A COMPARATIVE STUDY OF

ANALYSIS OF FUNCTIONAL OUTCOME OF INTRAARTICULAR DISTAL RADIUS FRACTURES TREATED WITH DYNAMIC EXTERNAL FIXATOR AND LOCKING COMPRESSION PLATE

Dissertation submitted to

THE TAMILNADU DR.MGR MEDICAL UNIVERSITY

CHENNAI- 600032

in partial fulfilment of the regulations for the award of the degree of

M.S (ORTHOPAEDIC SURGERY)

BRANCH II

GOVT. KILPAUK MEDICAL COLLEGE

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CERTIFICATE

This is to certify that this dissertation entitled '***A COMPARATIVE STUDY OF*** **ANALYSIS OF FUNCTIONAL OUTCOME OF INTRAARTICULAR DISTAL RADIUS FRACTURES TREATED WITH DYNAMIC EXTERNAL FIXATOR AND LOCKING COMPRESSION PLATE'** is a record of bonafide research work done by **Dr. V.S.NISANTH**, post graduate student under my guidance and supervision in fulfilment of regulations of The Tamilnadu Dr. M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2011 to 2014, in the Department of Orthopaedics, Govt. Kilpauk Medical College, kilpauk, Chennai-600010

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DECLARATION

I **Dr. V.S.NISANTH,** solemnly declare that the dissertation, '***A COMPARATIVE STUDY OF*** **ANALYSIS OF FUNCTIONAL OUTCOME OF INTRAARTICULAR DISTAL RADIUS FRACTURES TREATED WITH DYNAMIC EXTERNAL FIXATOR AND LOCKING COMPRESSION PLATE'** is a bonafide work done by me in the Department of Orthopaedics, Govt. Kilpauk Medical College, Chennai under the guidance of Prof. K. Raju, M.S.Ortho., D.Ortho., Professor of Orthopaedic Surgery, Govt. Kilpauk Medical College, Chennai-600010.

This dissertation is submitted to "THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY", towards partial fulfilment of regulations for the award of M.S.DEGREE BRANCH II (Orthopaedic Surgery).

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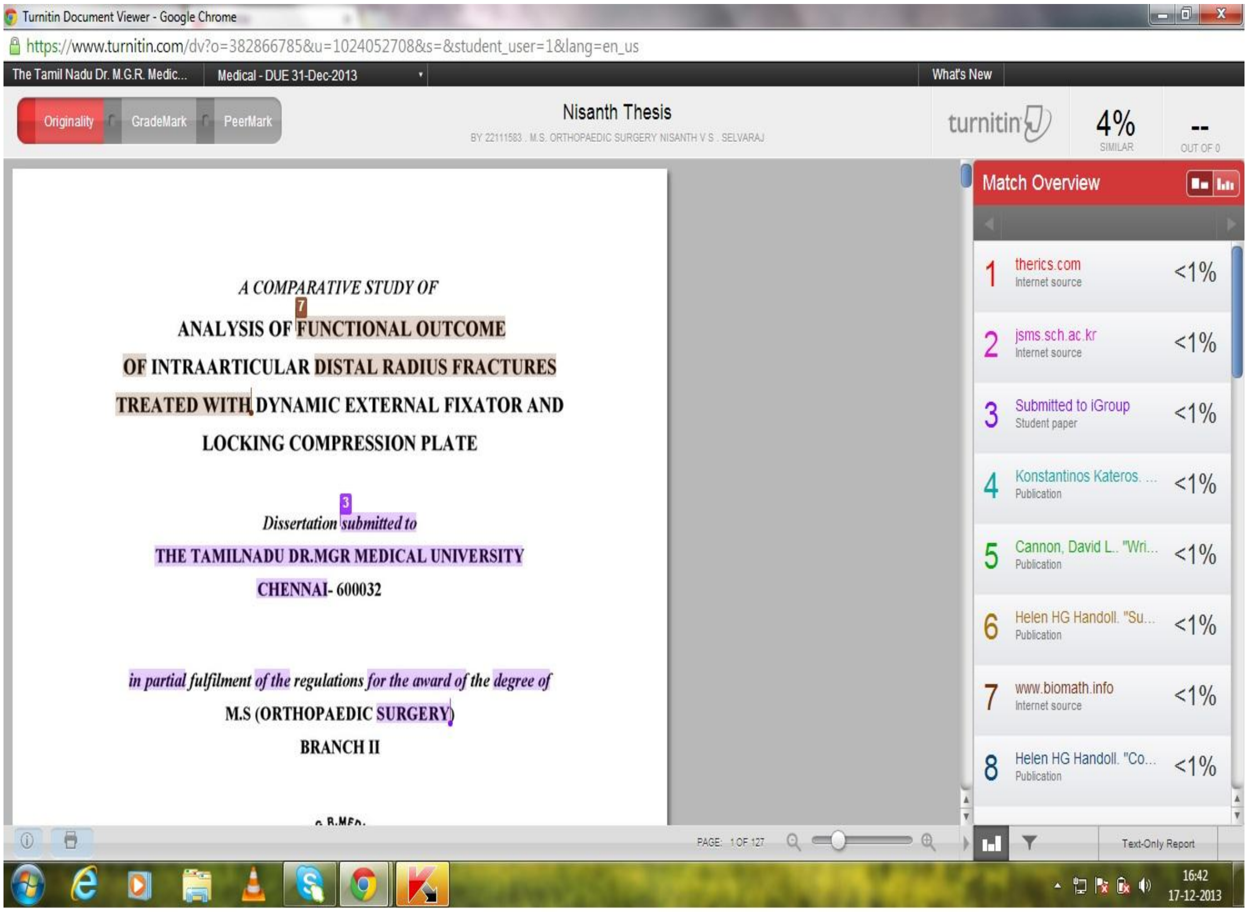

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ABSTRACT

Title: **A COMPARATIVE STUDY OF ANALYSIS OF FUNCTIONAL OUTCOME OF INTRAARTICULAR DISTAL RADIUS FRACTURES TREATED WITH DYNAMIC EXTERNAL FIXATOR AND LOCKING COMPRESSION PLATE**

Keywords: Intraarticular distal radius fractures, dynamic external fixator, locking compression plate, multiplanar ligamentotaxis, volar approach to distal radius.

Aim of the study: To analyze and compare the role and effectiveness of Closed reduction and External fixation with dynamic wrist fixator and Open reduction and Internal fixation with volar locking compression plate of intra articular distal radius fractures.

Materials and methods: This comparative study is conducted in Govt. Kilpauk Medical College from March 2012 to December 2013. About 47 patients with intraarticular distal radius fractures were selected and randomly classified into two groups namely Ex Fix group and LCP group and treated with dynamic external fixator (penning type II) with or without supplementary techniques and volar locking compression plate respectively. 24 patients in Ex fix group and 23 patients in LCP group were treated among which 3 patients in Ex fix group and 2 patients in LCP group had lost follow up and so 21 patients in each group were analysed in the study. Average follow up is 12.84 months in Ex fix group and 11.26 months in LCP group. The results were analysed as functional outcome using Green and O'Brien score (modified by Cooney et al) and anatomical outcome using Lidstrom score.

Results: After proper analysis and doing statistical comparison, we got p- value of 0.568 for functional outcome and 0.468 for anatomical outcome which is considered insignificant. (significance of p value determined as <0.05). But with regard to individual parameters in the scores, we got significantly better results in the values of volar tilt, radial inclination and intraarticular step off in volar locking compression plate than dynamic external fixator. Regarding complications, among Ex fix group, 3 patients had superficial pin tract infection, one patient had deep infection, one had malunion and one had pin bending complications and among LCP group one had screw penetration into joint space and one had secondary collapse of the fracture.

Conclusion: We conclude that there are no major differences in the functional outcome of both the techniques in terms of pain, range of movements, grip strength and return to work, in treating comminuted intra articular distal radius fractures. Eventhough there is no statistical difference in the functional outcome, volar locking compression plate plays a better role than dynamic external fixator in certain radiological parameters like volar tilt, radial inclination and intraarticular step off and also successful in achieving patient's satisfaction with limited number of minor complications and early return to work.

INTRODUCTION

In day to day practice of most orthopaedic surgeons, fractures of distal part of radius are one of the most commonly occurring fractures and encountering problems in selecting treatment option, accounting about 16% of all fractures in orthopaedic casualty and it has bimodal age distribution. Distal radius fractures are mostly insufficiency fractures in osteoporotic bone of elderly and following high velocity injuries in young patients[1].

Amazingly two hundred years before itself, Abraham Colles (1814)[2] described extraarticular distal radius fractures are having good outcome from his statement "*The nature of the injury once ascertained, it will be a very easy matter to explain the different phenomena attendant on it and to point out a method of treatment which will prove completely successful*". But this is not applicable to all the fractures of distal end of radius as stated by Colles'.Once the fracture geometry becomes complicated, the treatment of the distal radius becomes a challenging one.

Among all fractures of distal end of radius, about 50% of them involves the articular surface of either the radiocarpal joint or distal radioulnar joint and considered as unstable. Because premature axial loading causes displacement of the fracture fragments, impairs the articular congruity attained by the reduction technique and lead to post traumatic osteoarthrosis[3].

Hence the quality of reduction and fracture fixation technique are much more important for better outcome and patient satisfaction. Fernandez, Trumble reported that even as little as 1mm of articular incongruity will deprive the functional outcome[4] .Though various fixation options are available, the most commonly practising technique are Closed reduction and External fixation with early dynamisation and Open reduction and Internal fixation with locking compression plate. This is because both the techniques allow early mobilization of the wrist joint with good functional outcome.

Our study aim is to compare the functional outcomes of osteosynthesis of unstable distal radius fractures treated by Closed reduction with dynamic external fixator and Open reduction with volar locking compression plate.

AIM OF THE STUDY

To analyze and compare the role and effectiveness of Closed reduction and External fixation with dynamic wrist fixator and Open reduction and Internal fixation with volar locking compression plate of intra articular distal radius fractures.

REVIEW OF LITERATURE

Historically even 200 years before in the beginning of 18^{th} Century distal radius fractures were mistaken as wrist dislocations during the period of **Hippocrates**[5].

Though Colles' statement of distal radius fractures came in 1814, even 30 years before, a literature published in France "*Ancienne Ecole de Medecine Navale de Rochefor"* in 1783 in which **Pouteau**[6] explained fractures of distal radius in the types of forearm fractures and hence the name Pouteaus' fracture were used among French surgeons.

In 1814, **Abraham Colles**[2], an Irish anatomist and surgeon said about the importance of plaster splinting in fractures of distal radius in avoiding deformity and to get a pain free functional hand. Even before the use of x-rays came in, he quoted about the deleterious effect of palmar tilt in his publication "*On the fracture of the carpal extremity of radius*" launched in an article "*Edinburgh Medical Surgical Journal*" .

In 1830 **Goyrand**[7] said the displacement pattern of the distal end radius fractures was commonly occur in dorsal aspect and rarely in the palmar side.

In 1838, **Barton**[8] from United states first explained about the distal articular extention of fractures as the cause of subluxation of radiocarpal joint and not to be treated like sprain or dislocations of wrist as considered by many surgeons at that time.

In 1844, **Nelaton**[9,10] made a study on cadavers and described about the anatomy and mechanism of injury of the distal radius fractures.

In 1847, **Smith**[11] first explained the reason of " *Garden spade deformity*" in some distal radius fractures due to volar displacement of the distal fragment and considered as reverse of Colle's fracture pattern and published in his article " *Fractures of the forearm bones in the vicinity of wrist joint*"and thereafter these fractures are named as "*Smith fractures*"

In 1876 , **Championiere**[12] gave an idea of early mobilization of wrist joint in distal radius fracture favours better callus formation with good results compared to delayed mobilisation in his quote "*Le movement c'est la vie*" But he couldnot able to describe the residual deformity. **Marbaix**[13] also supported his statement.

In 1891, **Castex** did a study on dogs about patho-anatomy of fracture healing and ascribed that residual stiffness due to inappropriate fibrous tissue formation around muscles, tendons, ligaments around the fracture site.

Only at the end of the 18th century in 1898, **Beck**[14] and **Cotton**[15] first used the Roentgenogram findings in 140 cases of distal radius fractures to explain the anatomical disruption. Later on many authors **Destot**[16], **Pilcher**[17] and **Morton**[18] analysed and gave orientation of fracture pattern using X-rays.

In 1907, a Belgian surgeon named **Lambotte**[19] gave an idea of surgical approach for some displaced fractures by stabilizing radial styloid with one pin.

In 1929, **Ombredanne**[20] a surgeon first treated his patients with some form of external fixator device for carpal end distal radius fractures. He only introduced the concept but failed to improve wrist joint movements.

In 1944**, Anderson and O'Neil**[21] first introduced a adjustable external fixator to make use of it in distal radius fractures by placing pins in second metacarpal and connecting to simple bar so as to bridge the wrist joint and favouring wrist mobility.

Bishay[22] used the AO mini fixation device in which he inserted two pins in the distal fragment of carpal end of radius which produced complications like slipping and loosening of pins when compared to fragment fixation using four pins.

In 1951, **Gartland and Werley**[23] by doing a study of distal radius fracture and published their own classification system in the paper "*Evaluation of healed Colle's fratures in the Journal of Bone and Joint Surgery"*

In 1959, **Lidstrom**[24] explained about the fracture types on the basis of distal fragment displacement and intra articular extension and published his classification system in "*Fractures of the distal part of radius, a clinical and statistical study of end results*", in the article *Acta Orthop Scand*.

In 1965, **Ellis**[25] a popular surgeon introduced the concept of internal fixation using buttress plate through volar approach to treat Barton fractures. After his first step, the search on internal fixation techniques started from all the corners of the world.

The famous **Frykmann**[26] classification system was described by him in his paper "*Fractures of the distal radius, including squeal-shoulder-and finger syndrome, disturbance in the distal radio ulnar joint and impairment of nerve function, a clinical and experimental study*" in *Acta Orthop Scand Suppl*.He classified fractures respecting the involvement of the radiocarpal joint and radio ulnar joint and presence or absence of an ulnar styloid fractures .

In 1976 intra focal pinning technique was described by **Kapandji**[27] in which pins were introduced dorsally to the distal fragment crossing the fracture site into the proximal diaphysis helps fixing the fracture and preventing further dorsal dislocation.

In 1977, **Jones**[28] used an external fixator with a flexible tube between the connecting rods favouring wrist motion.

In 1984**, Melone**[29] announced a classification system based on four fracture components-radial styloid, dorsal medial facet, volar medial facet and shaft of radius. It helps in selecting indications of specific surgical approach for fixation of distal radius fracture.

In 1987, **Muller**[30] and his collegues published AO / ASIF classification. It elaborately describes the fracture geometry into three groups – extraarticular , partial articular and complete articular and further into 27 subtypes.

In 1993, **Fernandez**[31] launched his classification by explaining the forces acting the carpal end of radius at the time of injury and fracture displacement and collapse which was a modification of AO/ASIF classification.

Clyburn[32] introduced the first modern external fixator with a single ball and socket joint for favoring early wrist motions, but using his device radial shortening and loss of palmar tilt were not addressed.

John M. Agee[33] in his paper in Hand clinics described wrist biomechanics and the principles of multiplanar ligamentotaxis for achieving anatomical reduction of distal radius fracture.

W.Klein et al[34] used a double ball and socket joint type of external fixator which showed good functional outcome with early mobilization. He strongly recommended on supplementary techniques for better results.

In 2005, **Dean W.Smith** and **Mark H.Henry**[35] introduced volar fixed angle plating technique for comminuted distal radius fractures.

In 2011, **Kulshrestha et al**[36] did a randomized comparative study between dynamic and static external fixation and concluded early wrist mobilization gives better functional and anatomical outcome which is not provided by static fixator.

More recently **Day CS, Kamath AF, Makhni E et al**[37] introduced "*Sandwich plating*"technique combining dorsal and volar plate osteosynthesis for severely comminuted distal radius fracture. Eventhough it provides good stabilization of fracture, the dorsal plate may produce frequent complication like tendon rupture, tendinitis and tenosynovitis.

A latest evolution in complex distal radius fracture fixation with arthroscopic guidance has been introduced and carries on by **Wiesler ER et al.**

REVIEW OF ANATOMY

There are so many unproved axioms and beliefs about the phylogenetic evolution of human wrist and upper limb. The morphogenetic evolution of wrist was believed to be originated some 400 million years before from the pectoral fins of the primitive fish[39]. When amphibians evolved, for locomotion in ground and for weight bearing, syndesmosis appears between radius and ulna distally. As arthropod apes evolved, brachiation of the upper limb and the development of bipedalism emphasise wrist joint mobility for free climbing and to catch hold food or prey[40]. As hominids evolved from primates, for fine skilled movements of hand and wrist led to the development of synovial lined distal radio ulnar joint, radio carpal joint allowing multiplanar motions in the wrist joint.

WRIST JOINT

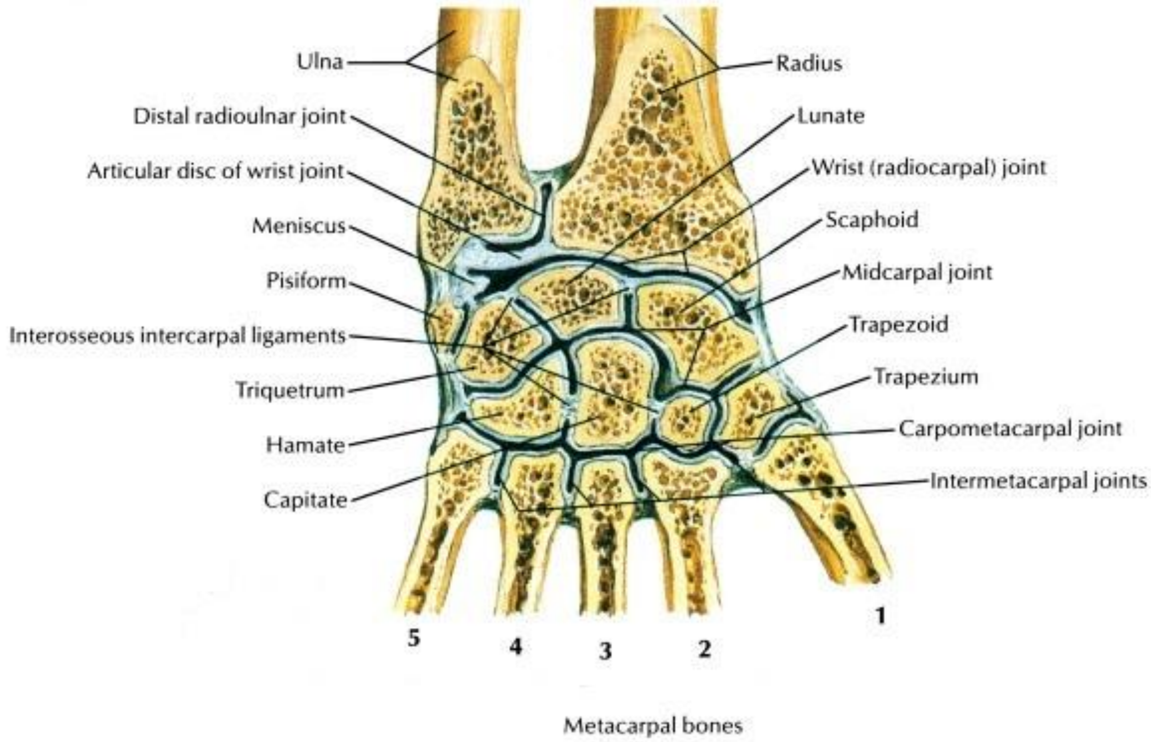
It is a compound joint composed of

1. Radio Carpal Joint.

2. Distal Radio Ulnar Joint

3. Inter Carpal Joints.

WRIST JOINT



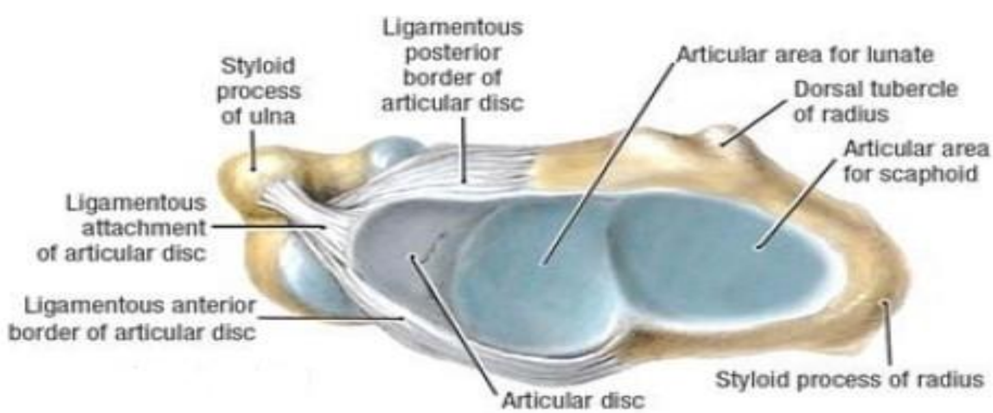
RADIO CARPAL JOINT

The radio carpal joint is a synovium lined condyloid type joint[41,42] and its level approximately marked by the proximal wrist crease. Here the distal end of radius articulates with scaphoid laterally and lunate medially, distal end of ulna has its attachment of triangular fibrocartilage complex on the fovea of ulna styloid to catch hold the triquetrum with articular disc inbetween. The proximal convex surfaces of the scaphoid, lunate and triquetrum articulate with concave distal articular surfaces of radius and articular disc.

DISTAL RADIO ULNAR JOINT

It is a synovium lined pivot type of joint. The distal radius at its ulnar side has the sigmoid notch which articulates with the ulnar head. The complex fibro ligmentous attachment with the triangular articular disc is attached with its apex on the base of styloid process of ulna and base on the medial side of sigmoid notch. This joint has a longitudinal axis where distal radius rotates around a relatively static ulna[43].The synovium lining the inner side of capsule forms sacciform recess proximally between distal radius and ulnar head.

FIG: DISTAL RADIOULNAR JOINT



INTERCARPAL JOINT

Eight Carpal bones are arranged in two rows forming synovial joints in between.

JOINTS BETWEEN THE PROXIMAL ROW CARPAL BONES

The carpal bones from lateral to medial in proximal row are scaphoid, lunate and triquetrum in addition pisiform articulates with the volar side of triquetrum at a small oval synovial piso triquetral joint.The synovial cavity communicates with radiocarpal joint.

JOINTS BETWEEN THE DISTAL ROW CARPAL BONES

The carpal bones are from medial to lateral are trapezium, trapezoid, capitate and hamate.

MID CARPAL JOINT

It is a complex divided into medial and lateral compartments[42]. Medially the convexities of capitate and hamate articulate with concave surface scaphoid, lunate and much of triquetrum. Laterally trapezium and trapezoid form compound articulation with scaphoid. These joints are plane synovial or sellar type of compound joint.

OSSEOUS ANATOMY

DISTAL RADIUS

The cross section of distal radius containing cancellous bone is quadrangular in shape containing anterior surface, posterior surface, lateral and medial surfaces. The lateral surface has a bony projection distally called styloid process and it is slightly rough. The anterior surface has a prominent volar ridge which divides into two on the radial side describing the watershed line. The medial surface is concave and smooth providing articulation for head of ulna and articular disc. The posterior surface has a palpable dorsal tubercle (Lister's tubercle) which is restricted on the medial side by an oblique groove for extensor tendon of the wrist. The groove is in line with the webspace between second and third fingers.

The distal articular surface is biconcave separated by a cartilaginous capital ridge called interfacetal prominence forming two separate articular facets for scaphoid laterally and lunate medially. The scaphoid facet is almost triangular with a small radius of curvature than the lunate facet and both are slightly tilted in two planes. The lunate facet is quadrangular and less inclined on the medial side compared to the scaphoid fossa. The dorsal cortex of the distal radius is slightly thinner than the volar cortex so more prone of getting collapsed on axial loading above the level of threshold.

FIG: DISTAL RADIUS-METICULOUS ANATOMY

LIGAMENTOUS ANATOMY

Complex wrist movements, stability and wrist kinematics are strongly guided by the dorsal and volar extrinsic and intrinsic ligaments, interosseous ligaments as well as TFCC. All the ligaments of wrist are called intracapsular as they lie between the fibrous and synovial layers of the joints except pisometacarpal, pisohamate and flexor retinaculum which are situated superficial to fibrous layer and termed extracapsular[44].

EXTRINSIC LIGAMENTS

Extrinsic ligaments are attached between forearm bones and carpal bones and carpus to the base of meta carpal on both volar and dorsal sides[44,45]. Volar ligaments are generally stronger than dorsal ligaments.

VOLAR EXTRINSIC LIGAMENTS

1. Radioscaphocapitate ligament (guides scaphoid kinematics)

2. Radioscapholunate ligament (nothing but a neurovascular tuft of synovium) called as *Ligament of Testut*.

3. Radiolunate ligaments - long and short.

4. Ulnolunate ligament.

5. Ulnotriquetral or ulnar collateral ligament.

DORSAL EXTRINSIC LIGAMENTS

1. Extrinsic intercarpal ligament (from trapezium to triquetrum)

2. Radiotriquetral ligament.

FIG: VOLAR WRIST LIGAMENTS

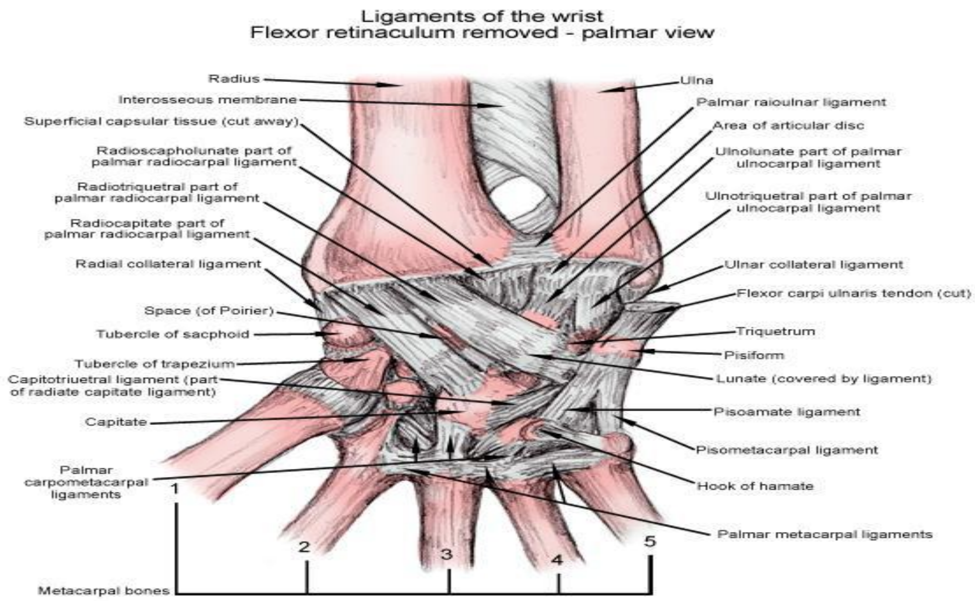
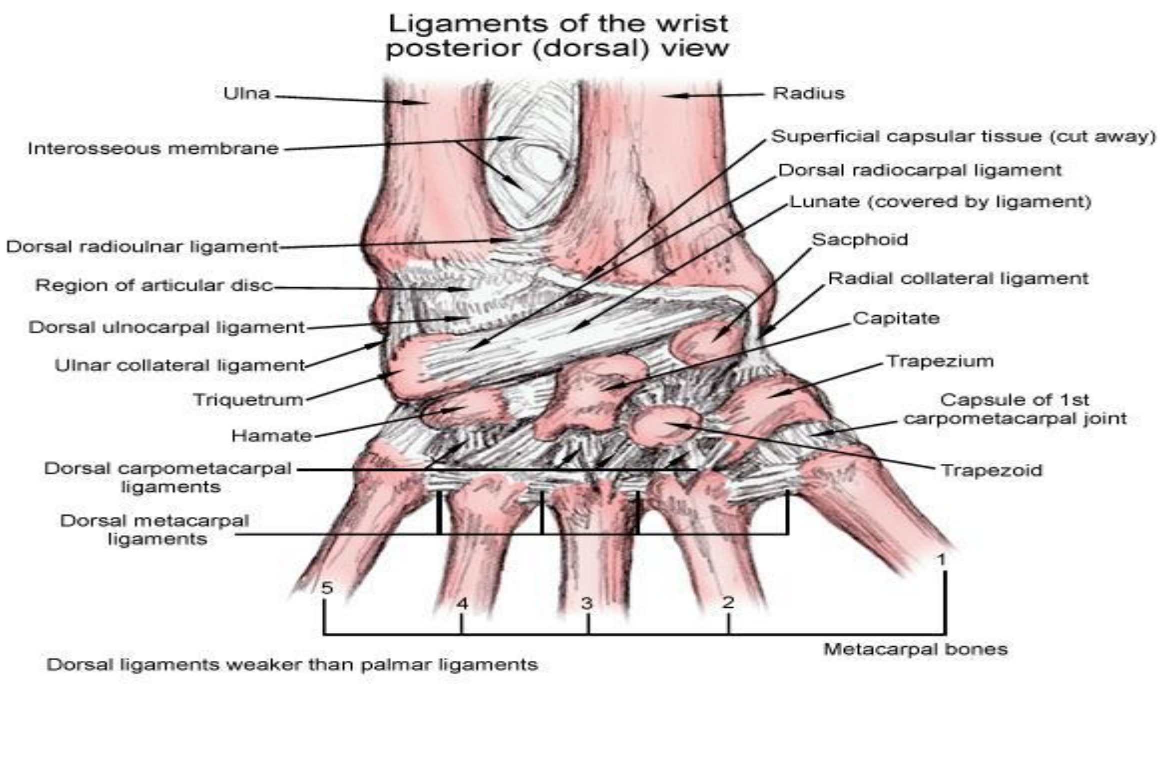


FIG:DORSAL WRIST LIGAMENTS



SIGNIFICANCE OF LIGAMENTS

Radioscaphocapitate (RSC) ligament stabilizes the distal pole of the scaphoid and using the ligament as an axis, scaphoid rotates from a volar flexed perpendicular position to a dorsiflexed longitudinal position.

There is a ligament free area on the volar aspect of wrist between capitate and lunate called as "*Space of Poirier*" which is biomechanically weaker and becomes the point of collapse in perilunate dislocation.

Radioscapholunate ligament also play an important role as *mechano-receptor* of wrist joint.

Ligaments play a significant role in closed reduction techniques by their orientation. Extrinsic ligaments from the radial styloid are relatively oblique when compared to the more vertical ligaments attached to lunate facet.

The dorsal ligaments are thinner than the volar ligaments and arranged in 'Z' fashion which gives freedom to lengthen even with less force compared to vertically attained volar ligaments. So during traction and closed reduction, palmar ligaments become taut before dorsal ligaments and thus volar cortex is more easily aligned anatomically than dorsal cortex.

INTRINSIC LIGAMENTS

These are attached between carpal bones and are stronger than extrinsic ligament and are attached to them by interdigitating fibres.Intrinsic ligaments -2 types-one those which connect carpal bones in same row and the other which cross the midcarpal joint to interconnect proximal and distal rows of carpal bones.

PROXIMAL ROW INTRINSIC LIGAMENTS

- Scapholunate ligament
- Lunotriquetral- most important stabilizer of proximal row

DISTAL ROW INTRINSIC LIGAMENTS

These are numerous, taut ligaments situated transversely between the distal carpal bones on dorsal, palmar and in intraarticular locations.

MIDCARPAL LIGAMENTS

-scaphocapitate-trapezoid ligament

-triquetro hamate ligament

-triquetrocapitate ligament

TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC)

The triangular fibrocartilage complex consists of several components and its the major stabilizer holding the distal end of radius and ulnar carpus (triquetrum) to the distal ulna. It is about 2-5 mm in thickness lying over the ulnar head to form a biconcave articular surface distally.

Components of TFCC

1. Cartilaginous articular disc
2. The meniscal homologue
3. Radio ulnar interconnecting ligaments
4. Floor of extensor carpi ulnaris subsheath
5. Ulnolunate
6. Ulnar collateral
7. Ulno triquetral ligament

TFCC is the main stabilizer of distal radioulnar joint and plays an important role in load sharing. During axial loading, radius transmits 82% load and ulna carries only 18% but in positive ulnar variance load transmission across TFCC increases to 42% because TFCC extends the distal radius joint surface to cover the ulnar head. Only the peripheral 15-20% of TFCC has blood supply.

VASCULAR SUPPLY

The carpal bones and joints are supplied by branches from

1) Anterior and posterior carpal branches of radial and ulnar arteries
2) Anterior interosseous artery
3) Recurrent branch from deep palmar transverse arch
4) Small metacarpal arteries

NERVE SUPPLY

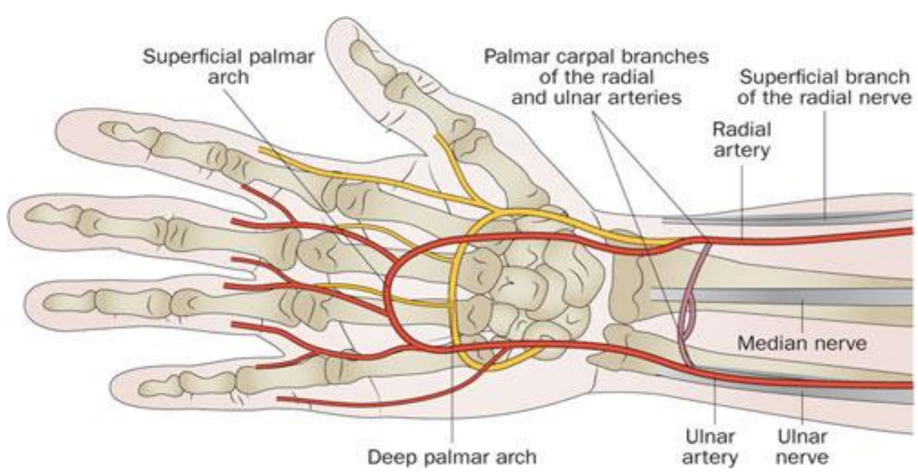
The structures around Radio carpal joint are innervated by

-Ulnar nerve main trunk and dorsal cutaneous branch ,

-Median nerve man trunk and anterior interosseous branch and palmar cutaneous branch ,

-Superficial cutaneous branch of radial nerve

FIG: NEUROVASCULAR ANATOMY OF WRIST



NORMAL MOVEMENTS

Flexion	0-85 degrees
Extension	0-85 degrees
Abduction (radial deviation)	0-15 degrees
Adduction (ulnar deviation)	0-35 degrees
Supination	0-85 degrees
Pronation	0-80 degrees

BIOMECHANICS OF WRIST AND CARPAL KINEMATICS

BIOMECHANICS OF WRIST;

It is a complex phenomena and wrist enjoys a freedom of three varieties of movements in different ranges and different axes. The global motion of wrist consists of flexion & extension in the coronal axis, radioulnar deviation in the sagittal axis at the radiocarpal joint and pronation & supination in the longitudinal axis at the distal radioulnar joint. Wrist allows approximately 145 degrees of flexion from full extension, 60 degrees of radioulnar deviation and 140 degrees of rotation. The movements of the wrist are synchronized by small amount of movements in the intercarpal joints. The radiocarpal joint is a modified ellipsoid joint where its centre of rotation lies in the head of capitate for flexion- extension and abduction- adduction movements.

Abduction is restricted by the distal protrusion of radial styloid process and it occurs entirely at midcarpal joint where adduction occurs entirely on radio carpal joint. For functional use of wrist joint it needs atleast 40 degrees of both flexion and extension and combined 40 degrees of forearm supination and pronation.

CARPAL KINEMATICS

Proximal row carpal bones scaphoid, lunate and triquetrum acts as an intercalated segment as it has no tendinous insertions and inherently unstable. However during wrist dorsiflexion and palmar flexion, each carpal row makes same amplitude and same direction of angulation. But in radioulnar deviation, the proximal row alone makes a secondary angulation in the sagittal plane synchronously to the wrist motions in coronal plane. This is explained by the arrangement and contour of the proximal row requiring extensive excursion of the wrist joint for maintaining stability around a longitudinal axis .This is explained as Variable geometry of proximal row.

Scaphoid acts as a connecting strut and flexion movement of scaphoid synchronously is balanced by extension of triquetrum. When scapholunate ligament is injured, it results in flexion of scaphoid and extension of lunate and triquetrum called as DISI (Dorsal Intercalated Segmental Instability) and injury to lunotriquetral ligament causes the opposite called VISI (Volar Intercalated Segmental Instability).

THEORIES OF CARPAL KINEMATICS[43]

'*ROW THEORY' BY JOHNTSON (1907)*

Carpal bones arranged in two rows acts as rigid functional units producing two transversely made up joints (radiocarpal and midcarpal).

'COLUMN THEORY' BY NAVARRO (1935)

He divided carpal bones into three independent longitudinal columns

1) Lateral column composed of scaphoid, trapezium and trapezoid and transmits axial load across wrist.
2) Central column comprises lunate, capitate and hamate assisting wrist flexion from full extension.
3) Medial or rotational column is made up of triquetrum and its volar attached pisiform bone controlling pronation and supination.

'TWO COLUMN THEORY' BY WEBER (1980)

He divided capitate, trapezoid, scaphoid and lunate as load bearing column and triquetrum and hamate as control column.

'RING THEORY' OF LICHTMAN ET AL. (1981)

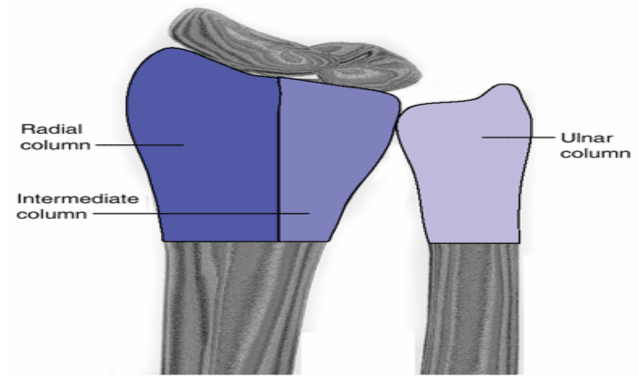
The distal row carpus, scaphoid, lunate and triquetrum functions as four interdependent segment and are arranged in a oval ring connected by ligamentous links.

Craigen and Stanley proposed that radioulnar deviation occurs in two patterns of rotation exhibited by proximal carpal row along the frontal plane (row pattern) or along the sagittal plane (column pattern).

THREE COLUMN CONCEPT OF DISTAL RADIUS FRACTURES

This three column concept proposed by Rikli and Regazzonni divides distal radius and ulna into three distinct columns namely

1) Lateral or radial column composing scaphoid facet of radius acting like osseous buttress for the carpus.
2) Intermediate column comprising lunate facet further divided into dorsal and volar lunate facets for load transmission.
3)
4) Medial column equates ulnar styloid and TFCC contributing axis of wrist rotation.



Our study aims to maintain near normal anatomical alignment of scaphoid facet, lunate facet and sigmoid notch of DRUJ by either dynamic external fixator or by volar locking compression plate.

"DART THROWER'S PLANE" OF MOTION

Almost all the skilled routine functions of the hand are accomplished with synchronous repetitive motion of wrist either in radial deviation with dorsiflexion of the wrist or by ulnar deviation with palmar flexion of the wrist. This is described as "dart thrower"s plane of motion.

DISTAL RADIUS FRACTURES-MANAGEMENT

EPIDEMIOLOGY

Almost 16% of fractures that we encounter in orthopaedic casualty are distal radius fractures among which 50% are considered as unstable fractures. It has bimodal distribution[1] more common in post menopausal women as insufficiency fractures as they are associated with osteopenia[46].

Another group is the young active population following high velocity trauma like sports injuries or motor vehicle collisions.

MECHANISM OF INJURY;

The level of injury is actually decided by the bone strength, magnitude and direction of the force of impact and position of the wrist when contact to the ground. A fall on the outstretched hand with pronated forearm and with wrist in 40-90 degrees of dorsiflexion at ground contact can cause distal radius fracture with dorsal displacement. Distal radius first fails in tension causing fracture in the palmar cortex, followed by compression on the dorsal cortex causing comminution. The associated fractures of ulnar styloid indicate load transmitted along the intact TFCC.

Fractures of distal radius with volar displacement claimed by Smith are explained due to fall with flexed hand and dorsum of wrist touching the ground. Smith fractures may also occur in fall on outstretched extended hand or a fall with forearm in supination. A strong compressive force from ground reaction can exert on the lunate to cause die-punch fracture of distal radius with splitting of intermediate lunate facet into dorsal and volar fragments.

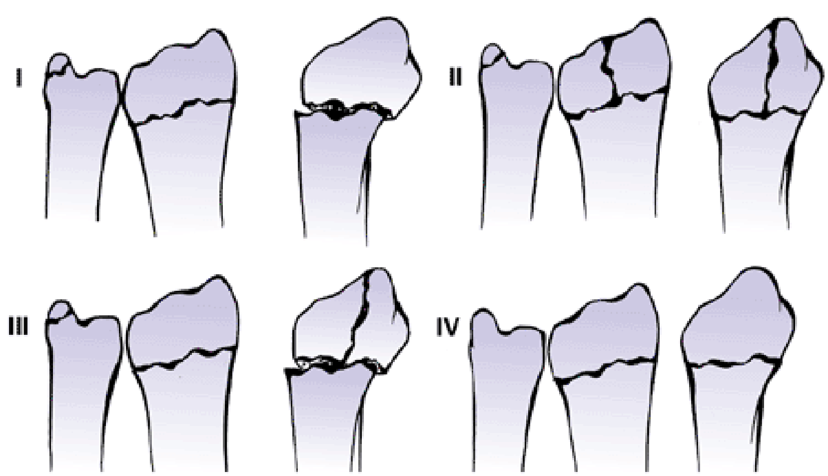
Radius styloid fractures resulted from avulsion force exerted by the palmar extrinsic ligaments .Various ligamentous disruptions are also associated with this types of injuries.

CLASSIFICATION OF DISTAL RADIUS FRACTURE

Since fractures of distal radius have so many eponyms like Colle's, Barton's, Smith's, Reverse Barton's, Chauffer's, Pouteau's to avoid confusion and to do decision making for specific treatment option, classification systems have been established[1]. Though more than 20 exhaustive classification systems had been published, only a few classification systems withstood decade of years and been used by the orthopaedic surgeons for better understanding of distal radius fractures.

GARTLAND AND WERLEY CLASSIFICATION

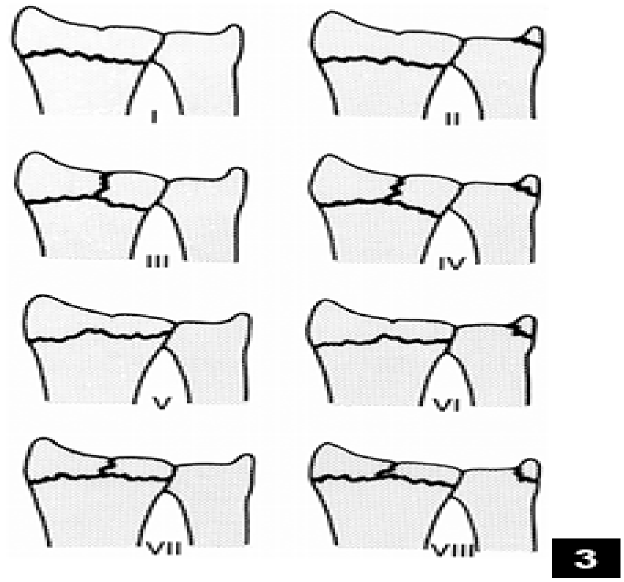
Gartland and Werley proposed the first clinically useful outcome classification system which emphasised on three basic properties a) comminution of cortex, b) intraarticular involvement and c) displacement and collapse of fragements[23].



- Group I - Simple Colle's fractures without articular extension
- Group II - Comminuted Colle's fracture involving articular surfaces but without any displacement
- Group III - Comminuted Colle's fracture with complete collapse involving joint surfaces and displacement
- Group IV - Extraarticular, undisplaced fractures

FRYKMANN CLASSIFICATION

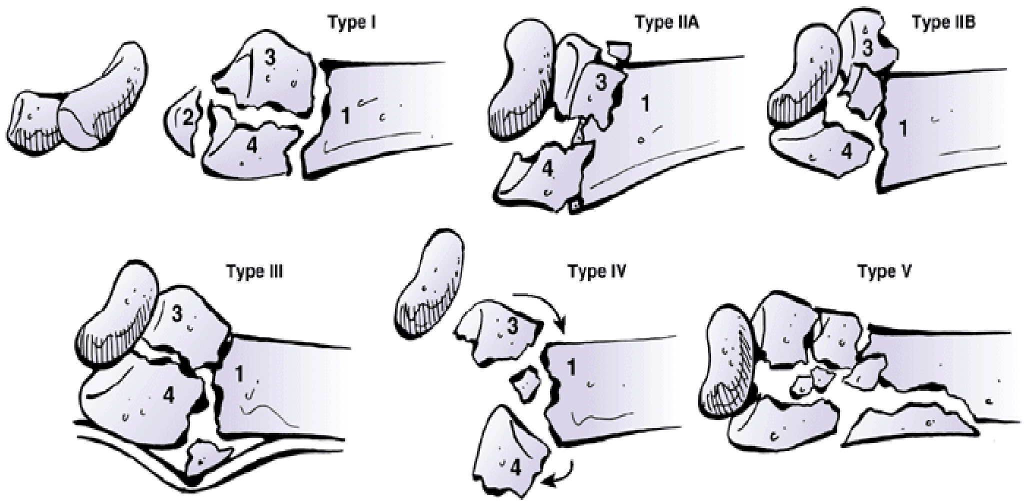
Frykmann in 1967[26] published a simple and useful classification system followed by most orthopaedicians based on the involvement of radiocarpal and radioulnar joint associated with or without ulnar styloid fractures.



- Type I - Extraarticular fracture
- Type II - Extraarticular fracture plus ulnar styloid fracture
- Type III - Radio carpal articular involvement
- Type IV - Radiocarpal involvement plus ulna styloid fracture
- Type V - Radioulnar involvement
- Type VI - Radioulnar involvement plus ulnar styloid fracture
- Type VII - Radioulnar and Radiocarpal involvement
- Type VIII - Radioulnar and radiocarpal involvement plus ulnar styloid fracture

MELONE'S CLASSIFICATION

Melone[29] announced a classification system comprising five types based on the effect of lunate impaction causing characteristically four fracture fragments- Radial shaft, Radial styloid, Palmar medial and Dorsal medial.



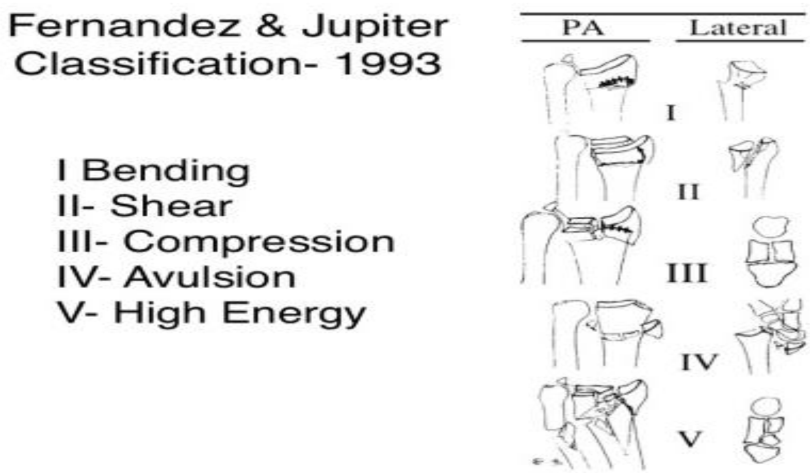
- Type I - Stable undisplaced fractures with radial styloid and palmar and dorsal lunate facets
- Type II - Unstable "die punch"fractures wuth comminution of volar and dorsal cortices and displacement of lunate facets

  Type IIA - Reducible

  Type IIB - Irreducible (central impaction fractures)
- Type III - "Spike" fractures with articular incongruity with proximal spike displacement
- Type IV - "Split"fractures, unstable medial complex, comminuted with collapse and or rotation of individual fragments
- Type V - Explosion injury

FERNANDEZ CLASSIFICATION

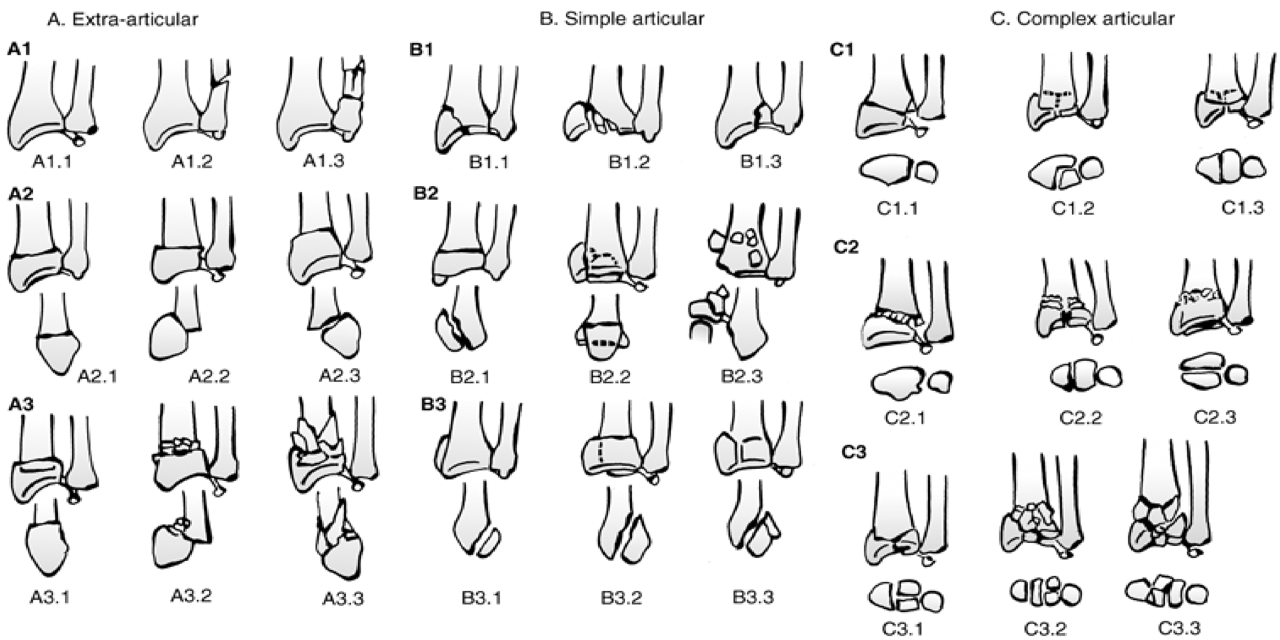
In 1993, Fernandez[31] classified distal radius fractures based on the mechanism of injury and force acting and also explaining the ligamentous disruptions.



- Type I - Metaphyseal bending fractures resembling extraarticular Colle's or Smith's fracture with resultant loss of palmar tilt and radial length.
- Type II - Shearing forces cause intraarticular fractures requiring buttressing for the articular segment
- Type III - Direct compression forces causing intraarticular fractures without characteristic fragmentation and causing significant interosseous ligament injury.
- Type IV - Avulsion fractures of ligamentous attachments or associated radiocarpal fracture dislocations.
- Type V - Multiple forces on high velocity causing fractures with extensive collapse.

AO CLASSIFICATION

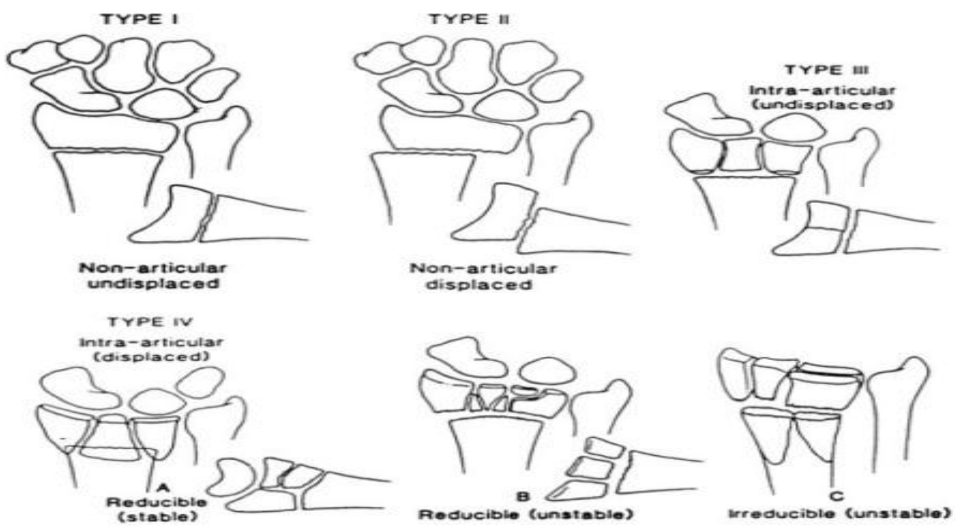
Muller[30] and his associates proposed AO (Arbeitgemein schaftfur Osteosynthesefragen) classification addressing the complexity of fracture fragments comminution and direction of fracture lines. This is composed of 27 subgroups.



- Type A - Extraarticular fractures –subgroups are based upon angulation and comminution .
- Type B - Partial articular fractures. Subgroups are based upon radial styloid, palmar or dorsal fragments.
- Type C - Complete articular fractures. Subgroups are based on the articular comminution and incongruity.

UNIVERSAL CLASSIFICATION OF DISTAL RADIUS FRACTURES

A modern treatment- based classification proposed by Cooney et al[47,48] in 1990 based on the classification systems of Gartland and Werley and of Sarmiento, considering the principles of treating intraarticular versus extraarticular fractures and stable versus unstable fractures.



- Type I - Extraarticular, undisplaced fractures
- Type II - Extraarticular displaced fractures

  II A- Reducible, stable

  II B- Reducible, unstable

  II C- Irreducible
- Type III- Intraarticular, non displaced fractures
- Type IV- Intraarticular, displaced fractures

IV A - Reducible,stable

IV B - Reducible,unstable

IV C - Irreducible

IV D - Complete

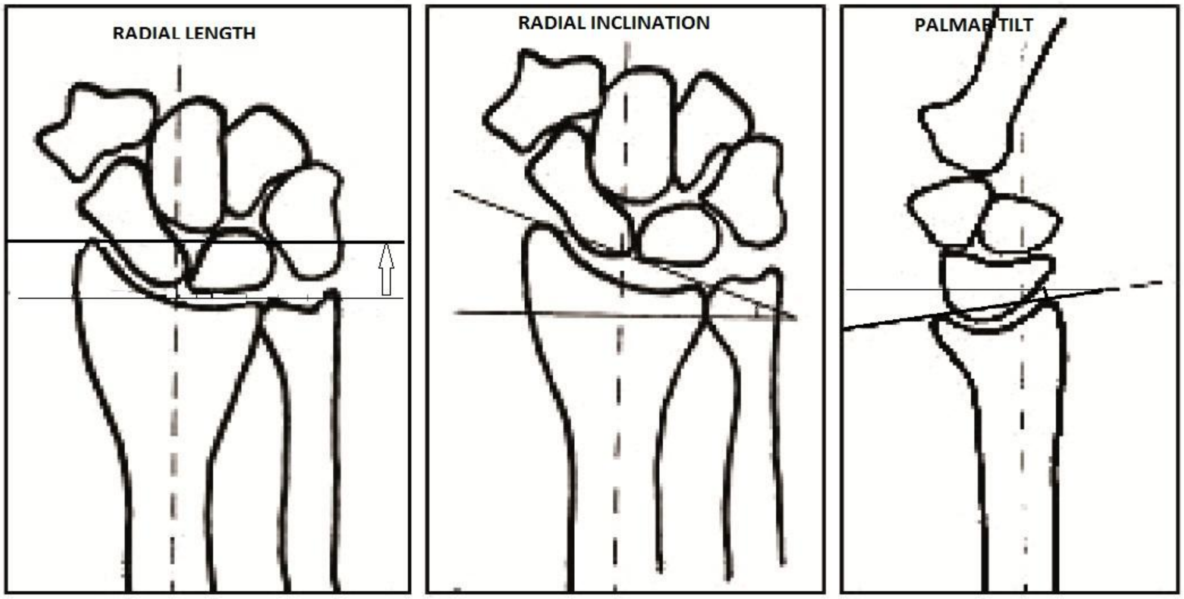
RADIOGRAPHIC EVALUATION

The goal of treatment in unstable distal radius fractures is to provide a pain free functional wrist and hand without the propensity of any future osteoarthritis and to permit the patient of all age groups to enjoy all type of vocational activities. To achieve this, certain radiological features should be kept in mind and assessed before and after treatment.

In emergency department, we routinely take PA and Lateral X ray views. The standard posterior-anterior view of the wrist is taken with elbow flexed 90 degree and shoulder abducted 90 degree with the forearm and wrist in neutral position.

The true lateral view of the wrist is obtained with elbow flexed 90 degree to the trunk with forearm and wrist in neutral position whilst X ray beam enters radially and exits ulnarly and perpendicular to the distal pole of the scaphoid[49].

Sometimes oblique or tangential views of wrist are needed not as a routine but during C-Arm guidance in surgery to visualise articular surface for any distal screws breach while doing plate osteosynthesis.



1: RADIAL LENGTH OR RADIAL HEIGHT:

It is the distance between two parallel lines both being perpendicular to the long axis of radius, one line through the tip of radial styloid and other line through the distal most part of ulnar head. The normal average is 11-12 mm[50,51].

2: RADIAL INCLINATION OR RADIAL TILT:

It is the angle between two lines drawn in PA radiograph, one line perpendicular to the long axis of radius and the other line between tip of radial styloid and the distal fragment inclination radially and normal range is 13-30 degree average being 22 degrees.

3: ULNAR VARIANCE:

It should not be confused with radial length as it the vertical distance between two parallel lines in PA radiograph, both perpendicular to the long axis of radius, one line through the distal point of ulnar head and the other through the distal point of medial end of radial articular surface. Average is 0-1 mm. Positive ulnar variance of even 2 mm will result in symptomatic loss of strength as studied by McQueen[52].

4: VOLAR TILT OR PALMAR TILT:

It is derived from the lateral radiograph and shows the volar inclination of distal fragment by the angle between one line perpendicular to the long axis of radius and the other line connecting dorsal and volar rims of distal radius articular surface. Normal range 0 – 28 degrees average being 11 degrees.

Acceptable level in these radiological parameters for healed radius fracture are

1) Radial length - Within 2-3 mm of the contralateral wrist
2) Palmar tilt - Neutral tilt (0 degree)
3) Intraarticular step off - < 2 mm
4) Radial angle - < 5 degrees loss
5) Carpal malalignment - Absent.

DISTAL RADIUS FRACTURES-TREATMENT OPTIONS

There are various treatment options available either in single or in combination and its decision making depends upon fractures pattern, comminution, displacement, age of the patient, quality of the bone, functional demand and associated co-morbid conditions.

Nana et al. and Graham recommended some guidelines for reduction of distal radius fractures[53, 54].

- Radial shortening <5 mm at distal radio ulnar joint
- Radial inclination on PA radiograph >15 degrees
- Sagital tilt on lateral view between 15 degree dorsal tilt and 20 degree volar tilt
- Intra articular step off or gap <2 mm of both radiocarpal and radioulnar joint.

I: CAST IMMOBILISATION

It is considered in non displaced extraarticular fractures with stable anatomy and also in low demand patients or those who have significant comorbid illness. This is immobilisation by short arm or long arm cast for 6 -8 weeks and after that a removable splint for another 3 weeks. Patients are instructed to perform active assist range of movement exercises to prevent stiffness. X rays should be taken weekly to asses fracture healing.

Malunion, secondary loss of reduction, stiffness, reflex sympathetic dystrophy, residual deformity are the potential complications possible in cast treatment[55].

II: CLOSED REDUCTION AND PERCUTANEOUS PINNING

In young patients with stable injury, due to good quality of bone reduction can be achieved easily by closed manipulation which can be maintained by percutaneous K-wire fixation. The use of Kapandji intra focal pinning is limited to simple extraarticular fractures.

ADVANTAGES

- Simple ,cost effective, time consuming
- Augments the stability of reduction
- Allows when used as joy sticks for reconstructing the near anatomical alignment.

DISADVANTAGES

- Need for an additional immobilisation
- Pin tract infection, pin loosening and migration
- Secondary collapse of fracture
- Injury to neurovascular structures

III: EXTERNAL FIXATION

The disadvantage of secondary displacement of the above two procedures can be overcome by the external fixation based on the principle of ligamentotaxis. Since it neutralizes compressive, torsional and bending forces it can be applied for unstable, severely comminuted fractures. Supplementary procedures like K wire fixation, bone grafting can be done to increase stability and improve healing respectively. Complications possible are pin tract infection, loosening, stiffness, radial sensory nerve injury and reflex sympathetic dystrophy.

There are various modes of external fixation of wrist- bridging or non-bridging, static or dynamic .Nowadays Dynamic bridging external fixators are commonly used in practice to minimise the above said complications. Dynamic fixator allows early mobilisation of wrist joint.

Kirschner wire augmentation technique is an important supplementary procedure which increases the stability of the construct by holding the fracture fragment and buttressing the subchondral bone. It increases the stability equivalent to 3.5 mm dorsal AO plate application[56,57]. It helps in avoiding over distraction and also reduces secondary collapse of intraarticular fractures due to relaxation of ligamentotaxis after some time allowing external fixator to act as a neutralisation device.

IV: OPEN REDUCTION AND INTERNAL FIXATION: DORSAL AND VOLAR PLATING

Both dorsal and volar plating favours direct visualisation of the fracture, direct reduction of multiple fragments, direct or indirect buttressing of fragments, reconstruction of the exact anatomy, rigid internal fixation, allowing early mobilisation, reduced hospital stay and earlier return to function[58].

The possible complications and disadvantages[59] are

- Hardware irritation
- Tendonitis
- Tendon rupture
- Attrition of flexor pollicis longus tendon
- Median nerve neuritis or injury
- Carpal tunnel syndrome
- Reflex sympathetic dystrophy
- Infection of the wound
- Keloid formation
- Technically demanding
- Invasive procedure
- Intraarticular screw penetration

- Collapse of reduction
- Late post operative arthritis
- Screw backout
- Additional surgery to remove the symptomatic implant

Eventhough dorsal plating has several theoretical advantages like- avoiding neurovascular structures on the palmar side, fixation on the compression side of most type of fractures, direct buttress against collapse, elevation of depressed central lunate fragment and subarticular bone grafting, hardware complications like extensor tendon irritation, tendonitis, tendon rupture, are common in dorsal plating compared to volar plating. Many surgeons are interested in the volar approach of distal radiuis because it minimizes the prominent hardware complications because pronator quadratus well pads the plate and avoids contact of the plate with flexor tendons. Also screw back out, loss of reduction and intraarticular screw migration are common in conventional plates rather than locking plates and screws. Further locking screws act as an indirect buttress in holding the dorsally comminuted fragments.

THREE TYPES OF VOLAR APPROACHES:

1) HENRY'S APPROACH:

It is through the plane between radial artery and brachioradialis which is the most lateral approach helpful to fix radial styloid fragment and also in full pronation, it may helpful to visualize the dorsal side of distal radius and facilitate subarticular grafting.

2) MODIFIED HENRY'S APPROACH (AO APPROACH)

Most useful approach for distal radius fractures carried through the plane between flexor carpi radialis and radial artery. Here the incision is ulnar to the radial artery but in Henry's approach it is radial to the radial artery. The risk in Modified Henry's approach is injuring the palmar cutaneous branch of median nerve and radial artery.

3) ELLIS APPROACH (EXTENDED CARPAL TUNNEL APPROACH):

This is the classical approach interested by many surgeons and it is preferred when majority of comminution is at the central lunate facet and when there is a need to expose the median nerve and DRUJ. Skin incision is centered over the ulnar border of the Palmaris longus tendon, the flexor tendons are mobilized radially and the ulnar neurovascular bundle retracted ulnarly.

Our study is to compare the two most commonly practised techniques for displaced intraarticular, unstable distal radius fractures- Dynamic external fixator with or without augmentation and volar locking compression plate osteosynthesis and to study the fracture healing pattern both radiologically and functionally and to address the complications in each procedure.

V: RECENT ADVANCES IN DISTAL RADIUS FRACTURE MANAGEMENT

1. *FRAGMENT SPECIFIC INTERNAL FIXATION*

By minimal dorsal and volar exposure[1,60] , specific fracture fragments are reduced and fixed with mini-fixation plates or contoured pins. Some basic tenets in this system are[61]

a) Application of small pre-contoured plates on the specific geometry of fragments.
b) Stability of the distal fragment based on the strong bone proximally
c) Hardware should have gliding properties
d) Fixation should allow early range of movements
e) Not suitable for unstable complex fractures

2. INTRAMEDULLARY FIXATION

The load sharing and load transferring properties of intramedullary devices offer great stability in extra articular fractures minimises soft tissues problems and maintain vascular supply of the fracture site and promote healing.Difficulties faced in this technique are

a) Placement of interlocking screws
b) Screw penetration into the distal radioulnar joint
c) Difficulty in observing sagittal alignment as obscured by the jig
d) Difficulty in maintaining initial reduction.

3. ARTHROSCOPICALLY ASSISTED FIXATION

Monitoring joint surfaces and percutaneous closed reduction pinning of distal radius fracture with wrist arthroscopy is a minimally invasive technically advanced procedure[62]. But it demands a steep learning curve associated with any arthroscopy procedure.

MATERIALS AND METHODS

This comparative study was conducted in the “Department of Orthopaedic Surgery” Govt. Kilpauk Medical College Hospital from March 2012 to December 2013. Ethical committee approval was obtained. Patients with intraarticular distal radius fractures were randomly classified into two groups based on certain demographic criteria, one group was treated with the application of double ball joint external fixator with or without K-wire augmentation and the other group treated with fixed angle locking compression plate through volar approach.

INCLUSION CRITERIA

1) Patients in the age group >18 years
2) Patients with distal radius fractures with intraarticular extension following road traffic accident or slip or fall on outstretched hand or assault
3) Closed fractures
4) Comminuted fractures with or without bone loss

EXCLUSION CRITERIA

1) Open fractures
2) Patients with head injuries and who are comatose
3) Associated ulnar diaphyseal fractures or carpal bone fractures
4) Associated neurovascular injuries

PREOPERATIVE EVALUATION AND CARE

About 47 patients with distal radius intraarticular fractures were treated, among which 5 patients had lost follow up and only 42 patients are included in the study. All of them were skeletally matured, came with pain, swelling, deformity and inability to use the wrist joint following injury. True posteroanterior and true lateral radiographs were taken. Distal radius fractures were classified according to Frykmann's classification and AO classification and managed initially in the casualty with closed reduction and Dorsoradial short arm POP under hematoma block.

Then patients were evaluated with chest X ray, ECG, complete hemogram, RFT, Random blood sugar, Blood grouping & typing required for anaesthetic fitness for surgery. Most of the patients were posted for surgery with 1-5 days in elective operation theatre. Distal neurovascularity, adjacent joint movements, skin condition and other co-morbid conditions and associated injuries were already assessed.

ANAESTHESIA

Among 47patients, 24 patients were treated with dynamic external fixator and 23 patients were treated with volar locking compression plate, all of them were given pre operative test dose of anaesthetic drugs and antibiotics. Among 47 patients, 32 patients were given supraclavicular block, 9 patients were given combined supraclavicular and axillary block and six patients were given General anaesthesia.

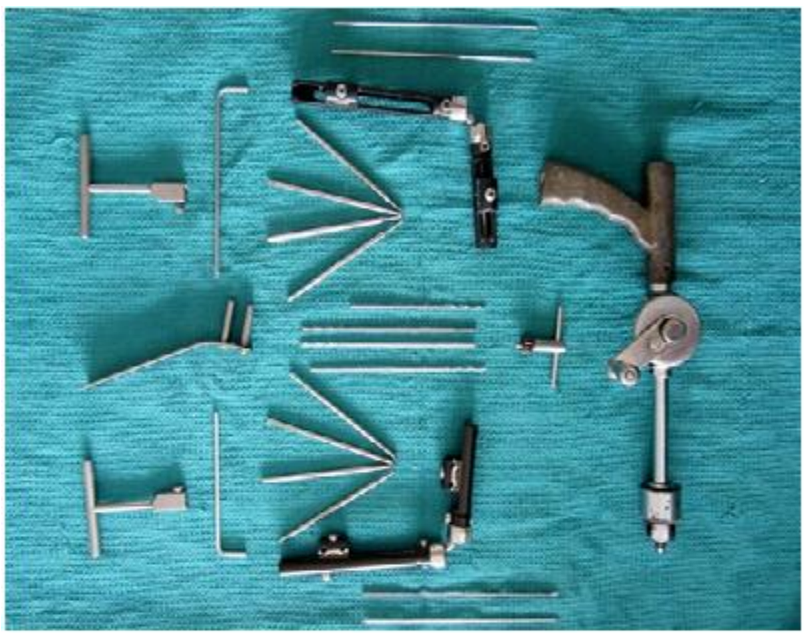
SURGICAL PROCEDURE FOR DYNAMIC EXTERNAL FIXATOR APPLICATION:

The limb to be operated was cleanly shaven and painted with betadine from hand to axilla and kept on the hand table. After draping, wrist was placed in neutral position with small folded towel under the ulnar crease of wrist for support. The fixator pins were inserted by open technique both in second metacarpal and radius. Preliminary reduction with closed manipulation and traction attempted and traction maintained with an assistant.

Radial pins were inserted about 4 cm proximal to the fracture end by a 2.5 cm small incision made on the true lateral side of radius diaphysis. Blunt dissecton was done upto bone to avoid injury to the superficial branch of radial nerve and extensor tendons. Two 3.5 mm schantz pins were inserted after predrilling with 2.7mm drill bit and by using jig and template. Bicortical insertion of schantz pins confirmed with image intensifier.

Similarly metacarpal pins were inserted at the radial side of second metacarpal base and distal shaft using 2.0 mm drill bit and 2.5 mm schantz pins with a small incision.

Then the double ball joint external fixator with all the locks open was applied into the schantz pins on both the radius and metacarpal using clamps and they were tightened using T-wrench or Allen wrench.



REDUCTION TECHNIQUE

After preliminary reduction which maintains radial length, it is crucial to ensure the position of distal ball and socket joint at the capitolunate junction which is the centre of rotation of the wrist joint. The priniciple of multiplanar ligmentotaxis is achieved by the palmar translation of the carpal bones at the level of unlocked proximal ball joint to restore the normal palmar tilt. After verifying the fracture site and joint congruity under image intensifier final tightening of all the clamps done. Over distraction was avoided by checking the flexion of the fingers passively. Thorough wound wash given and wound closed in layers. Sterile dressing done.

SUPPLEMENTARY TECHNIQUES

- *LIMITED OPEN REDUCTION*

  Through a 2-3 cm dorsal incision, the depressed lunate facet was elevated with a small osteotome and buttressed subchondrally with K-wire.

- *K WIRE FIXATION*

  1.5/1.8 mm K- wires passing through the subchondral bone to buttress and to hold the fracture fragments is highly recommended in comminuted fractures.

- *DRUJ STABILISATION*

  In DRUJ instability, one or two K-wires inserted transversely from radius to ulna in supination to stabilise it.

- *BONE GRAFTING*

  Cancellous bone or pegs from ipsilateral olecranon or iliac crest to fill the void of elevated lunate facet and comminution can be done.

POSTOPERATIVE PROTOCOL

Patients were advised for gentle active finger movements and limb elevation for 3 days. Distal neurovascularity assessed regularly, intravenous antibiotics given for 3 days and then converted to oral antibiotics till suture removal. Patients discharged on 2- 5th postoperative day and suture removal done on 11th post operative day. Advised about weekly visit, pin site cleaning and care and physiotherapy. .During each visit, pin site care, loosening of the clamps or pins, fracture healing were checked.

Once the fracture was sticky usually at the end of 2nd week and patient become symptom free, dynamisation was started by loosening the distal ball joint using Allen wrench, which allows an arc of motion of about 50 degree of flexion and extension. Dynamisation can be postponed to 3 -4 weeks in highly comminuted fractures. Supplementary K-wires were removed at 3 weeks.

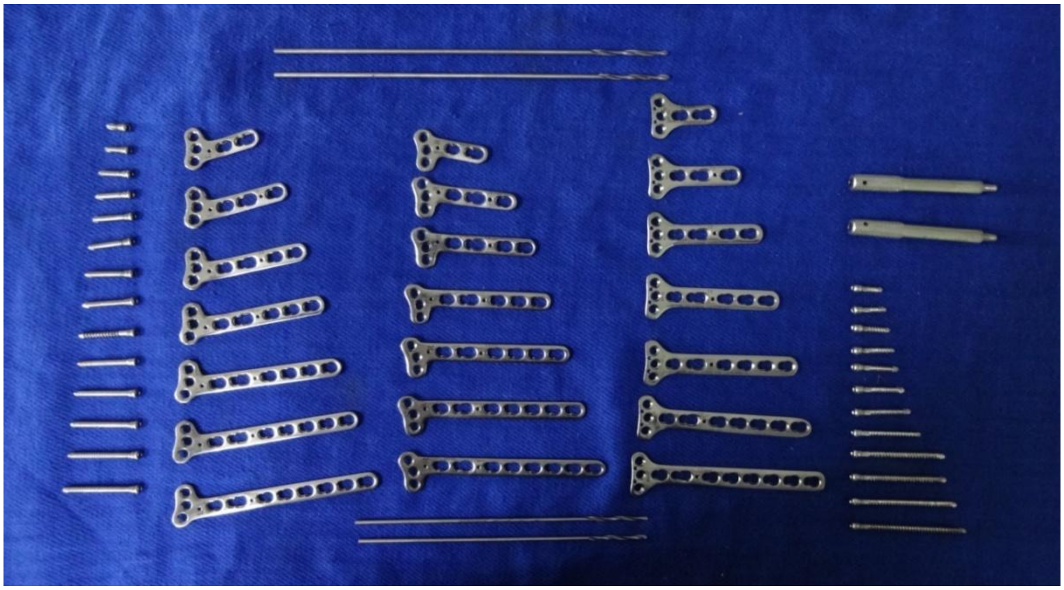
External fixator was removed at 6-8 weeks after clinically and radiographically assessing the fracture healing. Follow up X rays were taken at recommended hospital visits on immediate post operative 6 weeks, 3 months, 6 months and 12 months interval.

SURGICAL PROCEDURE FOR VOLAR LOCKING COMPRESSION PLATE: THROUGH MODIFIED HENRY'S (AO) APPROACH:

Preoperative preparation of the patient was the same like for external fixation and posted in elective operation theatre. Patient's wrist was placed on the hand table and after painting with betadene and draping, wrist was placed supine and neutral, a 5cm skin incision was made starting just distal to the proximal wrist crease and medial to the radial artery pulsation, incision deepened dy dividing the deep fascia.

Flexor carpi radialis was retracted ulnarwards and radial artery with brachioradialis retracted radially exposing the pronator quadratus. Care should be taken not to injure the sensory branch of median nerve and radial artery. The wrist is pronated and pronator quadratus was divided and elevated from the radial side of radius exposing the distal radius fracture.

The fracture was then reduced by direct visualization of the fragments. The central lunate fragment which plays a key role in load transmission if found depressed should be elevated with a small osteotome and subarticular cancellous or peg bone grafting can be done if needed.



Then the locking compression plate was placed on the smooth curved volar surface of distal radius and after correcting its placement just proximal to the imaginary watershed line (2mm from the radicarpal joint surface), the plate is temporarily stabilized with a K wire or a unicortical screw in the sliding hole of the shaft. True AP, lateral views were taken under C-arm image intensifier and any fine adjustments if needed can possibly be done on the plate, so that the screws were aimed to be placed 2mm below joint line and should not penetrate into the articular area. The distal screws were put which should be 2mm short from the dorsal cortex so that the screws would not irritate the extensor tendons. Finally AP, lateral and oblique views should be taken to check the fracture reduction and distal screw penetration. After thorough wound wash and achieving hemostasis, wound closed in layers and sterile bandage applied.

THROUGH ELLIS APPROACH:

In this approach, the skin incision is centered over the ulnar border of Palmaris longus tendon and after dividing the deep fascia, medial retraction of Palmaris longus and lateral retraction of flexor carpi radialis reveals the median nerve entry into the carpal tunnel. In this approach pronator quadratus was released from ulna after supination to expose the distal radioulnar joint, sigmoid notch and lunate facet fragments. The median nerve could be decompressed by division of the flexor retinaculum proximally. The reduction and plating techniques were similar to the other volar approach.

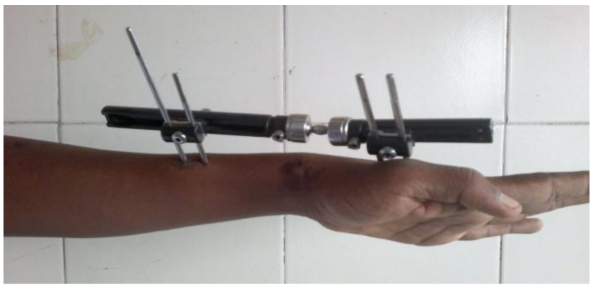
POST OPERATIVE CARE AND REHABILITATION:

Patients were encouraged limb elevation and active finger mobilization exercises in immediate post op period. Distal neurovascularity was assessed regularly and intravenous antibiotics were given for 3 days and after that changed to oral antibiotics till suture removal. Post operatively the wrist was immobilized in a short arm POP for 10-12 days. Suture removal was done for all the cases between 10 to 12 days from post op. After suture removal the slab was removed and gentle active wrist mobilization exercises were started. Resisted exercises were started about 6 weeks after surgery. Patients were recommended for follow up at 6 weeks, 3 months, 6 months and 12 months interval and routine xrays were taken to assess the fracture healing.

IMAGES OF SURGICAL STEPS IN DYNAMIC EXTERNAL FIXATOR:

Position of wrist in hand table

Insertion of Radius and Metecarpal half pins



Atfer application of Dynamic External fixator

IMAGES OF SURGICAL STEPS IN VOLAR LOCKING COMPRESSION PLATE:

Skin incision in volar approach

Exposure of the median nerve and its Palmar cutaneous branch

Application of Volar locking plate

OBSERVATION AND ANALYSIS

TABLE 1: AGE DISTRIBUTION

In our study the average age in Ex Fix group is 41.29 years ranging from 23 to 72 years and the average age in LCP group is 43.05 years ranging from 20 to 70 years. The maximum number of cases in 31 to 40 years of both groups.

AGE	MALE		FEMALE		TOTAL NO. OF CASES	
	EX FIX	LCP	EX FIX	LCP	EXFIX	LCP
20-30	4	3	1	1	5	4
31-40	5	4	2	3	7	7
41-50	3	2	1	3	4	5
51-60	1	2	2	1	3	3
61-70	1	1	0	1	1	2
71-80	0	0	1	0	1	0
TOTAL	**14**	**12**	**7**	**9**	**21**	**21**

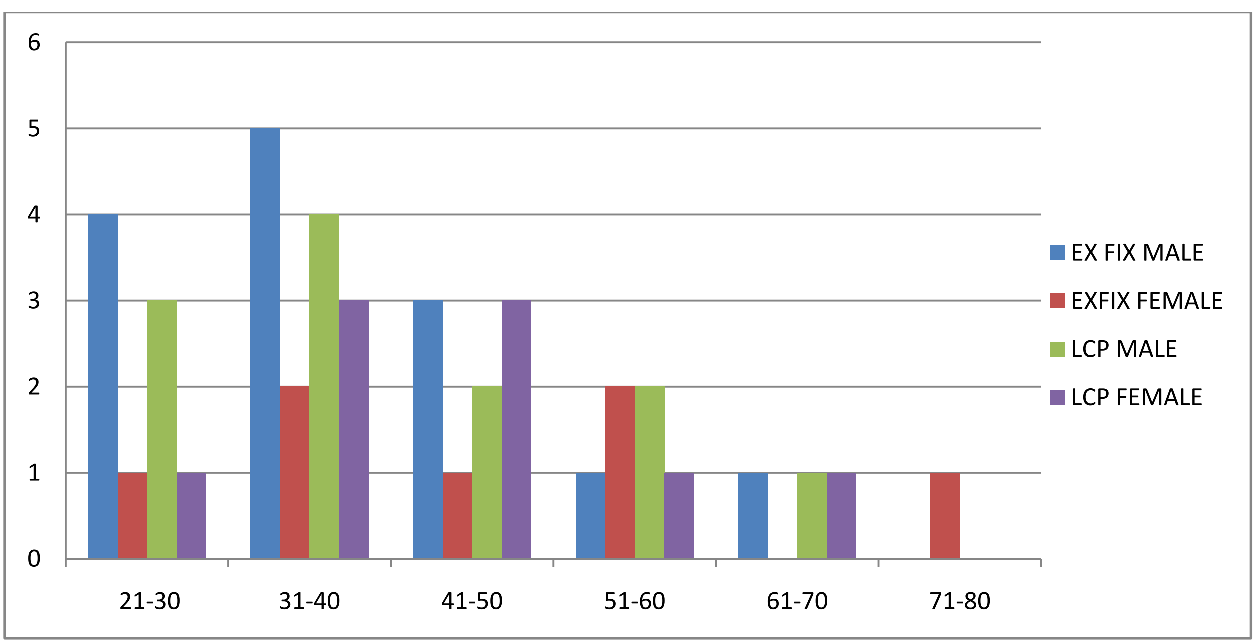
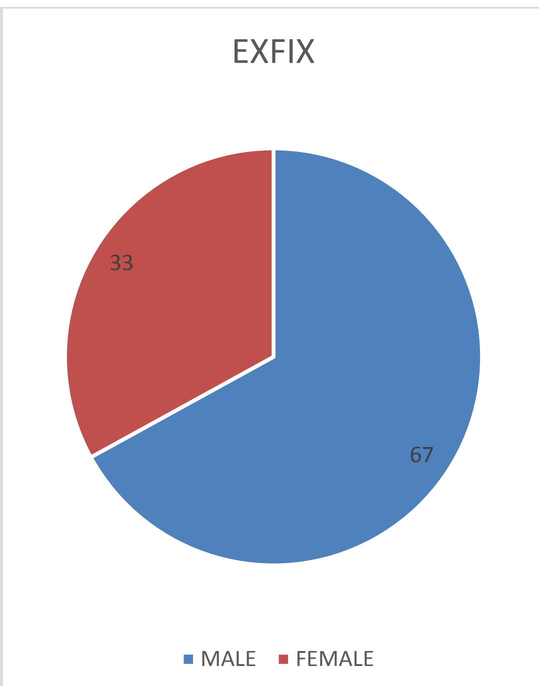


TABLE: 2: SEX DISTRIBUTION

The male: female ratio in Ex Fix group is 2:1 and the ratio in LCP group is 4:3.

SEX	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
MALE	14	12	67	57
FEMALE	7	9	33	43
TOTAL	**21**	**21**	**100**	**100**



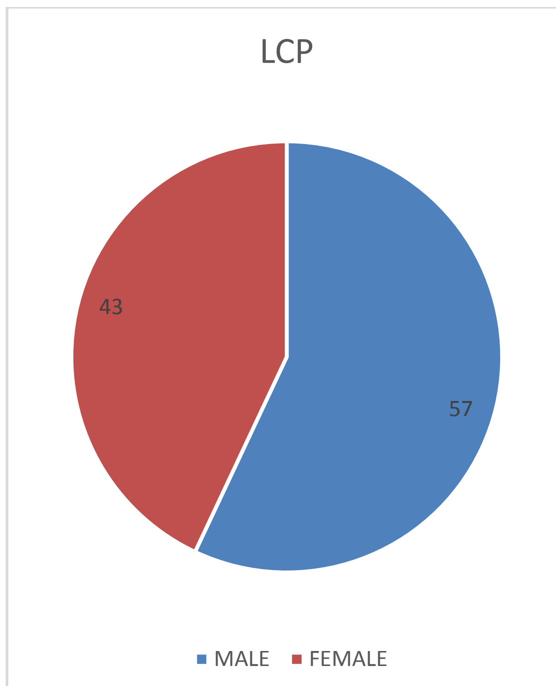
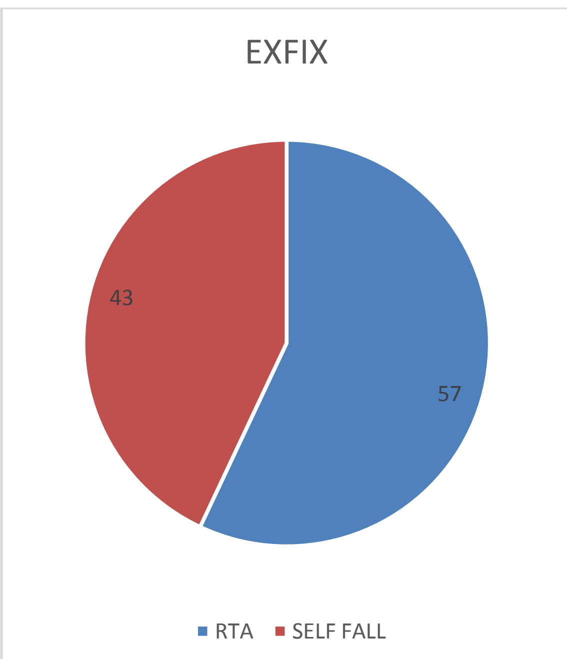


TABLE: 3: MODE OF INJURY

MODE OF INJURY	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
RTA	12	10	57	48
SELF FALL	9	11	43	52
TOTAL	**21**	**21**	**100**	**100**



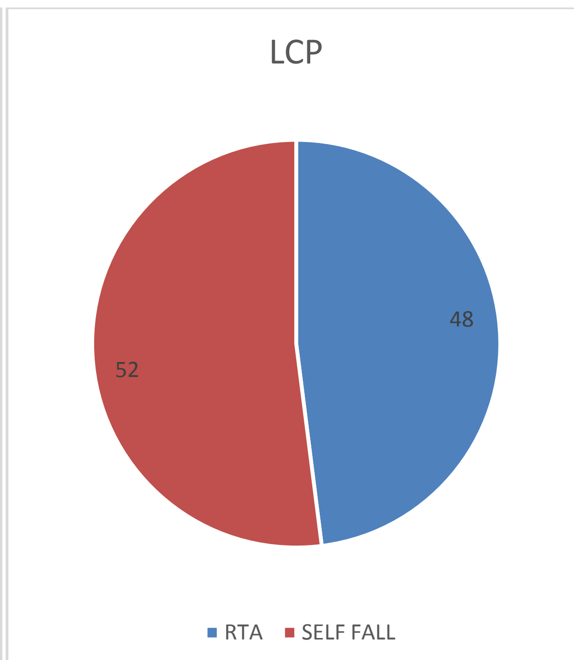
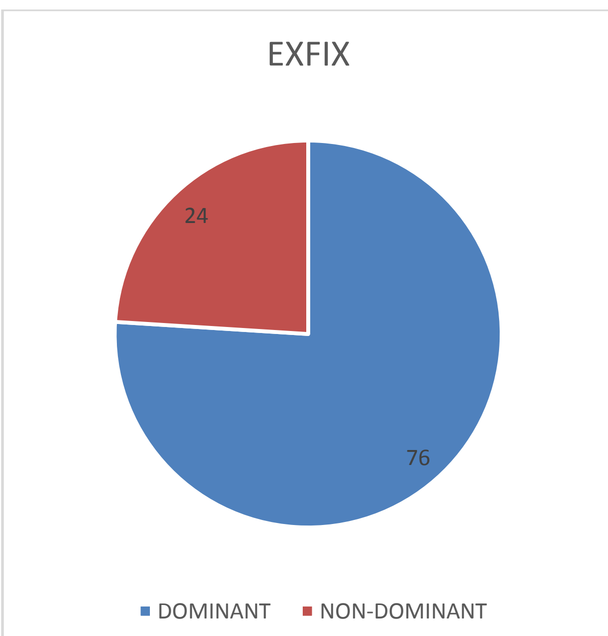


TABLE: 4: DOMINANT VS NON-DOMINANT LIMB

EXTREMITY	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
DOMINANT	16	14	76	67
NON DOMINANT	5	7	24	33
TOTAL	**21**	**21**	**100**	**100**



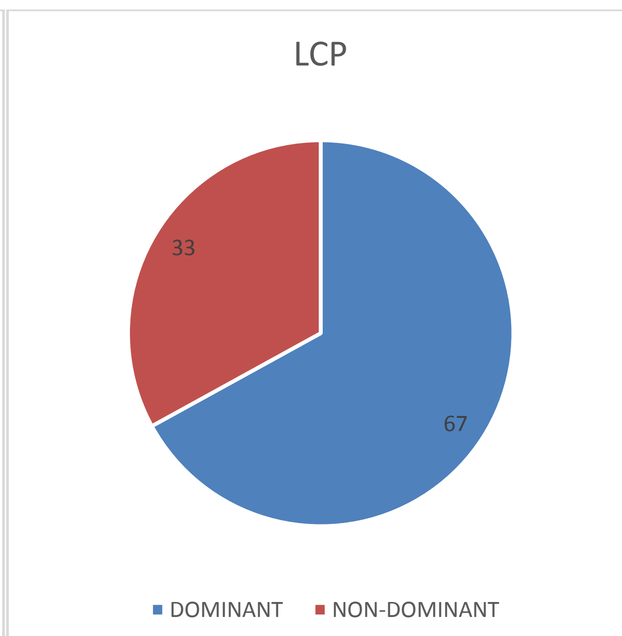


TABLE:5: CO MORBID CONDITIONS

Out of 21 cases treated with dynamic external fixator, 8 cases had associated medical illness- 4 cases had Diabetes mellitus, 3 cases had DM with hypertension and one case had isolated hypertension.

Out of 21 cases treated with volar locking compression plate, 5 cases had co morbid illness like DM in 3 patients and systemic hypertension in 1 person and seizure disorder in 1 patient.

Co morbid Illness	No. of cases		Percentage	
	Ex fix	LCP	Ex fix	LCP
Yes	8	5	38%	24%
No	13	16	62%	76%
Total	21	21	100%	100%

TABLE: 6: ASSOCIATED FRACTURES

Out of 21 cases treated with dynamic external fixator, 4 patients had other fractures also- 2 cases had intertrochanteric femur fracture, 1 case had fracture middle 3^{rd} of clavicle and one case had fracture surgical neck of ipsilateral humerus.

Out of 21 cases treated with volar locked plating, 3 cases had other fractures – one patient had intertrochanteric femoral fracture, one case had fracture calcaneum and one case had fracture clavicle.

Asso. Fracture	**No. of cases**		**Percentage**	
	Ex fix	**LCP**	**Ex fix**	**LCP**
Yes	4	3	19%	14%
No	17	18	81%	86%
Total	21	21	100%	100%

DYNAMISATION IN EX FIX GROUP PATIENTS:

Dynamisation of wrist joint by loosening the distal ball joint of external fixator was started after a mean period of 2.72 ± 0.46 weeks. Only in 4 cases we started dynamisation at the 3 rd week, in all other cases it was started at the end of 2nd week.

EX FIX REMOVAL:

Fixator removal was done after an average period of 6.57 weeks. For 11 patients we have done fixator removal at 6th week, for 6 patients done at 7th week, for 4 cases done after 8th week.

MOBILISATION OF WRIST IN LCP GROUP PATIENTS:

Out of 21 cases, 14 cases were applied loose short arm splint till suture removal. All cases suture removal done on 11th or 12th post operative day.

Gentle active wrist mobilization was started in an average of 3.27 weeks. For 9 cases, wrist mobilization was started only after 4 weeks interval. Active range of movement exercises were started at an average of 6.91 weeks.

Only for 2 cases in locked volar plating technique, we did implant removal because those patients complained of pain on movements of wrist joint.

TABLE: 7: FRYKMANN CLASSIFICATION

Since only intra-articular fractures were taken for study, we categorized fractures from type III to VIII under Frykmann's classification. We have no cases in type V.

FRYKMANN TYPE	**NO. OF CASES**		**PERCENTAGE**	
	EXFIX	**LCP**	**EXFIX**	**LCP**
III	3	5	14	24
IV	1	1	5	5
V	0	0	0	0
VI	2	1	10	5
VII	8	7	38	33
VIII	7	7	33	33
TOTAL	**21**	**21**	**100**	**100**

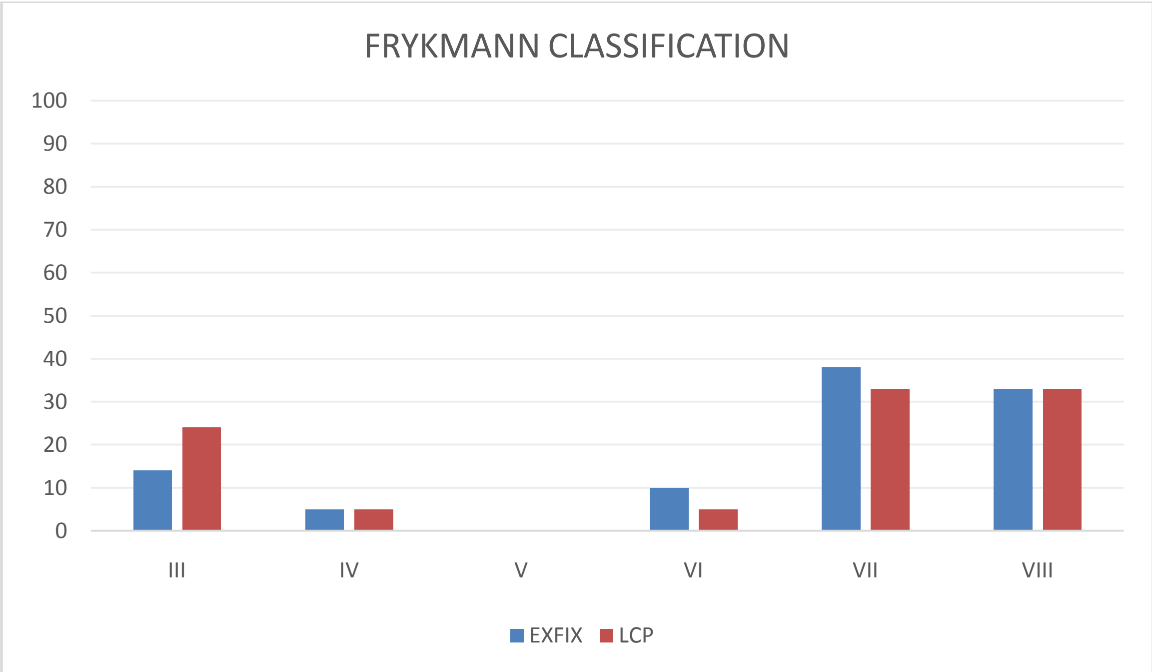


TABLE: 8: AO CLASSIFICATION

All the cases taken in our study had intra-articular extension with complete articular type of AO classification.

AO TYPE	**NO. OF CASES**		**PERCENTAGE**	
	EXFIX	**LCP**	**EXFIX**	**LCP**
C1	6	7	28	33
C2	10	11	48	52
C3	5	3	24	15
TOTAL	**21**	**21**	**100**	**100**

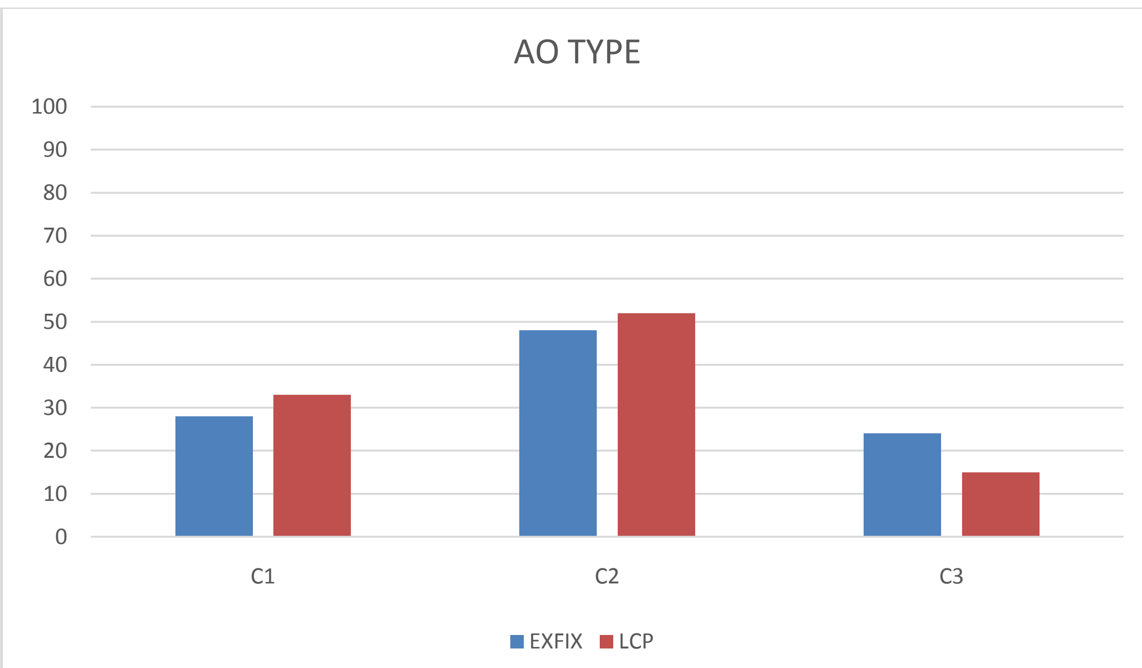


TABLE: 9: SUPPLEMENTARY TECHNIQUES IN EXTERNAL FIXATION

Supplementary techniques are more enthusiastically done in external fixation procedure rather than open reduction and internal fixation for fracture stabilization and healing. In volar locking plate technique, out of 21 cases, 5 cases need bone grafting from ipsilateral olecranon process. The supplementary procedures used in Dynamic external fixator are given below.

TECHNIQUE	NO. OF CASES IN EXFIX PROCEDURE
K WIRE	13
MINIMAL OPEN REDUCTION	2
BONE GRAFTING	2
DRUJ STABILISATION	6

SUPPLEMENTARY TECHNIQUES IN DYNAMIC EXTERNAL FIXATOR

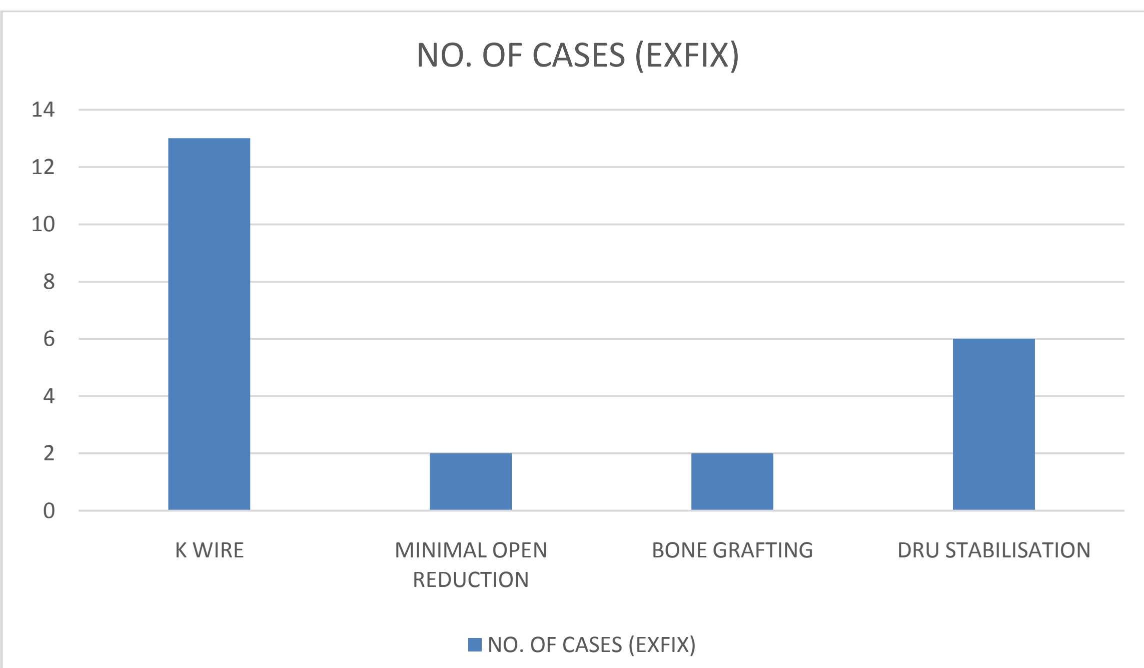


TABLE: 10: PAIN

CHARACTER	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
NO PAIN	3	7	14	33
MILD	12	9	57	43
MODERATE	5	3	24	14
SEVERE	1	1	5	10
TOTAL	**21**	**21**	**100**	**100**

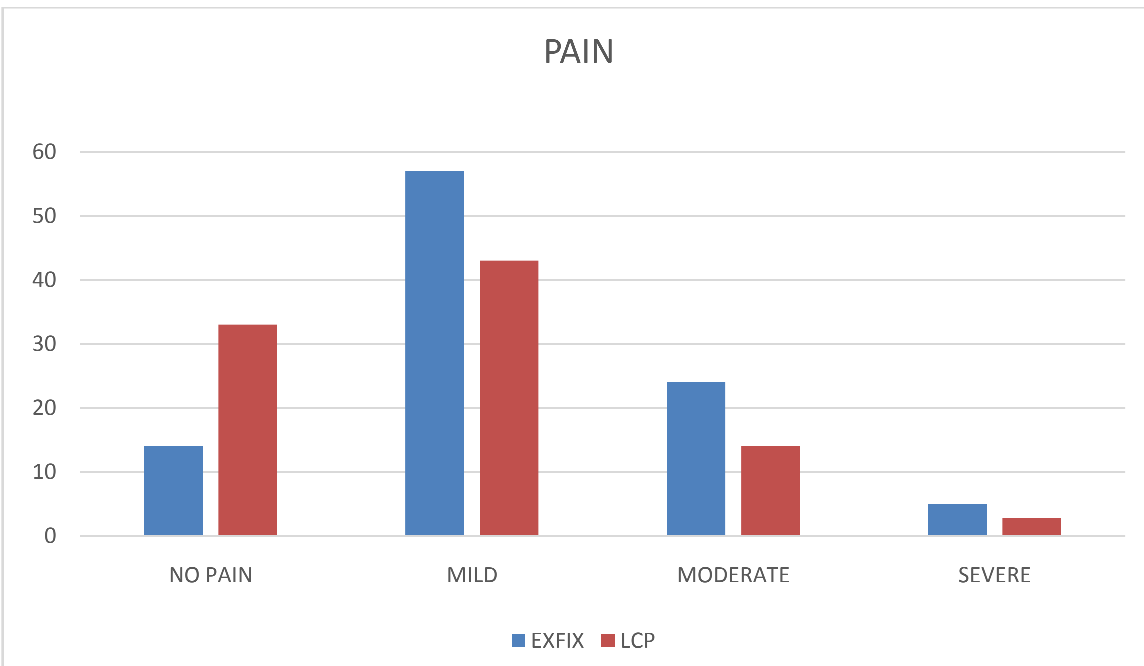


TABLE:11 :RANGE OF MOVEMENTS

The movement of the wrist joint- flexion, extension, radial deviation, ulnar deviation, pronation and supination were evaluated using Goniometer and calculated in degrees and compared with normal side of the wrist. The normal ranges of movements of the wrist joint in various planes were already said in the literature.

% OF ROM COMPARED TO OPPOSITE SIDE	**NO. OF CASES**		**PERCENTAGE**	
	EXFIX	**LCP**	**EXFIX**	**LCP**
100%	8	11	38	52
75-99%	10	7	47	33
50-74%	2	1	10	5
0-49%	1	2	5	10
TOTAL	**21**	**21**	**100**	**100**

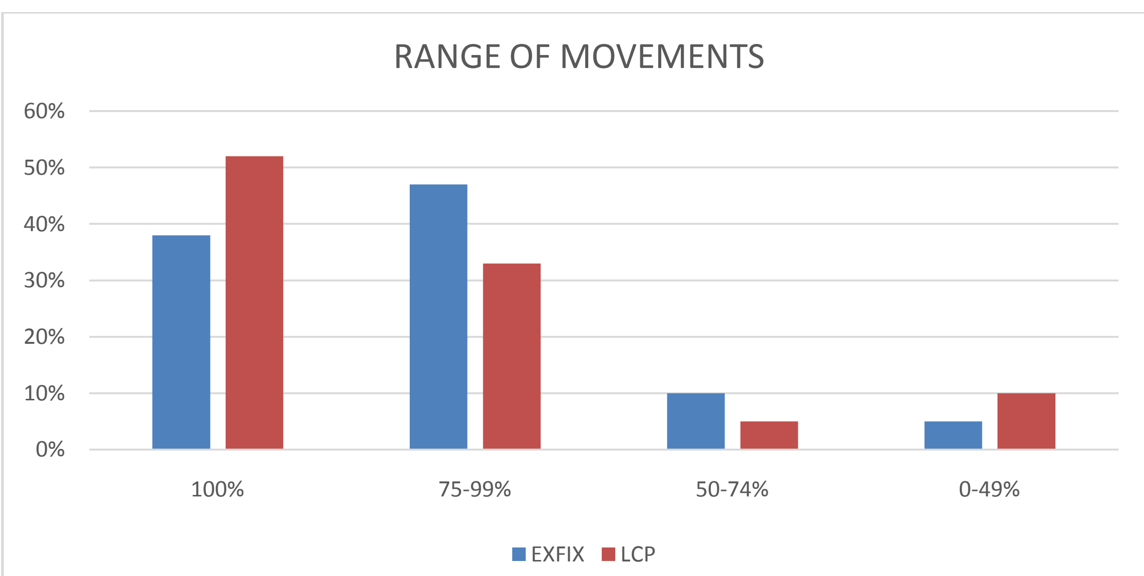


TABLE: 12: GRIP STRENGTH

Grip strength is assessed using hand dynamometer and compared with the opposite side and calculated as percentage.

% OF OPPOSITE SIDE GRIP STRENGTH	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
100%	4	7	19	33
75-99%	8	9	38	43
50-74%	9	4	43	19
0-49%	NIL	1	0	5
TOTAL	**21**	**21**	**100**	**100**

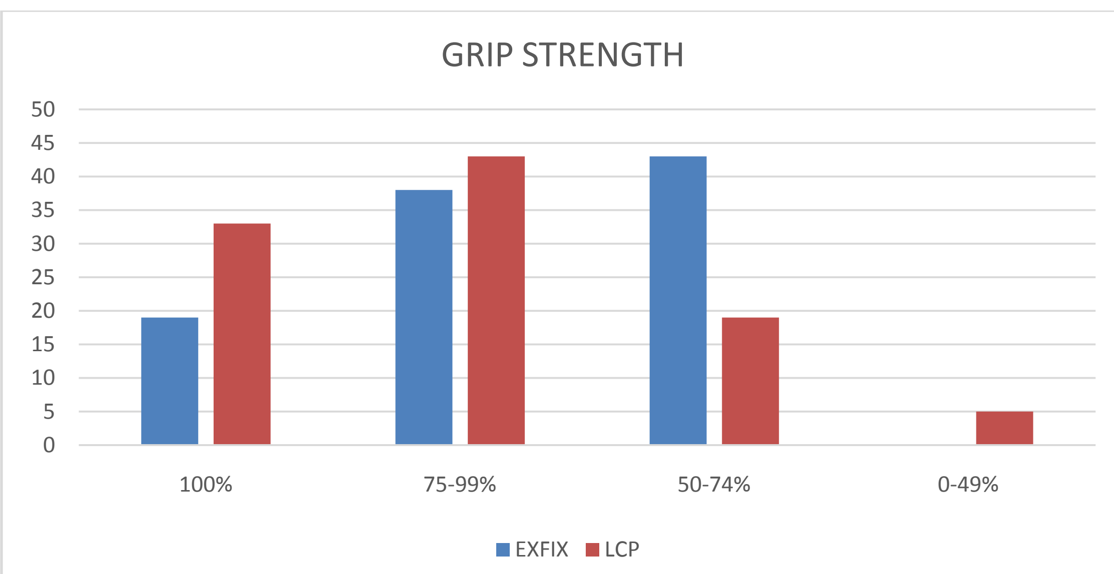


TABLE: 13 : RETURN TO WORK

	EXFIX	LCP	EXFIX	LCP
REGULAR WORK	14	18	67	86
RESTRICTED WORK	4	2	19	9
ABLE TO WORK UNEMPLOYED	3	1	14	5
UNABLE TO WORK DUE TO PAIN	NIL	NIL	0	0
TOTAL	**21**	**21**	**100**	**100**

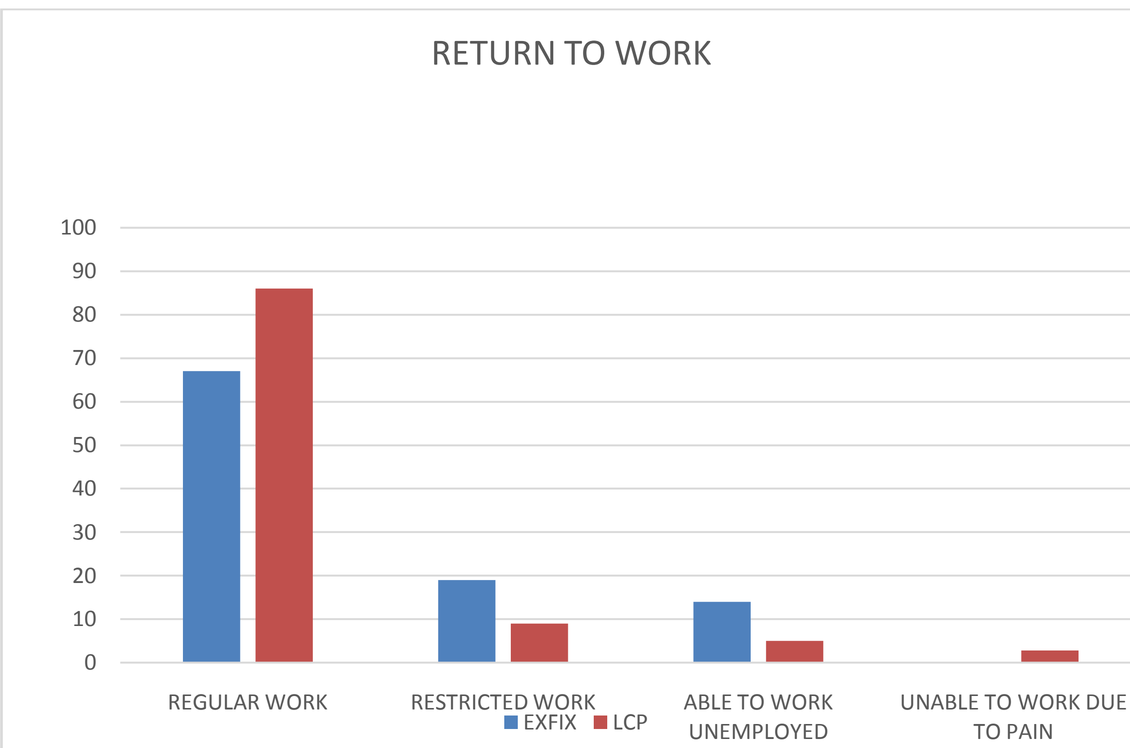


TABLE: 14: FUNCTIONAL EVALUATION

The functional outcome of wrist in both procedures were assessed using Green and O'Brien functional scoring chart which was modified by Cooney et al and tabulated as follows,

GRADING	NO.OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
EXCELLENT	7	10	33	48
GOOD	6	6	29	29
FAIR	6	4	28	18
POOR	2	1	10	5
TOTAL	**21**	**21**	**100**	**100**

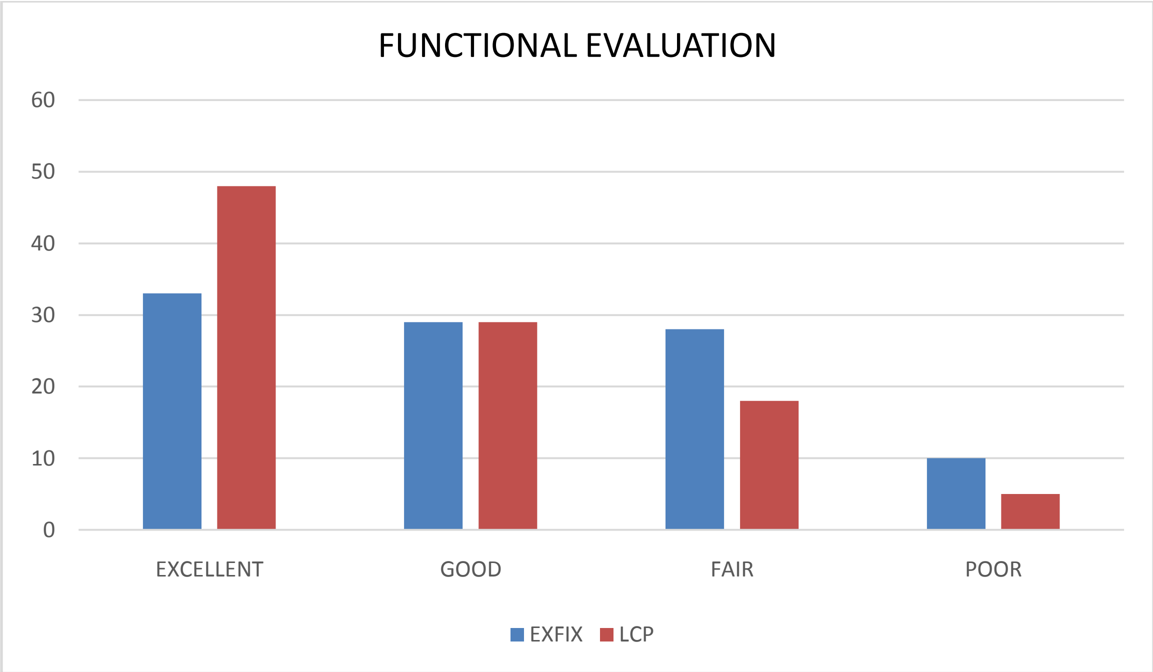
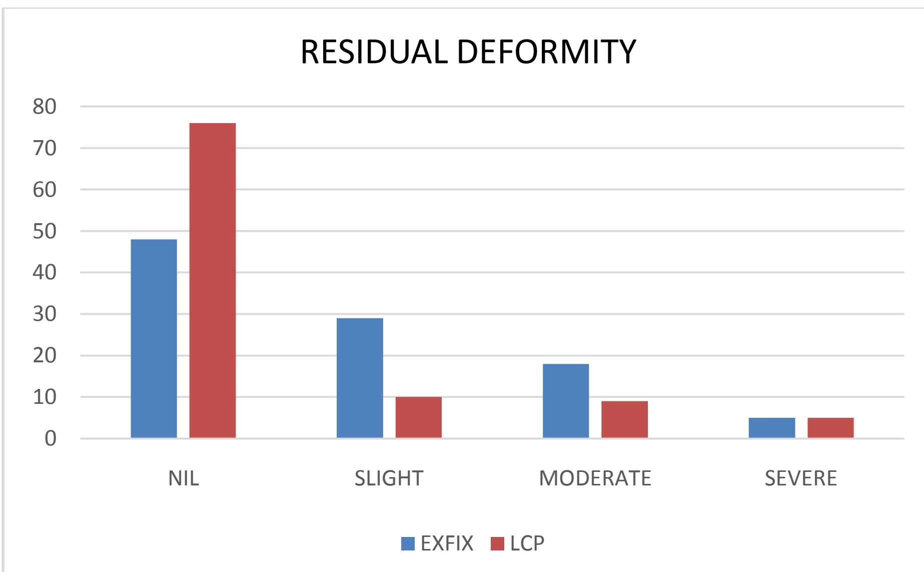


TABLE: 15: RESIDUAL DEFORMITY

DEFORMITY	NO. OF CASES		PERCENTAGE	
	EXFIX	LCP	EXFIX	LCP
NIL	10	16	48	76
SLIGHT	6	2	29	10
MODERATE	4	2	18	9
SEVERE	1	1	5	5
TOTAL	**21**	**21**	**100**	**100**



ANATOMICAL EVALUATION

TABLE:16: RADIOLOGICAL EVALUATION – INDEPENDENT SAMPLE T TEST

After comparison of both the groups, volar locking plate shows statistical significant result in certain parameters like Volar tilt, Radial inclination and Intra articular step off.

RADIOLOGICAL PARAMETERS	TECHNIQUE	PRE OP	POST OP	6 MONTH FOLLOW UP	NORMAL SIDE
I.RADIAL LENGTH(MM)	EX FIX	1.24±3.96	9.29±2.10	8.19±1.96	10.86±0.79
	LCP	3.38±2.31	9.57±1.21	9.10±1.62 (**p value=0.11**)	11.24±0.89
II.VOLAR TILT(DEGREES)	EX FIX	-13.9±7.39	7.00±7.54	5.81±6.65	10.86±0.85
	LCP	-10.0±8.78	10.0±1.05	9.29±1.82 (**p value=0.03**)	11.2±0.98
III.RADIAL INCLINATION(DEGREES)	EX FIX	8.00±4.90	18.7±4.15	16.0±4.04	21.9±0.86
	LCP	7.05±4.32	19.6±2.65	18.5±3.40 (**p value=0.03**)	22.1±1.09
IV.ULNAR VARIANCE(MM)	EX FIX	1.57±1.78	-0.14±1.24	-0.19±0.93	-1.19±0.60
	LCP	1.52±0.81	-0.52±0.68	-0.48±0.75 (**p value=0.28**)	-1.14±0.57
V.INTRA ARTICULAR STEP(MM)	EX FIX	2.67±0.91	1.38±0.80	1.14±0.79	
	LCP	1.95±0.97	0.52±0.60	0.57±0.75 (**p value=0.02**)	

TABLE:17: FUNCTIONAL OUTCOME-GREEN AND O'BRIEN SCORE(MODIFIED BY COONEY ET AL)

			Group		Total	P value
			Dynamic External Fixator	Volar Locking Compression Plate		
Functional Outcome	Poor	Count	3	3	6	0.568
		% within Functional Outcome	50.0%	50.0%	100.0%	
		% within Group	14.3%	14.3%	14.3%	
	Fair	Count	8	6	14	
		% within Functional Outcome	57.1%	42.9%	100.0%	
		% within Group	38.1%	28.6%	33.3%	
	Good	Count	6	4	10	
		% within Functional Outcome	60.0%	40.0%	100.0%	
		% within Group	28.6%	19.0%	23.8%	
	Excellent	Count	4	8	12	
		% within Functional Outcome	33.3%	66.7%	100.0%	
		% within Group	19.0%	38.1%	28.6%	
Total		Count	21	21	42	
		% within Functional Outcome	50.0%	50.0%	100.0%	
		% within Group	100.0%	100.0%	100.0%	

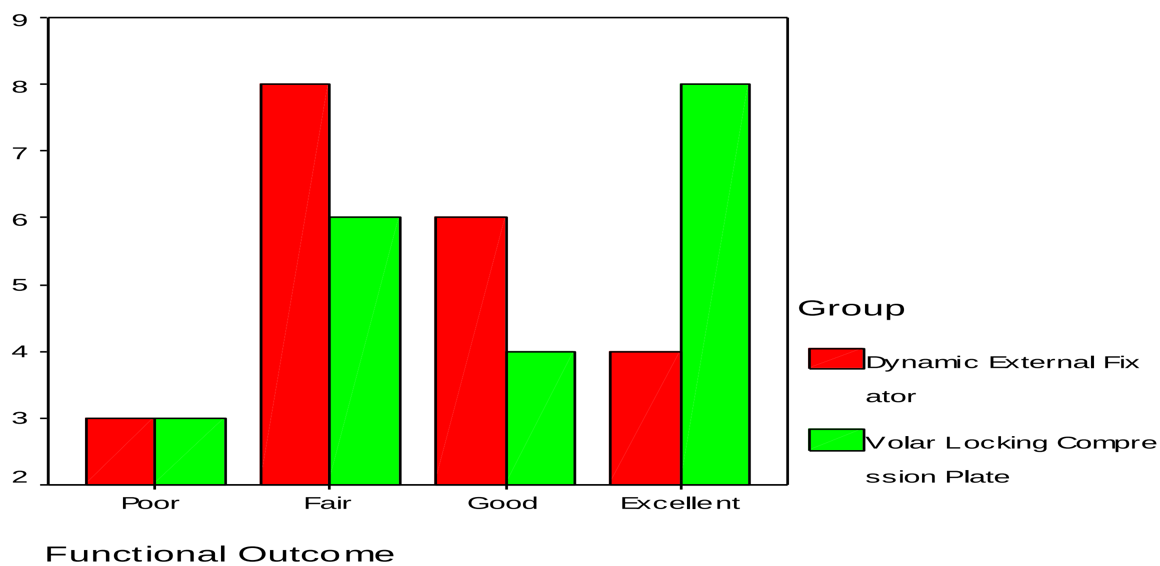
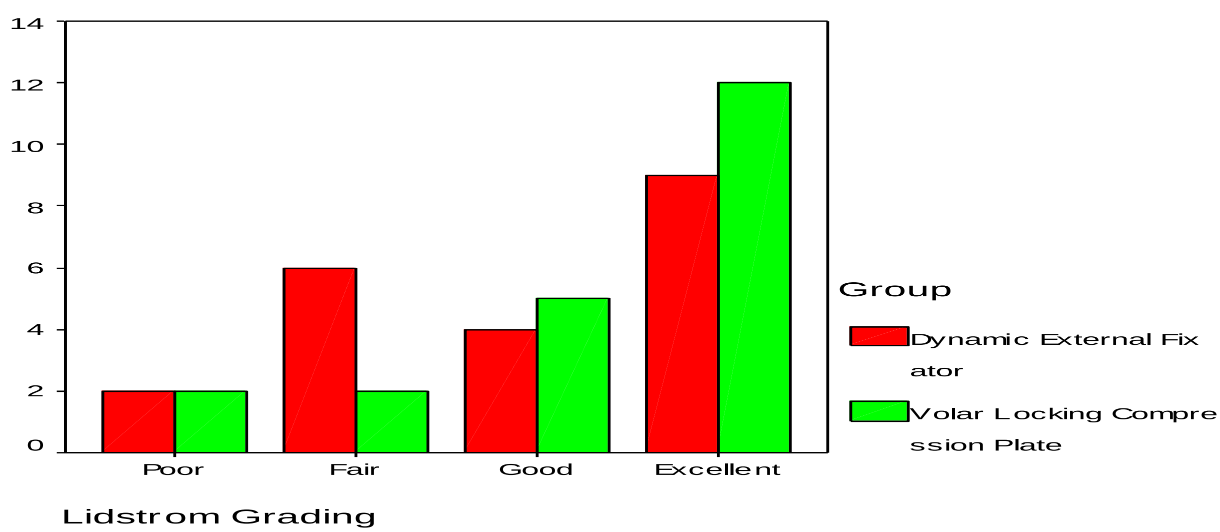


TABLE:18: ANATOMICAL OUTCOME-LIDSTROM GRADING

			Group		Total	P value
			Dynamic External Fixator	Volar Locking Compression Plate		
Lidstrom Grading	Poor	Count	2	2	4	0.468
		% within Lidstrom Grading	50.0%	50.0%	100.0%	
		% within Group	9.5%	9.5%	9.5%	
	Fair	Count	6	2	8	
		% within Lidstrom Grading	75.0%	25.0%	100.0%	
		% within Group	28.6%	9.5%	19.0%	
	Good	Count	4	5	9	
		% within Lidstrom Grading	44.4%	55.6%	100.0%	
		% within Group	19.0%	23.8%	21.4%	
	Excellent	Count	9	12	21	
		% within Lidstrom Grading	42.9%	57.1%	100.0%	
		% within Group	42.9%	57.1%	50.0%	
Total		Count	21	21	42	
		% within Lidstrom Grading	50.0%	50.0%	100.0%	
		% within Group	100.0%	100.0%	100.0%	



RESULTS

In our comparative study about 47 patients were treated for intra articular distal radius fractures, among which 24 patients were treated with double ball and socket joint type of external fixator and 23 patients, were treated with volar locking compression plate and they were designated as Ex fix group and LCP group respectively. Out of which 3 patients from Ex fix group and 2 patients from LCP group had lost follow up. Hence 21 patients with dynamic external fixator and 21 patients with volar locking plate were considered for the analysis.

Average follow up among Ex fix group was done for 12.84 months with maximum follow up for 17 months and minimum follow up for 6 months and average follow up among LCP group was 11.26 months with maximum follow up for 16 months and minimum follow up for 6 months. There were 14 cases with more than 12 months follow up and 7 cases with less than 12 months follow up in Ex fix group, similarly there were 13 cases with more than 12 months follow up and 8 cases with less than 12 month follow up in LCP group.

We had analysed the functional outcome as per Green and O'Brien scoring system modified by Cooney et. al and anatomical outcome by Lidstrom grading system and the results were tabulated below.

GRADE	FUNCTIONAL OUTCOME		ANATOMICAL OUTCOME	
	Ex fix	**LCP**	**Ex fix**	**LCP**
Excellent	19%(n=4)	38%(n=8)	42%(n=9)	57%(n=12)
Good	29%(n=6)	19%(n=4)	19%(n=4)	23%(n=5)
Fair	38%(n=8)	29%(n=6)	29%(n=6)	10%(n=2)
Poor	14%(n=3)	14%(n=3)	10%(n=2)	10%(n=2)

In our study among Ex fix group, 3 patients had superficial pin tract infection, one patient had deep infection, one had malunion and one had pin bending complications. Among LCP group one had screw penetration into joint space and one had secondary collapse of the fracture.

We have done the statistical comparison between the outcomes of dynamic external fixator and volar locking compression plate and level of significance is determined by p value <0.05. Using Pearson Chi square test for functional outcome, p value comes as 0.568 and using Independent sample T test for anatomical outcome p value comes as 0.468. Both were considered statistically insignificant.

DISCUSSION

In our comparative study we have compared the functional and anatomical outcome of dynamic external fixator with or without supplementary techniques and volar locking compression plate in the treatment of comminuted intraarticular fractures of the distal radius. We have randomly classified the patients with distal radius fractures into two groups considering the demographic characters in equal distribution into Ex fix group and LCP group and analysed the results.

Marco Rizzo et al[63]. in his retrospective study compared the outcomes of open reduction and internal fixation with locked volar plating with closed reduction and bridging external fixation and percutaneous K wire fixation of unstable distal fractures. The demographic characters were almost similar to our study but in his study, for Ex fix group he started wrist mobilization after fixator removal on an average of 6 weeks post op, but in our study we used the double ball and socket joint type external fixator for allowing the wrist a 50 degrees arc of motion after 3 weeks. But the range of movement and strengthening exercises were started after 6 weeks in both the studies. Unfortunately, most of the studies are comparing the bridging external fixator where the dynamisation started after 6 weeks with the volar locking compression plate for unstable distal radius fractures.

In Marco Rizzo et al. study regarding functional outcome the range of movements, pain, grip strength were almost similar and showed no statistical significance. The mean DASH score was 9 among LCP group and 23 among Ex fix group. Regarding anatomical outcome ulnar variance and volar tilt showed significantly better results in LCP group compared Ex fix group. But the radial inclination and radial length were almost similar in both groups. Regarding complications, none of the complications occurred in LCP group and in Ex fix group 2 cases had pin tract infection and one case had prolonged finger stiffness.

In our study we compared the functional outcome using Green and O'Brien scoring system which showed 19% (n=4) excellent, 29% (n=6) good, and 38% (n=8) fair and 14% (n=3) poor results among Ex fix group which shows no statistical significant result compared to LCP group where it is 38%(n=8) excellent, 19% (n=4) good, 29% (n=6) fair and 14% (n=3) poor results. Regarding anatomical outcome the LCP group showed statistically significant results with respect to volar tilt, radial inclination and articular step off compared to Ex fix group and the cases with excellent outcome are theoretically better in LCP group.

Statistical significance in both studies were analysed by Pearson Chi square test in qualitative data and Independent T test in quantitative data.

	Parameters	Marco Rizzo et. Al (LCP Vs Exfix)	Our study (LCP Vs Exfix)
1	ROM	Not Significant	Not Significant
2	Pain	NS	NS
3	Grip strength	NS	NS
4	Ulnar variance	0.013	NS
5	Articular step off	NS	0.028
6	Volar tilt	0.041	0.026
7	Radial height	NS	NS
8	Radial inclination	NS	0.034
9	Functional score	0.015	0.568

In both the studies, all the parameters showed similar functional outcome in both the groups but with regard to anatomical parameters like volar tilt, intraarticular step off and radial inclination showed a statistical difference of better outcome among LCP group. In total, patients treated with LCP are relatively better in both functional and anatomical outcome compared to bridging external fixator and also gaining patient's satisfactory statement.

In Marco Rizzo[63] study, they compared the average number of therapy visits which was less in LCP group (4) compared to Ex fix group (10). But in our study we documented the return to work which is almost similar among both the groups.

Germaine GQ Xu et. al[64] in his prospective study compared bridging external fixation and plate fixation of intra articular distal radius fractures. The demographic data were also similar to our study group. He randomized 30 patients into Exfix group (n=14) and LCP group (n=16) and compared the results using Green and O'Brien score and with radiological parameters. His study also had the same limitation that he mobilized the wrist joint of Ex fix patients only after 7 weeks.

Parameters	Germaine GQ Xu study		Our study	
	Ex fix (n=14)	**LCP(n=16)**	**Ex fix (n=21)**	**LCP(n=21)**
Flexion(◦)	46	47	61	58
Extension(◦)	51	55	67	65
Supination(◦)	81	82	72	72
Pronation(◦)	76	68	74	78
Ulnar deviation(◦)	25	20	32	34
Radial deviation(◦)	13	14	22	23
Grip strength(%)	79.43%	80.76%	81.86%	80.56%

p-value (using chi square test) in both the studies were insignificant.

Similarly in his study the radiological findings were also showed insignificant difference Green and O'Brien score like our study, despite statistical insignificance LCP group has slightly superior outcome at the follow up at 12 months.

Intra articular distal radius fractures has a variety of methods of treatment with successful outcome[65]. For unstable fractures, though external fixation alone is insufficient, external fixation along with K wiring and bone grafting proved to be successful[66]. In recent years, the interest has been shifted to open reduction and internal fixation either volar or dorsal plating and with the advent of locking plates even unstable dorsal metaphyseal fragments were also stabilized with volar plates.

In our study, it is found that there was no major difference in the functional outcome of both the techniques in terms of pain, range of movements, grip strength and return to work, in the treatment of distal radius fractures with intra articular extension. But certain radiological parameters like palmar tilt, radial inclination and intra articular step off showed statistical significance of better results in volar locking compression plate than dynamic external fixator.

The effects of loss of normal palmar tilt of 11 to 12 degrees on functional outcome have been studied by many surgeons. Gartland and Werley[50] accepted that residual dorsal tilt significantly affects the outcome compared to other parameters like radial inclination, radial shortening and articular step off. Kopylov[77] in his retrospective study said that loss of as little as 12 degrees from normal palmar tilt increases the risk of radiologically apparent arthritis of wrist joint to 80%. McQueen[78] in his study concluded that negative palmar tilt or loss of normal palmar tilt result in carpal malalignment and affects the radiocarpal kinematics and that was the prime reason for reduction in functional outcome. Not only radiocarpal mechanics, loss of normal palmar tilt also affects radioulnar mechanics by increasing the tension on palmar and dorsal radioulnar ligaments which results in the increased load requirement for forearm rotation[79].

The aim to achieve normal radial length while doing reduction of distal radius fractures is also stressed by many surgeons. Jenkins[80] said that loss of radial length of even 4 mm not only resulted in loss of strength but also correlated with pain. The same cadaveric study done on distal radius fractures showed that loss of radial inclination shifts the carpus ulnarly, and increases the load on TFCC and ulna which ultimately resulted in decreased grip strength[80]. Adams explained that positive ulnar variance was the most important in affecting the kinematics of radioulnar joint when compared to loss of radial inclination and palmar tilt[81].

Margaliot et al[67]. in his meta analysis compared the outcomes of external fixator and plating and concluded that there were significantly higher rates of complications like infections, pin loosening and post operative neuritis in Ex fix group. Like that in our study also there are relatively higher rates of complications in Ex fix group.

An important randomized controlled trial done by Kapoor et al[68]. in 2000 concluded that ORIF had least chances of arthritic complications and also told that ORIF should be avoided in AO type C3 fractures where external fixation is advised to maintain the radial length by using the principle of multiplanar ligamentotaxis proposed by Gupta[69] and Agee et. Al[23,70]. They emphasized on translation and dorsiflexion of midcarpal bones rather than palmar flexion by tethering the palmar ligaments.

Dienst M et. al[73] in his prospective study on closed comminuted intra articular distal radius fractures treated with dynamic external fixator reported 81% good and excellent outcomes with early mobilization of the wrist on an average of 3 weeks. Similarly Kulshreshtha et. al[36] compared dynamic external fixator with static ones and found that 70% excellent results in dynamic external fixator. But in his study there was a limitation that only 23% cases were AO type C fractures. But in our study all the fractures were type C fractures. In both the above studies, they emphasized the use of supplementary techniques for additional stability of the fracture and to prevent the secondary displacement of the fragments.

In our study also, about 62% (n=13) in Ex fix group had additional stabilization of the fracture fragments and buttressing of the subchondral bone by K wires were done. This increases the stability of the construct[74], maintains reduction[56] and decreases the requirement of ligamentotaxis and collapse, and allows early wrist dynamisation. Cancellous or peg bone grafts taken from the ipsilateral iliac crest was done in 2 cases in Ex fix group with minimal dorsal incision and 5 cases in LCP group for subarticular bone grafting and to fill the void aiding elevation of the central lunate column to prevent collapse of the load transmitting segment of the distal radius.

In cases with distal radioulnar joint subluxation, stabilization by radioulnar K wire fixation[75] was done in 5 cases in Exfix group and one case in LCP group which was removed after 3 weeks. Superficial branch of radial nerve injury occurred in one case of Exfix group which is limited by the "Open method" of insertion of radial pins between the extensor carpi radialis longus and brevis[76]. One case in LCP group had median nerve neuropathy which is reduced by the surgeon's skill and meticulous dissection. The well padded pronator quadratus over the volar plate did not produce any tendon complications by the the hardware in long term follow up.

Eventhough the above said procedures showed no statistical significant difference in the outcomes, according to the studies done by Margaliot et. al[67], Grewel (dorsal)[71], and Westphal et. al[72] the external fixation technique has relatively a number of complications like pin tract infection, malunion, pin bending, late collapse and redisplacement and dorsal plating has hardware complications, volar locking compression plating takes the superior lead for unstable distal radius fractures with limited number of complications and better clinical outcome. In our study also, it is confirmed that most of the unstable distal radius fractures can be successfully treated by volar locked compression plating with limited number of minor complications rather than other techniques.

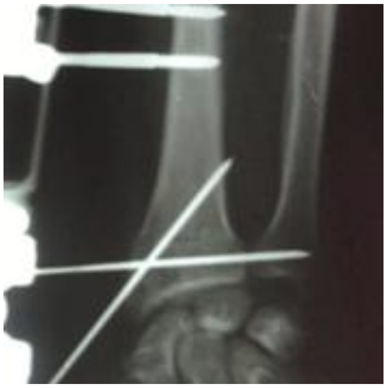
STUDY LIMITATIONS:

Our study has some of the limitations because it is a comparative study of prospective design, we have only limited number of cases in the stipulated period and also there is only short term follow up of most cases. Even to avoid minor complications in volar locked plating, there are advanced plate designs like variable angle locking plates, low profile plates are nowadays being introduced. We suggest a multi centre, randomized study comparing the variable angle and fixed angle volar locking compression plates for comminuted distal radius fractures with long term follow up and adequate number of patients.

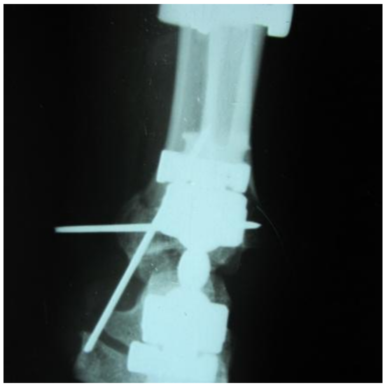
<u>**CASE 1: DYNAMIC EXTERNAL FIXATOR**</u>

PRE OP: AP VIEW

PRE OP: LAT VIEW



POST OP:AP VIEW



POST OP:LAT VIEW

18 MONTH :AP VIEW

NORMAL SIDE:AP VIEW

18 MONTH: LAT VIEW

NORMAL SIDE:LAT VIEW

PALMARFLEXION

DORSIFLEXION

SUPINATION

PRONATION

RADIAL DEVIATION

ULNAR DEVIATION

CASE2: DYNAMIC EXTERNAL FIXATOR

PRE OP: AP VIEW

PRE OP: LAT VIEW

POST OP:AP VIEW

POST OP:LAT VIEW

10 MONTH :AP VIEW

NORMAL SIDE:AP VIEW

1O MONTH: LAT VIEW

NORMAL SIDE:LAT VIEW

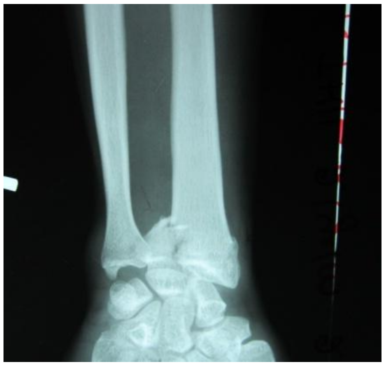
DORSIFLEXION **PALMARFLEXION**

PRONATION **SUPINATION**

ULNAR DEVIATION

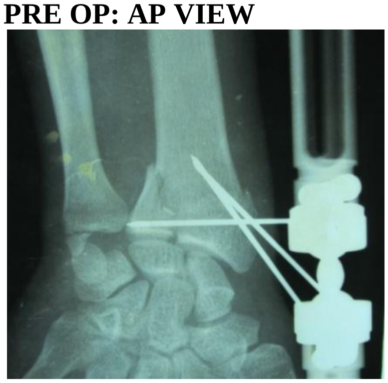
RADIAL DEVIATION

<u>CASE3:DYNAMICEXTERNAL FIXATOR</u>



PRE OP: AP VIEW

PRE OP: LAT VIEW



POST OP:AP VIEW

POST OP:LAT VIEW

IYEAR :AP VIEW

NORMAL SIDE:AP VIEW

1 YEAR: LAT VIEW

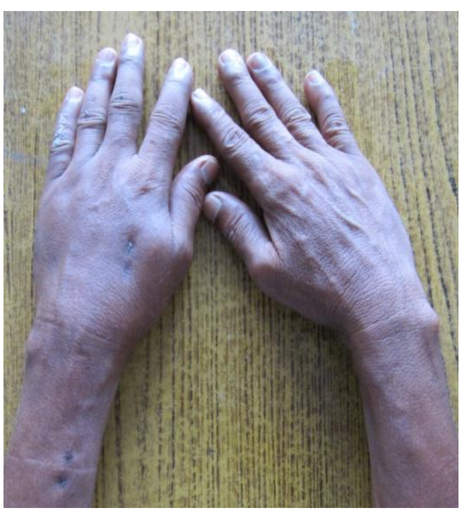
NORMAL SIDE:LAT VIEW

PALMARFLEXION

DORSIFLEXION

SUPINATION

PRONATION



RADIAL DEVIATION

ULNAR DEVIATION

CASE1: VOLAR LOCKING COMPRESSION PLATE

PRE OP AP VIEW **PRE OP LATERAL VIEW**

POST OP AP VIEW **POST OP LATERAL VIEW**

IMPLANT EXIT AFTER ONE YEAR AP AND LATERAL VIEWS

NORMAL OPPOSITE SIDE WRIST AP AND LATERAL VIEWS

PRONATION

SUPINATION

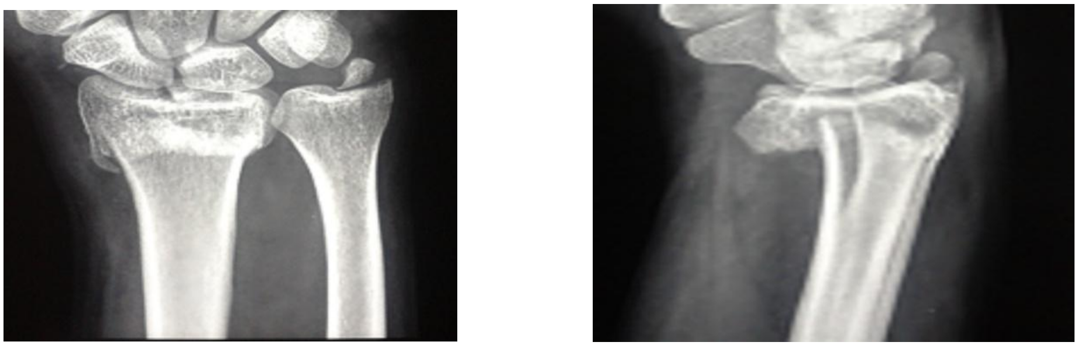
DORSIFLEXION

PALMAR FLEXION

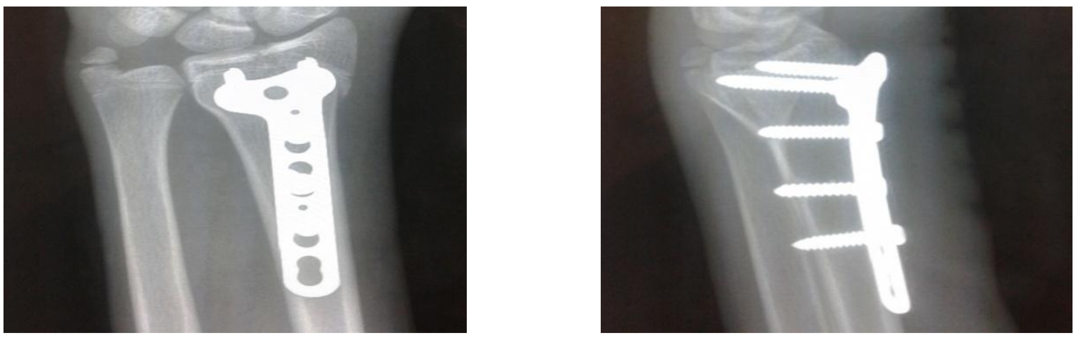
RADIAL DEVIATION

ULNAR DEVIATION

CASE 2: VOLAR LOCKING COMPRESSION PLATE

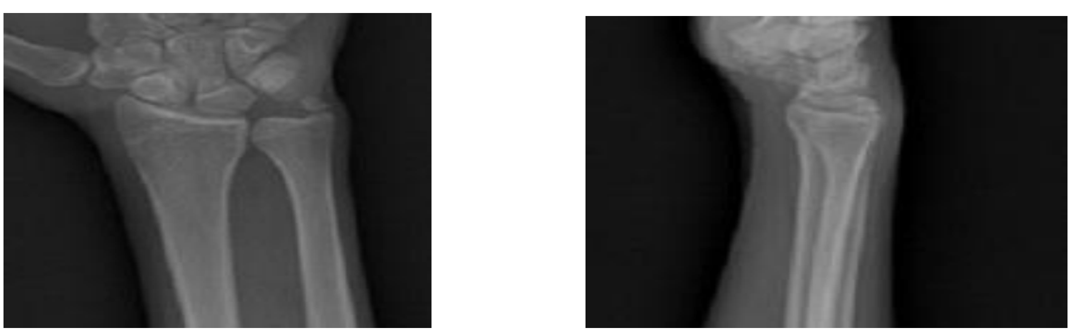


PRE OPERATIVE AP AND LATERAL VIEWS



POST OPERATIVE AP AND LATERAL VIEWS

10 MONTHS POST OP FOLOW UP AP AND LATERAL VIEWS



NORMAL OPPOSIDE WRIST AP AND LATERAL VIEWS

PRONATION

SUPINATION

DORSI FLEXION

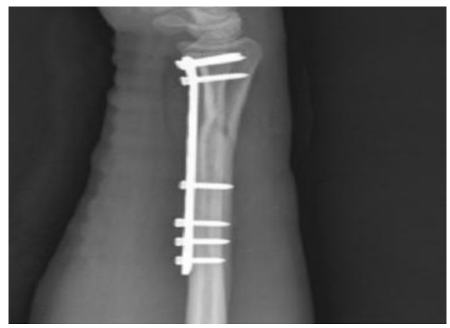
PALMAR FLEXION

RADIAL DEVIATION

ULNAR DEVIATION

CASE 3: VOLAR LOCKING COMPRESSION PLATE

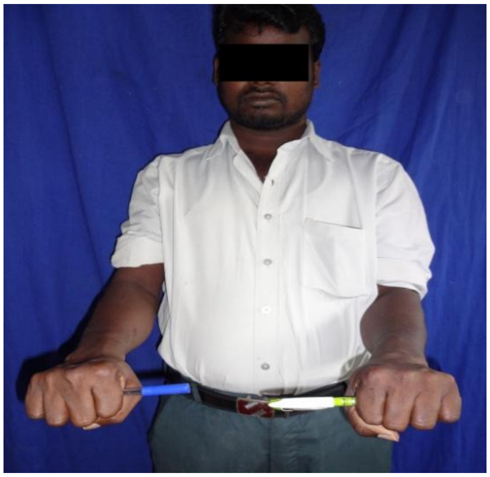

PREOPERATIVE AP AND LATERAL VIEWS

POST OPERATIVE AP AND LATERAL VIEWS

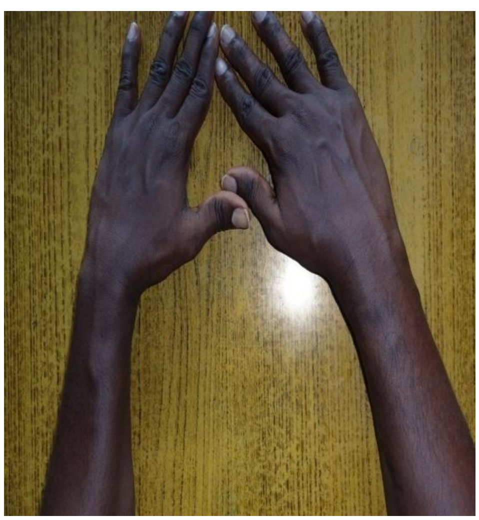

1 YEAR POST OP AP AND LATERAL VIEWS

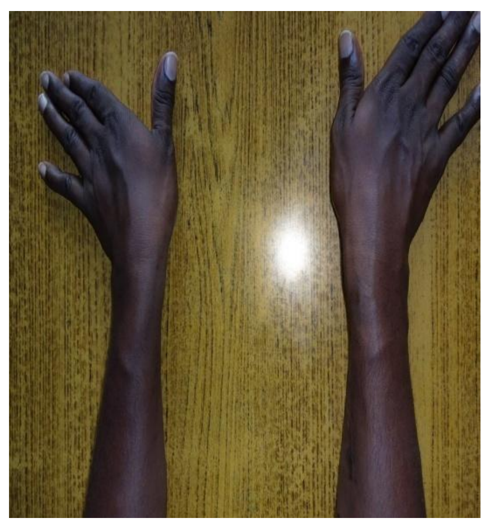

NORMAL OPPOSIDE WRIST AP AND LATERAL VIEWS



PRONATION **SUPINATION**

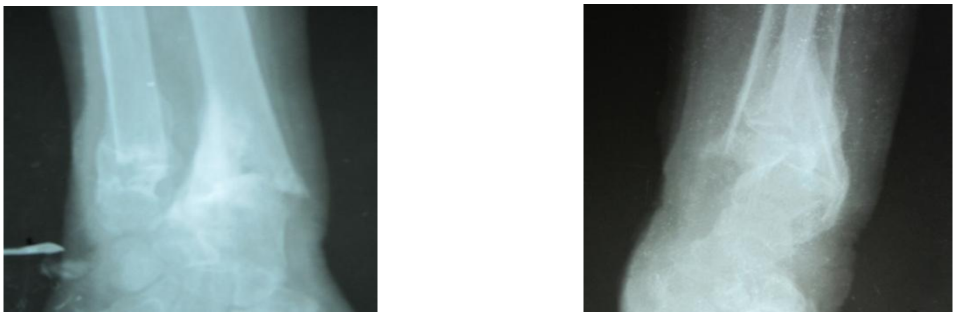
DORSIFLEXION **PALMAR FLEXION**





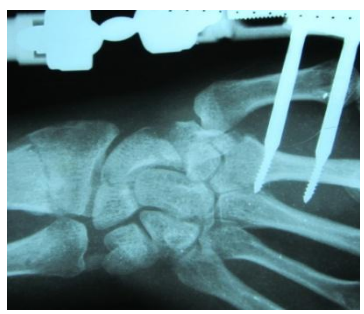
RADIAL DEVIATION **ULNAR DEVIATION**

COMPLICATIONS IN DYNAMIC EXTERNAL FIXATOR:



MALUNION

DEEP INFECTION **SUPERFICAL INFECTION**



PIN BENDING

COMPLICATIONS IN VOLAR LOCKING COMPRESSION PLATE:

SECONDARY COLLAPSE

SCREW PENETRATION

KELOID FORMATION

SUMMARY

Comminuted intra articular fractures of the distal radius are one of the most common fractures in our day to day orthopaedic practice and facing much difficulty in producing a satisfactory outcome.

The goals of treatment in unstable distal radius fractures should be

1. Restoration of the normal anatomy and congruency of the articular surface of the distal radius.

2. Stable fixation of the fracture fragments.

3. Early rehabilitation of the wrist and hand and early return to work.

4. To prevent fracture disease.

In this study we compared and analysed the outcome of two techniques, both of them being practised in modern orthopaedics by most of the surgeons- namely Closed reduction and dynamic external fixator application with or without supplementary techniques like K wire stabilization of fragments, bone grafting, DRUJ stabilization and minimal open reduction Versus Open reduction and internal fixation with volar locking compression plate.

CONCLUSION

We conclude that there are no major differences in the functional outcome of both the techniques in terms of pain, range of movements, grip strength and return to work, in treating comminuted intra articular distal radius fractures. Eventhough there is no statistical difference in the functional outcome, volar locking compression plate plays a better role than dynamic external fixator in certain radiological parameters like volar tilt, radial inclination and intraarticular step off and also successful in achieving patient's satisfaction with limited number of minor complications and early return to work.

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PATIENT PROFORMA

NAME: **UNIT NO.:**

AGE/SEX: **I.P.NO.:**

OCCUPATION: **DATE OF ADMISSION:**

ADDRESS: **DATE OF SURGERY:**

DATE OF DISCHARGE:

CONTACT NO:

MODE OF INJURY:

DOMINANT EXTREMITY:

COMPLAINTS:

HISTORY:

MEDICAL HISTORY: Diabetes/ hypertension/ dyslipidemia/ asthma/ clotting disorders/ seizures

PERSONAL HISTORY: chewing tobacco/ smoking/ alcohol/ steroid intake/ drug abuse

GENERAL PHYSICAL EXAMINATION:

SYSTEMIC EXAMINATION:

LOCAL EXAMINATION:

Deformity

Swelling

External wound

Tenderness

Crepitus

ROM:

Neurovascular deficits

Other joints: Elbow

Shoulder

Other associated injuries:

X-RAY VIEWS

PA:

LAT:

FRACTURE CLASSIFICATION:

AO Classification:

FRYKMANN'S Classification:

INVESTIGATIONS:

Chest X-Ray	RBS
ECG	Renal profile
CBC	Blood grouping and Typing:

SURGERY:

Date:

Procedure:

ANAESTHESIA:

Position:

Difficulty if any:

Supplimentary techniques:

POST OP PERIOD:

Antibiotics:

Post op x ray:

Post op complications:

Suture Removal:

Follow up on 1st 2nd 3rd week:

Pin site:

Checking the clamps:

Pin loosening:

Physiotherapy:

DYNAMISATION ON:

REMOVAL OF EX FIX:

MOBILISATION OF WRIST IN LCP:

ACTIVE RANGE OF MOVEMENTS ON:

ANATOMICAL OUTCOME

Radiological parameters	Pre-OP	Post-OP	6 Mon	Normal side
Radial Length				
Volar Tilt				
Ulnar Variance				
Radial Inclination				
Intra Articular Step				

FUNCTIONAL EVALUATION

	AFFECTED SIDE	NORMAL	%OF NORMAL
Flexion			
Extension			
Palmar deviation			
Ulnar deviation			
Supination			
Pronation			
Grip strength			

CLINICAL OUTCOME

GRADING	AFEECTED SIDE
FUNCTIONAL SCORING SYSTEM of Green and O'brien (1978) modified by Cooney *et al*. (1980).	
ANATOMICAL OUTCOME Lidstrom criteria (Sarmiento's modification)	

RESIDUAL DEFORMITY:

COMPLICATIONS:

CONSENT FORM
நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம்:கீழ் தொடை பகுதியில் உள்ள எலும்பு முறிவிற்கு உலோக தகட்டை சிறு கீறலின் மூலம் பொருத்தும் அறுவை சிகிச்சையின் பயன்களை அறியும் ஆய்வறிக்கை

ஆராய்ச்சி மையம்: அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை

நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐
2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐
3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாரய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐
4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐
5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐
6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

FUNCTIONAL SCORING CHART: GREEN AND O'BRIEN(1978)

(Modified by Cooney WP et al. on 1980)

Pain (25 points)	
No pain	25
Mild occasional	20
Moderate tolerable	15
Severe to intolerable	0
Functional status (25 points)	
Return to regular employment	25
Restricted employment	20
Able to work, unemployment	15
Unable to work because of pain	0
Range of motion (25 points) Percentage of normal	
100%	25
75-99%	15
50-74%	10
25-49%	5
0-24%	0
Dorsiflexion-Plantarflexion arcs if only injured hand reported	
120^0 or more	25
91^0-119^0	15
61^0-91^0	10
31^0-60^0	5
0-30^0	0
Grip Strength (25 points) Percentage if normal	
100%	25
75-99%	15
50-74%	10
25-49%	5
0-24%	0

Excellent 90-100 points

Good 80-89 points

Fair 65-79points

Poor < 65 points

LIDSTROM CRITERIA FOR ANATOMICAL EVALUATION

(Sarmiento's modification)

Type	Residual deformity	Loss of palmar inclination	Radial shortening(mm)	Loss of Radial Inclination
Excellent	Nil	0^0	<3	$<5^0$
Good	Slight	$1\text{-}10^0$	3-6	$5\text{-}9^0$
Fair	Moderate	$11\text{-}14^0$	7-11	$10\text{-}14^0$
Poor	Severe	$\geq 15^0$	≥12	$>14^0$

KEYS TO MASTER CHART

SEX	M:	MALE
	F:	FEMALE
DOM HAND:	DOMINANT HAND	
SIDE	R:	RIGHT
	L:	LEFT
COMORB COND:		COMORBID CONDITION
	DM:	DIABETES MELLIITUS
	SZ:	SEIZURES
	HT:	HYPERTENSION
MOI:	RT: ROAD TRAFFIC ACCIDENT	
	SF: SELF FALL	
ASSO FRAC:	ASSOCIATED FRACTURE	
	IT:	INTERTROCHANTERIC
	CLAV:	CLAVICLE
	SOH: SURGICAL NECK OF HUMERUS	
FRYK CLASS:	FRYKMANN CLASSIFICATION	
AO CLASS:	AO CLASSIFICATION	
SUPP TECH:	SUPPLEMENTARY TECHNIQUES	
	K:	'K' WIRING

BG: BONE GRAFTING

MR: MINIMAL OPEN REDUCTION

DJ: DRUJ STABILISATION

DO: DORSAL OPENING

DYN: DYNAMISATION AFTER

EX FIX REM: EX FIX REMOVAL AFTER

SURG APPR: SURGICAL APPROACH

MOBIL: MOBILISATION OF WRIST JOINT

PAIN: GR: GRADING

NO: NO PAIN

MLD: MILD

MOD: MODERATE

SEV: SEVERE

SC: SCORE

ROM: RANGE OF MOTION

RET TO WORK: RETURN TO WORK:

AW: ABLE TO WORK

RE: REGULAR EMPLOYMENT

SW: RESRICTED EMPLOYMENT

FE: DORSIFLEXION AND PALMARFLEXION ARC

GRIP STRE: GRIP STRENGTH

FUNC OUTC: FUNCTIONAL OUTCOME

RL: RADIAL LENGTH

VT: VOLAR TILT

RI: RADIAL INCLINATION

UV: ULNAR VARIENCE

IAS: INTRAARTCULAR STEP

PRE: PRE-OP

PS: POST-OP

FU: AT FINAL FOLLOWUP

N: NORMAL SIDE

LIDS GRAD: LIDSTROM GRADING

COMPL: COMPLICATION

SUP INF: SUPERFICIAL INFECTION

DEEP INF: DEEP INFECTION

RSD: REFLEX SYMPATHATIC DYSTROPHY

MUN: MALUNION

NERV IR: SUPERFICIAL BRANCH OF RADIAL NERVE IRRITATION

PIN BE: PIN BENDING

SEC COLL: SECONDARY COLLAPSE OF FRACTURE

MED NEURITIS: MEDIAN NERVE NEURITIS

MASTER CHART I-FUNCTIONAL OUTCOME-DYNAMIC EXTERNAL FIXATOR

SI.NO	NAME	AGE	SEX	SIDE	DOM.HAND	MOI	COMORB CONDN	ASSO.FRAC	FRYK CLASS	AO CLASS	SUPP.TECH	DYN	EF REM	PAIN		RET TO WORK		ROM		GRIP STRE		TOTAL SCORE	FUNCTIONAL OUTCOME
														GR	SC	GR	SC	FE	SC	%	SC		
1	AJZ	23	M	L	R	RT	NIL	NIL	III	C1	NIL	2	6	NO	25	RE	25	170	25	100	25	100	EXCELLENT
2	MTO	38	F	R	L	RT	NIL	NIL	VIII	C2	K/MR	2	7	MOD	15	AW	20	115	15	90	15	65	FAIR
3	PQN	49	M	L	L	SF	DM	NIL	VIII	C3	K/DJ	3	7	MLD	20	RE	25	104	15	64	10	70	FAIR
4	NSV	40	M	R	R	SF	NIL	NIL	VII	C2	K	2	6	MLD	20	RE	25	125	15	70	10	70	FAIR
5	KNM	28	M	R	L	RT	NIL	NIL	VII	C1	K	2	6	NO	25	RE	25	150	25	100	25	100	EXCELLENT
6	FAS	57	F	L	R	SF	DM/HT	SOH	VIII	C3	K/DJ	3	8	SEV	O	SW	15	94	15	62	10	40	POOR
7	TRE	31	M	R	R	RT	NIL	NIL	IV	C1	NIL	2	6	MLD	20	RE	25	158	25	93	15	85	GOOD
8	LSM	43	F	L	R	RT	NIL	NIL	VII	C2	K	2	6	MLD	20	RE	25	104	15	74	10	70	FAIR
9	KIG	69	M	L	R	SF	DM/HT	IT	VIII	C3	K/BG/DJ	3	8	MOD	15	SW	15	86	10	60	10	50	POOR
10	MIS	27	F	L	R	RT	NIL	NIL	III	C1	NIL	2	6	MLD	20	RE	25	160	25	95	15	85	GOOD
11	BQT	53	M	R	R	SF	HT	NIL	VII	C2	K	2	6	MLD	20	AW	20	130	25	85	15	80	GOOD
12	XVR	33	M	R	L	RT	NIL	NIL	VI	C1	DJ	2	7	MLD	20	RE	25	155	25	94	15	85	GOOD
13	KKR	72	F	R	R	SF	DM/HT	IT	VIII	C3	K/BG	3	8	MOD	15	SW	15	60	5	54	10	45	POOR
14	DSA	27	M	L	R	RT	NIL	NIL	VII	C2	K	2	6	MLD	20	RE	25	140	25	100	25	95	EXCELLENT
15	VKN	35	M	L	R	RT	NIL	CLAV	VI	C2	DJ	2	7	MLD	20	RE	25	150	25	90	15	85	GOOD
16	AHD	46	M	L	R	SF	DM	NIL	VII	C2	K	2	6	MLD	20	AW	20	158	25	90	15	80	GOOD
17	AKS	39	F	L	R	RT	NIL	NIL	VII	C2	K	2	6	MLD	20	RE	25	118	15	72	10	70	FAIR
18	SKO	52	F	R	L	SF	DM	NIL	VIII	C3	K	3	7	MOD	15	RE	25	100	15	70	10	65	FAIR
19	PPB	24	M	L	R	RT	NIL	NIL	III	C1	NIL	2	6	NO	25	RE	25	162	25	100	25	100	EXCELLENT
20	GEP	44	M	L	R	RT	DM	NIL	VIII	C2	K	2	7	MLD	20	RE	25	108	15	72	10	70	FAIR
21	RIZ	37	M	L	R	SF	NIL	NIL	VII	C2	K/MR	3	8	MOD	15	AW	20	135	25	84	15	75	FAIR

MASTER CHART-II-ANATOMICAL OUTCOME-DYNAMIC EXTERNAL FIXATOR

S.No	NAME	RL in mm				VT in degrees				RI in degrees				UV in mm				IAS in mm			DEFORMITY	LIDSTROM GRADING	COMPL
		PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU			
1	AJZ	2	10	10	12	-13	10	9	11	9	24	21	22	2	0	0	-1	3	1	1	NIL	EXCELLENT	NIL
2	MTO	-6	7	7	10	-15	-5	3	10	10	14	11	21	2	-2	-1	-2	4	2	2	MODERATE	FAIR	NIL
3	PQN	-4	9	8	11	-12	8	6	12	3	15	12	23	2	0	1	-1	3	1	1	MODERATE	FAIR	SUP INF
4	NSV	-3	7	8	12	-5	8	8	11	5	15	14	21	2	1	1	0	2	1	1	SLIGHT	GOOD	NIL
5	KNM	6	11	8	10	-8	14	11	11	5	22	18	21	3	1	0	-1	2	0	0	NIL	EXCELLENT	NIL
6	FAS	-2	8	8	10	-17	10	5	12	9	13	15	22	1	0	-1	-1	3	2	1	MODERATE	FAIR	MUN
7	TRE	1	9	8	11	-6	10	8	11	7	17	15	23	1	1	0	-1	2	1	1	SLIGHT	GOOD	NIL
8	LSM	2	7	6	10	-15	6	6	12	3	14	13	21	3	1	1	0	3	1	1	SLIGHT	GOOD	NIL
9	KIG	-3	6	6	11	-22	-10	-10	11	5	15	15	23	2	1	0	-2	3	2	2	SEVERE	POOR	DEEP INF/RSD
10	MIS	4	11	10	12	-12	9	6	10	5	20	20	22	0	-1	-1	-1	1	0	0	NIL	EXCELLENT	NIL
11	BQT	3	6	6	11	-23	6	5	10	9	25	25	22	3	0	0	-2	3	1	1	NIL	EXCELLENT	NIL
12	XVR	8	9	9	11	7	10	8	10	17	20	18	21	-3	1	0	-1	1	0	0	NIL	EXCELLENT	NIL
13	KKR	-6	7	7	10	-20	-15	-15	10	10	11	11	21	2	-2	-2	-2	4	3	3	SEVERE	POOR	MUN
14	DSA	4	13	11	12	-15	12	11	10	8	24	21	22	2	-2	-1	-1	3	2	1	NIL	EXCELLENT	NIL
15	VKN	5	10	10	11	-10	13	13	12	13	20	20	22	2	0	0	-1	2	1	1	NIL	EXCELLENT	NIL
16	AHD	4	10	10	11	-10	11	11	12	7	21	20	21	2	-1	-1	-2	2	2	1	NIL	EXCELLENT	PIN BE
17	AKS	0	10	5	10	-24	9	4	10	20	20	14	22	4	0	1	-1	4	2	2	MODERATE	FAIR	NIL
18	SKO	0	10	5	10	-24	9	6	10	-2	20	12	22	4	0	1	-1	4	2	2	MODERATE	FAIR	SUP INF
19	PPB	4	13	12	12	-20	12	10	10	9	25	10	24	-1	-3	-2	-2	2	1	0	NIL	EXCELLENT	NERV IR
20	GEP	2	12	10	11	-13	10	8	12	12	17	15	23	-2	1	0	-1	2	2	1	SLIGHT	GOOD	SUP INF
21	RIZ	5	10	8	10	-15	10	9	11	4	20	16	22	2	1	0	-1	3	2	2	MODERATE	FAIR	NIL

MASTER CHART - III - FUNCTIONAL OUTCOME- - VOLAR LOCKING COMPRESSION PLATE

SI.NO	NAME	AGE	SEX	SIDE	DOM.HAND	MOI	COMORB CONDN	ASSO.FRAC	FRYK CLASS	AO CLASS	SURG APPR	SUPP.TECH	MOBIL	PAIN		RET TO WORK		ROM		GRIP STRE		TOTAL SCORE	FUNC OUTC
														GR	SC	GR	SC	FE	SC	%	SC		
1	MTH	39	M	L	R	RTA	NIL	NIL	VII	C2	ELLIS	NIL	2	MLD	20	RE	25	146	25	92	15	85	GOOD
2	KML	48	F	R	R	SF	NIL	NIL	VIII	C2	AO	NIL	2	MLD	20	RE	25	110	15	78	15	75	FAIR
3	VRL	20	M	L	R	RTA	NIL	CALCAN	III	C1	ELLIS	NIL	2	NO	25	RE	25	168	25	100	25	100	EXCELLENT
4	LNS	46	F	R	L	SF	NIL	NIL	VII	C2	AO	NIL	2	MLD	20	RE	25	125	25	80	15	85	GOOD
5	GTV	40	M	R	R	RTA	NIL	NIL	VII	C2	AO	NIL	2	MLD	20	RE	25	125	25	86	15	85	GOOD
6	HVM	36	F	L	R	SF	NIL	NIL	VIII	C2	AO	NIL	2	NO	25	RE	25	136	25	90	15	90	EXCELLENT
7	ALE	43	M	L	R	SF	SZ	NIL	VII	C2	AO	NIL	2	MLD	20	RE	25	94	15	80	15	75	FAIR
8	DIN	68	F	L	R	SF	DM	IT	VIII	C3	AO	BG	3	SEV	0	AW	20	60	5	50	10	35	POOR
9	VSN	24	M	L	L	RTA	NIL	NIL	III	C1	ELLIS	NIL	2	NO	25	RE	25	172	25	100	25	100	EXCELLENT
10	RRV	59	M	R	L	SF	NIL	NIL	VIII	C2	AO	BG	3	MOD	15	RE	25	100	15	75	15	70	FAIR
11	KTR	50	F	R	R	SF	NIL	NIL	VII	C2	AO	NIL	2	MOD	15	RE	25	95	15	62	10	65	FAIR
12	NEP	33	M	L	R	RTA	NIL	NIL	VI	C1	ELLIS	DJ	2	NO	25	RE	25	160	25	100	25	100	EXCELLENT
13	YRS	57	M	R	L	SF	DM	NIL	VIII	C3	AO	NIL	3	SEV	0	SW	15	45	5	30	5	25	P0OR
14	RIN	29	F	R	R	RTA	NIL	NIL	IV	C1	ELLIS	NIL	2	NO	25	RE	25	170	25	100	25	100	EXCELLENT
15	TEP	48	M	L	R	SF	NIL	NIL	VII	C2	AO	BG	2	MLD	20	RE	25	106	15	78	15	75	FAIR
16	LIM	60	F	R	L	RTA	HT	NIL	VIII	C2	ELLIS	BG/DO	3	MOD	15	RE	25	92	15	56	10	65	FAIR
17	BOM	40	M	R	L	SF	NIL	NIL	III	C1	ELLIS	NIL	2	NO	25	RE	25	160	25	100	25	100	EXCELLENT
18	MIV	31	F	R	R	RTA	NIL	CLAV	VII	C1	AO	NIL	2	MLD	20	RE	25	156	25	100	25	95	EXCELLENT
19	FKN	70	M	L	R	SF	DM	NIL	VIII	C3	AO	BG	3	MLD	20	AW	20	68	10	50	10	60	P0OR
20	SMY	27	M	L	R	RTA	NIL	NIL	III	C1	ELLIS	NIL	2	NO	25	RE	25	174	25	100	25	100	EXCELLENT
21	ARM	36	F	L	L	RTA	NIL	NIL	III	C2	ELLIS	NIL	2	MLD	20	RE	25	125	25	93	15	85	GOOD

MASTER CHART 1V- ANATOMICAL OUTCOME-VOLAR LOCKING COMPRESSION PLATE

S.No	NAME	RL in mm				VT in degrees				RI in degrees				UV in mm				IAS in mm			DEFORMITY	LIDS GRAD	COMPL
		PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU	N	PRE	PS	FU			
1	MTH	4	11	11	12	-8	11	10	12	11	21	21	23	1	-1	-1	-1	1	0	0	NIL	EXCELLENT	NIL
2	KML	1	9	9	12	-16	12	11	10	6	21	21	23	2	0	0	-1	3	1	1	NIL	EXCELLENT	NIL
3	VRL	3	9	9	11	-21	11	11	10	3	20	21	24	1	-1	-1	-2	2	1	0	NIL	EXCELLENT	NIL
4	LNS	6	11	11	13	0	9	9	11	13	21	20	24	1	0	-1	-2	2	0	0	NIL	EXCELLENT	NIL
5	GTV	2	9	9	11	-14	10	10	12	10	18	16	22	1	-1	-1	-1	2	1	1	NIL	GOOD	NIL
6	HVM	5	11	10	12	0	11	11	10	11	22	22	21	1	-1	0	-1	2	0	0	NIL	EXCELLENT	KELOID
7	ALE	6	9	9	10	-8	10	9	11	9	20	18	23	2	-1	-1	-1	2	0	0	SLIGHT	GOOD	NIL
8	DIN	1	9	5	11	-22	10	4	11	2	20	11	21	3	0	1	-1	4	1	2	SEVERE	POOR	SEC COLL
9	VSN	5	10	11	11	-20	12	12	13	5	20	20	22	0	-1	-1	-1	1	0	0	NIL	EXCELLENT	NIL
10	RRV	0	8	8	10	-13	9	8	10	9	17	15	21	2	1	0	0	3	1	1	MODERATE	FAIR	MED NEURITIS
11	KTR	3	8	7	12	-5	10	8	12	5	18	18	23	2	0	0	-1	2	1	1	SLIGHT	GOOD	NIL
12	NEP	10	11	11	11	9	10	10	12	19	20	20	21	0	0	-1	-1	1	0	0	NIL	EXCELLENT	NIL
13	YRS	4	8	7	11	-9	9	8	12	7	11	11	22	2	0	1	0	2	1	2	SEVERE	POOR	SCREW MIG
14	RIN	2	10	11	13	-10	10	10	11	8	22	22	24	2	-1	-1	-1	1	0	0	NIL	EXCELLENT	NIL
15	TEP	4	9	9	10	-6	10	8	10	4	20	20	21	1	-1	-1	-2	1	0	0	NIL	EXCELLENT	NIL
16	LIM	0	10	9	11	-30	8	7	11	0	20	18	22	3	-1	0	-1	3	1	1	SLIGHT	GOOD	NIL
17	BOM	4	11	10	12	-2	10	11	11	8	22	21	21	2	-1	-1	-2	1	0	0	NIL	EXCELLENT	NIL
18	MIV	3	11	10	11	-10	10	10	10	5	21	21	22	1	-1	-1	-1	1	0	0	NIL	EXCELLENT	NIL
19	FKN	2	8	7	11	-12	8	8	12	2	15	13	22	2	1	1	-1	4	2	2	MODERATE	FAIR	NIL
20	SMY	2	9	9	10	-15	10	11	11	5	21	20	21	1	-1	-1	-1	1	0	0	NIL	EXCELLENT	KELOID
21	ARM	4	10	9	11	-6	10	9	13	6	22	20	21	2	-1	-1	-2	2	1	1	NIL	GOOD	NIL

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.12117/ME-1/Ethics/2012 Dt:03.01.2013.

CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on a comparative study on functional outcome between external fixator with dynamic mode and locking compression plate for distal radius fractures with intraatricular extension" for project work.submitted by Dr.V.S.Nisanth, MS (Ortho), PG Student, Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

CHAIRMAN, 21/1/13.
Ethical Committee
Govt.Kilpauk Medical College,Chennai

GOVT. KILPAUK MEDICAL COLLEGE
21 JAN 2013
Kilpauk, Chennai-10.