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Use of the Kapandji technique in the reduction and fixation of distal radial fractures

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ABSTRACT

Introduction: The technique of reduction and fixation of distal radial fractures consisting in the introduction of K-wires between bone fragments ("intrafocal technique") was firstly described by French orthopedic surgeon dr. Adalbert Kapandji in 1967. This method allows a reduction of the fracture using the K-wire as a "lever", which elevates displaced bone fragments and places it on site. The objective of this article is the presentation of the Kapandji technique and the results of the treatment of distal radial fractures operated on at the authors' institution.

Materials and methods: A total of 187 patients, 151 women (81%) and 36 men (19%) aged on average 62 years were operated on using the Kapandji technique. The patients were followed up 6 months after surgery, according to standard protocol.

Results: The mean wrist total arch of motion (dorsal + palmar flexion) was 93°, grip strength of 17.2 kG and the quickDASH score 21 points. All these variables reflect the overall good function of the affected hand. Meaningful secondary displacements were noted in only 5 patients (2.6%). In general, the results obtained by the patients were satisfactory. The results of our study show that using the Kapandji technique for the treatment of distal radial fractures resulted in satisfactory clinical outcomes and relatively rare complications.

Keywords: distal radial fracture treatment; Kapandji technique; outcome measurements.

INTRODUCTION

The technique of reduction and fixation of distal radial fractures consisting in the introduction of K-wires (also called "pins") between bone fragments ("intrafocal technique") was firstly described by French orthopedic surgeon dr. Adalbert Kapandji in 1976 [1]. The Kapandji pinning technique is typically used and maintained throughout the fracture healing period. Before, that method was not accepted because it was believed that the presence of a metallic foreign object between fracture fragments would disturb the process of bone healing. The excellent outcomes of the treatment shown by dr. Kapandji proved its usefulness and prompted surgeons to apply it in their work. The Kapandji technique allows a reduction of the fracture by using an intrafocal K-wire as a "lever" which elevates displaced bone fragments and places them on site. This allows an anatomical (or nearly anatomical) reduction of the fracture. The thick pin left in the fracture site stabilizes it additionally, prevents collapsing of the osteoporotic bone, and does not disturb the consolidation process.

The Kapandji technique is typically indicated for displaced two-part distal radial fractures without involving the articular surface, with no or minimal comminution of the dorsal cortex, and for extra-articular or intra-articular fractures with only 1 fracture line. In AO classification, it corresponds with A3, B2, and C1 fracture configurations [2, 3, 4]. The Kapandji technique is also recommended for the open reduction and internal fixation, and a temporary reduction of the fracture before the final stabilization using the plate [5]. In general, the Kapandji technique is not recommended for intra-articular fractures involving the radiocarpal joint and severely osteoporotic bone [1, 3].

The objective of this article was to present and illustrate the Kapandji technique for the reduction and fixation of distal radial fractures. Another aim was the presentation of the results of the treatment of these fractures operated on using this technique at the authors' institution.

OPERATIVE TECHNIQUE

The operation is performed under brachial plexus block anesthesia. The subsequent stages of this technique in the reduction and fixation of distal radial fracture type AO A3 are shown in Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11:

— A 2.0 mm K-wire is introduced manually under fluoroscopic control at the dorsal side of the distal forearm (Fig. 1). The pin (K-wire) should be adequately stiff, allowing its use as a "lever" for the elevation of the dorsal bone fragment (in this text, it is called a "lever pin").

— At the beginning of the procedure, the wrist is kept in the horizontal position, but in the course of introducing the pin, the wrist is turned laterally, which facilitates monitoring the position of the pin between bone parts (Fig. 2, 3).

— When the K-wire is placed intrafocally (between the bone fragments), it is used as a lever; the dorsally displaced distal fragment is elevated distally (Fig. 4, 5). This manoeuvre corrects the displacement and the reduction of the fracture is achieved (Fig. 6).

— After achieving a satisfactory position of the bone fragments, the "lever pin" can be retrieved, and the final fixation of the fracture is performed using thinner (1.4 mm) K-wires introduced from the radial styloid (Fig. 7).

— In the presented case of relatively simple AO A3 fracture, 3 radial styloid pins, and an additional pin introduced from the ulnar side are enough for the firm stabilization of bone fragments (Fig. 8, 9).

— After the completion of the procedure, the pins are cut and their ends are buried under the skin (Fig. 10).

— Final view of the wrist after surgery is shown in Figure 11.

FIGURE 1. Introduction of the lever pin into the fracture line (intrafocal)

FIGURE 2. Intraoperative X-ray showing the introduction of the lever pin

FIGURE 3. Lever pin placed in the fracture line

FIGURE 4. Elevation of the dorsally displaced fragment using the lever pin

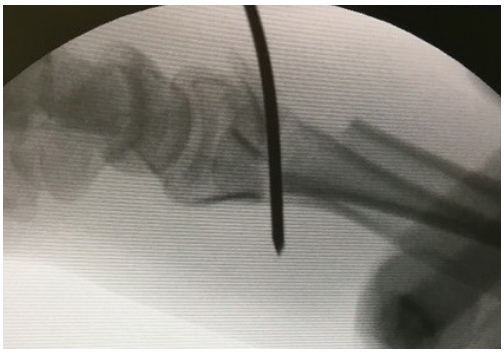

FIGURE 5. Reduction of the displaced dorsal fragment elevated using the lever pin

FIGURE 6. Anatomical position of the bone fragments. The fracture is reduced

FIGURE 7. Percutaneous introduction of the first, trans-styloid K-wire

FIGURE 8. Final view after the fixation of the fracture using 4 K-wires

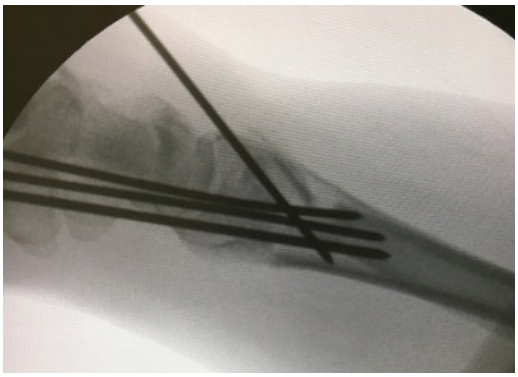

FIGURE 9. X-ray (lateral view) of the completed fixation

FIGURE 10. Cutting the K-wires and burying them under the skin

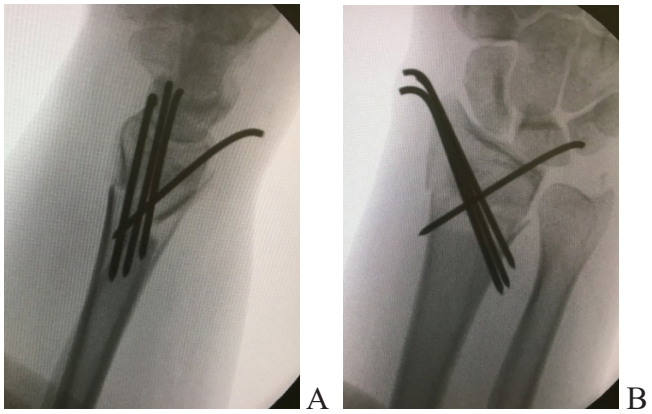

FIGURE 11. X-ray (A – lateral view; B – p-a view) of the completed fixation using the shortened K-wires

Nowadays, the operation is performed in a slightly different manner. After achieving the repositioning of the fracture, the thick, 2 mm "lever pin" is not retrieved, but inserted into the cortical bone on the palmar side of the distal radius. This manoeuvre prevents an accidental loss of the reduction of the fracture during the retrieval of the lever pin and, additionally, augments the stability of the construction. In relatively frequent situations of radial displacement of the distal radius (except of dorsal displacement), it can be corrected with another 2 mm "lever pin" introduced intrafocally from the lateral side of the distal radius. The hand is then kept horizontally on the table, and the K-wire is moved distally which restores the correct radial inclination of the distal radius. After the completion of this manoeuvre, the lever pin is inserted into the ulnar cortex of the distal radius. Figures 12, 13 show the fracture being reduced and fixed using this updated method.

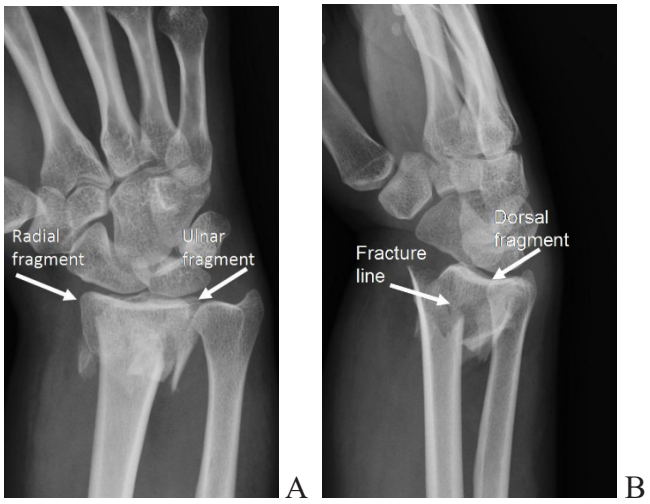

FIGURE 12. X-ray (A – p-a view; B – lateral view) of the AO C1 distal radial fracture with marked bone fragments

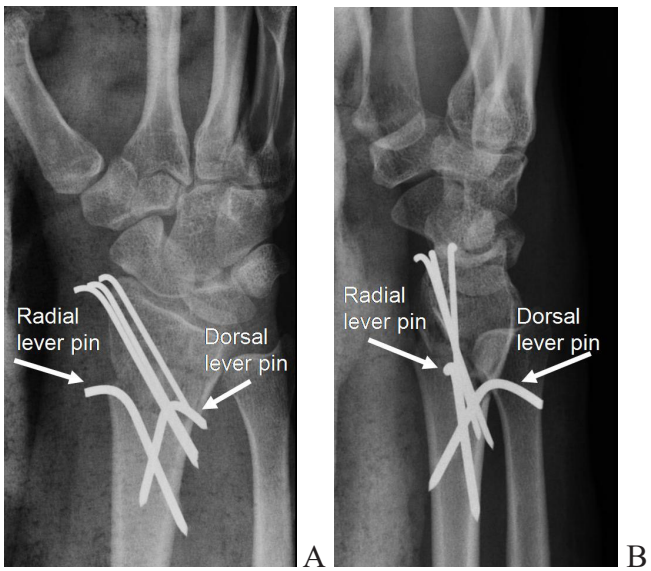

FIGURE 13. X-ray (A – p-a view; B – lateral view) of the completed fixation. Note marked radial and dorsal lever pins

Post-operatively, the patients had the wrist immobilized with a short palmar plaster splint for 3–4 weeks. The distal end of the splint should not exceed half of the metacarpus, allowing undisturbed finger flexion (Fig. 14). After the removal of the splint, movements in the wrist joint are allowed. The K-wires were removed as an office procedure at 6 weeks post-operatively.

FIGURE 14. The wrist immobilized using a short palmar plaster splint

MATERIALS AND METHODS

In 2021, a total of 187 patients referred to the authors' institution with distal radial fractures were operated on using the Kapandji technique. These were 151 women (81%) and 36 men (19%) aged on average 62 years (range 34–88). Eighty-two patients (44%) sustained a fracture of the right, and 107 (56%) of the left wrist. All fractures had A3, B2, C1, or C2 configurations in the AO classification. All patients were treated according to the protocol presented above. The patients were followed up 6 months after the fracture and surgery, according to the same protocol, including the measurement of the wrist range of motion, total grip strength, and subjective hand function using the quickDASH questionnaire.

RESULTS

The outcomes of the treatment are summarized in Table 1. In general, the results obtained by the patients were satisfactory. The mean wrist total arch of motion (dorsal + palmar flexion) was 93°, grip strength of 17.2 kg, and the quickDASH score 21 points. All these variables reflect overall good hand function.

TABLE 1. Outcomes of the treatment of the 187 patients at 6-month follow-up

Variable	n = 187 patients	
	mean	range
Palmar flexion	49°	28–80
Dorsal flexion	44°	12–71
Total grip strength	17.2 kg	8–41
DASH score	21	6–45

Meaningful secondary

Meaningful secondary displacements (dorsal tilt 20°, ulnar variance 10 mm) were noted in 5 patients (2.6%). All these patients had fracture configurations C2 and B2, with severe comminution. In all of these patients, the final outcome can be considered malunion; however, their symptoms were mild and they did not require corrective operations.

Complications

An irritation (but no infection) around 1 of the K-wires was noted in 7 patients (3.7%), due to superficially buried pins. In 8 other patients (4.2%) the pins were buried too deeply and had to be retrieved in the operative room, with fluoroscopic assistance. Eight patients (4.2%) complained of tenderness at the site of the retrieved pins but this disappeared by the final follow-up visit. Two patients (1%) developed mild complex regional pain syndrome (CRPS), diagnosed at 2 months and treated successfully using calcitonin injections for 1 patient and i.v. mannitol/dexamethasone infusions in an in-patient setting for the other one [6]. Regardless of the resolution of the CRPS episode, these patients recorded the worst scores in all outcome measures at the final assessment.

DISCUSSION

Several articles have been published about the treatment of distal radial fractures using the Kapandji technique. We will review some of them in this section.

Kamiloski et al. reported the outcomes of the treatment of 48 displaced distal radial fractures in patients aged 6–14 years, using the Kapandji technique of reduction and fixation. K-wires were manually introduced at the site of the fracture from the posterior aspect. Two 2.2 mm pins were used in the smaller children, while two 2.8 mm pins were used in the larger patients. The post-op immobilization lasted 4–7 weeks with an underarm cast. The patients were followed for 6 months following the intervention. The anatomic reduction was achieved with this type of technique in every case. In the post-op period, there was no significant loss of reduction, and another surgical procedure was not needed in any of the cases. The authors conclude that the Kapandji technique allows easy and good anatomical reduction of pediatric distal radial fractures and gives good post-op results [7].

Jirangkul et al. reported the results of the treatment of 57 patients with intra-articular fractures of the distal radius using the Kapandji technique as a reduction tool and definitive fixation with a locked palmar plate. K-wires were used to temporarily maintain a reduction of the fracture, before the final stabilization using the plate. The authors believe that it can be performed easily and reliably. The mean follow-up period was 12 months. The results proved appropriate and the technique has its merit as it obviates the need for dorsal exposure in most cases [5].

Stoffelen and Broos presented the results of a randomized prospective trial, comparing the effectiveness of the closed

reduction and plaster application vs. Kapandji pinning for distal radial fractures. Closed reduction and plaster cast application were performed in 50 patients and Kapandji pinning in 48 patients. According to the Cooney score, good and excellent results were found in 74% of patients in the closed reduction and plaster cast group compared with 75% of patients in the Kapandji-pinning group. In terms of the maintenance of the reduction and functional outcome at one-year follow-up, no statistically significant differences were found between the 2 groups. The authors conclude, therefore, that both techniques can be applied to extra-articular fractures of the distal radius according to the characteristics of the forearm and the surgeon's or the patient's preference [3].

Brady et al. reported the results of the treatment of 36 patients with extra-articular distal radial fractures. Twenty--two of these fractures were deemed unstable and were treated using the percutaneous intrafocal Kapandji pinning. Twenty (91%) of these patients were recalled for review 11 months post-surgery on average. At this stage, the wrist was examined clinically and radiologically. The initial satisfactory correction of deformity was achieved using this technique. Between the time of wire removal and final review, however, there was a significant recurrence of dorsal angulation ($p < 0.05$), but no significant radial shortening on radiographs. The patients had satisfactory clinical results in spite of these radiological parameters [4].

Valisena et al. reported the results of the treatment of 56 pediatric patients who underwent closed reduction and fixation using the Kapandji technique for the unstable displaced metaphyseal distal radial fracture. One or 2 percutaneous K-wires were inserted intrafocally without crossing the epiphysis to lever out, reduce, and stabilize the distal fragment. After the operation, the arm was immobilized using an above-elbow cast for 6 weeks. K-wires were removed at a mean of 6 post-operative weeks. At the mean follow-up of 18 months, all fractures showed good healing and the patients had full function of the wrist. No pin-related complications were found. The authors conclude that Kapandji pinning is a reliable technique in pediatric patients with unstable displaced distal radial fractures. It shows a lower complication rate compared to other techniques. For these reasons, they suggest implementing its use in clinical practice [8].

Weil and Trumble reviewed several articles presenting the outcomes of surgery for distal radial fractures using the Kapandji technique. The results of these studies demonstrate that young patients with displaced extra-articular distal radius fractures and minimal comminution can be treated by percutaneous intrafocal pin fixation alone, whereas, patients over 55 years of age and younger patients with comminution involving 2 or more surfaces of the radial metaphysis require bridging fixation besides percutaneous pin fixation. The use of this technique achieves the goal of surgical treatment of distal radial fractures: restoration of the hand and wrist function through the restoration of alignment and articular surface congruity [9].

In conclusion, the results of our study showed that using the Kapandji technique for the treatment of distal radial fractures resulted in satisfactory clinical outcomes and relatively rare complications.

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