

The First Case of Forearm Crisscross Injury in Children: A Rare Case Report

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Abstract

Background

Forearm crisscross injury is rare in children; there is no relevant literature so far. Surgeons lack experience and knowledge in treating this type of crisscross injury. We report a case of forearm crisscross injury in a child for the first time analyze its mechanism, and use minimally invasive treatment to obtain good therapeutic effects.

Case presentation

An 8-year-old boy experienced pain in his left forearm when he accidentally fell while skateboarding. Physical examination revealed swelling and deformity of the left forearm. We performed imaging and results revealed left radial head dislocation, left distal radial epiphyseal separation from the shaft, and interruption of the continuity of the dorsal cortex of the left distal ulna. X-ray films of the anteroposterior and lateral positions showed that the radius and ulna were crisscrossed. Diagnosis included superior radioulnar joint dislocation, left distal radial epiphyseal injury, and left distal ulnar fracture. After unsuccessful manual reduction, we adopted a minimally invasive procedure and succeeded. After a 14-week follow-up, the patient had good left upper limb function, no complaints of pain and limited range of motion, and good follow-up results.

Conclusions

This is the first report of a child with a forearm crisscross injury in which the mechanism, as well as the differences from an adult crisscross injury were analyzed. Minimally invasive surgery with intramedullary fixation achieved a good therapeutic effect. Simultaneously, it provides a reference for the treatment of similar patients in the future.

Background

Forearm crisscross injury is rare due its special mechanism; less than 10 cases have been reported in the existing literature. Among current reports, all forearm crisscross injuries occurred in adult patients, while there have been no reports on pediatric patients. We report the first pediatric case of a forearm crisscross injury and analyze the differences between the mechanism of injury in adult patients, which could improve the understanding of forearm crisscross injury in children. Minimally invasive surgery lead to the patient's smooth recovery at follow-up week 14. This case provided a reference for diagnosis and treatment of forearm crisscross injuries in children.

Case Presentation

An 8-year-old patient experienced pain and deformity in his left forearm due to an accidental fall. He was admitted to our hospital 2 hours after semi- restriction of movement. A detailed medical history revealed

that the patient accidentally fell while skateboarding; his palm touched the ground, causing excessive external rotation of his forearm, resulting in injury. Physical examination revealed ecchymosis, deformity of the left wrist, and limited range of motion due to pain. The left forearm showed no obvious swelling, he had no paresthesia of the left upper extremity, and no vascular or nerve injuries.

We performed X-ray and 3-dimensional computed tomography, which showed that the left elbow humeroradial joint was poorly aligned and the radial head was dislocated forward (Fig. 1). The left distal radial epiphysis was separated from the shaft, indicating a Salter-Harris type II epiphyseal injury. The cortical continuity of the left distal ulna was interrupted. Anterior and lateral radiographs showed that the ulna and radius were crisscrossed. Diagnosis was superior radioulnar joint dislocation, left distal radial epiphyseal injury, and left distal ulnar fracture. Written informed consent was obtained from the patient for the publication of this manuscript and any accompanying images.

None of the examinations suggested any obvious contraindications; hence, manual reduction was performed under anesthesia. Unfortunately, manual reduction failed and open reduction surgery was planned. After anesthesia induction, a 5-cm longitudinal incision was made on the radial side of the palmar side of the left wrist to expose the distal radius. The anterior spiral muscle was embedded in the distal radius fracture. The embedded soft tissue was removed and the distal radius fracture was fully reduced under direct vision. Crossed K-wire fixation was performed. When the distal ulnar and radial anatomical structures are restored, the original anatomical position of the superior radioulnar joint is also automatically restored. Afterward, the distal ulnar fracture was fixed using a 2.0-mm elastic intramedullary needle (Fig. 2).

Postoperatively, the left elbow was flexed to 90° and the forearm was in a neutral position. 6 weeks of plaster cast immobilization followed, X-ray examination at 6 weeks of follow-up showed that the fracture fully healed and the disabilities of the arm, shoulder, and hand (DASH) score was 16 points. Hence, the plaster and internal fixation were removed and functional exercises were started (Fig. 3). At follow-up week 14, the patient had good left upper extremity function without complaints of pain or limited range of motion. The DASH upper extremity function score was 9 points, with good follow-up results (Fig. 4).

Discussion And Conclusions

Forearm crisscross injury is rare. Due to the special mechanism, less than 10 cases have been reported worldwide; all cases involved adult patients.^[1, 2] To date, this special injury has not been reported in children; its pathogenesis, treatment, and prognosis remain unclear. Leung et al.^[2] first reported the definition of crisscross injury and diagnostic criteria in 2002. A currently recognized crisscross injury refers to simultaneous upper and lower radioulnar joint dislocation with intact interstitial membrane, accompanied by fractures of the radial head and the ulnar styloid process, but not accompanied by ipsilateral ulnar and radial shaft fractures. Lateral and anteroposterior radiographic findings of the forearm revealed radioulnar crisscross. According to Leung's study, crisscross injuries can be classified into two types: type I refers to forward radial and ulnar head dislocations; type II refers to posterior

dislocation of the radial and ulnar heads. The former is due to forearm overpronation, while the latter is caused by supination (with the intact interosseous membrane serving as a fulcrum that participates in the mechanism of the forearm crisscross injury).^[3] Our patient's imaging data showed that the ulna and radius were crisscrossed in the anterior and lateral X-ray images. Although we did not perform magnetic resonance imaging to prove that the interosseous membrane of the forearm was intact, but the patient's forearm was not swollen. When the anatomical structure of the distal ulna and radius recovered, the superior radioulnar joint was automatically restored without any additional intervention. These results indirectly proved that the interosseous membrane was intact. In our case, strictly speaking, only the superior radioulnar joint was dislocated. The distal radius epiphysis was fractured and some distal joints are still connected to the ulna; hence, the inferior radioulnar joint does not comprise a true dislocation. Since the ligament strength in children is greater than that of the epiphyseal plate, epiphyseal injury occurs in the distal radius without inferior radioulnar separation. We believe that this is a special manifestation of crisscross injury in children.

In this diagnosis of crisscross injury in adults, simultaneous dislocation of the superior and inferior radioulnar joints did not combine ipsilateral ulnar and radial shaft fractures were comprising universally accepted diagnostic criteria. Current reports include no description of fractures other than the radioulnar joint dislocation.^[2, 4, 5] During adolescence, tendons, ligaments, and joint capsules are two to five times stronger than epiphyses plates.^[6] Therefore, when radioulnar joint dislocations occur in children, their forearms are extremely pronated or supinated, injuries to the epiphyseal plate" are possible because the tendons, ligaments, and joint capsules are stronger than the epiphyseal plates. In our case, the patient's forearm was extremely externally rotated and the shearing force of the epiphysis and ligament of the distal radius increased. Epiphyseal fracture occurred due to the different strengths of the epiphyses and ligaments. The child's single ulna was unable to support the weight of the body and fracture. Our case was different from that reported in the existing literature, possibly due to the strength between children's different from of bones and ligaments than that of adults. Our patient's imaging performance is fully consistent with the diagnosis of a type I crisscross injury, ignoring the impact of distal radial epiphyseal fractures and considering the palm and ulna as a whole.

Cases of crisscross injuries reported in the existing literature have been successfully treated with closed reduction, manipulation, plaster, or external fixation. Patients had no complications of joint instability or pain. In a patient reported by Potter et al., closed reduction failed multiple times due to deformities of the radial head, and scar reduction was ultimately successful.^[4] In our case, multiple manual reductions failed and the patient had an open epiphyseal fracture. Therefore, epiphyseal fractures must be properly treated as early as possible, and focusing on anatomical reduction; otherwise, late deformities can easily occur due to premature epiphyseal closure. We performed intramedullary fixation to treat the fracture, reducing the patient's traumatic stress, while achieving anatomical reduction. The patient fully recovered and returned to his normal life, 3 months postoperatively.

In this study, we report a case of forearm crisscross injury in children for the first time and analyze the mechanism and differences from adults. Minimally invasive surgery with intramedullary fixation for a

forearm crisscross fracture achieved good results. This case provides a reference for future diagnosis and treatment of similar patients.

Abbreviations

DASH: Disabilities of the Arm, Shoulder and Hand

Declarations

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

Written informed consent to publish clinical images and case reports was obtained from the patient's parents.

Availability of data and materials:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

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Author contributions:

All authors contributed to the manuscript. FG and DKW contributed equally to this work. YKJ was responsible for the patients' surgical treatments. YKJ, FG, and DKW drafted the initial manuscript and reviewed and revised the final manuscript. YBW and CDP critically reviewed and revised the manuscript for important intellectual content. All authors have authorized the submission of the final manuscript and agreed to be responsible for all aspects of the work.

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Figures

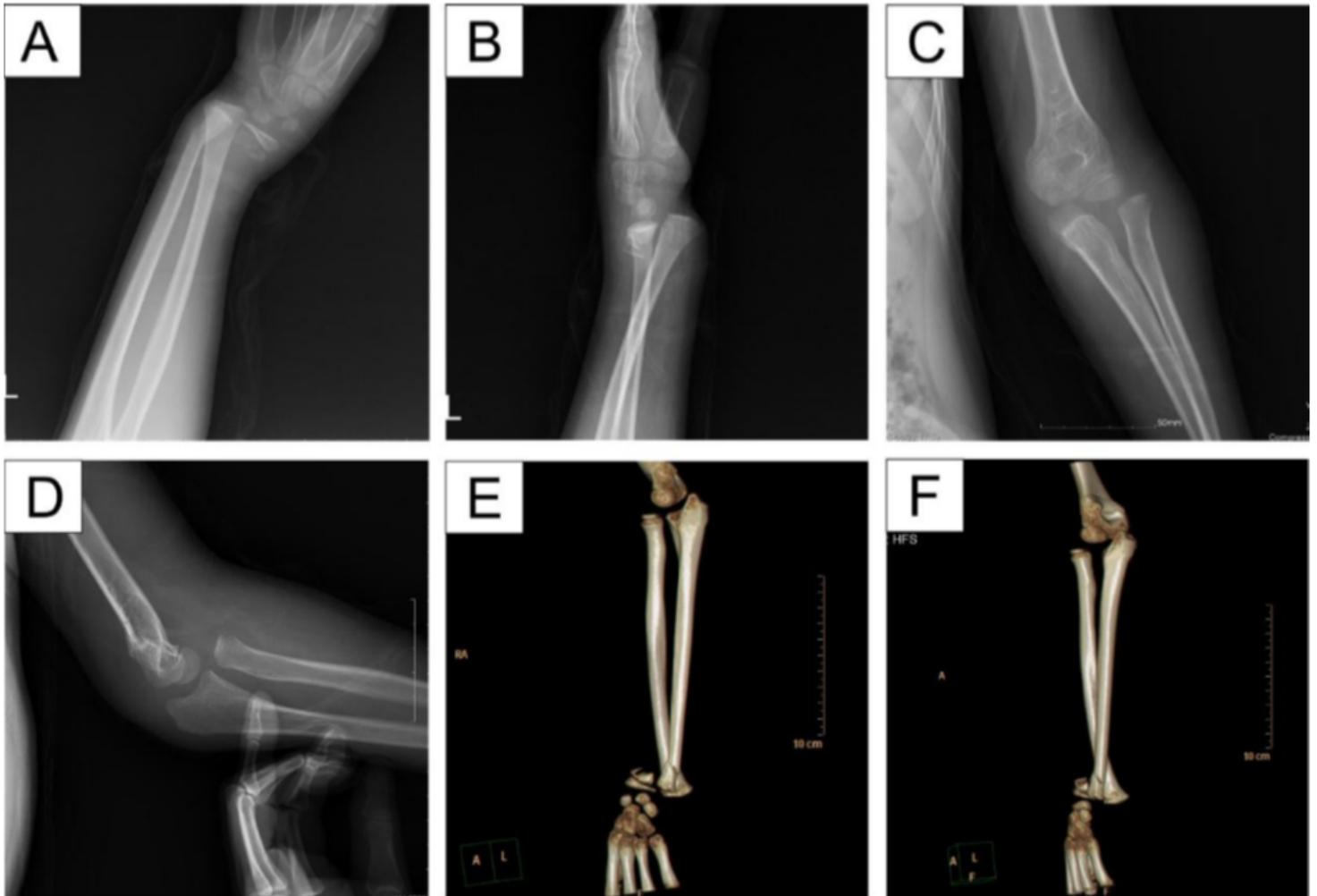


Figure 1

The patient's preoperative imaging examination showing that the distal radius and ulna are fractured. Anterior and lateral positions of the ulna and radius show a crisscross state.

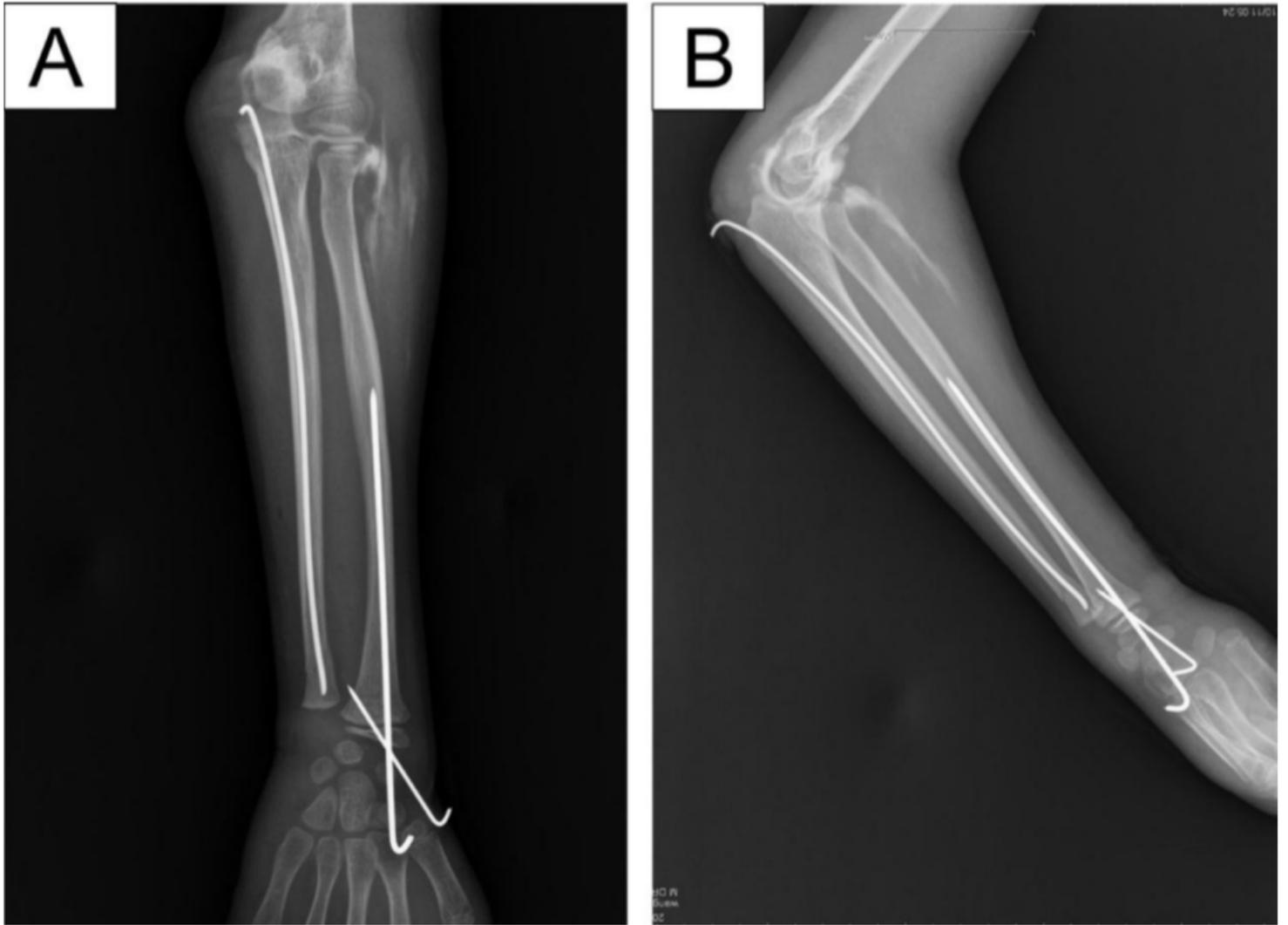


Figure 2

We performed a postoperative imaging examination. The forearm returned to its normal anatomical position and internal fixation functioned well.

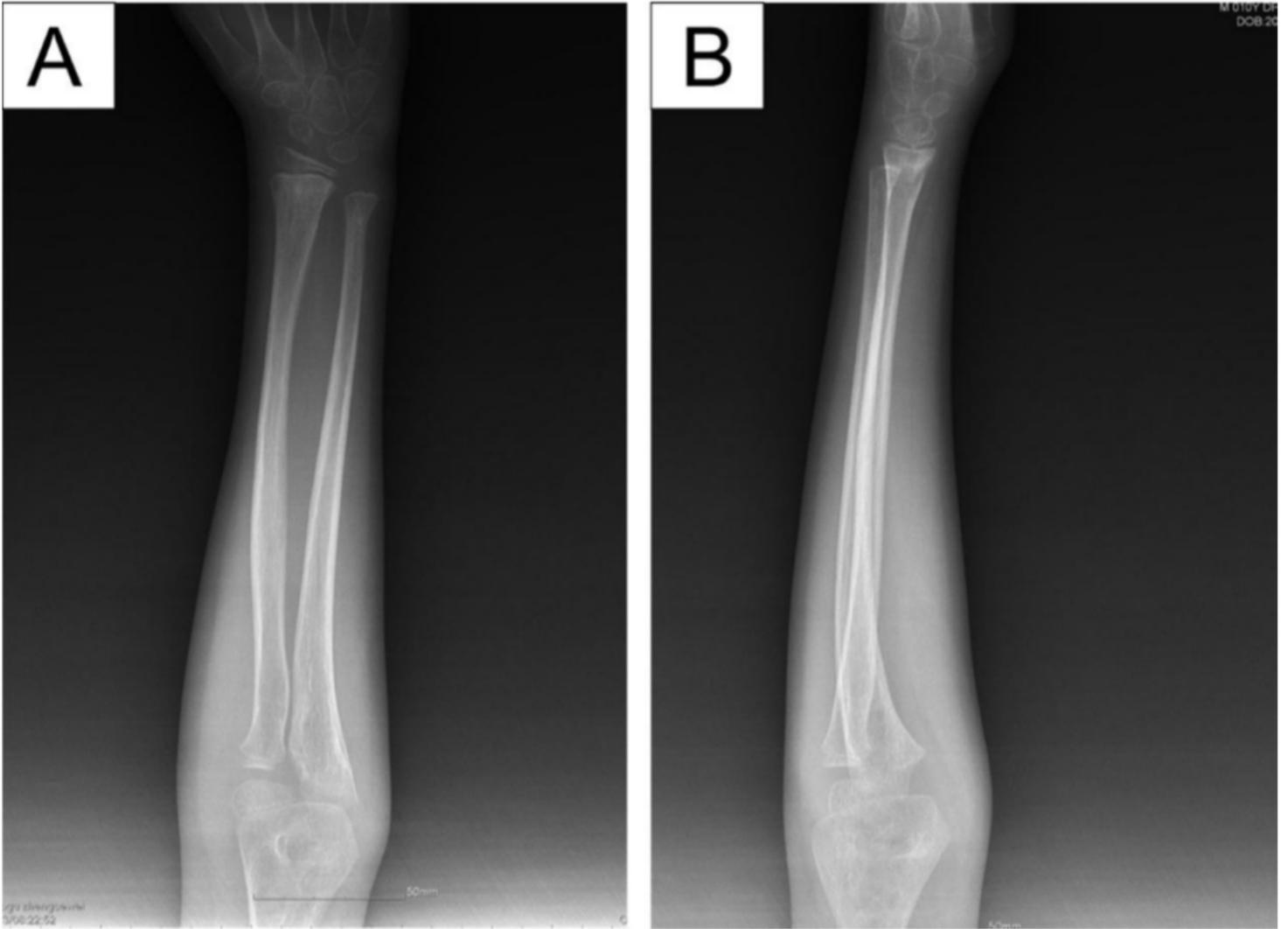


Figure 3

At postoperative week 6, the fracture heals smoothly and hardware for internal fixation was removed.

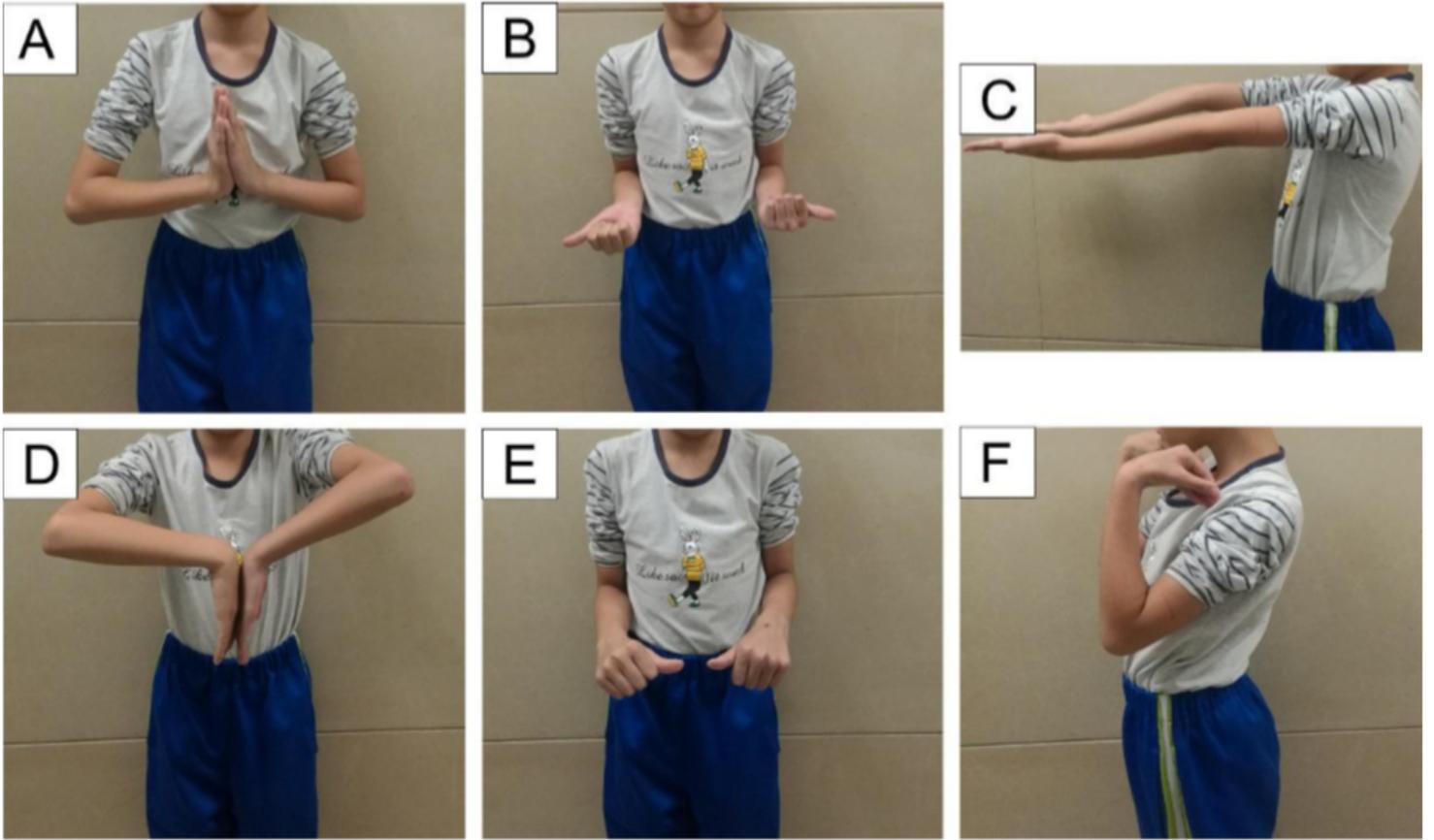


Figure 4

At postoperative week 14, the patient's forearm function returned to normal and surgery was effective.