

Intra-focal Pin Fixation of Distal Radial Fractures

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INTRODUCTION

Unstable fractures of the distal radius remain as challenging problems for orthopaedic surgeons. Unsatisfactory results are often associated with significant malunion. Many methods are aimed to maintain radial height, radial and palmar inclinations and articular congruity following reduction. Kapandji¹ described intra-focal pin fixation of distal radial fractures in 1976. The pins pass through the fracture line and anchor to the far cortex. The radial and dorsal pins aid reduction of the fracture and maintain reduction by buttressing the distal fragments. Volar intra-focal pin is recommended when there is volar displacement of the distal fragment. Addition of a conventional static pin has been shown to increase the stability of dynamic intra-focal pin fixation². Stable fixation of the distal radius fractures allows early mobilisation of the wrist and hand.

Literature Review

In 1976, Kapandji¹ described a method of using limited open placement of buttressing Kirschner wires to fix unstable extra-articular fractures of the distal radius in young patients, which he termed intra-focal pinning.

Since then, there are many modifications of the technique. The aim is to restore the radial length to 12 mm, radial inclination to 22 degrees and palmar tilt to 11 degrees³. Trumble et al⁴ in 1998 found that restoration of the radial length has the most significant effect on range of motion and grip strength. Modification of technique includes the use of additional pin, change of pin placement and design of a special pin. The indications of the technique also extend from extra-articular fracture to intra-articular fracture and from young patients to elderly patients and children.

Modifications of technique

A) Use of additional pin

Addition of a dorso-ulnar intra-focal pin: Kapandji⁵ reviewed his experience in 1987. He recommended an addition of a third pin inserted dorso-ulnarly to provide

further support and extended the use of intra-focal pin to fractures with multiple fragments.

Addition of convention static pins: Fritz et al² in a cadaver model, studied the use of combined Kapandji dynamic and conventional static Kirschner wire osteosynthesis (KWO). The combined technique unified the advantage of volar stability of the conventional KWO with the high dorsal stability of dynamic KWO.

Addition of anterior intra-focal pins: Anteriorly displaced distal radial fractures can be treated by Kapandji intra-focal pinning with the pins inserted through an anterior approach to give good reduction and stability of the fracture. Hoel and Kapandji⁶ described two anterior approaches for intra-focal pinning of distal radius fractures with anterior tilt, Smith type, anterior margin type and excessive anterior reduction after reduction. They also recommended the use of arum pins, open approach for insertion of pin and protection of pin ends to minimise complications. Guichet et al⁷ described a modified procedure for fixation of Smith's fracture in six children. The pins were placed through a posterior approach that decreased the risks of neuromuscular damage.

B) Change of pin placement

Intramedullary placement of the pins: Benoist and Freeland⁸ used a modification of Kapandji technique. They used an intramedullary styloid pin, a combined extra-medullary intra-medullary dorsal buttress pin and a posterior medial corner pin. They recognised that routine stress views after pinning could yield information concerning carpal instability, palmar instability and need for bone grafting. Kroitzsch et al⁹ modified the Kapandji procedure by using pre-stress K wires. These pins were introduced into the fracture and into the proximal fragment as medullary pins. The specially bent pins glide smoothly into the medullary cavity and snugly fit along the distal fragment, thereby minimising the risk of damaging extensor tendons.

C) Use of special pin

Arum pin: Kapandji in 1991¹⁰ introduced the use of arum pins for intra-focal osteosynthesis of fractures of the distal radius. The screw pin prevents pin expulsion. A special nut to cover the pin end can prevent injury of the tendon by the cut end of the pin. Rayhack in 1993¹¹ reported the use of arum pins and nuts in Kapandji technique. Shiota in 1999¹² recommended arum pin and cone-head wedging screw as fixation materials in elderly patients and suggested short term postoperative immobilisation.

Biodegradable rod: Casteleyn et al¹³ compared biodegradable rods versus Kirschner wire for fixation of

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wrist fractures. They concluded that polyglycolic acid rod should not be recommended because of the numerous transient complications from foreign body reactions.

Indications of intra-focal pin fixation

With improvement of the technique, the use of intra-focal pinning can be extended from extra-articular fractures¹⁴ to intra-articular fractures^{15,16,17,18} and multi-fragmentary fractures^{5,18}. Furthermore, intra-focal pinning can also be used in children¹⁹ and elderly patients¹⁶. Siwinski et al²⁰ advocated that intra-focal pin is useful in the treatment of selected types of the distal radius fracture namely A2, A3, B1, B2 and C1 types.

Results of intra-focal pin fixation

Peyroux et al¹⁴ in a series of 159 extra-articular distal radial fractures treated with intra-focal pin fixation reported excellent and good results in 93% of cases. They also concluded that anterior over-reduction could cause progressive secondary displacement that necessitated regular follow up.

Epinette et al¹⁶ in 1982, extended the use of intra-focal pinning to elderly patients and fractures with an intra-articular extension with no displacement of the articular surface. Good and excellent results were reported in 84% of patients. Complications occurred in 26% of patients but these were associated with a negative result in only 7% of patients. Significant complications included secondary displacement after pinning, extensor tendon rupture and reflex sympathetic dystrophy.

Prevot et al¹⁹ in 1997 reported the use of intra-focal pinning in children. They advocated that if instability, irreducibility and / or incorrect reduction exist, management must include postero-lateral intra-focal percutaneous pinning, especially so in older children.

Docquier et al¹⁵ in 1982 also extended the use of intra-focal pinning to articular fractures. Complications included two patients with radial sensory nerve irritation out of 32 patients.

Nonnenmacher and Neumeier¹⁷ reported the outcome of 150 fractures treated with intra-focal pin fixation in 1987. Intra-articular involvement was present in 60% of fractures. Three intra-focal pins were generally used. Subjective results were good and excellent in 92% and objective results were good and excellent in 99% of patients. Nonnenmacher and Kempf¹⁸ reported a series of 350 procedures in 1988. Patients with more extensive comminuted or intra-articular fractures did poorer. Complications included distal radio-ulnar instability (one case), reflex sympathetic dystrophy (8%), the need for early pin removal (7%), radial sensory nerve irritation (6%), ulnar neuropathy of the wrist (one patient), extensor tendinitis (2%) with two cases of extensor tendon rupture and a 14% incidence of displacement of fragments after pinning.

Problems with intra-focal pin fixation

There are specific problems encountered in intra-focal pin fixation and these include loss of reduction, anterior over reduction and fractures with cortical comminution.

Loss of reduction with inferior radiological results: This problem is commonly seen in elderly patients. Dowdy et al²¹ in 1996 reported that there was a trend for patients with osteopenic bone to lose reduction after the fixation and patients older than 65 years of age had significant inferior radiological results. Greeting and Bishop²² in 1993 reported the Mayo experience of 24 procedures. Good and excellent radiological results were achieved in 79% of patient less than 65 years of age. Only 60% good and excellent radiological results were seen in subjects greater than 65 years of age. 70% of patients less than 65 years of age and 100% of patients greater than 65 years of age obtained good or excellent clinical results, indicating that the technique provides acceptable clinical results in elderly patients despite some loss of reduction after pinning.

Anterior over-reduction: Peyroux et al¹⁴ in 1987 concluded that anterior over reduction could cause progressive secondary displacement that necessitated regular follow up. Milliez et al²³ in 1996 reported the use of intra-focal pinning in 58 distal radial fractures and noted 14% of anterior carpal translation and led to anterior instability. Benoist and Freeland⁸ recognised that routine stress views after pinning could yield information concerning carpal instability, palmar instability and the need for bone grafting. Hoel and Karpandji⁶ recommended the use of anterior intra-focal pin in fractures with anterior over-reduction.

Fractures with anterior cortical comminution: Nonnenmacher et al²⁴ in 1994 reported satisfactory results in 90% of 400 cases. They advocated supplementing intra-focal pin fixation with an anterior plate in cases with anterior cortical comminution. Bahm et al²⁵ who used intra-focal pinning with palmar plate in the treatment of distal radius fractures reported good results in 80% of cases.

Fractures with both cortical comminution: Trumble et al⁴ recommended external fixator to be used in addition to intra-focal pinning fixation of distal radial fractures with comminution of both volar and dorsal sides of radial metaphysis in young patients. They also concluded that restoration of radial length had the most significant effect on range of motion.

Fractures with single cortex comminution in older patients: Trumble et al⁴ recommended external fixator to be used in addition to intra-focal pinning fixation of distal radial fractures with comminution of one side of radial metaphysis in older patients.

Comparison with other techniques

Intra-focal pin fixation has been used to compare with other procedures. Stoffelen and Broos in 1998²⁶ and 1999²⁷ published their study comparing closed reduction versus Kapandji pinning for extra-articular distal radial fractures. They concluded that no statistical significant differences could be found between the 2 groups after one year of follow-up. Kerboul et al²⁸ in 1986 reported that intra-focal pin fixation gave better results when compared with closed reduction and plaster immobilisation.

Delattre et al²⁹ compared the outcomes of intra-focal pinning technique to those of Py's elastic pinning procedure. They concluded that Kapandji technique was better than Py's technique and advocated increasing the

intra-focal pin's angulation to minimise hyporeduction in Kapandj procedure. Lenoble et al³⁰ in 1995 compared trans-styloid fixation and immobilisation with Kapandji fixation and early mobilisation. Pain and reflex sympathetic dystrophy were more frequent after Kapandji fixation and early mobilisation. However, the range of motion was better although it was statistically insignificant after 6 weeks. The radiological reduction was better soon after Kapandji fixation, but there was some loss of reduction and increased radial shortening during the first 3 postoperative months. The clinical result at 2 years was similar in both groups. Stefert et al³¹ in 1998 concluded that the Kapandji technique showed no difference in comparison to the conventional wire fixation method.

Mobilisation against immobilisation

Intra-focal pin fixation provides stable fixation that allows immediate mobilisation. Milliez et al³² did a study comparing immobilisation against active mobilisation following intra-focal pinning. Pin migration and rupture of the extensor tendons occurred in the mobilised group. Reflex sympathetic dystrophy occurred in the immobilised group. Grip was better after 2 months in those who mobilised early. Early mobilisation should be used in subjects who have good quality bone and will carefully observe instructions.

Shiota¹² recommended arum pin and cone-head wedging screw as fixation materials in elderly patients and suggested short-term postoperative immobilisation.

Operative technique

The operation is performed under general or regional anaesthesia. A tourniquet is applied over the arm. Preoperative intravenous antibiotic is given at induction of anaesthesia. The injured hand is cleaned and draped below the tourniquet. The hand is elevated and the tourniquet is inflated.

Insertion of dorsal and radial pins: The entry points for the radial pin (between first and second dorsal extensor compartments), the dorso-radial pin (between third and fourth dorsal extensor compartments), the dorso-ulnar pin (between fourth and fifth compartments) are marked on the skin at the fracture site. Small longitudinal stab incision is made at the entry point for the dorso-radial pin. Small artery forceps is used to dissect the tissue down to the fracture site. Care is taken to retract the tendons, sensory nerves and soft tissues away. A free 1.6-mm strong arthrodesis wire is initially placed from the dorsal side of the fracture directly into and parallel to the fracture site. Half way passed the fracture, the wire is then directed

obliquely at 45° in a proximal direction till it hits the volar cortex of the proximal bone. The exposed end of the wire is then connected to a drill. The other end of the wire is driven across the volar cortex for 3 to 5 mm. Drilling at the latest part of wire introduction is to avoid damaging the soft tissues by the spinning wire or the heat generated. Drilling across the volar cortex of the proximal bone for a short distance is to avoid damaging the volar soft tissues. Similar procedure is repeated for insertion of the dorso-ulnar pin. The radial pin is inserted from the radial aspect of the fracture and anchor to the ulnar cortex of the proximal bone. Fracture reduction and position of the pins are verified using the image intensifier. Fracture reduction is considered adequate when the radial height, radial inclination and palmar tilt are restored.

Insertion of the volar pins: Volar pin is needed if there is volar displacement of the fracture fragments. The entry points for the radio-volar pin (radial to the flexor carpi radialis) and the radio-ulnar pin (ulnar to the flexor carpi ulnaris) are marked on the skin at the fracture site. The pin is inserted from the volar aspect of the fracture and anchored to the dorsal cortex of the proximal bone. Similar precautions are taken to avoid damaging any soft tissues.

Insertion of the trans-styloid pin: A trans-styloid pin is inserted to supplement the intra-focal pin fixation. Through a stab incision over the tip of the styloid, the pin is driven through the styloid process, the fracture site and into the ulnar cortex of the proximal bone. Similar precautions are taken to avoid damaging soft tissues.

The pins are bent 90° close to the fracture and cut 5 mm from the bending part. The pin ends are buried under the skin. The stab incisions are closed with an interrupted suture.

Postoperative rehabilitation

Gentle active and passive range of finger and wrist motion exercises begin on the first postoperative day. The patient is instructed to keep the hand elevated to prevent oedema and stiffness of the elbow and shoulder. The sutures are removed on the fourteenth postoperative day. Carrying of any weight is prohibited till union has occurred. The pins are removed once radiological union occurs. Muscle strengthening and weight carrying exercises begin one day after removal of the implants.

CONCLUSION

Intra-focal pinning is a safe, simple and effective method for treating unstable fractures of the distal radius. Significant complications can be avoided if attention is paid to the details of the surgical technique.

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