4-Pin Technique of Management of Distal Both Bone Fracture of Forearm in Elderly

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Abstract:
Introduction: Distal both bone fractures are one of the most common injury of an elderly who falls with flexed elbow, landing on the wrist. There is a wide variety of treatment options such as closed reduction and POP cast, internal fixation, external fixation and percutaneous pin fixation in many configurations to treat both bone fracture of forearm however the comorbidity of the elderly precludes the methods of internal fixation in many situations. Hence we devised a novel percutaneous 4 pin configuration of K wires for management of distal both bone fractures of the elderly, where closed reduction is possible, and the ulna is re-constructible. This study reports the outcomes of this technique.

Methods: All patients who are more than age of 50 and who presented with distal both bone fracture during the period of 3 years Jan 2015 to Dec 2017 managed were included in the study. They are managed by closed reduction and 4-pin fixation and were evaluated for complications including wire loosening and infection, tendon or nerve injury, reflex sympathetic dystrophy and functional outcome.

Results: A total of 49 consecutive patients with 50 distal both bone fractures were treated in the study period with a mean age of 55.4 years; 67% were female and 3% were due to domestic falls. After death from unrelated causes and loss to follow-up, 42 patients were reviewed and clinical outcome was evaluated using Cooney’s modification of Green and O’Brien’s score. All fractures healed and 84.2% had an ‘excellent’ outcome and 13.6% were ‘good’; only one patient achieved a ‘fair’ outcome, who had highly comminuted fracture. Complications were limited and temporary with no cases of deep infection, tendon or nerve injury or reflex sympathetic dystrophy.

Conclusions: This study proved that our novel customised 4-pin percutaneous fixation was sufficiently stable and controlled all fragments of distal both bone fractures effectively to allow early mobilisations to prevent stiffness with excellent functional outcomes.

Keywords: Distal both bone fractures, Percutaneous K-wire fixation, 4-Pin fixation, Elderly

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1. Introduction:

Management of distal forearm fractures in the elderly is a challenging task to the orthopaedic surgeon. Review of the literatures shows that there are various treatment options for the distal radius fractures in the elderly but on the management of the distal both bone forearm of the elderly evidences are still lacking. Most of the treatment outcomes of the elderly fractures are poor mostly due to the poor bone stock due to osteoporosis and medical co-morbidities. Distal both bone forearm fractures occur in the young due to high energy trauma like falls from heights, motor vehicle accidents (MVA) and sports13 which are often associated with polytrauma, whereas in the elderly age group, it is due to both low-energy injuries and insufficiency fractures. Most of the lattercases are seen in women following a fall during domestic activities.

Although the management of distal both bone fractures has not been extensively discussed, surprisingly in the elderly there is a disagreement on treatment correlation between radiological and functional outcomes. Various techniques are described for the management of forearm fractures including closed reduction, Plaster of Paris(POP) cast immobilisation, internal fixation, lockingplates, external fixation and percutaneous pin fixation in various configurations.

The choice depends on several factors like fracture type, bone stock, associated diseases, age of the patient, surgeon’s experience, imagination and so on. Over the past few years, we have been trying to develop a
standardised configuration for percutaneous K-wire fixation for treating distal both bone fractures in elderly osteoporotic patients in a reproducible manner, which can be used in most types of distal both bone fractures where closed reduction is possible, and the ulna is reconstructable.

II. A new concept

Since in the elderly the distal both bone fracture of the forearm is just an extension of the distal radius fracture where the force exits thorough the ulna with impaction to the ground with the distal fragment remain fixed and furthermore of the upper limb fractures the ulna. Most of the cases had deformity similar to the distal radius with impacted fracture of the ulnar column. So our major aim is to address the distal radius fracture so that the ulna will get reconstructed on its own with the length being maintained at the radial side. By addressing the middle and the lateral column which bears the major share of load in the distal radioulnar joint the medial column is left to heal naturally without meticulous work to reduce it anatomically.

The deformities of distal radius fracture are classically described as dorsal displacement, dorsal tilt, lateral displacement, lateral tilt, supination and impaction. This describes a fracture with a deformity and by reduction the surgeon is actually performing a deformity correction through the fracture site and fixing it to prevent relapse of the deformity. Based on the principles of deformity correction, it is impossible to have all these deformities through a single fracture \(^{(2)}\) and when combined with the fracture of the ulna the distal fragments become loose and resultant position when radiographed in standard anteroposterior (AP) and lateral views shows the fracture mainly with impaction and supination, projecting as the named six complex deformities.

The aims of the study were to assess the effectiveness of our standardised configuration of percutaneous K-wire fixation for treating distal both bone fracture of the elderly and to assess its full potential and limitations, through scrutiny of our own case series. It also attempted to answer the major question of consistency of the method in managing the distal both bone fracture of the elderly.

III. Materials & Methods:

All patients who are more than age of 50 and who presented with distal both bone fracture during the period of 3 years Jan 2015 to Dec 2017 managed were included in the study. Fractures with high comminution and in patients aged less than 50 are excluded from the study. All patients included in the study are managed by closed reduction and 4-pin fixation and were evaluated for complications including wire loosening and infection, tendon or nerve injury, reflex sympathetic dystrophy and functional outcome.

Fracture reduction technique

All procedures were performed under brachial plexus block with the patients supine, the shoulder and elbow at 90 degrees and the forearm kept in neutral position. One assistant was instructed to hold the patient’s arm tightly on the arm table and the fracture manipulated. Our main aim is to address the radial column and middle column of the distal both bone resulting in natural reduction of the ulnar column. Hence two thumbs were placed on the dorsal aspect of proximal fragment near the fracture and two indices were kept on the volar aspect just distal to the fracture site and proximal to wrist. The whole distal fragment was supinated and brought in contact with the proximal end and maintained in the long axis. As the distal fragment gets aligned and disimpacted, both thumbs are slid distally to pronate it back into its original position at the same time as the index fingers are slid proximally onto the proximal fragment – in most cases, the fragment automatically sits into its original position and simply needs to be guided. The ulnar column is checked for the reduction while holding the radial column between the thumb and index of one hand and once the reduction is complete, the relationship of the radial and ulnar styloids is checked and confirmed by fluoroscopy. In the case of a die punch fragment, it is elevated and using a percutaneous K wire as a joystick.

K-wire configuration

As the mechanism of injury is supination, reduced by pronation, the first step of stabilisation is to counter these supination of the distal fragment of the radius; moreover in radial column of the distal both bone, the only tendon attached to the distal fragment is brachioradialis. \(^{(3,4)}\) In the supinated position, brachioradialis a pronator, and in the pronated position, it is a supinator, whereas in neutral, it is an elbow flexor – the proximal fragment is still under the control of pronators, supinator and biceps. As perfect reduction gives intrinsic stability, the wires/pins should neutralise these deforming forces.
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The first wire is a 1.8mm distalulno-radial wire, inserted from distal ulna, distal tofracture site either through the inferior radioulnar joint into the distal fragment of the radius parallel to the wrist joint line at subchondral level or rarely by an oblique wire just proximal to inferior RU jointaiming the radial styloid. It maintains radial length and prevents supination. Care should be taken to ensure that this first wire is not distracting the radial styloid fragment further. If this happens, the first wire is slightly withdrawn and the second, volar radial styloid wire is passed at 45 degrees oblique to the long axis of the proximal radius in both AP and lateral planes to catch the proximal radial cortex. This wire pushes the radial fragment medially. If the first wire was previously withdrawn to prevent pushing the radial styloid fragment laterally, it can be reinserted now. The second wire stabilises the radial column.

Adequate care must be taken while inserting the radial styloid wire to avoid injury to the superficial radial nerve. The third wire is the Lister’s tubercle wire taking care not to impale the tendon of extensor pollicis longus (EPL) by staying radial to the tubercle to engage the volar cortex of the proximal radius; occasionally, in a far distal fracture, this can act like an intrafocal Kapandji wire for far distal fractures entering the fracture site to engage the anterior cortex; the wire is retained as it effectively prevents dorsal tilt of the distal fragment.

The fourth wire is the ulnar wire which goes from the ulnar side to stabilise the distal fragment of the ulna by holding it to the lateral cortex of the proximal ulnar fragment to stabilise the ulnar column.

In distal both bone fracture of the elderly the proximal radio ulnar wire as a fifth wire is outweighed due to the stabilisation of the ulnar column by the fourth wire providing necessary support to the radial and middle column fixation. Hence we restricted our configuration to minimal pin count of 4. Additional wires may be required in selected cases depending on the comminution.

Post-operative care

Post-operative splinting is performed with a removable aluminium splint in the functional position of the wrist. Immobilisation with splinting is advised for the initial 4 weeks, during which patients are encouraged to mobilise the fingers, elbow and shoulder within their tolerable limits (except forearm movements and wrist movements).

Pin site care

The most important point in maintaining a healthy pinsite is proper placement of the pin without undue skin tension around it, as if there is inadvertent tension on any side of the pin; it produces skin-pin intolerance and that part of the compressed skin may develop necrosis and predisposes to pin infection. In such cases, we prefer to keep it buried under the skin.

The pins are removed in 6–8 weeks after an aradiograph and the patient encouraged to resume mild domestic activities. Follow-up with physiotherapy was performed every fortnightly for 3 months post op.
Most patients would recover completely by two months. By three months post-operatively, a follow-up X-ray was taken to confirm healing and to rule out any bony collapse and they were then reviewed at 6 and 12 months.

During follow-up, patients were examined for pain, wire loosening, wire infection, nerve injuries, tendon impalement, wrist instability, reflex sympathetic dystrophy (RSD), radiological findings and associated medical conditions.

IV. Results:

A total of 49 consecutive patients with 50 distal both bone fractures (1 bilateral) were treated in the study period with a mean age of 55.4 years (50-78); 67% were female and 59% were due to domestic falls. After death from unrelated causes and loss to follow-up, 42 patients were reviewed and clinical outcome was evaluated using Cooney’s modification of Green and O’Brien’s score.

Outcome assessment:

The Cooney modification of Green and O’Brien’s score for clinical outcomes was used to evaluate the results and physical findings (Figure 2). 7 Out of the 49 patients, 2 were dead at one year due to unrelated causes and 5 were lost to follow-up, leaving a total of 32 patients who were reviewed and an additional 10 patients contacted by telephone interview who were unable to physically attend the clinic for personal reasons but who did not report any problems that warranted review in person.

Evaluation:

Pain
All patients had immediate post-operative pain and stiffness of fingers, especially the thumb. NSAIDS were mostly avoided due to the comorbid conditions hence IV Paracetamol for one day then orally for five to seven days was given. Finger and wrist movements started on day 1, and all patients were discharged on the next day.

Wire loosening and infection
Migration of wires were noted in 12 ulno-radial pins. There were no deep infections, but 5 cases of superficial infection were resolved after removal of the K-wires and oral antibiotics; superficial infection was more common on the volar radial wire, probably because of more skin-pin interference.

Nerve injuries
No one developed median or ulnar nerve compression syndrome, but irritation of the sensory branch of the radial nerve was seen in 2 cases and promptly resolved after removal of wire.

Tendon impalement, wrist instability and RSD
Tendon impalement occurred in one case on Extensor Carpi Ulnaris; EPL injury and wrist instability were not noticed. There were no cases of RSD.

Radiological findings
Radiological healing of the fractures was noted at six weeks in all except 6 cases – wires were removed by 6-8 weeks, and in the non-healed 6 cases, wires were left in for two further weeks beyond the 6–8-week point. Good radial tilt, radial translation and ulnar variance were achieved in all; the volar tilt was well restored during the insertion of the second and third wires. No patients showed significant loss of reduction in comparison with the immediate post-operative films on further X-rays taken after 12 to 18 months.
Elbow and shoulder functions
No one had any symptoms or stiffness of shoulder or hand syndromes. All fractures healed and 84.2% had an ‘excellent’ outcome and 13.6% were ‘good’; only one patient achieved a ‘fair’ outcome, who had highly comminuted fracture.

V. Discussion:
Although anatomical fracture reduction is a major determinant of outcome in the management of the distal both bone fractures in the young our study noted that the reduction has no significant relation to the functional outcome since the physiological demands of the patients are not very high to cause significant disability to the individual. In a study to identify the major factor which results in the loss of reduction in the closed management of the forearm fracture, age is found to be the major criteria where any person aged more than 60 years had more chance of loss of reduction compared to the individuals of lesser age group.\(^{(9,10)}\)

The concept of using ulna as an external fixator in the percutaneous K wire management of distal radial fracture is made to work here after stabilising the ulna component with the ulnar wire as the fourth wire. The greater the number of fragments or the larger the articular involvement, the worse the prognosis,\(^{(11)}\) which can only be countered by inserting additional K wires for stabilising each fragment.

Restoration of radial tilt, ulnar variance and radial translation is easy to achieve, while greater difficulty is encountered in restoring the volar tilt, which is achieved in this technique by the Lister’s tubercle wire which is sometimes used as a joystick to correct the residual dorsal tilt by derotating the distal fragment around the distal ulno-radial wire. Rosati et al.\(^{(12-15)}\) demonstrated that a volar tilt does not impair the range of motion of the wrist and hand, because it is compensated for by the midcarpal joint, whereas if the volar tilt is more than 10 degrees above normal, biomechanical changes follow, which affect strength and mobility of the joint.

There were few complications, but all were manageable and justifiable and less than rates previously reported. Six patients (14.2%) did not show sufficient evidence of healing at the six-week radiograph, so pins were retained for nearly eight weeks and all subsequently healed. These patients require close follow-up to ensure good results – we tend to retain wires for a little longer if there is any doubt rather than removing them early.

The reported incidence of nerve injuries ranges from 0.2% to 79%.\(^{(16,17)}\) but there were no permanent nerve lesions, probably due to the site of introduction of the K wires at the radial styloid process, avoiding the nerves and the radial artery, although two patients (4.7%) did experience numbness and mild neuralgia along the sensory branch of the radial nerve which resolved completely after removal of the wires and local massage.

Migration of the K wires was noted in 12 cases (28.5%), which happened more on the ulno-radial pins as some patients tended to rest their wrist on a table, pushing those wires radially producing skin irritation on the radial side. Most of the migration is attributed to the loss of the hold due to poor bone stock in the elderly. This was treated by pulling the wires back into position and later prevented by packing rolled pads on either side of the wires so that the pintips were not touching the surface. There was no iatrogenic fracture of the bone during K wire insertion or deep infections. Interestingly, there were no cases of RSD in this series.

With the 4-pin method using 1.8mm K wires in the described configuration, we can now manage most fractures in osteoporotic individuals, with provision for additional pinsas and when required.

VI. Conclusion
Our case series has confirmed that our innovative technique of perfect closed reduction and 4-pin fixation was stable and effectively controlled the fragments of distal radial fractures with excellent functional outcomes in the elderly with distal third forearm fractures. Further validation of the technique is needed with larger case series in future for reproducibility.

References:

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