RESEARCH ARTICLE

Ultrasound-guided Percutaneous Medial Pinning of Pediatric Supracondylar Humeral Fractures to avoid Ulnar Nerve Injury

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Abstract

Background: Medial pinning is one of the most controversial aspects of the surgical treatment of supracondylar fractures (SHF) owing to the risk of ulnar nerve injury.
Aim: To evaluate the safety and usefulness of medial pinning for SHF using ultrasound imaging for ulnar nerve visualization.

Methods: Fifteen children, with a mean age of 60 months, with displaced SHF were treated with a crossed-pinning configuration after fracture reduction. Intraoperative ultrasound was used to guide medial pin insertion to avoid ulnar nerve injury.

Results: Cubital tunnel anatomy was easily identified in all children. All children showed a subluxating ulnar nerve that required elbow extension to about 90º before medial pin insertion. None suffered ulnar nerve dysfunction after using the referred technique.

Conclusions: Although technically demanding, ultrasound may be a valuable adjuvant to avoid ulnar nerve injury while performing a medial pinning in pediatric SHF.

Key words: Elbow pinning, Musculoskeletal ultrasound, Pediatric elbow, Pediatric supracondylar elbow fractures, Ulnar nerve

Introduction

Pediatric supracondylar humeral fractures (SHF) are a common type of fractures, nonetheless, problematic (1). When displaced, closed reduction and percutaneous pinning should be considered. However, medial pinning remains one of the most controversial aspects of such intervention, due to the risk of ulnar nerve injury (2, 3). An extensive number of studies analyzed the ideal pin configuration to obtain the highest stability when compared to cross pinning, but with avoiding medial pinning (4).

The purpose of this study was to evaluate the safety and usefulness of medial pinning for SHF using ultrasound imaging for ulnar nerve visualization.

Materials and methods

We prospectively treated fifteen children with a mean age of 60.58 months (range: 18 to 107 months) who had sustained a displaced SHF and were treated with the proposed technique, between October 2011 and March 2012. Mean follow-up was 7.15 months (range/; 4 to 9 months). Their respective parents consented to the

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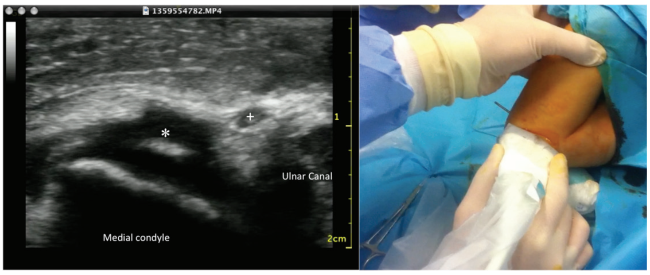

Figure 1. Ultrasound anatomy of the cubital tunnel in a 90º flexed elbow. (Left figure: ulnar nerve (+), medial epicondyle (*). Right figure: After lateral pin insertion, elbow is released in order to do an ultrasound of the medial elbow.

surgery. Neurovascular status was documented before and after the intervention.

All procedures were performed by the same surgeon (FS for initials), with expertise in pediatric musculoskeletal ultrasound imaging. The patient was placed in the supine decubitus position with the affected arm on a radio-transparent table. A closed reduction of the fracture was then attempted under fluoroscopic control. If satisfactory reduction with the conventional maneuver was not obtained, an open anterior approach was then performed under a tourniquet (5) . Reduction was maintained with an elastic band, with the elbow in full flexion. A pillow was placed under the elbow to assist in the abduction of the limb off the hand table and to facilitate pin insertion. First, a lateral percutaneous pin was inserted under fluoroscopic control through the capitelum. A second lateral pin was added for fractures needing an open reduction. Then, the elastic band was released and the elbow was extended to approximately 90º flexion. Through the use of an ultrasound scope the medial pin was finally inserted through the medial epicondyle.

Ultrasound technique for medial pin insertion

A Venue 40 ultrasound (GE Healthcare, Fairfield, CT, USA) with a L8-18i transducer was used. With the elbow at 90 degrees flexion, the transducer was placed with its longitudinal axis on the line uniting the medial epicondyle with the olecranon. The ulnar nerve located within the cubital tunnel and the medial epicondyle was identified [Figure 1]. Extension of the elbow was performed to separate the ulnar nerve from the top of the medial epicondyle.

The tip of a pin was hand-placed on the top of the medial epicondyle under ultrasound control; avoiding injury to the ulnar nerve. The tip of the wire was maintained at this position and reoriented using the lateral pin as a reference. The pin was then further drilled with the use of a motor. Correct pin insertion was verified fluoroscopically [Figure 2; 3]. The ultrasound was again used to verify that the ulnar nerve was free along its entire course at the elbow joint. The elbow was finally immobilized with a dorsal splint for 3 to 4 weeks. Afterwards, the splint and pins were removed at the outpatient clinics.

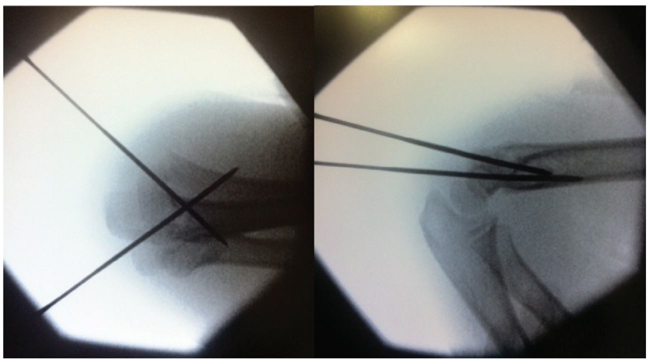

Figure 2. Fluoroscopic assessment of supracondilar humeral fracture reduction and pin placement.

Results

At presentation and prior to the reduction, one patient had developed a partial median nerve palsy and another child had an anterior interosseus nerve palsy. Open reduction was needed in three cases, thus; 2 lateral and one medial Kirschner wire were used in these cases.

Ulnar nerve and cubital tunnel anatomy were easily identified in all cases. All cases showed ulnar nerve subluxation with the ulnar nerve located on the top of the medial epicondyle at elbow flexion beyond 90° [Figure 3] (6). Thus, elastic band release and elbow extension to around 90° was needed in all cases.

None of the 15 patients suffered ulnar dysfunction after surgery. Both nerve lesions that were present initially, spontaneously and fully recovered thereafter. Fracture consolidation occurred uneventfully and with no further complications in all cases.

Discussion

A crossed pin configuration for fixation of SHF provides the highest fracture stability, but medial percutaneous pinning has been associated with a considerable risk of ulnar nerve injury (3,7-9). Thus, many studies focusing on pin configuration have been done, studying the most stable configuration without median pin insertion. Although most displaced SHF can be adequately

Figure 3. Cubital tunnel ultrasound in a beyond 90º flexed elbow showing the ulnar nerve (+) located over the medial epicondyle (*). Entrance of the pin is visualized (arrow). Same patient as in Figure 1 (left). While the ulnar nerve was located with ultrasound, the pin was inserted with the contralateral hand.

stabilized with lateral pins, some fractures still require a medial pin to achieve a satisfactory stability (4,8) and many surgeons prefer a crossed pin configuration with percutaneous pin insertion (1, 10). A medial elbow incision with or without ulnar nerve dissection has been described to decrease the risk of nerve injury for medial pinning (11). In addition, positioning the elbow at 90º for medial pin insertion has also been described with the purposes of decreasing the risk of ulnar nerve injury in cases of subluxating ulnar nerves (12). In line with previous studies, the technique described in the present paper was intended to decrease or eliminate the risk of ulnar nerve injury during medial pinning. Since crossed pin configuration for fixation of SHF provides the highest fracture stability, our technique provides a tool to allow medial elbow pinning while avoiding ulnar nerve injury (4). Ultrasound-guided pining allowed a continuous and live visualization of the nerve during pin insertion. One important limitation to our study was the limited number of cases included. However, since we had a constant visualization of the ulnar nerve we could conclude that our technique ensures safe medial pin insertion without risk of direct nerve injury. A prospective comparative study with proper statistical power is necessary to confirm potential benefits of the use of our technique.

Most ulnar nerve injuries occurring after medial pinning are transient and probably due to nerve strangulation by local soft tissue (10). However direct nerve injury with nerve penetration has been described (8). We did not observe any nerve anomaly in ultrasound imaging after pin placement, nor did we have sensitive or motor deficits at posterior clinical exam. Ultrasound guidance ensured that the pin was not placed inside the cubital tunnel and thus, hypothetically avoiding ulnar nerve strangulation by the adjacent soft tissues.

Furthermore, through the use of intraoperative ultrasound, we could reliably and reproducibly identify the ulnar nerve and safely preserve it during percutaneous medial pinning of SHF.

Ultrasound static and dynamic ulnar nerve anatomy has been recently described in the pediatric age (6). Fifty percent of children between the age of 6 and 10 showed dislocating or subluxating ulnar nerve. In our study, we could verify that the nerve was located close to the top of the ME with elbow flexion beyond 90º (i.e., subluxating nerve) in all of our patients. Thus, our study supports the concept of extending the elbow to decrease risk of ulnar nerve injury before medial pinning (12).

Another inherent limitation to our technique is the need for a specific training and experience in musculoskeletal ultrasound. However, ultrasound imaging is progressively gaining recognition in the clinical practice of pediatric orthopedics for both diagnosis and intervention; similarly to what has occurred previously with other surgical or medical specialties (rheumatology, anesthesiology, obstetrics and gynecology, cardiology, etc…) (13-15). We believe that mastering of the ultrasound will soon form a part of the usual clinical practice of pediatric orthopedic surgeons.

In spite of being a demanding technique, ultrasound guidance may be a valuable adjuvant to avoid ulnar nerve injury while performing medial pinning of pediatric supracondylar elbow fractures.

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