

Results of Treatment of Displaced Supracondylar Humeral Fractures in Children by K-wiring

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ABSTRACT

The supracondylar fracture of the humerus in children remains the most challenging injury for the orthopedic surgeon. It is important to consider the options of treatment very carefully and tailor the treatment according to the characteristics of each fracture. In this study we observed outcomes of surgical procedures using the Kirschner-wire for the dislocated (displaced) supracondylar fractures in 135 children (mean age 6.7 years). In 96 patients closed reposition (reduction) and fixation with crossed K-wire was done. A total of 41 children were operated by the means of open reposition and crossed K-wire fixation. Another 41 underwent similar (1-mm) K-wire application. In classifying the fractures Gartland classification of the supracondylar fractures of the humerus was used. Postoperatively, cubitus varus was found in seven, and cubitus valgus in three children (5% and 2% respectively). Stiffness of the elbow was recorded in 18 patients, while the paresis of the ulnar nerve was recorded in three cases (13 and 2% respectively). In conclusion, we can suggest crossed fixation while applying the K-wire throughout two cortices, since such technique ensures the most superior fixation and stable osteosynthesis.

Key words: Kirschner wire, children, displaced fracture, crossed fixation

Introduction

The supracondylar fracture of the humerus in children is a common childhood injury accounting for 3–7% of all fractures¹ and the majority (55–80%) of all elbow fractures in children². The commonest type is the extension fracture, in which the condylar complex shifts posteromedially or posterolaterally after a fall on the outstretched arm, but in 2% the condylar complex shifts anterolaterally: the flexion type fracture³. In 1959, Gartland⁴ noted »the trepidation with which men, otherwise versed in the management of trauma, approach a fresh supracondylar fracture«. The first radiological classification system for Supracondylar fractures was proposed by Felsenreich⁵ in 1931 according to the degree of displacement; however, this is generally accredited to Gartland. Wilkins^{6,7} modified the Gartland classification but maintained the basis of the 3 types:

- Type I when the fracture is undisplaced or minimally displaced, such that the anterior humeral line still passes through the ossification centre of the capitellum

- Type II when there is an obvious fracture line with displacement of the distal fragment, but there is still an intact cortex posteriorly. The direction of the displacement may be straight posteriorly, or angulated medially or laterally and there may be a rotary component
- Type III when the fracture is displaced with no cortical contact with either posteromedial or posterolateral displacement.

Wilkins subdivided type III fractures (often misquoted as type II) into A and B, depending on the absence or presence of rotation.

Treatment of supracondylar fracture is based on the classification. More precisely, type 1 fractures are treated with simple immobilization in a plaster cast without any manipulation; type 2 fractures are treated by manipulation followed by immobilization in a plaster cast. The cast is kept for three weeks, while type 3 fractures require operative treatment. An attempt is made to reduce

the fracture without exposing the bone fragments through an incision. If successful then the fracture is held in place by 1.5 or 2 mm stainless steel wires called Kirschner (K) wires. If this is unsuccessful then the fracture is exposed by an incision and the bone fragments are aligned under vision. They are then held in place by K wire^{8,9}. Postoperative complications include cubitus varus, cubitus valgus, Volkmann's ischemic contracture, vascular injury, nerve (ulnaris, medianus, radialis) injury, compartment-syndrome, malunion (fracture unites in a wrong position called gun stock deformity), and loss of movement¹⁰.

The aim of this study was to analyze the outcomes of the K-wire surgical procedures for the dislocated (displaced) supracondylar fracture performed at the University Hospital Mostar, Bosnia and Herzegovina.

Materials and Methods

In this study we included 135 children, aged 6.7 years on average (1–14 years). All patients were operated from 1998–2008 for the dislocated humerus fracture, at the Clinics for Orthopedics of the University Hospital Mostar.

In 96 patients closed reposition (reduction) and fixation with crossed K-wire was done. A total of 41 children underwent open reposition and crossed K-wire fixation. Another 41 patients underwent open reposition with percutaneous fixation with similar (1-mm) K-wire. In classifying the fractures Gartland classification of the supracondylar fractures of the humerus was used.



Fig. 1. Good reposition of the bone parts by means of the crossed K-wires.



Fig. 2. Good reposition of the bone parts by means of the crossed K-wires.

Operational procedure

As soon as possible after arrival to the hospital, fractures were reduced under general anesthesia and image intensifier control. All patients were fully anesthetized. With the exception of seven patients with open fracture and/or compromised blood circulation, after cleaning and covering the operational field manual reposition has been tried for other patients. Assistant performs longitudinal traction and elbow flexion until the angle of the 120 degrees is reached. With the patient in a supine position, traction was applied to the forearm and the elbow then flexed while pressure was exerted simultaneously on the olecranon. An acceptable reduction of the coronal and sagittal alignment as well as rotational alignment was attempted. We checked radiographs and accepted the reduction as adequate when the difference in the Baumann angle¹¹ was within 5°–8°. On the lateral view, we accepted it as adequate when the capitellar angle from the anterior humeral line was within 10° of that of the contralateral elbow. In the case of well positioning, fracture is immediately fixated with the crossed K-wires and additionally checked by X-ray screening.

When an adequate reduction and reposition could not be obtained by second closed manipulation or the surgeon could not accept the status of the closed reduction, open reposition (surgical procedure) was applied. Medial approach and mandatory observation of the N. Ulnaris was applied. We have tried to position the K-wires through the long cortex of the humerus to ensure additional stability of the osteosynthesis. Open reposition was done in seven patients. In five of them open fracture was evidenced, whereas in two cases we judged compromised circulation.

Results were checked according to: postoperative RTG, evidencing the Baumann's angle, the range of motion in elbow joint and Flinn's criteria.

Results

Postoperatively, cubitus varus was found in seven, and cubitus valgus in three children (5% and 2% respectively). In 18 patients (13%), after K-wire removal, we have registered stiffness of the elbow which was efficiently treated by means of physical therapy. Paresis of the N. Ulnaris was evidenced in three children (2%). In one child permanent paralysis of the N. Radialis was found, but it must be stated that this patient was treated for the open Gartland 3 extension fracture, with preoperatively evident malfunction of the N. Radialis. Altogether, we have found no significant differences in the surgical outcomes between the open and closed reposition (χ^2 ; $p > 0.05$)

Finally, the results are evidenced as excellent for 120 children; fair in 14 children, and poor in one child.

Discussion

A severely displaced supracondylar fracture during childhood is a challenging injury to treat. With the fear of developing Volkmann's ischemic contracture and the cubitus varus deformity, closed reduction and cast application is thought to be inappropriate for this injury¹² most physicians now tend to favor closed reduction and percutaneous pinning¹³. Despite success with this technique, a certain portion of the displaced fractures cannot be reduced with a closed method. Brachialis muscle entrapment at the fracture site is the most common cause of blocked reduction, as the distal spike of the proximal fragment is driven through the substance of the muscle¹⁴.

K-wires are immensely versatile in fracture fixation in the pediatric population. Complications associated with the K-wiring procedure vary from minor to life-threatening. There are several reports in the literature describing fatal complication following distant migration of a K-wire to vital structures such as the heart, thoracic big vessels and lungs^{15–17}. Minor complications could be important factors in enhancing parental anxiety and prolonging patients' recovery; however, they are extremely under-reported.

Previously published studies have emphasized the complications specific to a particular fracture in children rather than implant specific^{18,19}. We found no studies specifically examining the complication rate associated

with use of K-wires in fracture fixation in children regardless of their specific anatomical location.

Millis et al.²⁰ proposed open reduction when an adequate closed reduction was not obtained. We planned a similar schedule for these fractures in our study. Prevention of cubitus varus is one of the important goals, and anatomic reduction of the fracture is required to decrease the deformity. From this viewpoint, our results with Baumann angle difference can be interpreted as similar to those found in other studies (see Oh et al.¹¹ for example).

As in previous studies²¹, we have identified the inaccurate reduction of the angle as the main cause of poor results using the closed operational procedure. Evidently, we have to support the observation of the Oh et al.¹¹ where authors noted that such outcome led them to believe that the results are not related to the closed or open method but, rather, to the stability of the fixation or the quality of the reduction. Loss of motion, myositis ossificans, and infection are the possible complications of open reduction^{22,23}, but we have not found such complications in our series.

The proponents of the open reposition with K-wire fixation, as well as the proponents of the K-wire positioning with the lateral side approach are of the opinion that such procedures ensure relatively clean iatrogenic lesions of the N. Ulnaris²⁴. However, we are of the opinion that the risk of the eventual iatrogenic lesions of the Nerves can be minimized by adequate surgical technique. From our point of view, the most important parameter is the palpability of the medial epicondylus (ME). In cases when ME is not palpable, K-wire can be securely and accurately placed with small incision and application of the leader. Secondly, our experience led us to conclusion that surgeon has to evade hyperflexion in the elbow joint while applying the K-wires. Briefly, it seems that such approach reduces the possibility of the injury of the N. Ulnaris. Finally, it is crucial to reduce the attempts of the adequate positioning of the fixations to the minimum.

Conclusion

Generally, we can conclude that open surgical procedure and K-wire fixation of the supracondylar fracture of the humerus is a safe procedure and that it produces good anatomical and functional outcomes if, after several attempts, closed reduction fails.

By all means we can suggest crossed fixation while applying the K-wire throughout two cortexes, since such technique ensures the most superior fixation and stable osteosynthesis.

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REZULTATI LIJEČENJA SUPRAKONDILARNIH RPIJELOMA NADLAKTIČNE KOSTI S POMAKOM KOD DJECE

SAŽETAK

Suprakondilarni prijelomi kod djece su jedna od najzahtjevnijih ozljeda u ortopediji. Njihovo značenje uzrokuje potrebu za razmatranjem izbora liječenja u skladu s obilježjima svakog prijeloma. U ovom radu prikazali smo rezultate liječenja 135 djece (srednje dobi 6, 7 godina), kod kojih je korištena Kirschenrova žica u liječenju suprakondilarnih prijeloma s pomakom. Kod ukupno 96 pacijenata primijenjena je zatvorena repozicija i fiksacija, dok je kod 41 pacijenta primijenjena otvorena repozicija u kojoj je korištena Kirschenrova žica od 1 mm. Pri tome je korištena Gartlandova klasifikacija za suprakondilarne prijeloma. Nakon operacije cubitus varus je zabilježen u sedam slučajeva, a cubitus valgus u tri slučaja (što je odgovaralo ukupno 5% i 2% pacijenata). Zakočenost ramena zabilježena je kod 18 pacijenata (13%), a pareza ulnarnog živca u tri slučaja (2%). Ukrižena fiksacija korištenjem K-žice kroz dva kortikalna područja je metoda koju predlažemo kao najbolju, jer ona osigurava najbolju fiksaciju i omogućuje stabilnu osteosintezu.