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# 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 toDec 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 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. All fractures healed and 84.2% had an 'excellent' outcome and 13.6% were 'good'; only one patients achieved a 'fair' outcome, who had highly comminutedfracture. 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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## I. Introduction:

Management of distal forearm fractures in the elderly is a challenging task to the orthopaedic surgeon. Review of the literatureshows 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 fromheights, motor vehicle accidents (MVA) and sports[(1)]which are often associated with polytrauma, whereasin the elderly age group, it is due to both low-energyinjuries and insufficiency fractures. Most of the lattercases are seen in women following a fall during domesticactivities.

Although the management of distal both bone fractures has not beenextensively discussed, surprisingly in the elderly there is a disagreement on treatment correlation betweenradiological and functional outcomes. Various techniquesare described for the management of forearmfractures including closed reduction, Plaster of Paris(POP) cast immobilisation, internal fixation, lockingplates, external fixation and percutaneous pin fixationin various configurations.

The choice depends onseveral factors like fracture type, bone stock, associateddiseases, age of the patient, surgeon's experience,imagination and so on.Over the past few years, we have been trying todevelop a

standardised configuration forpercutaneousK-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 fractureswhere closedreduction 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 furtherforce 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 classicallydescribed as dorsal displacement, dorsal tilt, lateraldisplacement, lateral tilt, supination and impaction.This describes a fracture with a deformity and by reductionthe surgeon is actually performing a deformity correctionthrough the fracture site and fixing it to preventrelapse of the deformity.Based on the principles of deformity correction, it isimpossible to have all these deformities through a singlefracture[(2)] and whencombined 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 complexdeformities.

The aims of the study were to assess the effectivenessof our standardised configuration of percutaneousK-wire fixation for treating distal both bone fracture of the elderly andto assess its full potential and limitations, through scrutinyof our own case series. It also attempted toanswer 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 plexusblock with the patientsupine, the shoulder and elbow at 90 degreesand the forearm kept in neutral position. One assistantwas instructed to hold the patient's arm tightly on tothe 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 twothumbs were placed on the dorsal aspect of proximalfragment near the fracture and two indices were kept onthe volar aspect just distal to the fracture site and proximalto wrist. The whole distal fragment was supinated and brought in contact with the proximal end and maintained in the long axis. As thedistal fragment gets aligned and disimpacted, both thumbs areslid distally to pronate it back into its original positionat the same time as the index fingers are slid proximallyonto the proximal fragment – in most cases, the fragmentautomatically sits into its original position andsimply 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 ischecked and confirmed by fluoroscopy. In the case of a die punch fragment, it is elevatedusing a percutaneous K wire as a joystick.

**K-wire configuration**

As the mechanism of injury is supination, reduced bypronation, the first step of stabilisation is to counter thesupination 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, brachioradialisis a pronator, and in the pronated position, it is asupinator, whereas in neutral, it is an elbow flexor – theproximal fragment is still under the control of pronators,supinator and biceps. As perfect reduction givesintrinsic stability, the wires/pins should neutralise thesedeforming forces.

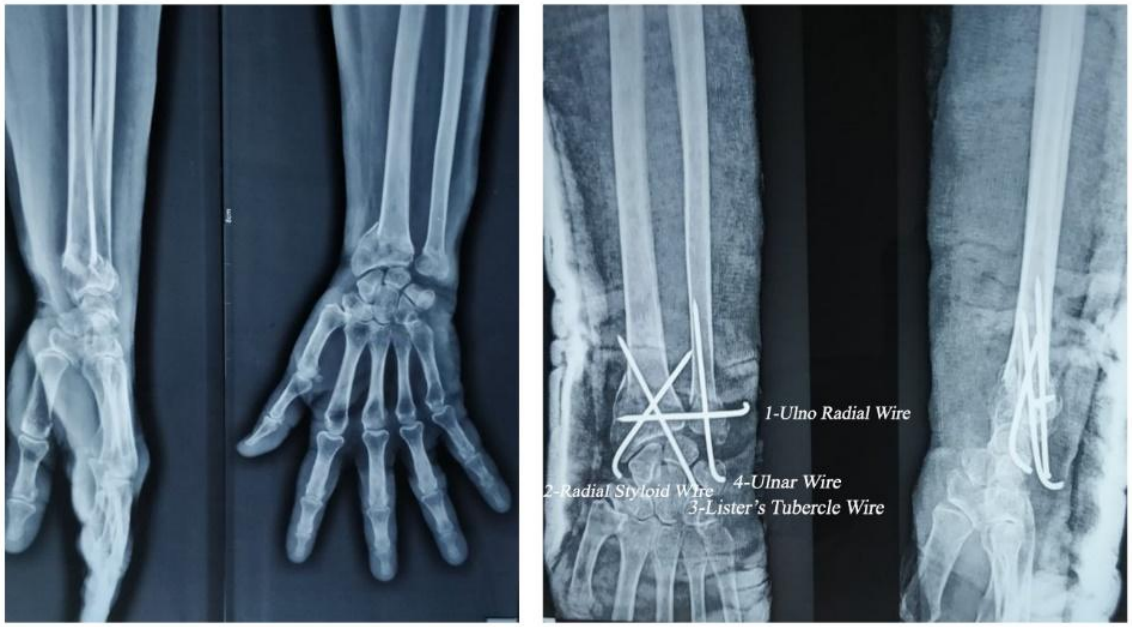


*Figure 1 showing the Pre-Op and the Post fixation status of the distal both bone fracture of the forearm in an elderly by 4-pin fixation technique.*

The first wire is a 1.8mm distalulno-radial wire, inserted from distal ulna, distal tofracture site either through the inferior radioulnarjoint into the distal fragment of the radius parallelto the wrist joint line at subchondral level or rarely byan oblique wire just proximal to inferior RU jointaiming the radial styloid. It maintains radial lengthand prevents supination. Care should be taken toensure that this first wire is not distracting the radialstyloid fragment further. If this happens, the first wire isslightly withdrawn and the second, volar radial styloidwire is passed at 45 degreeoblique to the long axisof the proximal radius in both AP and lateral planes to catch the proximalradial cortex. This wire pushes the radial fragmentmedially. If the first wire was previously withdrawn toprevent pushing the radial styloid fragment laterally, itcan be reinserted now. The second wire stabilises theradial column.

Adequate care must be taken whileinserting the radial styloid wire to avoid injury to thesuperficial radial nerve.[5-7] The third wire isthe Lister's tubercle wire taking care not to impale thetendon of extensor pollicis longus (EPL) by stayingradial to the tubercle to engage the volar cortex ofthe proximal radius; occasionally, in a far distal fracture,this can act like an intrafocalKapandji wire forfar distal fractures entering the fracture site to engagethe anterior cortex[8]; the wire is retained as it effectivelyprevents dorsal tilt of the distal fragment.

The fourthwire is the ulnar wire whichgoes 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 casesdepending on the comminution.

**Post-operative care**

Post-operative splinting is performed with a removablealuminium splint in the functional position of the wrist. Immobilisation with splinting is advised for the initial 4 weeks, during which patients are encouragedto 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 skintension around it, as if there is inadvertent tension onany side of the pin; it produces skin–pin intolerance andthat part of the compressed skin may develop necrosisand predisposes to pin infection. In such cases, weprefer to keep it buried under the skin.

The pins areremoved in 6–8 weeks after aradiograph and the patient encouraged to resume milddomestic activities. Follow-up with physiotherapy was performedevery fortnightly for 3 month post op.

Most patients wouldrecover completely by two months. BY threemonths post-operatively, a follow-up X-ray was takento confirm healing and to rule out any bony collapseand 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 medicalconditions.

## 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 scorefor clinical outcomes was used to evaluate the resultsand physical findings (Figure2).7 Out of the 49patients,2 were dead at one year due to unrelatedcauses and 5 were lost to follow-up, leaving a totalof 32 patients who were reviewed and afurther 10 patients contacted by telephone interviewwho were unable to physically attend the clinic for personalreasons but who did not report any problems thatwarranted review in person.

| Score | Findings |
|---|---|
| **Pain** | |
| 25 | None |
| 20 | Mild, occasional |
| 15 | Moderate, tolerable |
| 0 | Severe or intolerable |
| **Functional status** | |
| 25 | Returned to regular employment |
| 20 | Restricted employment |
| 15 | Able to work but unemployed |
| 0 | Unable to work because of pain |
| **Range of motion** | |
| 25 | Full |
| 15 | 75-99% of normal |
| 10 | 50-74% of normal |
| 5 | 25-49% of normal |
| 0 | Less than 25% of normal |
| **Grip strength** | |
| 25 | 120° or more |
| 15 | 91-119° |
| 10 | 61-90° |
| 5 | 31-60° |
| 0 | 30° or less |
| **Or evaluating dorsiflexion-palmar flexion arc of injured hand** | |
| 25 | |
| 15 | 75-99% of normal |
| 10 | 50-74% of normal |
| 5 | 25-49% of normal |
| 0 | 0-24% of normal |
| **Final result** | |
| 90-100 | Excellent |
| 80-89 | Good |
| 65-79 | Fair |
| <65 | Poor |

*Figure 2 showing the Cooney's modification of Green and O'Brien's score.*

**Evaluation:**

**Pain**

All patients had immediate post-operative pain and stiffnessof fingers, especially the thumb. NSAIDS were mostly avoided due to the comorbid conditions hence IV Paracetamol for one day then orallyfor five to seven days was given. Finger and wrist movementsstarted on day 1, and all patients were discharged on thenext day.

**Wire loosening and infection**

Migration of wires were noted in 12ulno-radial pins.There were no deep infections, but 5 cases of superficialinfection were resolved after removal of the K-wiresand oral antibiotics; superficial infection was morecommon on the volar radial wire, probably becauseof more skin–pin interference.

**Nerve injuries**

No one developed median or ulnar nerve compressionsyndrome, but irritation of the sensory branch of theradial nerve was seen in 2 cases and promptly resolvedafter removal of wire.

**Tendon impalement, wrist instability and RSD**

Tendon impalement occurred in one case on ExtensorCarpi Ulnaris; EPL injury and wrist instability were notnoticed. There were no cases of RSD.

**Radiological findings**

Radiological healing of the fractures was noted at sixweeks in all except 6 cases – wires wereremoved by 6-8 weeks, and in the non-healed 6cases, wires were left in for twofurther weeks beyond the 6–8-week point. Goodradial tilt, radial translation and ulnar variancewere achieved in all; the volar tilt was well restoredduring the insertion of the second and third wires. Nopatients showed significant loss of reduction in comparisonwith the immediate post-operative films onfurther X-rays taken after 12 to 18 months.

**Elbow and shoulder functions**

No one had any symptoms or stiffness of shoulder orhand syndromes.All fractures healed and 84.2% had an 'excellent' outcome and 13.6% were 'good'; only one patients 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 largerthe articular involvement, the worse the prognosis,[11]which can only be countered by inserting additionalK 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 thevolar tilt, which is achieved in this technique by the Lister's tubercle wire which is sometimes used as a joystickto correct the residual dorsal tilt by derotating thedistal fragment around the distal ulno-radial wire.Rosatiet al.[12-15] demonstrated that a volar tiltdoes not impair the range of motion of the wrist andhand, because it is compensated for by the midcarpaljoint, whereas if the volar tilt is more than 1o degreesabovenormal, biomechanical changes follow, which affectstrength and mobility of the joint.

There were few complications, but all were manageableand justifiable and less than rates previouslyreported. Six patients (14.2%) did not show sufficientevidence of healing at the six-week radiograph,so pins were retained for nearly eightweeks and all subsequently healed. These patientsrequire close follow-up to ensure good results – wetend to retain wires for a little longer if there is anydoubt rather than removing them early.

The reported incidence of nerve injuries ranges from0.2% to 79%, [16,17] but there were no permanent nervelesions, probably due to the site of introduction of theK wires at the radial styloid process, avoiding thenerves and the radial artery, although two patients(4.7%) did experience numbness and mild neuralgiaalong the sensory branch of the radial nerve whichresolved completely after removal of the wires andlocal massage.

Migration of the K wires was noted in 12 cases(28.5%), which happened more on the ulno-radial pinsas some patients tended to rest their wrist on a table,pushing those wires radially producing skin irritationon 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 wiresback into position and later prevented by packingrolled pads on either side of the wires so that the pintips were not touching the surface. There was no iatrogenicfracture of the bone during K wire insertion ordeep infections.Interestingly, there were no cases ofRSD in this series.

With the 4-pin method using 1.8mm K wires in thedescribed 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 innovativetechnique of perfect closed reduction and 4-pin fixationwas 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.

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