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Functional outcome of treatment of fractures of distal radius with volar locking plate & crossed k wires

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Abstract
This is very common injury faced by Orthopaedic surgeons. It accounts 15-16% of the total percentage trauma. The restoration of normal congruency of distal radius is essential, otherwise the secondary osteoarthritis of wrist joint sets in at a faster pace. The modalities of treatment available are a) Closed reduction, b) crossed K-wires, c) External fixator, d) volar locking compression plate.
There are various parameters to assess the displacement which are a) ulnar variance, b) radial length, c) radial inclination, d) palmar tilt, e) dorsal angle. The results of fixation depend entirely on all these factors aforementioned, which can judge whether the normal anatomy of the joint is restored.
15 cases of fracture distal radius are treated with volar LCP, 33 cases are treated with crossed k wires with or without external fixator frame. The results of both the techniques were more or less similar. But volar LCP require more precison & soft tissue dissection. The operating time & the hospitalization, is more along with the risk of infection.
The other technique i.e. fixation with crossed K -wires is user friendly technique, where there is no need of open surgery, results are comparable with those fixed with volar LCP. But when there is involvement of partial articular surface, AO type B, volar LCP is the treatment of choice.

Keywords: volar LCP, crossed K wires, fracture distal radius, radial inclination, ulnar variance, palmar tilt.

Introduction
This is the injury which accounts for 15 - 16% of the trauma of upper extremity [1]. This can be due to low velocity trauma with fall on an outstretched hand in 6th decade or it can be a squeal of the high velocity trauma in vehicular accidents [2].
The fracture is at the metaphyseal level / cortico-cancellous junction of the distal end of radius. There are various types of classification of the fracture of distal third of radius. Out these, Frykmann's & AO classification is followed by the majority of the people [3].

TABLE 57-9 Classification of Distal Radial Fractures

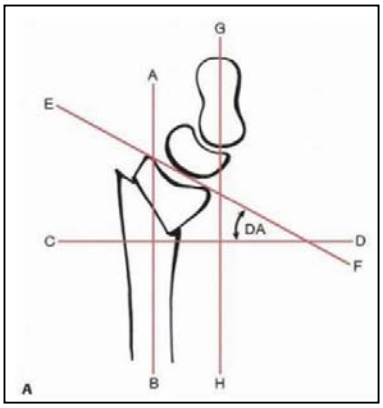
	GARTLAND AND WERLEY (1951)
Group I	Simple Colles fracture
Group 2	Comminuted Colles fracture, undisplaced intraarticular fragment
Group 3	Comminuted Colles fracture, displaced intraarticular fragment
	FRYKMAN (1967)
Group 1	Extraarticular without fracture of the distal ulna
Group 2	Extraarticular with fracture of the distal ulna
Group 3	Intraarticular involving the radiocarpal joint without fracture of the distal ulna
Group 4	Intraarticular involving the radiocarpal joint with fracture of the distal ulna
Group 5	Intraarticular involving the distal radioulnar joint without fracture of the distal ulna
Group 6	Intraarticular involving the distal radioulnar joint with fracture of the distal ulna
Group 7	Intraarticular involving both radiocarpal and distal radioulnar joints without fracture of the distal ulna
Group 8	Intraarticular involving both radiocarpal and distal radioulnar joints with fracture of the distal ulna

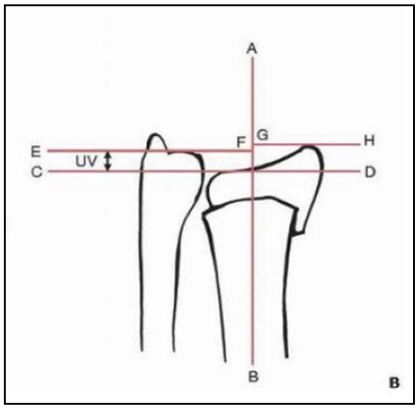
	MODIFIED AO
Type A	Extraarticular
Type B	Partial articular B1–radial styloid fracture B2–dorsal rim fracture B3–volar rim fracture B4–die-punch fracture
Type C	Complete articular

Courtesy: Campbell's Operative Orthpaedics [4]

Imaging techniques

Standard PA/ Lateral & oblique are sufficient to diagnose the fracture geometry, but 3-D Ct would give us exact information about comminution & displacement of fracture fragments & carpal malalignment.sufficiency (independency), community-living.





Assessment of carpal alignment
AB: Long axis of radius,
CD: Line perpendicular to AB
EF: Line tangent to volar &dorsal margins
DA: Dorsal angle.
GH: Long axis of capitates
If GH intersects through carpus, there is Carpal alignment.

Radial displacement
AB: Long axis of radius
CD: Line tangent to lunar facet
EF: Line tangent to Ulnar head
GH: Line tangent to radial styloid
UV: Ulnar variance
GF: Radial length.

Courtesy: Rockwood Green's Fractures in Adult [5]

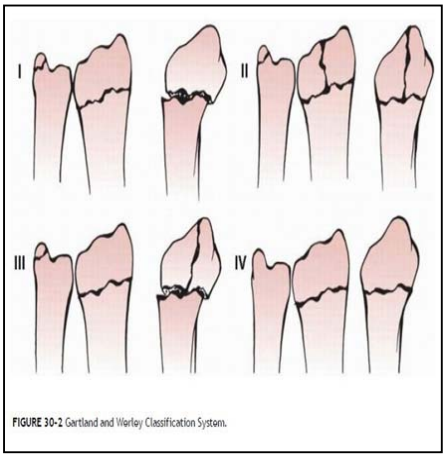


FIGURE 30-2 Gartland and Werley Classification System.

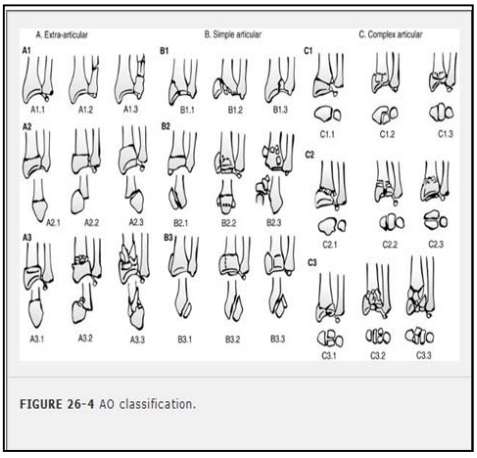


FIGURE 26-4 AO classification.

Gartland & Werley's classification AO classification

Courtesy: Rockwood Green's Fractures in Adult

1. The treatment modalities available for are,
2. Closed reduction under anaesthesia
3. Closed reduction with percutaneous K-wires
4. External fixators with / without distraction rod.
5. Volar locking plates.

In quite a few cases fixation can be easily done by closed reduction with or without percutaneous K-wires. But in few cases the reduction is unstable / unacceptable, wherein one has to choose between surgical options aforementioned [6-9].

TABLE 57-8 Radiographic Criteria for Acceptable Reduction of Distal Radial Fracture

CRITERION	NORMAL	ACCEPTABLE
Ulnar variance (radial length)	±2 mm comparing level of lunate facet to ulnar head	No more than 2 mm of shortening relative to ulnar head
Radial height	12 mm	????
Palmar (lateral) tilt	11 degrees of volar tilt	Neutral
Radial inclination	20 degrees as measured from lunate facet to radial styloid	No less than 10 degrees
Intraarticular step or gap	None	Less than 2 mm of either

Courtsey: Campbell's Operative Orthopaedics

There is a universal acceptance, after the clinical outcome & biomechanical studies, that

i) Ulnar variance should be ± 2mm
ii) Radial height 12mm
iii) Palmar tilt of distal articular facet of 11º
iv) Radial inclination of 20º (Not less than 10º)
v) No intra-articular step / gap [10-11]

La Fontaine *et al* [12], identified the factors responsible for instability of reduction distal radius, which are as under,

i) Dorsal angulation with volar tilt more than 20º
ii) Dorsal metaphyseal comminution
iii) Intra articular fractures (Barton's injuries)
iv) @ ulnar fracture
v) Patient more than 60 yrs (Osteoporosis)

In majority of the cases this can be achieved with closed method with / without minimal invasive procedures. But in quite a few cases especially AO type B injuries wherein there is partial articular involvement, with /without displacement, one has to opt for locking plate. Volar surface of distal radius being flat this surface is preferred for fixation. Incidence of tendon attrision or rupture is also less in volar plating [13-15].

Stability of wrist joint

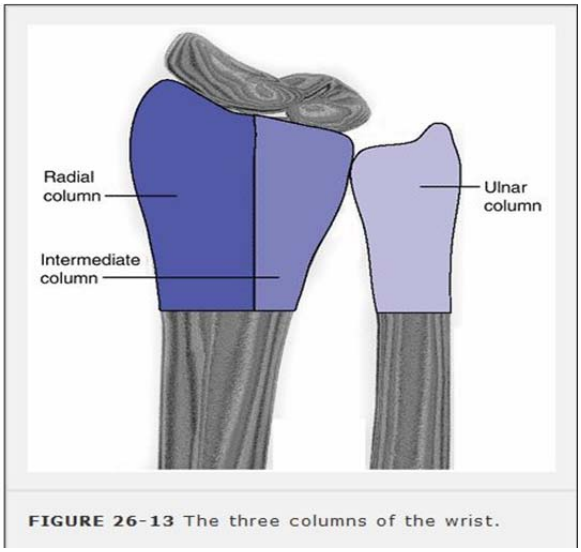


FIGURE 26-13 The three columns of the wrist.

Courtesy: Rockwood Green's Fracture in Adult

A. Bony stability

Bony complex has 3 columns, i) Radial Column ii) Intermediate column, & iii) Ulnar column, which provide anatomical congruity & stability to wrist joint.

B. Ligamentous stability

The extrinsic ligaments of the wrist joint provide additional stability & strength to grip. They are palmar & dorsal extrinsic ligaments.

The orientation of ligaments from Radial styloid is oblique, hence during ligamentotaxis, as compared to ligaments from lunar facet. When the ligaments are stretched, the carpal bones are automatically aligned with radius.

The dorsal extrinsic ligaments are thinner & more laxed (Z orientation). Hence when the ligaments are stretched palmar extrinsic ligaments are unyielding as compared dorsal ligaments. And thus the palmar tilt of distal radius is restored.

Aim of the treatment:

i) To restore congruity of distal radius
ii) To restore carpal alignment
iii) To minimize ulnar variance
iv) To restore radial angle
v) To restore palmar tilt.

Material & Methods

Volar locking plates (2.4 mm thickness) for distal end radius, self-tapping locking screws, 1.5 mm K-wires. The patient was operated with standard Henry's approach & the fracture was fixed with locking plate & screws [16]. In cross K wire fixation, the k wires were inserted from dorsal aspect of the wrist, one from radial styloid & other from Lister's tubercle.

Sample size

Total 48 cases of fracture of the distal end of radius were evaluated in this study. Out of these, 33 cases were treated with cross K wire fixation & 15 cases were fixed with volar locking plate.

Out of the 33 cases treated with crossed K-wires, in 21 cases stable fixation could be achieved just with crossed K- wires. In 12 cases, the residual instability was noted which required additional stabilization by external fixator frame.

The 15 cases treated with volar locking plate, 2 aspects were noted.

1. Fracture pattern was more unstable
2. Articular surface of distal radius was involved.
3. Bone purchase available for distal screws was bare minimum.

Duration of the study: March 2015 to Feb 2017, for the period of 2 years.

Inclusion criteria

1. The patients above 18years & less than 65 years.
2. Fractures of distal end radius.
3. Articular involvement / Barton's injuries.

Exclusion criteria

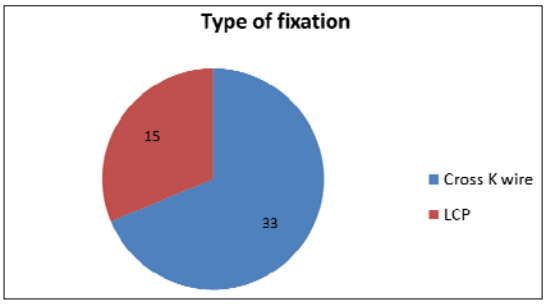
1. Paediatric age group
2. Patients who have not attained skeletal maturity
3. Pathological fractures.

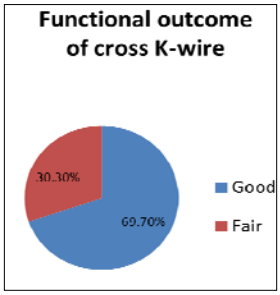
Observation & Results

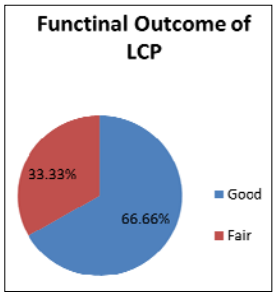
15 cases were treated with volar locking plate, while 33 cases were treated with cross K-wires.

	Volar LCP	Crossed k wire
15 cases of # distal radius	√√	
33 cases of # distal radius		√√
21 cases		√√
12 cases		√√ with ext fixator
Time from injury to surgery	3 – 7 days	3 – 7 days
Average stay in hospital	15 days	4 - 5 days

Average time for surgery	90 - 120 min	20 - 30 min
Open surgery	++	Not required
Blood loss	Insignificant	Nil
Complications		
Superficial infection	3 (20%)	Nil
Ulnar variance	corrected in13 cases (86.66%)	corrected in 27 cases (81.81%)
Radial Inclination	corrected in14 cases (93.33%)	corrected in 30 cases (90.9%)
Palmar tilt	corrected in 12 cases	corrected in 28 cases (84.84%)
Carpal malalignment	Nil	Nil
Stiffness of wrist	Seen in 3(20%),	Seen in 6 (18.18%).
Reflex sympath dystrophy	Not seen	Not seen
Grip strength	Good –9, Fair—6.	Good—22, Fair—11.
Mannus valgus	Seen in 2,	Seen in 4,
Dorsal / volar angulation	Seen in 3,	Seen in 5
Functional outcome	Good-10 (66.6%), Fair-5(33.33%.)	Good—23(69.7%), Fair—10(30.3%)







Cross K-wire

X-rays

Cross K- wire with distractor

Volar LCP

Discussion

The aforementioned table revealed the following inference.

1. The technique of crossed K wire with / without external fixator, is a user friendly technique. Hence the number of cases of fracture distal radius performed in this study with cross K wires were more than double the cases performed with volar LCP.
2. Technique of volar LCP requires more precision, & meticulous soft tissue dissection to protect neurovascular structures [18, 19].
3. Although volar LCP was fixed under tourniqutte with minimum blood loss, in crossed K wires, blood loss was nil.

4. Duration of surgery in crossed K wires was less than a third of the time required for volar LCP.
5. Average stay in the hospital was also reduced to a third than that required volar LCP.
6. The incidence of infection was also reduced to nil in crossed wire technique.
7. The results of correction achieved with both the techniques were comparable. There was no significant difference in the results achieved with the 2 techniques [17].
8. One definite advantage was noted with volar LCP was, when the fracture was involving articular margins, (AO type B) the articular congruity could be easily achieved with volar LCP than Crossed K wires.
9. If the fracture is AO type A, that can be achieved with crossed K wires.
10. Immediate post operative stability of fracture was better in volar LCP than in crossed K wires.
11. The cases with crossed K wires were to be immobilized for 4-6 weeks with either slab or external fixator frame which can be the reason for initial stiffness in early post operative period.
12. Grip strength was more or less same with both the techniques.
13. The residual deformity like mannus valgus was due to excess comminution of fracture with or without bone loss especially over dorsal metaphysis of radius.
14. The functional outcome in both the cases was almost similar [20].
15. The indications for volar LCP were
    a) racture involving partial articular surface (AO type B)
    b) Ulnar variance not corrected by traction,
    c) To achieve articular congruity.
16. In excess comminution of the articular margins (AO type C), since one does not have adequate bone purchase, it is safer to fix such fractures with crossed K wires with external fixator frame.
17. Volar LCP was not beneficial when there was
    a) Excess comminution of articular surface (AO type C)
    b) Bone loss on the dorsal metaphysis of radius.

Conclusion

Both techniques had given similar results in our study. The volar LCP technique requires more precision, soft tissue dissection. Crossed k wire does not require opening of fracture site, hence more a sort of biological healing.

Average stay in hospital is definitely less & that the technique is user-friendly.

If the fracture is involving partial articular surface (AO type B), volar LCP should be the treatment of choice. If it is AO type A, it is best treated with crossed K wires unless the reduction of fracture is not complete.

In AO type C, where there is excess of comminution, with or without dorsal metaphyseal bone loss, it is better to avoid Volar LCP.

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