury. If inserted under the exact C-arm image control, it is similar to other lateral pinning techniques to prevent ulnar nerve injury, but may have superior fracture stability.

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