COMBINATION OF FIXATION TECHNIQUES IN THE MANAGEMENT OF COMPLEX DISTAL RADIUS FRACTURE- OUR EXPERIENCES

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ABSTRACT

BACKGROUND

The aim of the study is to categorically suggest the apt method of surgical technique for a particular type of distal radius fracture (Frykman's type III-VI). Distal radius fracture are among the most common fractures of the upper extremity inspite of increased focus on regular prevention of osteoporosis, early identification and its prompt management. Most distal radius fractures are the result of low energy mechanisms that can be successfully treated either nonoperatively or with a variety of operative techniques if indicated. Complex distal radius fractures occur most commonly in high-energy injuries with extensive comminution or bone loss and associated soft tissue or vascular injuries. These high-energy fractures can present challenges in reconstructing the distal radius. Effective restoration of the bony architecture requires a thorough knowledge of distal radius anatomy, understanding of the goals of treatment, versatility in surgical approaches and familiarity with multiple fixation options. Although, majority of the extra-articular fracture without signs of instability can be successfully managed with POP immobilisation for a period of 4-5 weeks followed by active physiotherapy, other types (Frykman's III-VI) need surgical management that too with combination of surgical techniques namely augmented spanning external fixator with supplemented K-wire fixation or external fixation followed by fragment specific volar locking compression plate osteosynthesis.

MATERIALS AND METHODS

I have studied 50 cases of distal radius fractures classified using Frykman's classification using combination of techniques namely augmented spanning external fixator application with K-wire supplementation and spanning external fixator application followed by volar LCP fixation in which external fixator had been used as a reduction tool in majority of the cases and external fixator had been removed after plate osteosynthesis. In some cases retained for a period of 4-6 weeks after plate osteosynthesis, which is followed by bone grafting. By early removal of external fixator, fixator-related issues like muscle tendon and nerve impalement, pin tract infection at the site of pin insertion can be minimised.

RESULTS

Outcome is determined by multiple factors and depends greatly on the soft tissue injury, patient factors and management and the adequacy of restoration of osseous and ligamentous relationships. In contrary to prolonged use of augmented spanning external fixator, which resulted in stiffness of wrist and finger, pin tract infection in both groups (whether external fixator application followed by K-wire fixation as well as external fixator application followed by volar plate osteosynthesis) external fixator can be removed at the end of 4 weeks while K-wires are still in place. Patient can be encouraged to move their fingers and wrist, allowed them to do minimal daily activities. With the use of external fixation in combination protocol radial length has been achieved by ligamentotaxis in majority of the cases (except in die punch intra-articular fracture) and in spite of ground-glass comminution - good reduction is always almost possible.

In highly impacted intra-articular die punch fracture-variant arthroscopy-assisted reduction followed by K-wire fixation and further maintained on external fixation. Need for bone grafting was almost negligible unless there was evidence of segmental bone loss from day 1. As in one case (open fracture) where external fixator was applied in order to maintain length of distal radius and soft tissues healing followed by bone grafting and VLCP fixation.

CONCLUSION

Finally, combination techniques instead of single technique offers various advantages in the management of complex comminuted fracture distal radius both in closed and open fractures.

KEYWORDS

Distal Radius Fracture, Augmented Spanning External Fixator, K-Wire, Volar Locking Compression Plate, Frykman's Classification.

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BACKGROUND

Complex distal radius fractures are high-energy injuries of the wrist with articular disruption, ligamentous instability, significant comminution, soft tissue injury and/or neurovascular impairment. The management of these injuries requires a thorough understanding of wrist functional anatomy and familiarity with a wide selection of approach and fixation options.

This article reviews an approach that involves structured evaluation, aggressive soft tissue management, early reduction and skeletal stabilisation and a columnar

approach. Despite increased focus on injury prevention as well as osteoporosis identification and management, distal radius fractures continue to be one of the most common injuries in clinical practice. They occur in a bimodal fashion with predictable peaks in the young and elderly. Many lower-energy non-articular fractures and most epiphyseal fractures in children can be treated with closed reduction and casting with excellent outcomes. On the other hand, comminuted fractures of the distal radius secondary to osteoporosis in the elderly maybe easy to reduce, but difficult to maintain in a cast after closed reduction. Similarly, fractures in younger patients as the result of higher-energy injuries often result in unstable fracture patterns that require surgery.

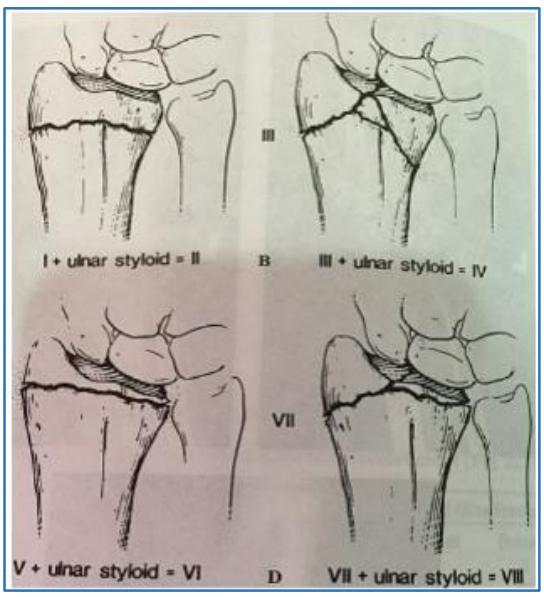
MATERIALS AND METHODS

I present my 2 years' experience in the management of complex comminuted intra-articular fracture of distal radius both closed and open with combination of (1). Augmented spanning external fixator application followed by multiple K-wire supplementation. (2). External fixator application followed by VLC plate fixation. This retrospective study was done at Dr. SMCSI Medical College Hospital and Dr. Isaac Fracture Clinic from July 2014 to July 2016.

Classification

- Most Common Orthopaedic Injury with a Bimodal Distribution:
  - Younger patients-high energy.
  - Older patients-low energy/falls.
- 50% intra-articular:
- Associated injuries:
  - DRUJ injuries must be evaluated.
  - Radial styloid fx-indication of higher energy.
- Osteoporosis.
  - High incidence of distal radius fractures in women >50.
  - Distal radius fractures are a predictor of subsequent fractures.
  - DEXA scan is recommended in woman with a distal radius fracture.

All distal end of radius fractures were classified using Frykman's classification based on joint involvement (radiocarpal and/or radioulnar) ± ulnar styloid fx.



Eponyms

Die-punch fxs: A depressed fracture of the lunate fossa of the articular surface of the distal radius.
Barton's fx: Fx dislocation of radiocarpal joint with intra-articular fx involving the volar or dorsal lip (volar Barton or dorsal Barton fx).
Chauffer's fx: Radial styloid fx.
Colles' fx: Low energy, dorsally displaced, extra-articular fx.
Smith's fx: Low energy, volar displaced, extra-articular fx.

Imaging
Radiographs

View	Measurement	Normal	Acceptable Criteria
AP	Radial Height Radial inclination Articular step-off	13 mm 23° Congruous	<5 mm shortening Change <5° <2 mm step-off
LAT	Volar tilt	11°	Dorsal angulation <5° or within 20° of contralateral distal radius

- CT scans.
  - Important to evaluate intra-articular involvement and for surgical planning.
- MRI useful to evaluate for soft tissue injury.
  - TFCC injuries.
  - Scapholunate ligament injuries (DISI).
  - Lunotriquetral injuries (VISI).

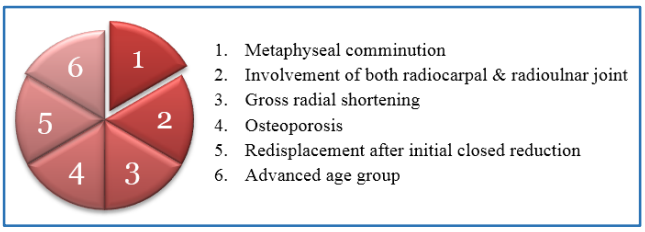
Selection Criteria for this Study

1. Closed unstable fractures Frykman Type III-Type VI.
2. Open unstable fractures Frykman Type III-Type VI.
3. Medically optimised in consultation with internal medicine specialist.

Almost, all fractures selected for the study had signs of instability (Mackenny et al[1]) such as:

1. Metaphyseal comminution.
2. Involvement of both radiocarpal and radioulnar joint.
3. Gross radial shortening.
4. Osteoporosis.

5. Redisplacement after initial closed reduction.
6. Advanced age group, etc. (Lafontaine et al[2]).



Predicting instability (Nesbitt et al[3])

Exclusion Criteria

1. Stable undisplaced fracture (Frykman Type I and II).
2. Medically not optimised due to comorbidity.
3. After 3 weeks of initial injury.

RESULTS

Outcome is determined by multiple factors and depends greatly on the soft tissue injury, patient factors and management and the adequacy of restoration of osseous and ligamentous relationships. In contrary to prolonged use of augmented spanning external fixator, which resulted in stiffness of wrist and finger, pin tract infection. In both groups (whether external fixator application followed by K-wire fixation as well as external fixator application followed by volar plate osteosynthesis) external fixator can be removed at the end of 4 weeks while K-wires are still in place. Patient can be encouraged to move their fingers and wrist allowed them to do minimal daily activities. With the use of external fixation in combination protocol radial length has been achieved by ligamentotaxis in majority of the cases (except in die punch intra-articular fracture) and in spite of ground-glass comminution - good reduction was always almost possible.

In highly impacted intra-articular die punch fracture-variant arthroscopy-assisted reduction followed by K-wire fixation and further maintained on external fixation. Need for bone grafting was almost negligible unless there was evidence of segmental bone loss from day 1. As in one case (open fracture) where external fixator was applied in order to maintain length of distal radius and soft tissues healing followed by bone grafting and VLCP fixation.

Follow-up

All 50 patients were followed up for a period of 2 years. After getting discharged from the hospital, patients were followed up weekly for 3 weeks, bi-weekly for 6 weeks, monthly for 6 months and once in 3 months for a period of 2 years.

Case 1

Case 2

Case 3

Case 4

Case 5

Case 6

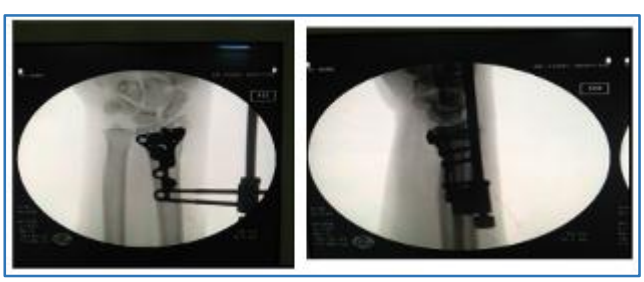
Case 7

Case 8

Case 9

Case 10

Case 11



Results: (Both Radiological and Clinical)[4-6]:			
	Excellent	**Good**	**Poor**
Range of Movement	40	6	4
Radial Length	5-7 mm (44)	5 mm (4)	<5 (2)
Palmar Tilt	Neutral (23)	Dorsal tilt 5°(3)	-
Ulnar Variant	+(15)	Neutral (7)	- (7)

End of 3 Months

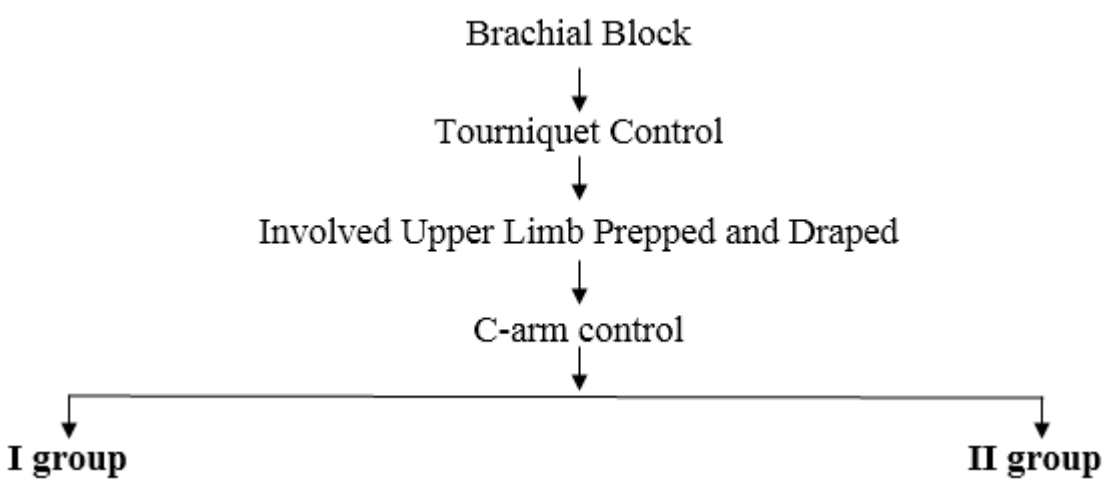
End of 3 Months:

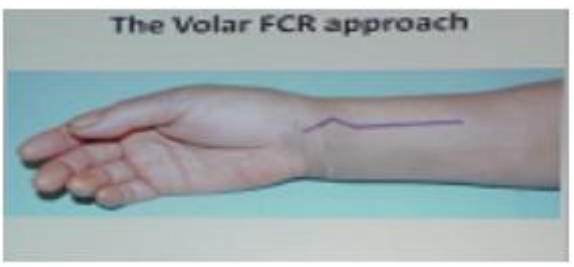
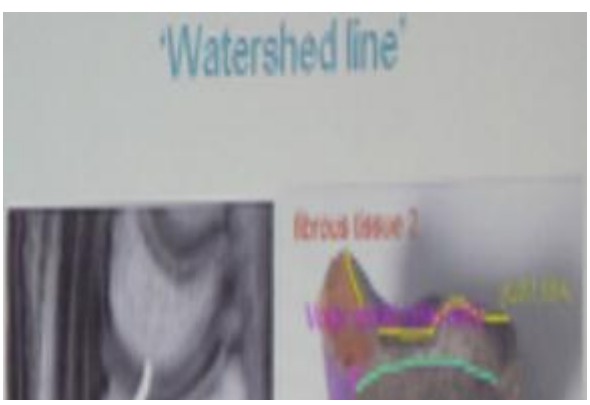
End of 2 Months 3 Weeks:

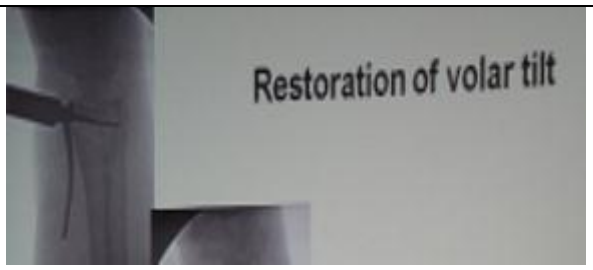
End of 3 Months:

Procedure

Majority of the cases were operated between 6-8 hrs. postinjury on a timely thoughtful intervention.



Augmented Spanning External Fixator Followed by K-Wire Fixation	(External Fixator Application Followed by Volar Locking Compression Plate Fixation
1. Frykman's Type III-VI in Paediatric age Group with Open Physis	1. Unstable Fracture Pattern with volar Barton's Component Predominantly
2. Open Fracture	2. Open Fractures with Segmental Bone Loss
Selected for External Fixator Followed By K-wire Fixation	Selected for External Fixator Application Followed by VLCP
External fixator applied-2 pin in distal Radius-above 5-7 cm from R. Styloid-45° to long Axis-avoiding superficial branch of radial nerve and lateral cutaneous nerve of forearm 2 pins applied in II metacarpal in the proximal half-45° to long axis-avoiding impingement of dorsal interossei and extensor tendon	Modified Henry's approach Volar FCR-radial artery interval 
Distraction of external fixator was done under C-arm control and looked for the adequacy of radiocarpal, radioulnar joint reduction, correction of radial length palmar tilt and articular congruity	Volar Surface of Radial Reached Watershed Line delineated 
In order to avoid translation forces acting on the fracture site, percutaneous K-wire fixation done additionally to stabilise fracture fragment. 2 K-wires passed from ulnar side radial cortex dorsally to volar lateral cortex radially and 2 K-wires passed from inferior-lateral radial styloid to superior ulnar side of radial shaft	Adequacy of reduction checked under C-arm
Postoperative Protocol	VLCP temporally fixed with K-wire checked under C-arm
Finger movements-PIP/DIP/MCP encouraged from day 1. Elbow and shoulder movements also from day 1. At the end of 4 weeks, external fixator and distal radioulnar joint K-wires removed and wrist and forearm rotations started gradually. When the radiological union was evident on serial x-ray evaluation remaining K-wires were removed usually at the end of 6 weeks	Definite fixation done in the following order-ulnar screw 1st-screw position confirmed by tilting the C-arm with the beam 20° inclined from distal to proximal, then remaining all screws on the distal row of plate were filled
	Following the raff screw fixation, plate was compressed on to the radial shaft by using compression screw. By doing so, the palmar tilt can be corrected without much manipulation. Then, remaining shaft screws were placed



Distal radioulnar joint wire used routinely in all cases. Majority of the cases, external fixator was used as a reduction tool and removed at the end of plate fixation. In some cases, it was retained for specific reasons such as open injuries, bone loss, etc.[7-9]

In case of segmental bone loss and gross unstable situation, external retained for 4 weeks

Once soft tissue environment was favourable, ORIF VLCP with bone grafting done

Postoperative Protocol

Finger movements-PIP/DIP/MCP encouraged from day 1, elbow and shoulder movements also from day 1 in cases in which external fixator was used as a reduction tool, same was removed at the end of VLCP fixation and wrist movements also started on day 1

DISCUSSION

Usual Complications are

- Most frequent neurologic complication.
- 1-12% in low energy fxs and 30% in high energy fxs.
- Prevent by avoiding immobilisation in excessive wrist flexion.

Treat with Acute Carpal Tunnel Release for

- Progressive paraesthesias.
- Paraesthesias do not respond to reduction and last >24-48 hours.

Ulnar Nerve Neuropathy

- Seen with DRUJ injuries.

EPL Rupture

- Nondisplaced distal radius fractures have a higher rate of spontaneous rupture of the extensor pollicis longus tendon.
- Extensor mechanism is felt to impinge on the tendon following a nondisplaced fractures and causes either a mechanical attrition of the tendon or a local area of ischaemia in the tendon.

Radiocarpal Arthrosis (2-30%)

- 90% young adults will develop symptomatic arthrosis if articular step-off >1-2 mm.
- Maybe non-symptomatic.

Malunion and Nonunion

- Intra-articular malunion.
- Treat with revision at >6 weeks.

Extra-Articular Angulation Malunion

- Treat with opening wedge osteotomy with ORIF and bone grafting.

Radial Shortening Malunion

- Radial shortening associated with greatest loss of wrist function and degenerative changes in extra-articular fxs.
- Treat with ulnar shortening.

ECU or EDM Entrapment

- Entrapment in DRUJ injury. Combination of surgical techniques in the management of complex unstable distal radius is inevitable.

- Yields good outcome in terms of range of movement, radial length, palmar tilt, ulnar variant and articular congruity.
- Loss of reduction, shoulder-hand syndrome, Sudeck's osteodystrophy are rare.
- Need for bone grafting was almost nil except for cases with primary bone loss.
- With the use of external fixation in combination protocol radial length has been achieved by ligamentotaxis in majority of the cases (except in die punch intra-articular fracture) and inspite of ground-glass comminution-good reduction is always almost possible.
    a. "I happen to use a small fragment fixation over large fragment fixation. I augment this with bilateral internal fixators," Hanel said at the American Academy of Orthopaedic Surgeons annual meeting during a presentation on enhanced stability and fixation of complex distal radius fractures.
    b. Hanel told audience members that constructs they select for complex distal radius fractures from various thickness and length plates to pins, screws, wires and internal and external fixators-must withstand the rigors of patients' weightbearing on a freshly healing distal radius fracture that can reach 360 N.
    c. Implants that hold up under such conditions are hard to find, he added.
    d. By adding an internal or external fixator, you can double the fixation and the stiffness of any construct to withstand weightbearing.
    e. A fracture plate alone may not always be sufficient.

CONCLUSION

Fractures of the distal radius are very common and are treated using either casting or surgical techniques such as internal and external fixation. There are nearly as many ways to treat a distal radius fracture as there are distal radius fractures. In other words, there is no one treatment that is effective for all types of fractures. Each fracture requires individual treatment customised to deal with the specific characteristics of the fracture. "An important consideration when treating the fracture of the distal radius is to assess its personality and to customise one's treatment to best match its personality."

Complex

This is a catastrophic injury with extensive damage to the joint surface, fragmentation of the widened flare (metaphysic) of the distal radius and damage to the shaft of the radius and/or the neighbouring ulna. Although, the introduction of fragment specific LCP fixation system has virtually replaced external fixator applied almost universally still there is a strong place for external fixator application in very low distal radius fracture, which is not amenable for plate fixation impacted articular die punch fracture and volar lip fracture.[10] With the use of external fixation in combination protocol, radial length has been achieved by ligamentotaxis in majority of the cases (except in die punch intra-articular fracture) and in spite of ground-glass comminution - good reduction is always almost possible. In highly-impacted intra-articular die punch fracture variant, arthroscopy-assisted reduction followed by K-wire fixation and further maintained on external fixation. Need for bone grafting was almost negligible unless there was evidence of segmental bone loss from day 1. As in one case (open fracture) where external fixator was applied in order to maintain length of distal radius and soft tissues healing followed by bone grafting and VLCP fixation. I conclude that combination techniques instead of single technique offers various advantages in the management of complex comminuted fracture distal radius both in closed and open fractures.

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