"FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION"

by

Dr. AMRUTH ANAND R

Dissertation Submitted to

The BLDE (DEEMED TO BE UNIVERSITY) Vijayapura, Karnataka.

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

In

ORTHOPAEDICS

Under the guidance of

DR. ASHOK NAYAK
M.S. ORTHOPAEDICS
PROFESSOR
DEPARTMENT OF ORTHOPAEDICS
BLDE (DEEMED TO BE UNIVERSITY)
SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTER**,VIJAYAPURA , KARNATAKA-586103**

DOI 10.5281/zenodo.15487572
https://zenodo.org/records/15487573

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "**FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION**" is a bonafide and genuine research work carried out by me under the guidance of DR. ASHOK NAYAK MBBS, M.S, Professor, Department of Orthopaedics at BLDE (Deemed to be University) Shri B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

Date: 29/7/2024

Place: Vijayapura

DR.AMRUTH ANAND R
DEPARTMENT OF ORTHOPEDICS
B.L.D.E (DEEMED TO BE) UNIVERSITY
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL AND RESEARCH CENTRE,
VIJAYAPUR, KARNATAKA

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled "**FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION**" is a bonafide research work done by Dr. AMRUTH ANAND R in partial fulfillment of the requirement for the degree of M.S in orthopaedics.

Date: 29/7/2024

Place: Vijayapura

DR. ASHOK NAYAK,
(MS ORTHOPAEDICS)
PROFESSOR
DEPARTMENT OF ORTHOPEDICS
B.L.D.E (DEEMED TO BE) UNIVERSITY
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL AND RESEARCH CENTRE,
VIJAYAPUR, KARNATAKA

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT

This is to certify that the dissertation entitled "**FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION**" is a bonafide research work done by Dr. SATYAM TALEGAONKAR under the guidance of DR. ASHOK NAYAK MBBS, MS, Professor, Department of Orthopaedics at BLDE (Deemed to be University) Shri. B. M. Patil Medical College Hospital and Research Centre, Vijayapura.

Date: 29/7/2024

Place: Vijayapura

DR. SANTOSH S NANDI,
(MS ORTHOPAEDICS)
PROFESSOR & HOD DEPARTMENT OF ORTHOPAEDICS,
B. L. D. E. (DEEMED TO BE UNIVERSITY)
SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled "**FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION**" is a bonafide research work done by Dr. SATYAM TALEGAONKAR under the guidance of DR. ASHOK NAYAK MBBS, MS, Professor, Department of Orthopaedics at BLDE (Deemed to be University) Shri. B. M. Patil Medical College Hospital and Research Centre, Vijayapura

Date: 29/7/2024

Place: Vijayapura

DR. ARAVIND PATIL,
PRINCIPAL,
B. L. D. E. (DEEMED TO BE UNIVERSITY)
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL & RESEARCH CENTRE,
VIJAYAPURA

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the BLDE (Deemed to be University), Shri B.M.Patil Medical College And Hospital Research Centre, Vijayapura Karnataka shall have the rights to preserve, use and disseminate this dissertation / thesis in print or electronic format for academic/ research purpose.

Date: 14/12/2022

Place: Vijayapura

DR. AMRUTH ANAND R
DEPARTMENT OF ORTHOPEDICS
B.L.D.E (DEEMED TO BE) UNIVERSITY
SHRI B. M. PATIL MEDICAL COLLEGE
HOSPITAL AND RESEARCH CENTRE,
VIJAYAPUR, KARNATAKA

ACKNOWLEDGEMENT

It is my pride and privilege to express, with a deep sense of respect, my undying gratitude and indebtedness to my guide and esteemed teacher Dr. ASHOK NAYAK, Professor, Department of Orthopaedics, BLDE (Deemed to be University) Shri B. M. Patil Medical College, for the constant motivation and support, which he encompassed me with in preparing this dissertation as well as in pursuit of my post graduate studies.. I am extremely grateful to my esteemed HOD Dr. Santosh S Nandi M.S., Professor and HOD, Department of Orthopaedics, BLDE (Deemed to be University) Shri B. M. Patil Medical College, for his overall guidance, inspiration, and care during my residency. I am grateful to Dr. Aravind V. Patil M.S., Principal of B.L.D.E. (Deemed to be University), Shri. B. M. Patil Medical College Hospital and Research Centre, Vijayapura, for permitting me to utilize hospital resources for completion of my research. I am forever grateful to my teachers Dr. Ashok Nayak, Dr S S nandi, Dr Sandeep naik, Dr. Dayanand B B, Dr. Ravikumar Biradar, Dr. Anil Bulagond, Dr. Shreepad Kulkarni, Dr. Gireesh. k, Dr. Shrikant Kulkarni, Dr. Vijaykumar Patil, Dr. Prashant and Dr. Sahebgouda for their valuable encouragement and sustenance. I am thankful to my seniors, Dr Keyur and Dr Jayesh for their suggestions and advice. I am truly thankful to my fellow post-graduate students, Dr Nitesh, Dr. satyam, Dr. Arun, Dr Chandu, Dr. Prasad, Dr.

Anusha, Dr. Kaushal, as well as my juniors Dr Pranav Kamlay , Dr Rahul, Dr Anant, Dr Naveen for their co-operation and encouragement. I express my thanks to the library staff, OT staff and all hospital staff for their kind co-operation during my study. I would like to express my thanks to Dr. Vijaya Sorganvi statistician, Department of Community Medicine, for her help in statistical analysis. I would like to thank my father, BASAVALINGAPPA, for being an inspiration and giving me the strength to pursue my dreams. I am deeply thankful to my mother, MANGALA GOWRI, for being the pillar in my life and constantly encouraging me to pursue my ambitions. I am deeply indebted to my brother VIVEK and other family members for their constant encouragement, support, love, and blessings. Last but not the least, I convey my heartfelt gratitude to all the patients, without whose co-operation, this study would not have been possible.

Date: 29/07/2022,

Place: Vijayapura.

Dr. AMRUTH ANAND R

ABBREVIATIONS

AO : Arbeitsgemeinschaft fur Osteosynthesefragen

APL : Abductor Pollicis Longus

BSL : Bistyloid Line

Cms : Centimeters

CT : Computerized Tomography

DASH : Disability Of The Arm, Shoulder and Hand

DER : Distal end radius

DRUJ : Distal Radio Ulnar Joint

EPL : Extensor Pollicis Longus

EPB : Extensor Pollicis Brevis

FCR : Flexor Carpi Radialis

FDS : Flexor Digitorum Superficialis

FOOH : Fall On Outstretched Hand

HIV : Human Immunodeficiency Virus

HbSAg : Hepatitis B Surface Antigen

IV : Intra Venous

LCP : Locking compression plates

mm : Millimeters

ORIF : Open reduction and internal fixation

PA : Postero-Anterior

POP : Plaster Of Paris

Post Op : Post-operative

PQ : Pronator Quadratus

PRWE : Patient rated wrist evaluation

PT : Palmar Tilt

Pt. : Patient

RA : Radial Angulation

ROM : Range of movements

RTA : Road traffic accident

TFCC : Triangular Fibrocartilage Complex

UV : Ulnar Variance

WBC : White Blood Corpuscles

: Fracture

"FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION"

ABSTRACT

Context: This study evaluated the functional results and complications in patients treated with open reduction and internal fixation (ORIF) utilizing 2.7mm distal radius plates, as well as the patients' capacity to return to their regular activities. The investigation of particular problems associated with fragment-specific fixation was another goal of the study.

Materials and Procedures: 32 patients with distal radius fractures who underwent ORIF with fragment-specific locking plates were included in this prospective study. Between August 2022 and January 2024, the study was conducted at the Shri BM Patil Medical College and Hospital in BLDE. The patient-rated wrist evaluation (PRWE) score was used to evaluate the patients' functional results over a 6-month follow-up period following surgery

Findings: The study's patients were primarily male (87.5%) and had an average age of 38.59 years. In 59.3% of cases, the afflicted wrist was the dominant right wrist. Accidents involving vehicles were the most frequent cause of injuries. It took an average of 7.06 days from the injury to surgery. The average PRWE score following six months of fixation was 16.53. Of the patients, 71.88% had excellent outcomes and 18.75% had good outcomes. The most frequent side effects, which affected two individuals each, were subsequent collapse, stiffness and numbness, and superficial infection. Thirty patients were able to resume their pre-injury activities within six months, and thirty patients experienced fracture union in less than three months.

Conclusion: Based on the excellent PRWE scores, the study findings indicate that fragment specific fixation with 2.7mm distal radius plates provides robust and reliable fixation with good functional outcomes.

Keywords: fractures of the distal radius, patient-rated wrist evaluation (PRWE) score, fragment-specific fixation, open reduction and internal fixation (ORIF).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

INTRODUCTION

One of the most frequent skeletal injuries that orthopedic surgeons treat are distal radius fractures. Roughly one-sixth of the fractures treated in ERs are caused by them. Treatment for these injuries is quite difficult, particularly if the trauma was high-energy and resulted in intra-articular involvement or comminution. These fractures can result in problems like post-traumatic osteoarthritis because they are frequently unstable and challenging to minimize anatomically. First reported by Ponteau in 1783, and then by Abraham Colle in 1814, were fractures of the distal radius. For best functional results, appropriate therapy entails restoring radial length, radial inclination, and articular surface congruency. If near-anatomical reduction is not accomplished and maintained, degenerative arthritis, distal radioulnar and metacarpal instability, and ulnar nerve compression syndrome can cause discomfort, loss of movement, strength, and function[1].

Treatment strategies have changed as a result of an increase in high-energy vehicle trauma cases and patients' growing expectations for perfection. Treating complicated fractures requires understanding the fracture pattern and making sure that fixation is secure. To characterize fracture patterns, comminution, radial shortening, displacement, and soft tissue involvement, several classification schemes have been devised. Nevertheless, no single classification system considers every aspect of a single injury, necessitating a careful assessment by the surgeon.[2]

The significance of enhancing the diagnosis and categorization of distal radius fractures for treatment—open reduction, where suitable—has been brought to light by recent research. Restoring wrist function is the major objective of treatment for unstable distal radius fractures, which entails encouraging early hand mobilization and upholding a precise and stable reduction. For unstable fractures or fractures with articular maladjustment that cannot be fixed by external treatment, open reduction with internal fixation (ORIF) is recommended.

To stop the carpal bones from subluxing and losing their reduction in volar marginal fractures, small buttress plates like the ones Ellis described are frequently utilized. There is ongoing debate over the most effective way to attain and preserve an accurate repair of the joint anatomy. The secret to an effective treatment plan is to identify patterns that are intrinsically unstable and need more focus. Distal radius fracture treatment is changing, with internal fixation replacing pins, bandages, and external fixation increasingly frequently.This study evaluated the functional outcomes of ORIF employing supported plates and screws in adult patients with distal radius fractures.. One of the most frequent upper extremity fractures that orthopaedic trauma surgeons treat is a distal radius fracture. Of all fractures treated, they make up about 16% of those treated surgically and 1/6 of those treated in ERs. These fractures are more common as people age and are correlated with osteopenia in elderly persons. The incidence rises to 368 per 100,000 for women under 40 and 1,150 per 100,000 for women over 40, whereas for men 35 years of age and beyond, it is roughly 90 per 100,000 population annually. [3,4]

Distal radius fracture treatment is still debatable. Whereas displaced fractures are reduced and then immobilized in a cast, nondisplaced fractures are often treated in a cast for four to six weeks. Surgical intervention may be necessary for unstable fractures. Methods include ORIF using dorsal or volar plates and locking screws, external fixation, and percutaneous fixation. Evaluating stability at the moment of injury is challenging. Even if initial reduction and casting are effective, some fractures subsequently displace.

Restoring wrist function to its maximum potential is the aim of treatment for distal radius fractures, which necessitates early postoperative mobilization and anatomic restoration. The prognosis for extra-articular fractures is often better than that of intra-articular fractures. Age, fracture architecture, displacement, repositionability, stability, and joint discrepancy are some of the variables that affect functional result. The anatomic reduction's quality holds greater significance than the fixing technique[5]

For unstable distal radius fractures, such as metaphyseal comminution (A3 and C2 fractures), locking volar compression plates work well. The most common type of fractures are distal radius fractures, however even when skilled specialists follow evidence-based standard treatment, complication rates can reach 6% to 80%. From little swelling to severe painful deformity with loss of motion, complications might arise. According to McKay et al., rates of post-traumatic arthritis ranged from 7% to 65%, while overall complication rates ranged from 6% to 80%. Malunion, nonunion, hardware issues, tendon wear/rupture, and nerve injury are the most frequent complications. [6]

Roughly one-sixth of all fractures diagnosed and treated by orthopedic surgeons are distal radius fractures, which are the most common skeletal injuries. They account for 75% of forearm fractures and 17% of all fractures [7].

The prevalence of different kinds of fractures to the distal radius includes:

- Comminuted Colles' inside the articulation: 23.8%

- Driver: 6.3%

- Ground Smith: 2.5 percent

- Barton Volar: 1.3%

- Dorsal Barton plus Chauffeur combined: 1.3%

- 0.5% for dorsal barton

- Volar Barton plus Chauffeur combined: 0.3% (rarest)

The periarticular location, small size, and narrow proximal tendon and retinaculum sheath network of distal radius fractures make them particularly difficult to fix. The distal fragments are too thin to be fixed with screws, which can make it difficult to form enough retentive threads and result in iatrogenic fractures[8]

Research indicates that restoring function and distal radius anatomy are intimately related. Thus, the goal of both operational and closed management should be to restore:

- Articular congruity (to lessen degenerative changes and articular cartilage wear)

- Radial length and alignment (to correct the kinematics of the carpus and radioulnar joints)

- Movement (forearm, wrist, and fingers for functional tasks)

- Stability (keeping the fracture aligned and at the proper length till it heals)

- ❖ **Robert Medoff created a hybrid approach that combines percutaneous wire and plate fixation through tiny incisions in order to reduce the morbidity from the massive surgical dissections associated with classic dorsal plate fixation. Five fundamental fracture fragments—radial styloid, volar labrum, dorsal radius, dorsal ulna, and matrix punch—that can occur alone or in combination in any fracture are identified by its "fragment-specific" classification.**
- ❖ **"Fracture-fragment-specific fixation" fixes each fracture fragment separately by selectively placing screws and one or more low-profile implants along the distal radius column**.

utilizing the idea of fragment-specific fixation with or without K-wires, this study aims to assess the indications and functional results of open reduction and internal fixation utilizing a 2.7 mm low-profile distal radius plate either alone or in conjunction with strategic screw placement.

For unstable distal radius fractures, there is currently no evidence in the literature to support internal fixation over external fixation. The purpose of this research is to ascertain if fragment-specific fixation can improve functional results and facilitate a quicker return of patients—especially younger patients—to their regular lives.

AIMS AND OBJECTIVE

• To investigate how patients with distal end radius fare functionally.

fractures treated with 2.7mm low profile plates and fragment-specific fixation six months after surgery using the PRWE score

• To investigate the timeliness of the patients' return to their regular activities and the range of problems associated with fragment-specific fixation.

• Researching the range of motion possible with fragment-specific fixing

REVIEW OF LITERATURE

Historical Background and Development of Distal Radius Fractures Treatment:

Orthopedic literature has been interested in distal radius fractures for over 200 years, even before radiography was used. Although this type of fracture may have been mentioned in 1783 by a French physician by the name of Ponteau, Abraham Colles is generally credited in 1814 with identifying the most prevalent fracture pattern involving the distal radius. The phrase "Colles' fracture" refers only to fractures that occur outside of the joint and cause the distal fragment to shift dorsally. Other patterns—like the ones noted by Smith—involve the distal fracture's volar displacement, which occurs 0.5 to 1 inch proximal to the articular surface. [9]

Age Distribution and Difficulties with Fixation:

Age distributions for distal radius fractures are bimodal. They impact elderly people who have both high-energy trauma and insufficiency fractures, as well as younger people who have relatively high-energy trauma. Internal fixation and open reduction are the most appropriate treatment options for radial metaphysis fractures with unstable flexion. Because it prevents bridging the radiocarpal joint and directly regulates and maintains the physiological palmar inclination, this technique is becoming more and more popular. Distal fragments can be approached dorsally or volar and are often big and intact enough to offer sufficient support. Because screw support can avoid collapse or loss of the palmar inclination, palmar plate osteosynthesis is frequently favored. However, smaller distal pieces may require dorsal plate osteosynthesis and are more likely to cause damage to the extensor tendon.

Transformation Of Treatment Methods:

1929 saw the introduction of Bohler's "pin and plaster method," a trans-fixation technique that maintained fracture reduction by using bone pins and plaster cast. This procedure proved to be more effective than previous ones.[10]

- During World War II, **Anderson and O'Neil** invented the use of ligamentotaxis-based external fixation for distal radius fractures.

- 1950s: **James Ellis** promoted open reduction and internal fixation of unstable Smith's fractures and created a T plate for volar Barton's fractures.

In 1989, **John K. Bradway** and colleagues conducted a retrospective evaluation of 16 patients and concluded that the best course of treatment for comminuted intra-articular fractures that are displaced is open reduction and internal fixation, provided that closure is not an option.

- **Fitoussi et al**. concluded that internal fixation offers superior alignment and stability after studying 34 patients who received buttress plates and screws in 1997.

- 2003: After reviewing the available plating alternatives, **Kenneth Swan Jr**. concluded that volar plating was more straightforward and effective than dorsal plating.

- 2005: In order to achieve stable, mobile wrists in complex fractures, **David Ring et al**. examined combined dorsal and volar plate fixation in 25 patients. [11]

- 2006: A number of studies **(Ruch and Papadonikolakis,[12] Gruber et al., Kamath et al., [14]; Simic et al., Rozental and Blazar)** showed that palmar plating was safe and effective for treating unstable distal radius fractures, with good to excellent functional results being frequently attained.

- 2010: **Gerald Gruber et al**. [13] reported that, using the Gartland and Werley grading method, >90% of 54 patients with intra-articular distal radius fractures treated with volar locking plate systems had good to excellent results.

Current Research And Conclusions:

By attaining a dependable anatomical reduction, **Konrath et al.** (2002): Proved that fragment-specific fixation stabilizes unstable distal radius fractures efficiently. This technique produces excellent preliminary clinical and radiological outcomes as well as high patient satisfaction because it permits immediate motion without the need for casting or external fixation.[14]

Donald S. Bae and Mark J. Koris (2005): As a sensible strategy for treating distal radius fractures, they emphasized the efficacy of fragment-specific internal fixation employing small incisions and low-profile implants. [15]

Vlček M, Landor et al. (2011): For intra-articular distal radius fractures, the results of multidirectional plates and angle-stable plates with rigid-direction screw insertion were compared. At a 12-month follow-up, both approaches—applied using the volar approach—exhibited comparable functional and radiological outcomes. [17]

Helmerhorst GT, Kloen (2012): Performed a retrospective review to confirm that in patients with intra-articular distal radial fractures, locking volar plate fixation in conjunction with radial column plating utilizing the extended FCR method produced acceptable radiological and functional outcomes. [18]

In order to promote stability and functional recovery, Abdelgaid et al. (2015) recommended increasing volar plating with Kirschner wire fixation for distal radial fractures including tiny fragments or comorbidities such displaced ulnar styloid fractures or distal radioulnar joint instability. [19]

In the **Benson et al**. study, 81 patients with a mean follow-up of 32 months and 85 intra-articular distal radius fractures treated with fragment-specific fixation are analyzed retrospectively. According to Gartland and Werley scoring, they discovered positive clinical, radiological, and functional outcomes: 61 patients had excellent results, and 24 had good results. Wrist flexion and extension averaged 85% and 91%, respectively, of the undamaged wrist at the final evaluation, while grip strength averaged 92%. With an average result score of 9, the Disabilities of the Arm, Shoulder, and Hand showed generally acceptable functional outcomes. There were no documented incidences of clinical arthritis, and radiographic alignment was preserved. The study emphasizes fragment-specific fixation's capacity to produce stable fixation and positive patient outcomes in terms of strength, range of motion, and radiological integrity in order to justify its use as a practical management strategy for intra-articular distal radius fractures. [20]

Ferozkhan et al. conducted an observational study from July 2021 to June 2022 to examine the results of fragment-specific fixation in 62 cases of distal radius fractures over a 12-month follow-up period. With a mean age of 39.90 years and a preponderance of male participants (54.8%), the participants were treated based on exclusion criteria that excluded patients with neurovascular damage or coma. The two main causes of the fractures were slip-and-fall incidents (25.8%) and vehicular accidents (74.2%). The mean ranges of motion for the following functional outcomes were determined by utilizing Constant-Murley and DASH scores: palmar flexion (56.77°), dorsiflexion (62.90°), radial flexion (17.39°), and ulnar deviation (23.77°). According to the results, 29% had good outcomes and 71% had exceptional ones. According to the study's findings, fragment-specific fixation is a dependable course of therapy for distal radius fractures, supporting both patient satisfaction and the achievement of positive functional outcomes.[21]

Medoff created a hybrid technique of percutaneous wire and plate fixation, which fixes each fragment individually by making several tiny incisions. The findings of our investigation showed that approximately 19.4% had the dorsal wall, 12.9% had the radial column, 41.9% had the palmar edge, 6.5% had both the palmar edge and the dorsal wall, and 19.4% had both the palmar edge and the radial column. This methodology was dubbed the "Medoff technique." [22] Jawed et al.'s study revealed that 23% of patients experienced difficulties when they took a survey. [23]

Malunion, persistent soreness, stiffness, and paresthesia with tingling are some of these aftereffects. Saw et al. [24]have observed complications such paresthesia, avascular necrosis, distal radioulnar joint syndrome, instability, and complex regional pain syndrome.

Approximately 13% of lunate disc fractures may not be reduced with standard volar plating. It might be essential to position the plate far away from the fragments while using volar plating in order to catch the pieces. [25]

Consequently, hardware-induced pain is prevalent in this region and can arise in as many as 41% of fractures. [26]

According to a study by **Paramesha and Bansal**, thirty patients had returned to their pre-accident activity levels within six months, and thirty patients had mended their fractures within three months. [27]

The results of a study by Ganesan and Mohan showed that the mean degree of palmar flexion was 57.1 ± 3.5, dorsiflexion was 63.3 ± 3.2, radial deviation was 17.6 ± 3.0, and ulnar deviation was 24.1 ± 4.4. [28]

Gavaskar et al. sought to evaluate the efficacy of a Synthes locking distal radius system in treating AO type C distal radius fractures by means of 2.4 mm column-specific plating. Over a one-year period, they evaluated 105 patients, concentrating on clinical outcomes such as grip strength, radial length and inclination, volar tilt, wrist and forearm range of motion, and ulnar variance. Additionally, they examined functional scores and radiological indicators (Disabilities of the Arm, Shoulder, and Hand; Patient Rated Wrist Evaluation).Seventy-five percent of the patients received anatomically rebuilt articular surfaces after achieving union in all cases. Throughout the first year, there were constant advancements in both clinical and functional outcomes, with C1 fractures showing superior anatomical reduction compared to C2 and C3 fractures. It's interesting to see that degenerative alterations, reduction quality, and fracture type had no discernible effects on functional outcomes. According to the study's findings, column-specific plating presents a workable strategy for treating complicated intra-articular distal radius fractures with satisfactory outcomes. [29]

The objective of the study by **Babikir et al**. (30) was to assess the effectiveness of fragment-specific fixation in the treatment of comminuted intra-articular distal radius fractures at Hamad General Hospital throughout the three years between 2010 and 2013. The fractures were precisely AO type C2 fractures. A one-year follow-up was conducted on 25 patients who were part of this retrospective chart analysis. The cohort, which was 88% male and had a mean age of 42, was largely injured in falls, most of which were related to work. Injuries to the left wrist were more common, especially to the non-dominant hand. Wrist metrics showed statistically significant improvements after surgery, with supination and pronation showing advances at six weeks ($p = 0.04$ and 0.03 respectively). Grip strength increased significantly, reaching about 76% of the unaffected side. Fragment-specific fixation is a feasible treatment option for these fractures, according to the study's findings, as it preserves post-operative wrist alignment and promotes early rehabilitation while offering good clinical, radiological, and functional results.

50 patients with mostly nonreducible or subsequently redisplaced distal radius fractures were randomly assigned to receive either fragment-specific fixation ($n = 25$) or volar locking plates ($n = 25$) in a randomized research by **Landgren et al**[31]. Patients underwent a year-long follow-up to evaluate a variety of outcomes, including pain levels, grip strength, range of motion, Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) scores, and radiographic examinations.. The patients' mean age was 56 years (range, 21–69 years). Comparable grip strength was seen amongst the groups after 12 months, with the fragment-specific fixation group obtaining 87% and the volar locking plate group achieving 90% of grip strength in comparison to the undamaged side. The median QuickDASH score and range of motion did not differ

significantly. In contrast to the volar locking plate group (21%), the fragment-specific fixation group reported a greater rate of complications (52%). According to this study, the functional outcomes of both treatment approaches appear to be comparable; however, while choosing a course of action for distal radius fractures, surgeons should consider the potential risks of fragment-specific fixation.

NORMAL DISTAL RADIUS AND WRIST JOINT ANATOMY

The Distal Radius Anatomy[32]

The radius widens distally and has a quadrilateral cross-section at its distal end.

Important anatomy features consist of:

- Lateral Surface: The pyramidal styloid process extends distally and has a little rough surface.
- Inferior Surface: Smooth and articular, with a ridge dividing the concave portions into medial (ulnar) and lateral (scaphoid) areas. The lateral area articulates with the scaphoid, and the ulnar area with the lunate.
- Ulnar Surface: Has a notch that allows it to articulate with the ulna's head. Above this gap, the interosseous membrane joins to a triangular region bounded by anterior and posterior ridges.
- Anterior Surface: There is a noticeable ridge that is perceptible around 2 cm from the thenar eminence.

The dorsal tubercle of Lister is located on the posterior surface and can be felt in line with the cleft that separates the middle and index fingers. On this area, the extensor digitorum tendons are situated beneath the posterior interosseous nerve.

- Extensor Retinaculum: Deep fascia that has thickened and is attached to the anterior surface of the lateral ridge. It creates compartments for extensor tendons.

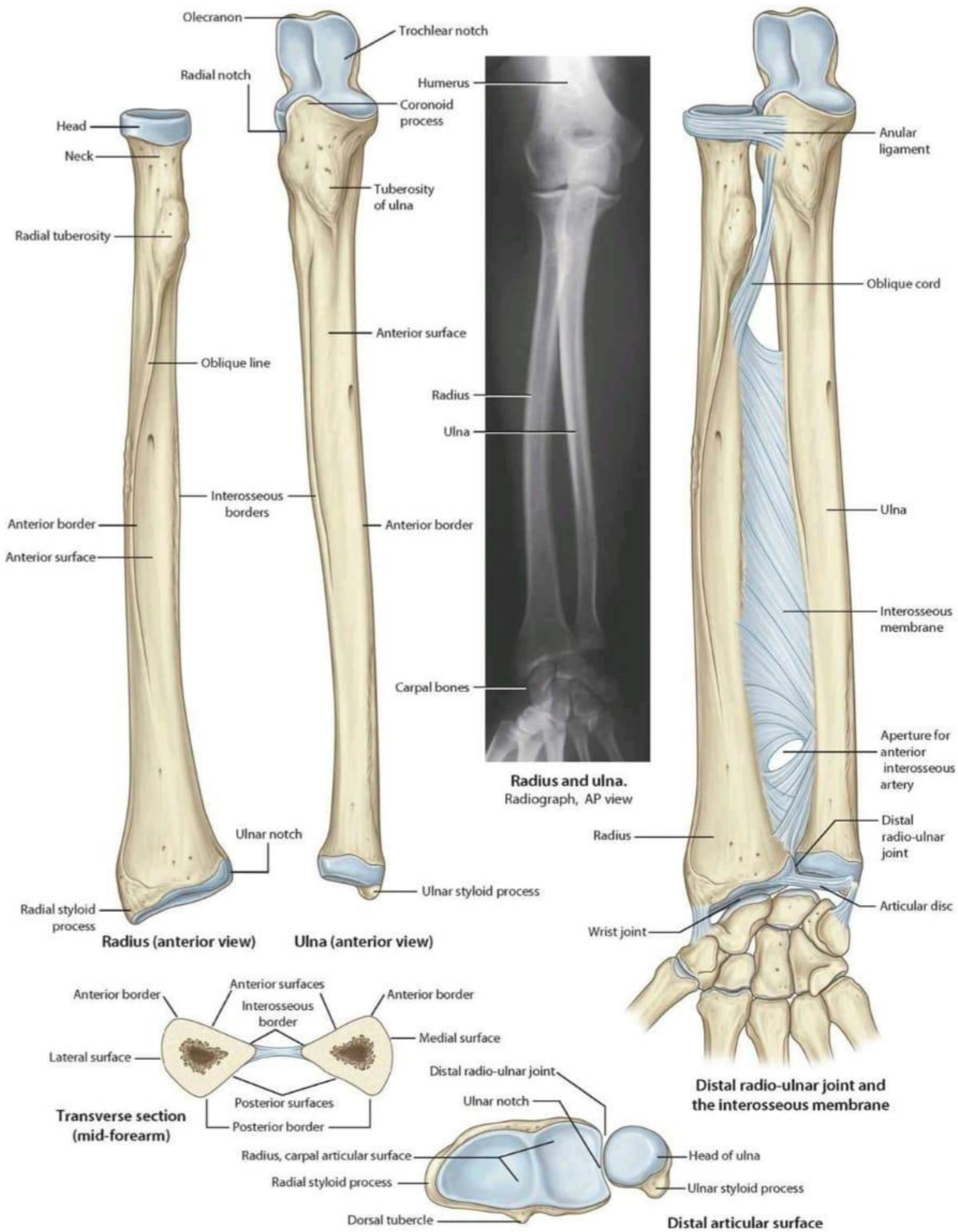


FIGURE 1: Distal radius anatomy

Wrist Joint Anatomy:

The radiocarpal (wrist) joint belongs to the ellipsoid class and is bi-axial. Among its constituents are:

- Articular Surfaces: Made up of the articular disc, the distal end of the radius, and the triquetral, lunate, and scaphoid bones.

- A modest ridge divides the joint's two concavities on its radial surface.

- The lunate, triquetral, and scaphoid bones' proximal surfaces fit into the radial concavity and are convex.

- Articular Capsule: Usually distinct from the synovial membranes of the inferior radio-ulnar and intercarpal joints, this capsule is lined. Ventral to the articular disc is a pre-styloid recess.

Ligaments:

- Palmar Radiocarpal Ligament: Broad band that extends distomedially to the scaphoid, lunate, and triquetral bones, and is linked to the anterior edge of the distal radius and its styloid process.

- Palmar Ulnocarpal Ligament: rounded fascicle that originates at the base of the ulnar styloid process and extends to the lunate and triquetral bones.

- Dorsal Radiocarpal Ligament: Attached to the dorsal surfaces of the scaphoid, lunate, and triquetral bones below and the posterior border of the distal radius above, this ligament is weaker and thinner than the palmar ligament.

- Ulnar and Radial Collateral Ligaments: Connecting to the ulna and radius, respectively, these ligaments provide the stability of the wrist joint.

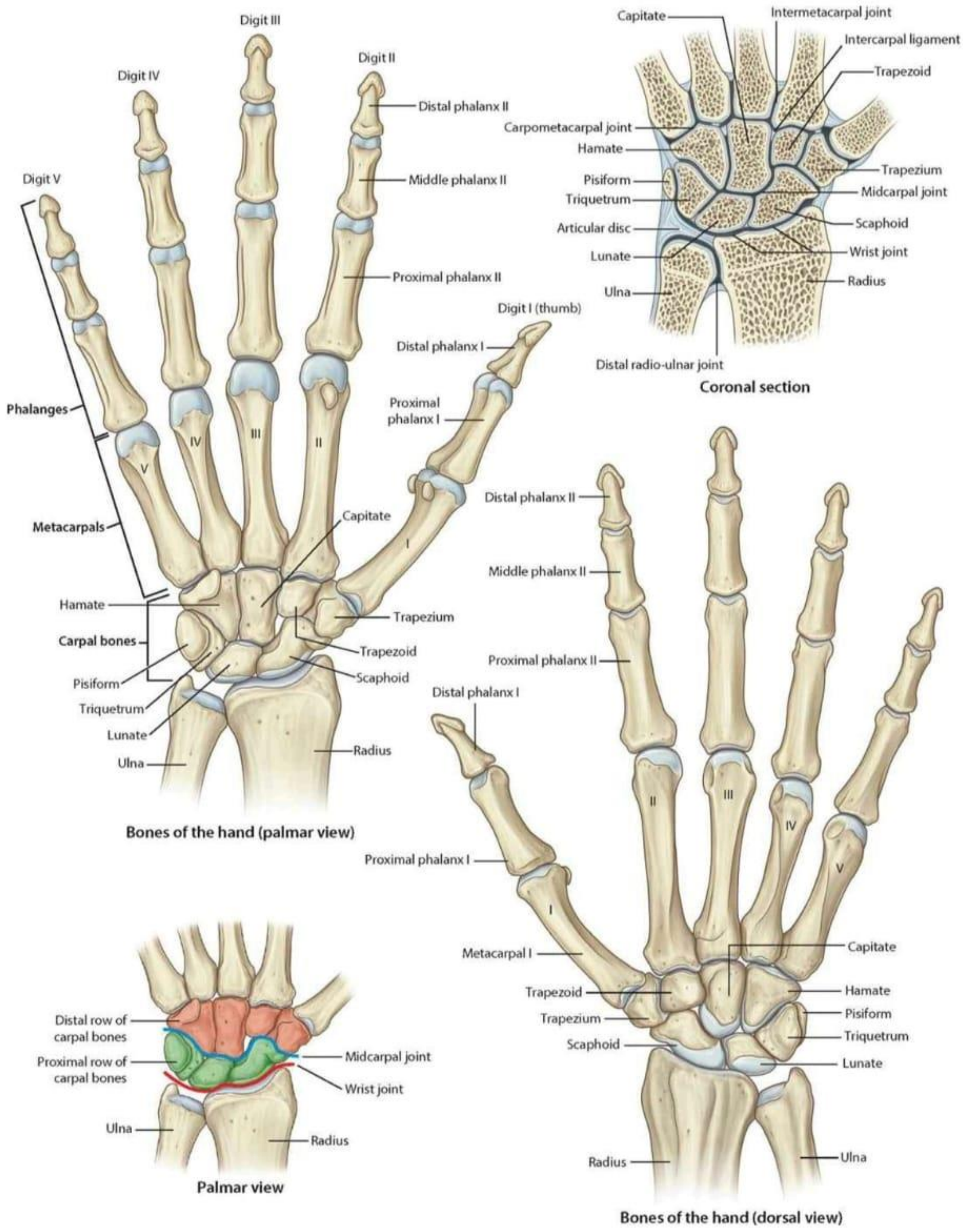


FIGURE 2: Wrist joint anatomy

The Distal Radioulnar Joint and Wrist Movements and Anatomy

Wrist and intercarpal joint movements:

The radiocarpal and midcarpal joints, which make up the wrist joint, permit the following motions that are mostly controlled by muscular activity:

- Flexion (Palmar Flexion): This ranges from about 60° to 65°, using the midcarpal and radiocarpal joints, with the midcarpal joint exhibiting more movement.

- Extension (Dorsiflexion): Ranges between 70° and 75°, mostly at the radiocarpal joint as a result of the scaphoid and lunate bones' proximal surfaces extending.

- Adduction (Ulnar Deviation): Most movement occurs at the radiocarpal joint, with a range of about 30° to 35°.

- Abduction (Radial Deviation): Mostly at the midcarpal joint, ranges between 20° and 25°. The capitate rotates around an anteroposterior axis during abduction.

Distal Radioulnar joint :

The radius's sigmoid notch and the ulna's circular head articulate at the distal radioulnar joint, which is a trochoid or pivot joint. Important functional and anatomical features include:

- Triangular Fibrocartilage Complex (TFCC) Anatomy:

- The articular disc (triangular fibrocartilage), ulnar collateral ligaments, dorsal and volar radioulnar ligaments, and additional supportive structures are all part of the TFCC.

- It originates from the ulnar aspect of the lunate fossa of the radius and is inserted into the base of the ulnar styloid to provide stability and gliding surfaces for wrist movements.

-Articular disc's ability to heal is impacted by its biconcave shape, which makes the center region avascular and the perimeter thicker.

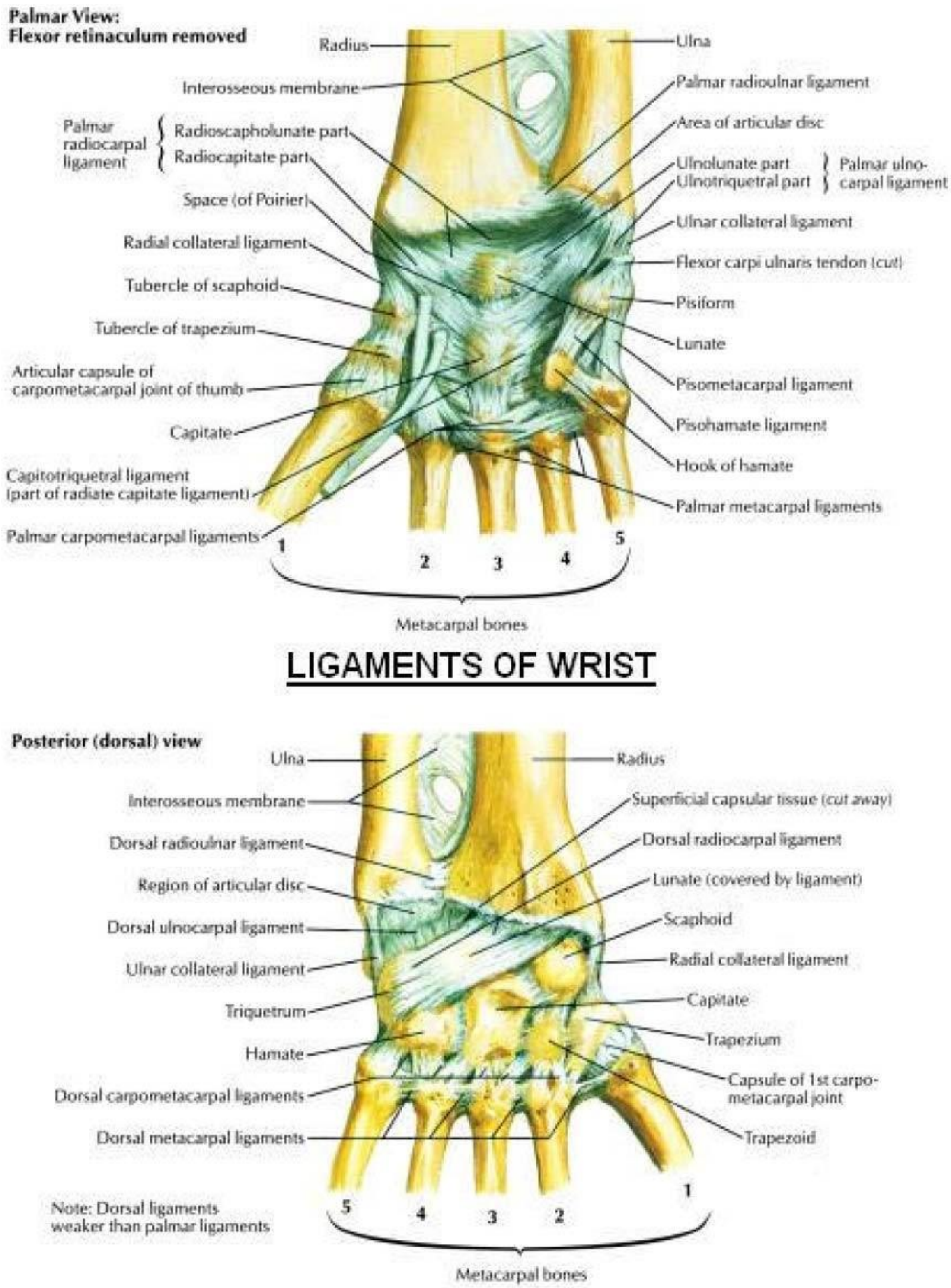
- TFCC Functions:

1. gives the wrists a smooth surface to glide over when they flex, extend, and translate.
2. stabilizes the radioulnar joint, allowing the forearm to rotate more easily.
3. sustains and suspends the ulnar carpus from the radius's dorsal surface.
4. cushions and absorbs stresses applied to the ulnocarpal axis.
5. preserves the integrity of the joint by firmly joining the volar carpus to the ulnar axis.

Clinical Consequences:

Distal radius fractures frequently result in complex disturbances of the distal radioulnar joint, which makes careful restoration of radial length and TFCC integrity necessary to preserve wrist function and stability. For wrist injuries and disorders to be effectively diagnosed, treated, and rehabilitated, it is essential to comprehend these anatomical characteristics.

Figure 3 LIGAMENTS OF WRIST:



BIOMECHANICS OF WRIST

The three-column concept is a helpful biomechanical model for understanding the biomechanics of wrist fractures. The radial column includes the radial styloid and scaphoid fossa, the intermediate column consists of the lunate fossa and sigmoid notch (distal radioulnar joint, DRUJ) and the ulnar column comprises the distal ulna (DRUJ) with the triangular fibrocartilaginous complex (TFCC).

1. Radial column (RC)

2. Intermediate column (IC)

3. Ulnar column (UC)

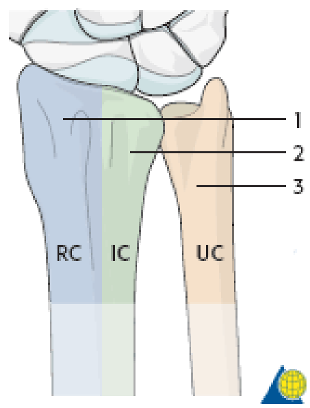


Figure 4: The three column concept

Biomechanics of the Wrist and Distal Radioulnar Joint [33,34]

Distal Radioulnar Joint Mechanics:

The ulnar carpal motion, pronation, and supination depend on the distal radioulnar joint (DRUJ). The ulnar head rolls and slides from the dorsal to the volar margin of the sigmoid notch during pronation and supination. The triangular fibrocartilage complex (TFCC) plays a pivotal role, initially taut dorsally and then volarly, supporting these movements.

Wrist Function and Anatomy:

The radius and its carpal and ulnar articulations must be aligned and intact for the wrist to function. The medial midcarpal complex and radiocarpal joint work like a "Link Joint," similar to a bicycle chain that is stable under tension and in the right alignment. These joints withstand longitudinal compression better when aligned, distributing pressure more evenly across articular surfaces.

The carpal bones are functionally divided into four units, Trapezium, Scaphoid, Hamate, Capitate, and Trapezoid, Triquetrum, and Lunate.

These units are loosely packed and mobile in most manual positions but form a rigid block in full extension (closed packed position), transmitting substantial forces during activities like resisting falls.

Ulnar Variance and Load Distribution:

Ulnar variance, the length difference between the radius and ulna at the wrist, affects load distribution across the joint. A neutral variance (0) distributes load 80% to the radiocarpal and 20% to the ulnocarpal joint. Positive variance (ulna shorter) reduces load transfer to the ulnar head, while negative variance (ulna longer) increases load transfer through the ulna.

Triangular Fibrocartilage Complex (TFCC) and Stability:

The TFCC stabilizes the DRUJ and ulnar carpus, providing:

1. Smooth gliding surfaces for wrist movements.

2. Stability for forearm rotational motions

3. The dorsal surface of the radius provides support for the ulnar carpus.

4. Force absorption along the ulnocarpal axis.

Stability is further maintained by ligaments such as the dorsal and volar radioulnar ligaments and the dorsal retinaculum. These ligaments prevent excessive play between the radius and ulna, crucial for maintaining joint integrity and function.

Understanding the biomechanics and anatomy of the wrist and DRUJ is essential for diagnosing and treating injuries like fractures and ligamentous disruptions, ensuring optimal functional outcomes.

PATHOANATOMY

Pathoanatomy of Distal Radius Fractures [35]

Mechanism of Injury:

Distal radius fractures typically occur due to a fall onto an outstretched hand, where the prominent thenar eminence absorbs much of the impact force. The fracture occurs while the triangular fibrocartilage complex (TFCC) is intact, involving a rotational element around the ulnar styloid. Continued force can lead to avulsion of the ulnar styloid, resulting in various displacement patterns of the distal radius.

Types of Distal Radius Fractures:

1. Colles' Fracture: Characterized by dorsal displacement and usually occurs with the wrist in dorsiflexion (>40° to 90°). It involves impaction, lateral or dorsal displacement, rotation, and sometimes supination of the distal radius.

2. **Smith's Fracture:** Also known as a reverse Colles' fracture, arises from a fall onto the dorsum of a flexed wrist, resulting in the distal radioulnar joint's possible dislocation as well as palmar displacement of the distal radial fragment.

3. **Barton's Fracture:** This fracture variant involves the articular surface of the distal radius, either dorsally (dorsal Barton's fracture) or volarly (volar Barton's fracture), often associated with dislocation or subluxation of the carpus.

4. **Die Punch (Lunate Load) Injury:** These are impacted intra-articular fractures where significant force impacts the carpus, causing fractures that can lead to posttraumatic arthritis if not restored with proper alignment. [36,37]

Biomechanical Considerations:

- Majority of distal radius fractures are extra-articular (outside the joint).
- Intra-articular fractures are more unstable, often associated with ligamentous injuries.
- The force required to cause a distal radius fracture varies but is substantial, particularly in dorsiflexed wrists, ranging from 105-440 kg.

Clinical Implications:

- Common complications include associated injuries to the ulnar styloid (60%), TFCC tears (50%), and carpal fractures (12%).
- Treatment goals include anatomical reduction to restore joint congruity and stability, especially in young adults to prevent posttraumatic arthritis.

DISTAL END RADIUS FRACTURE CLASSIFICATION

Originally, the name of distal end radius fractures was given to the surgeon who made the diagnosis. This posed an issue, though, as the fractures were originally reported by the named surgeon without radiographs being accessible. The original radiographs' appearance served as the basis for the development of a new categorization scheme.

A perfect categorization system should have predictive value, be reproducible, descriptive, and aid in communication as well as clinical decision-making and treatment planning.

These classifications have been based on:

I. The fracture displacement direction or appearance on radiography.

   a. AO classification
   b. Lidstorm classification.

II. Mechanism of injury.

   a. Fernandez classification

III. Articular joint surface involvement.

   a. Mayo classification
   b. McMurtry and Jupiter classification
   c. Melone classification.

IV. Degree of comminution:

   a. Gartland and Werley classification.
   b. Older classification.

Frykman's classification was established in 1967. It identified the involvement of radiocarpal and radioulnar joints and the presence or absence of ulnar styloid fracture.

FRYKMAN'S CLASSIFICATION OF DISTAL RADIUS FRACTURES [39] (1967):

Fractures	Ulnar styloid Fracture Absent	Ulnar styloid Fracture Present.
Extra-articular	I	II
Intra-articular involving Radiocarpal joint	III	IV
Intra-articular involving Radioulnar joint	V	VI
Intra-articular involving both Radiocarpal and radioulnar joints	VII	VIII

FRYKMAN'S CLASSIFICATION OF DISTAL RADIUS FRACTURES[39]

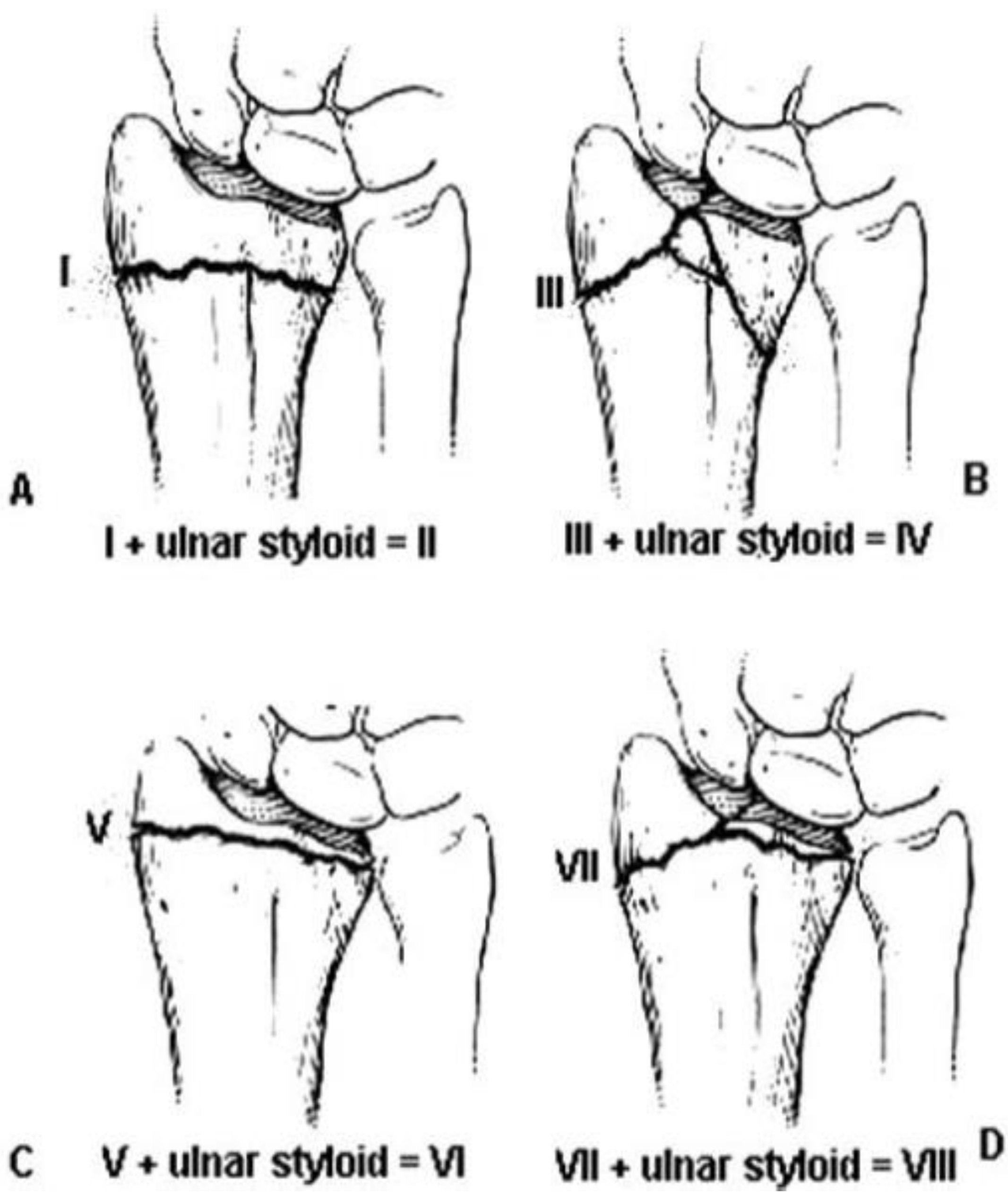


FIGURE 5:-FRYKMAN"S CLASSIFICATION

GARTLAND AND WERLEY CLASSIFICATION (modified by Sarmiento [40]1975):

TYPE	FEATURE
Type IA	Extra-articular undisplaced
Type IB	Extra-articular displaced
Type II	Intra-articular undisplaced
Type III	Intra-articular displaced

FERNANDEZ CLASSIFICATION [41](1992) :

FRACTURE-TYPE	MECHANISM OF INJURY
Type I	Bending
Type II	Shear
Type III	Compression
Type IV	Avulsions fracture, radiocarpal fracture, dislocations
Type V	Combined

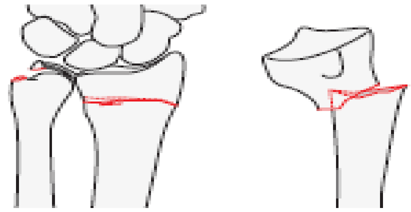
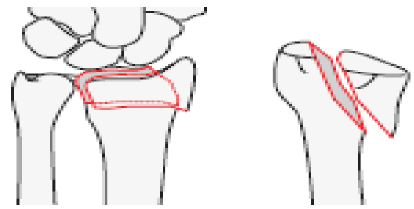
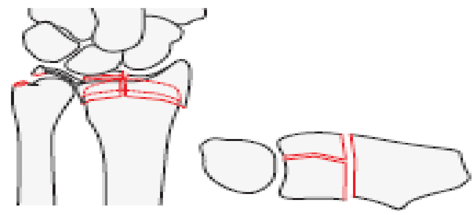
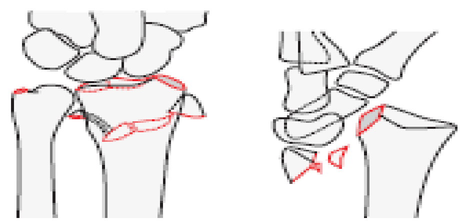
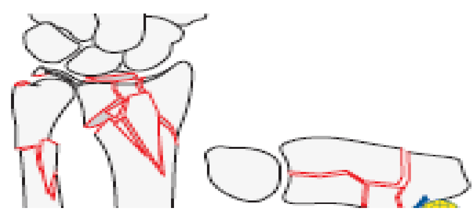
Type I Bending fracture of the metaphysis	
Type II Shearing fracture of the joint surface	
Type III Compression fracture of the joint surface	
Type IV Avulsion fractures, radiocar-pal fracture, dislocation	
Type V Combined fractures (I, II, III, IV); high-velocity injury	

FIGURE 6:- FERNANDEZ CLASSIFICATION

McMURTRY AND JUPITER CLASSIFICATION [42] (1991):

- Two parts: The other half of the radiocarpal joint is still whole. (Die punch, Chauffeur, and dorsal or palmar Barton fractures).
- Three parts: divided lunate and scaphoid facets, as well as the proximal portion of the radius.
- Four parts: The lunate facet is further fragmented into dorsal and volar fragments, otherwise it is the same as the three parts.
- Five parts: Including a wide variety of comminuted fragments.

MELONE'S INTRA-ARTICULAR FRACTURE CLASSIFICATION [43]:

Melone discovered that a large number of intra-articular fractures have both displacement and instability in particular patterns. He realized that three or four components are often present in intra-articular fractures.

Type I : Intra-articular type Undisplaced with minimal comminution.

Type II: Anterior or posterior displacement of die punch fracture.

Type III: Radial shaft element with the previously mentioned results

Type IV: Transverse split fracture with rotation.

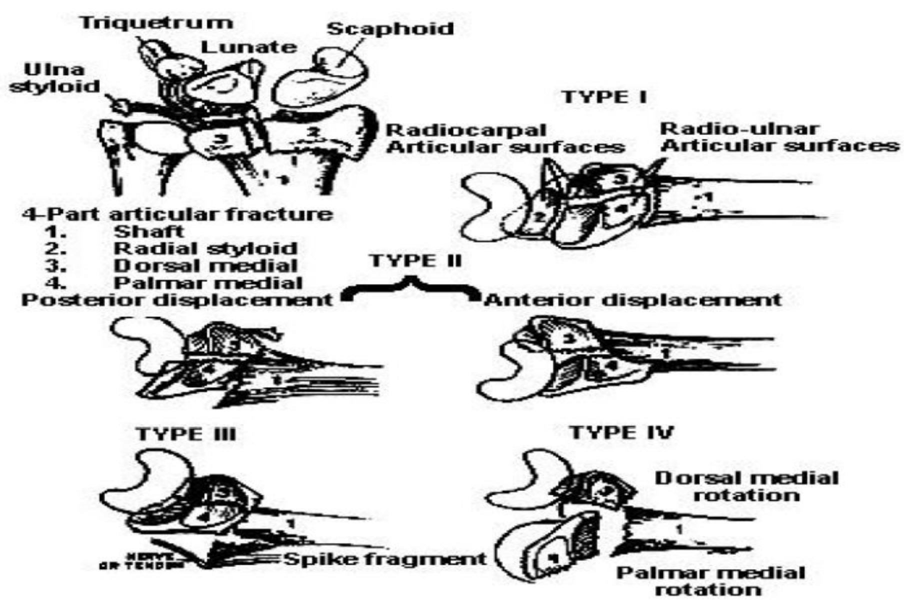


FIGURE 7: MELONE CLASSIFICATION

MAYO CLASSIFICATION OF INTRA-ARTICULAR FRACTURES [44]:

The primary aim of the Mayo and Melone classifications is to highlight the components of intra-articular fractures that require treatment in addition to the fracture involving the metaphysis and radial shaft.

Type-I: Radiocarpal extra-articular, radioulnar intra-articular.

Type II: The distal radius's intra-articular scaphoid fossa.

Type-III: Sigmoid fossa + intra-articular lunate fossa of distal radius.

Type IV: The distal radius's intra-articular, scaphoid, lunate, and sigmoid fossas.

LIDSTROM CLASSIFICATION [45]:

Type-I : Undisplaced.

Type-II:

A. Extraarticular Dorsal angulation.
B. Intraarticular but without gross separation of fragments with Dorsal angulation
C. Extraarticular with dorsal angulation and dorsal displacement.
D. Dorsal angulation plus dorsal displacement, intraarticular but without gross separation of fragments.
E. Dorsal angulation plus dorsal displacement, intraarticular with separation of fragments.

Older et al. Classification of Distal Radius Fractures [44]

The Older et al. classification system categorizes distal radius fractures based on displacement and comminution of the fracture. Here's an overview of the classification:

Type 1: Non-displaced

- Description: Fractures are non-displaced or have up to 5° dorsal angulation.

- Criteria:

  - Radial articular surface remains at least 2 mm distal to the ulnar head.

Type 2: Displaced with minimal comminution

- Description: Fractures are displaced with dorsal angulation or displacement.

- Criteria:

  - Radial articular surface is no lower than 3 mm proximal to the ulnar head.

  - Minimal comminution of the dorsal radius may be present.

Type 3: Displaced with comminution of dorsal radius

- Description: Fractures are displaced with significant comminution of the dorsal radius.

- Criteria:

  - Comminution of the dorsal radius is evident.

  - Radial articular surface remains proximal to the ulnar head.

  - Minimal comminution of the distal fragment.

4: Displaced with severe comminution of radial head

- Description: Fractures are severely displaced with marked comminution of both the dorsal and distal radius.

- Criteria:
  - Severe comminution of the dorsal and distal radius is present.
  - Radial articular surface is 2-8 mm proximal to the ulnar head.

Clinical Relevance

- Treatment Guidance: This classification helps in determining the appropriate treatment approach, whether conservative or surgical, based on the degree of displacement and comminution.
- Prognostic Indicators: It provides insights into potential outcomes and complications associated with each type of fracture.
- Communication: Orthopedic surgeons use this classification to communicate effectively about the fracture pattern and severity among medical professionals.

UNIVERSAL CLASSIFICATION:

It was proposed at the Symposium Conference on Distal Radius Fractures in 1990. This classification system was broadly based on the simple concepts and principles of extra-articular versus intra-articular, and stable versus unstable fractures.

Type I: Extra articular, undisplaced

Type II: Extra articular, displaced

A. Reducible, stable

B. Reducible, unstable

C. Irreducible

Type III: Articular, undisplaced

Type IV: Articular, displaced

A. Reducible, stable

B. Reducible, unstable

C. Irreducible

D. Complex

UNIVERSAL CLASSIFICATION

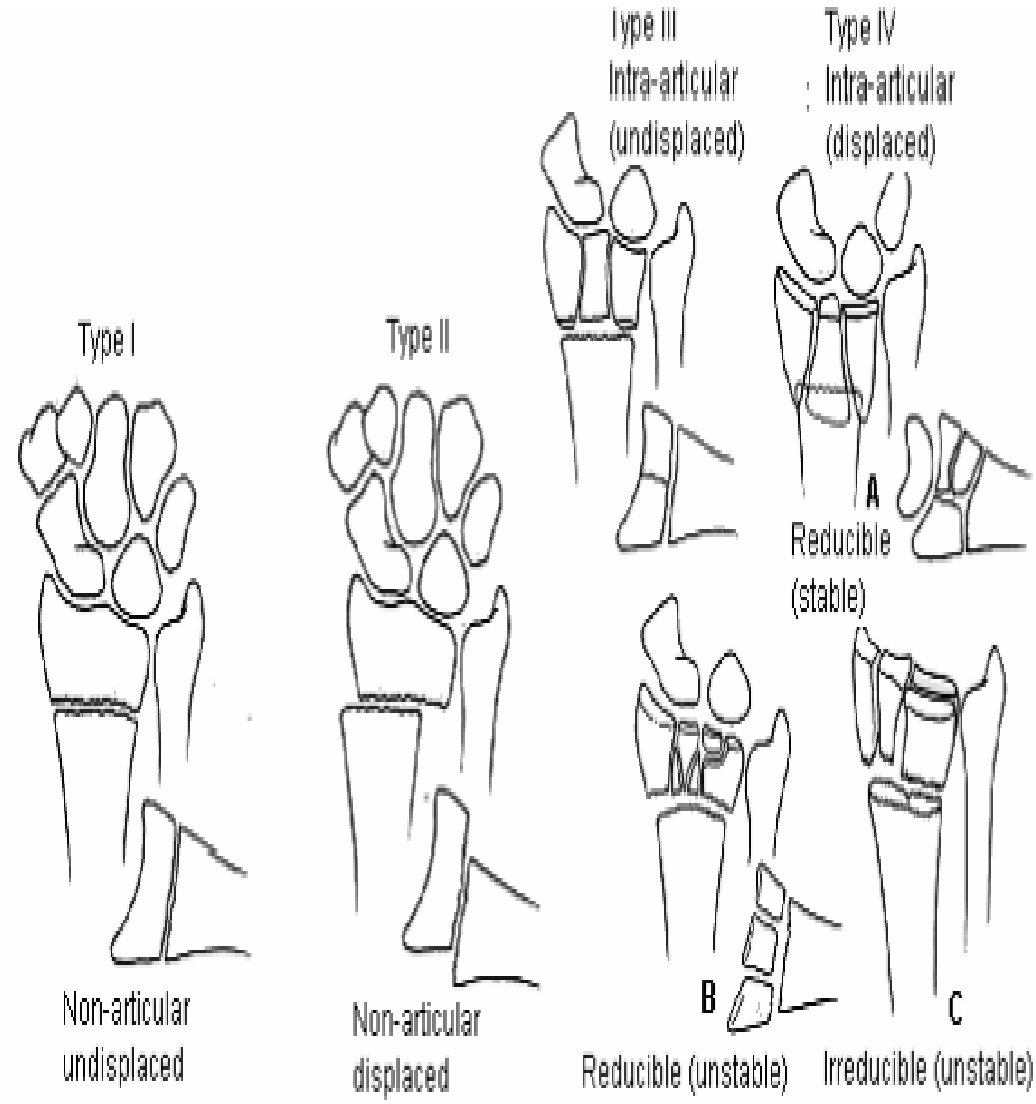


FIGURE 8:- UNIVERSAL CLASSIFICATION

AO CLASSIFICATION OF DISTAL RADIUS FRACTURES [46,47]

The AO classification system categorizes distal radius fractures based on the severity of osseous and articular involvement. Here's an overview of the classification:

Type A: Extra-articular Fractures

- **A1**: Extra-articular fractures distal to the ulna.
- **A2**: Extra-articular fractures distal to the radius.
- **A3**: Multi-fragmentary extra-articular fractures distal to the radius.

Type B: Partial Articular Fractures

- **B1**: Chauffer's fractures (radial styloid fractures resulting from avulsion forces).
- **B2**: Dorsal Barton's fracture (fracture involving the dorsal margin of the articular surface of the distal radius, often associated with dorsal dislocation or subluxation of the carpus).
- **B3**: Volar Barton's fracture (fracture involving the volar margin of the articular surface of the distal radius, often associated with volar dislocation or subluxation of the carpus).

Type C: Articular Fractures

- **C1**: Simple articular and metaphyseal fractures.
- **C2**: Simple articular and complex metaphyseal fractures.
- **C3**: Complex articular and metaphyseal fractures.

Clinical Relevance

- **Treatment Considerations**: The AO classification helps guide treatment decisions by providing a structured way to assess fracture severity and complexity.
- **Prognostic Value**: It also aids in predicting outcomes and potential complications associated with different fracture types.
- **Surgical Planning**: Surgeons use this classification to determine the appropriate surgical approach and fixation methods needed for optimal fracture reduction and stability.

Understanding the AO classification system is essential for orthopedic surgeons and healthcare providers involved in the management of distal radius fractures, ensuring a systematic approach to treatment planning and patient care.

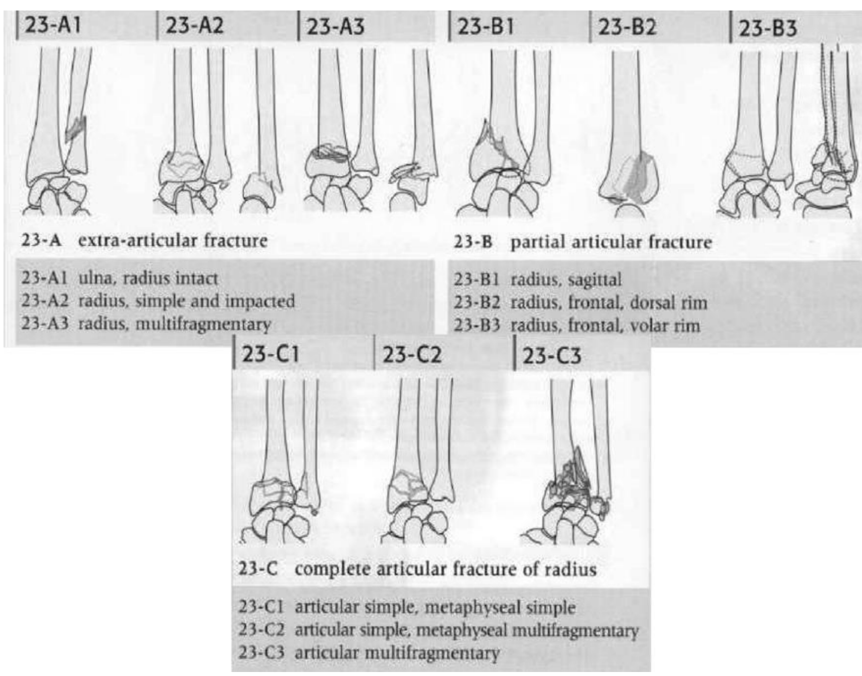


FIGURE 9:- AO CLASSIFICATION

RADIOGRAPHIC EVALUATION

Radiographic evaluation plays a crucial role in assessing distal radius fractures, guiding treatment decisions and predicting outcomes. Here's a detailed overview based on your provided information:

Radiographic Views

Standard x-ray views used for evaluating distal radius fractures typically include:

1. **Anteroposterior (AP) View:**
   - concave inferior articular surface of the distal radius which extending down to the tip of the ulnar styloid process.
   - Key parameters assessed: radial inclination, radial length, radial shift (tilt).
2. **Lateral View:**
   - Provides a side view of the radius, assessing dorsal or volar tilt of the distal fragment.
3. **Oblique View:**
   - Offers additional perspective to evaluate complex fractures, particularly to assess for articular involvement and displacement.

FIGURE 10:- X RAY DISTAL END RADIUS FRACTURE AP AND LATERAL

Radiograph of a dorsally displaced DRF (Colles' fracture), lateral and posteroanterior (PA) views

Radiographic Measurements

1. **Radial Angulation (Inclination):**
   - Measures the angle of the distal radial articular surface relative to a line perpendicular to the long axis of the radial shaft.
   - Average: 23 degrees (range 13 to 30 degrees).

2. **Radial Length:**
   - Compares the length of the radius to the ulna by measuring the distance in between lines drawn perpendicular to the long axis of the radius.
   - Average: 11 mm (range 8 to 18 mm).
3. **Ulnar Variance:**
   - Measures the vertical distance in between the distal ends of the medial corner of the radius and the ulnar head.
   - Average: 0 to -2 mm.
4. **Radial Shift (Tilt):**
   - Describes the displacement of the distal radius in comparision to the radial shaft.
   - Average: 11 degrees (range 0 to 28 degrees).

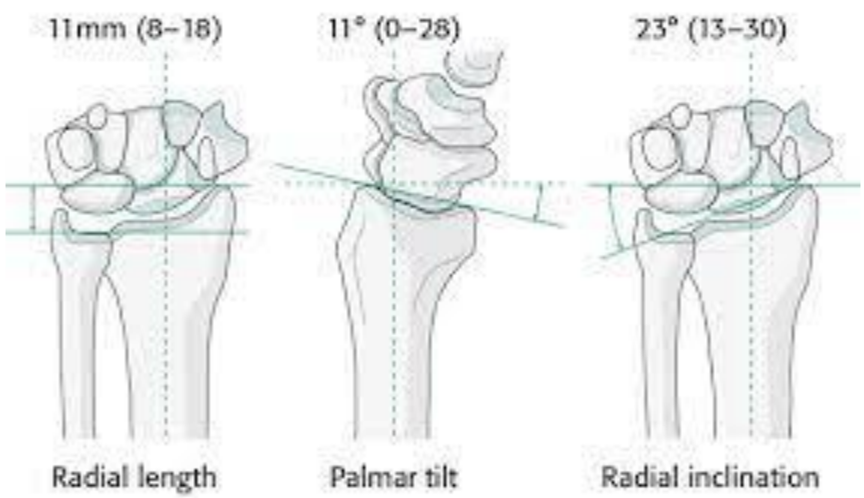


FIGURE 11:- DISTAL END RADIUS ANGLES

Guidelines for Acceptable Closed Reduction

Radial Inclination: ≥ 15° on the AP view.

- **Radial Length:** ≤ 5 mm shortening on the AP view.
- **Radial Tilt:** < 15° dorsal or < 20° volar tilt on the lateral view.
- **Articular Congruity:** < 2 mm step-off.

Radiographic Signs of Unstable Fracture [48,49]

These signs indicate that closed reduction alone may not be sufficient, necessitating careful consideration for surgical intervention:

1. **Dorsal Comminution:** > 50% of the width laterally.
2. **Palmar Metaphyseal Comminution.**
3. **Initial Dorsal Tilt:** > 20 degrees.
4. **Initial Displacement (Fragment Translation):** > 1 cm.
5. **Initial Radial Shortening:** > 5 mm.
6. **Intra-articular Disruption.**
7. **Associated Ulna Fracture.**
8. **Severe Osteoporosis.**

VARIOUS MODALITIES OF TREATMENT

The major goals of treatment are to precisely reduce the fracture and then keep it there while protecting the wrist in a way that allows the hand to heal and heal. Treatment methods that are advised include bandaging and different types of surgical fixation, such as using bone cement.

The various methods are.

1) Splints
2) Different methods of cast application
3) Percutaneous pinning.
4) Pins and plaster.
5) External skeletal fixation.
6) Open reduction and internal fixation.

Splints:

William Cassebaum (1950) Study:

- **Treatment:** Used dorsal and volar splints following closed manipulation for Colle's fractures.
- **Outcome:** Reported good functional results in 94% of cases.
- **Limitations:** Acknowledged that splints could not prevent shifting and shortening of oblique or comminuted fractures.
- **Complications:** Anatomic deformity and painful, disabled hand were common complications despite functional success.

Splints: Effective for many cases of Colle's fractures in achieving good functional outcomes. However, they may not adequately stabilize more complex fractures, leading to deformity and persistent pain. [50,51]

Cast Immobilization:

1. **Small (1965) Study:**
   - **Treatment:** Utilized cast immobilization.
   - **Outcome:** Reported good subjective results, but no differentiation was made between intra-articular and extra-articular fractures or fracture severity.
   - **Limitations:** Lack of distinction limits applicability to more complex intra-articular fractures where specific management may be needed.

- **Cast Immobilization:** Provides subjective relief and support but may not address the nuances of intra-articular fractures or severe comminution.

Cast Application:

1. **Pool (1973):**
   - Compared below-elbow cast vs. high plaster cast.
   - Found below-elbow cast to be better in preventing rotation of fragments.
2. **Bohler (1953):**
   - Recommended fixing the forearm midway between pronation and supination.
3. **Sarmiento (1965, 1975):**
   - Recommended immobilization in supination to minimize displacement.
   - Highlighted the role of the brachioradialis muscle in preventing re-dislocation.

4. **Wahlstrom (1982):**
    - Studied cast positions in pronation, mid-position, and supination.
    - Considered the role of the pronator quadratus muscle in cast immobilization.

Percutaneous Pinning:

- **De Palma (1952) [52]:**
    - Advocated using threaded K-wire for oblique fixation through the ulna into the distal radius.

      Initially reported 18% of results as unsatisfactory.
- **Dowing and Sawyer (1961):**
    - Showed 84% good to excellent results with percutaneous pinning.
- **Recent Studies:**
    - Clancy reported good anatomical reduction and few complications in displaced unstable fractures treated with percutaneous pinning.
- **Intrafocal Pinning:**
    - Described by Kapandji (1976) for unstable extra-articular fractures.
    - Reported good outcomes for intra-articular fractures without displacement.

Pins and Plaster:

- **Bohler (1929) and Green (1975):**
  - Introduced transfixation with skeletal pins incorporated into plaster to maintain reduction.
  - Green documented good or excellent results in 86% of patients, but noted significant complications related to the pins.
- **Complications:**
  - Chapman et al. (noted 1/3rd of complications related to pins, and a substantial need for reoperation in some cases).
- **Evaluation:**
  - While effective in maintaining reduction, complications related to pins have prompted Reassessing this methodology

External Fixation:

- **Roger Anderson (1944):**
  - Described early prototype of external fixator for distal radius fractures.
  - Emphasized maintaining traction to prevent shortening and malunion, especially in elderly osteoporotic bones.

- **Studies and Recommendations:**
  - Cooney et al. (1979) reported excellent outcomes in comminuted intra-articular fractures.
  - Some studies suggest reducing traction after 3 weeks to limit complications like pin tract infections and stiffness.

- **Cast Application:** Various methods exist, with differences in wrist and forearm position affecting outcomes.
- **Percutaneous Pinning:** Effective for stable extra-articular fractures and some intra-articular fractures, with good anatomical outcomes reported.
- **Pins and Plaster:** Historically effective but associated with significant complications related to pins, prompting caution and re-evaluation.
- **External Fixation:** Useful for complex fractures, particularly in elderly patients, but high incidence of complications like pin tract infections.

Each method has its merits and considerations based on fracture type, severity, and patient factors, highlighting the importance of tailored treatment approaches in distal radius fractures. [53,54]

OPEN REDUCTION AND INTERNAL FIXATION

Principles of ORIF for Distal Radius Fractures [55]:

1. **Anatomic Articular Reconstruction:**
    - Essential to prevent long-term complications like arthritis.
2. **Three-Dimensional Joint Orientation:**
    - Restoration is crucial to distribute forces correctly and prevent joint degeneration.
3. **Secure Fixation:**
    - Fixation devices must provide sufficient stability, especially in cases of comminution.
4. **Comminution Management:**
    - Requires stable fixation devices like Kirschner wires or screws to manage instability caused by bone fragmentation.
5. **Buttressing Devices:**
    - Used to prevent displacement by reinforcing the fracture site, particularly without direct fixation into articular fragments.
6. **Optimal Device Placement:**
    - Devices like Kirschner wires and screws should ideally be inserted perpendicular to the fracture site for maximal resistance to shear stress.
7. **Role of Bone Graft:**

- Supports structural integrity and aids in healing, especially when there is significant comminution or bone loss.

8. **Neurovascular Assessment:**
   - Essential pre-operatively and post-operatively to monitor for and prevent complications related to nerve or vascular compromise.

Indications for ORIF:

1. **Extra-articular Fractures:**
   - Particularly those with extensive soft tissue involvement or irreducible due to soft tissue interposition.
2. **Dorsal and Volar Barton's Fractures:**
   - Displaced fractures of the dorsal or volar rim of the radius.
3. **Displaced Intra-articular Fractures:**
   - Especially when closed reduction fails or when there is significant articular involvement without metaphyseal comminution.
4. **Fractures with Specific Features:**
   - Such as organized hematoma, soft tissue interposition hindering closed reduction, or fractures affecting palmar tilt or radial height.
5. **Complex Fractures:**
   - In cases involving bilateral injuries or when there is dysfunction in the contralateral limb.

Historical Studies and Recommendations:

- **Ellis (1965):**

  Promoted ORIF utilizing a T-shaped plate as a volar buttress for volar displaced fractures such as Smith's or Barton's types.

- **Lee BP and Tan CT (1992):**
  - Reported positive outcomes in comminuted intra-articular fractures treated with T-plate fixation, emphasizing pain reduction and functional recovery.

These principles and indications underscore the importance of surgical intervention in achieving anatomical alignment, stability, and functional outcomes in complex distal radius fractures. Each case requires careful consideration of fracture characteristics and patient factors to determine the most appropriate treatment approach.

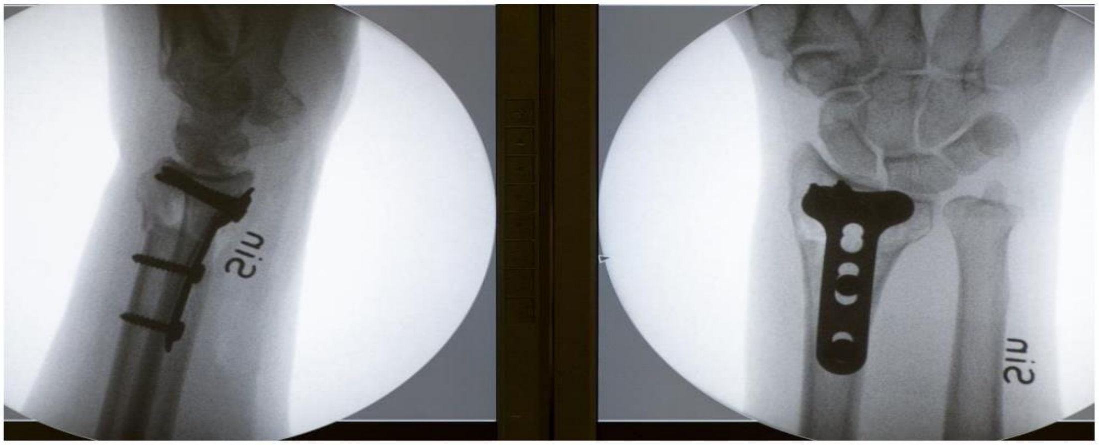


FIGURE 12:- RADIOGRAPHS AFTER VOLAR LOCKING PLATE FIXATION OF A DRF, LATERAL AND APVIEWS

General complications OF DRFs

Complex regional pain syndrome (CRPS) is a condition characterized by abnormal pain, swelling, hypersensitivity, increased or decreased fluid intake, and/or skin temperature after injury.

The etiology is unknown. The risk of CRPS of the hand after DRF is reduced by short operative times, limited tourniquet use, adequate analgesia, and precise occupational therapy.

Carpal tunnel syndrome (CTS) is caused by injury to the median nerve by sharp fracture ends, callus formation, hematoma, or volar plating.

This risk is reduced by proper reduction/preservation of the fracture and proper placement of the volar plate.

Rupture of the extensor pollicis longus tendon in the third dorsal compartment can also occur after nondislocation of the DRF. The etiology is unknown.

MATERIALS AND METHODS

Our study is a series of 32 adult patients with distal radial fractures treated with ORIF using fragment specific fixation. This study was conducted over a period of one and a half year from 1st August 2022- 1st January 2024 in the Department of Orthopedics in B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapura

Source of Data:

The source of data was inpatients at Department of Orthopedics in B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapura.

Study Design: Longitudinal study/ Prospective study

Sample size: 32

With anticipated Proportion of 17% outcome-based range of movements in patients with distal end radius fractures, the study would require a sample size of 17 patients with 95% level of confidence and 15% absolute precision.

The formula to calculate the sample size n is:

$$n = \frac{Z^2 \cdot p \cdot q}{d^2}$$

Where Z= Z statistic at α level of significance

d^2= Absolute error

p= Proportion rate

q= 100-p

After substituting the values the calculated sample size was, n=32

Study Subjects:

Study subjects were adult patients with fracture distal end of radius, visited BLDE hospital.

Inclusion Criteria

- Age group: >18 years both male and female
- **Intra-articular fracture distal end radius with or without ulnar styloid fracture**.
- Closed intra-articular fractures.
- Fracture with trauma <3 weeks.

Exclusion Criteria

- Patients with comorbid conditions preventing surgical intervention
- Patients with local tissue conditions making the surgery inadvisable
- Pathological fractures.
- Compound fractures

- Multiple fractures in ipsilateral limb.

METHOD OF COLLECTION OF DATA:

- Patients admitted in Department of Orthopaedics in B.L.D.E (DEEMED TO BE UNIVERSITY) Shri B.M patil's medical college, Hospital and Research centre, with diagnosis of distal end radius fracture
- By Interview method and clinical examination using Semi-structured pretested and validated questionnaire.

Data Analysis and Statistical methods applied:

Data was entered into an MS Excel spreadsheet and analysed using Epi-Info software. The descriptive data has been presented using descriptive tables, cross tables, bar diagrams, and pie charts in the form of percentages, proportions, and means. Tests like the student t-test and Chi-square/Fisher exact tests were applied to analyse the analytical data and found the association and difference between the two factors/ variables. The alpha error was set at p=0.05, indicating that results with a p-value less than 0.05 were considered statistically significant.

Ethical Committee Clearance: The Proposal was presented to IEC-Institutional Ethics Committee of B.L.D.E. (DEEMED TO BE UNIVERSITY) Shri B.M.Patil Medical College, Hospital and Research Centre, Vijayapura, and obtained the clearance before commencement of the study.

PRE-OPERATIVE EVALUATION

Immediate Management

To ascertain the mechanism of damage and extent of trauma, a thorough medical history was taken by the patient and/or nursing personnel upon admission. Every patient underwent a comprehensive examination. Records were kept of their overall health, related systemic illnesses, and related injuries. Every finding had the proper documentation.

Every patient had their wrist supported on the other side while the afflicted elbow was flexed. The patient was examined closely to check for edema, ecchymosis, and deformities. Tenderness, bone abnormalities, crinkling, and the relative positions of the radial and ulnar styloid processes were all assessed clinically in this patient. Examining the wrist and forearm movements revealed that they were uncomfortable and limited. Pallor, capillary refill, radial arterial pulsation, and paresthesias of the fingertips were used to assess the distal vasculature.

The affected forearm was immobilized and elevated in a POP plate below the elbow. Pain and inflammation were treated with analgesics such as diclofenac sodium 50 mg twice daily.

Pre-operative planning

Hemoglobin percentage, total and differential white blood cell count, blood urea, serum creatinine, bleeding and clotting time, HIV, and HbsAg were all measured by routine blood tests. Albumin and sugar levels in urine were measured.

. Blood pressure of all patients was recorded. Parts preparation was done on the day of surgery. All patients received tetanus toxoid injection and intravenous antibiotics before surgery. Medical suitability was determined for all patients. After a pre-anesthesia examination, the patient was given consent for surgery and the surgery was performed.

RADIOGRAPHIC EXAMINATION

Ap and lateral radiographs were taken to confirm the diagnosis and determine the type of fracture. In some patients with complex comminuted fractures, oblique and 45-degree supination or pronation views were also obtained.

To fully evaluate the pieces, CT scans of the wrist and hand were done on each patient. Analysis of the fracture fragments was done, and the distal radioulnar and radiocarpal joints' involvement was evaluated and categorized using the AO classification. The plan and selection of the technique and plate were made in accordance with the radiologist.

SURGICAL PROCEDURES

From the date of the injury until the date of the operation, the time span varied from 2 to 12 days (averaging 7.06 days).

ANAESTHESIA

20 patients were given Brachial block and 12 patients were given general anaesthesia were used during the procedures. Placement and tourniquet on the operating table, the patient was positioned supine. The afflicted limb was exsanguinated and raised for two to three minutes. After that, the affected limb was placed on a side arm board and a mid-arm pneumatic tourniquet was applied. After being properly cleaned, the forearm and hand were painted with spirit and betadine and covered.

PROCEDURE

Using a volar Henry approach for 10 patients, an extended dorsal approach 12 patients , a direct approach to the radial styloid 7 patients or a combination was used for 3 patients of these depending on the plates used, all instances are treated with locking plates, either alone or in conjunction with or without the use of K wires.

INSTRUMENTS AND IMPLANTS USED

- 2.7 mm distal end radius plates (5 plates)
- K wires
- 2.7 mm and 3mm drill bit and sleeve system
- Power/hand drill
- Tap for 2.7 mm cortical screws and depth gauge
- Hexagonal screw driver for 2.7mm and 3mm screws
- General instruments, such as bone levers, reduction clamps, periosteal elevators, and retractors.
- Pneumatic tourniquet.

❖ **DIFFERENT APPROACHES USED FOR FRAGMENT SPECIFIC FIXATION**

Henry approach :

Usually, the distal extent of the Henry approach is used to make the incision for volar fixation of the distal radius. Between the radial artery and the flexor carpi radialis (FCR) tendon, an incision is made. As this gap widens, the pronator quadratus muscle is visible more away from the wound and the flexor pollicis longus (FPL) muscle closer to it. The tendons of the FCR and FPL are drawn inside toward the ulnar side, and the radial artery is gently drawn outward.

At the most radial aspect, the pronator quadratus is separated, leaving a small cuff of muscle for potential subsequent reattachment. Because the anterior interosseous nerve innervates the FPL on its ulnar side, any elevation of the muscle should be done at its most radial aspect. Reduction procedures can be carried out under direct eyesight once the pronator quadratus has been separated and raised, making the fracture easily visible.

Any volar plate can be used in this manner; in our example, we employed small straight T plates or juxta articular T plates, as well as oblique plates. The same method can even be utilized to radial column plates by expanding the incision.

Direct approach to the radial styloid :

Between the first and second extensor compartments is where the approach is in this case. The floor is formed by the tip of the radial styloid, and the landmarks for the anatomical snuffbox are Extensor Pollicis Longus (EPL) and Extensor Pollicis Brevis (EPB). The superficial branches of the radial nerve are important tissues around the anatomical snuffbox and should be carefully safeguarded during plating of the radial column or Kwiring.

The radial artery should also be safeguarded since it crosses the anatomic snuffbox's floor.

The anatomical snuffbox is covered by a straight incision that is then extended as far proximally and distally as needed. By abrupt dissection, the resulting two skin/subcutaneous flaps are elevated from the deep fascial and extensor retinaculum beneath. The radial nerve's superficial cutaneous branch is recognized and safeguarded. Next, a sharp dissection reveals the radial styloid. If needed, the first and second compartments can be raised. This method uses radial column plates, and the bone is now visible.

Extended dorsal approach :

For joint-spanning plate fixation of comminuted intra-articular distal radius fractures, as well as for wrist fusions, this extended dorsal technique can be applied. Being careful not to damage the superficial radial nerve is important when mobilizing the skin flaps. In the extensor retinaculum, an incision is made across the third compartment parallel to the EPL tendon.

Steer clear of severing the tendon when opening the tendon sheath.

Proximally, the incision is extended in accordance with the EPL tendon. A vessel loop is passed around and the EPL is released. The radial side is where the tendon is pulled.While the compartment itself remains intact, the fourth compartment is elevated subperiosteally. Now that the intermediate column is visible. The ulnar side holds the tendons of the fourth extensor compartment in place.The second extensor compartment tendons are recruited to the radial side if required. This method can be applied to small straight T plates and dorsoulnar plates.

Reduction and fixation of plates :

Pre-operative planning determined the strategy and plates to be utilized, therefore the necessary incisions were made for the necessary plates; nonetheless, the fixation and reduction procedures are the same regardless of the plate being used. K wires were occasionally utilized in conjunction with plates to attain sufficient reduction.

The fracture is reduced and temporarily closed under fluoroscopy using K-wires, reduction forceps, or suture fixation following exposure and debridement of the fracture site. Reduction aids should be positioned to avoid getting in the way of the plate's positioning.

After the fracture is reduced, the suitable plate is chosen.

To temporarily fasten the plate to the proximal fragment, a conventional cortical screw was first inserted into the most distal oval hole of the vertical limb of the plate. As a result, simultaneous proximal and distal plate adjustment was possible. Once the distal piece was secured using subchondral screws, the plate was pushed distally to add radial length as needed. The oval hole is a combination hole made for placing a standard screw at the proximal end and a locking head screw at the distal end of the same hole. The initial standard screw can be replaced with another screw or left in place.

The distal screws should be positioned as well they can be, keeping the fracture fragment in place by inserting them at the radial styloid, under the lunate facet, and close to the sigmoid notch. Bi cortical or mono cortical engagement is possible for the distal screws. As much voluntary flexion of the wrist as feasible by an assistance can result in more volar tilt during the distal screw installation process. Further improvement of radial length can be achieved by pushing the entire plating system distally, with the oval plate hole and screw acting as a glide.

Using fluoroscopy, the plate's final location was verified.

K wire(s) or extra plates are employed in accordance with the demand if needed.

During the closure process, the front surface of the radius implants were partially covered by the pronator quadratus muscle.

The distal portion of the EPL tendon sheath is preserved in dorsal incisions, allowing the tendon to remain in its natural location even after the third compartment is closed. The V-shaped retinacular flap was drawn underneath the EPL tendon to prevent contact with the plate if the plate was applied with the EPL resting over it. It is also appropriate to leave the EPL tendon subcutaneously positioned.

Deep fascia is directly closed with a direct radial styloid incision.

The wound was bandaged with sterile compression dressing when hemostasis was established and stable fixation was attained. After the tourniquet was taken off, the fingers' capillary refilling was examined. With the wrist in a neutral posture, the operated limb was supported by an anterior below elbow POP slab.

Post – Operative care :

The patient's operative limb was kept in a POP slab with rigorous limb elevation and no weight bearing, but as soon as feasible after surgery, they were urged to move their elbow and fingers fully. After three days of IV broad spectrum antibiotics, patients were discharged to take oral antibiotics.

Both AP and lateral post-operative radiographs were acquired. When required, the proper analgesics were administered. On the second and sixth post-op days, the wound was examined. After being instructed in range-of-motion exercises for the elbow and fingers, patients who did not have accompanying injuries or whose presence did not warrant a hospital stay were released on the fifth or sixth postoperative day and asked to return for the removal of sutures on the twelfth postoperative day.

Follow up and assessment:

The patient received a wrist splint and was permitted to take a shower and clean the wound during following suture removal after 12 days. Patients were not permitted to lift weights but were permitted to type or write while taking analgesics as needed. The patient was given permission to actively move their wrists after four weeks. After six weeks, the splint was taken out, and usage was restricted to the workplace and physical therapy. After eight weeks Light lifting of weights were permitted. After twelve weeks, weight bearing was resumed as tolerated, complete range of motion was permitted both actively and passively, and wrist and grip strengthening exercises were initiated. In later visits, the patient was permitted to perform all physical labour as their strength improved.

The patients were followed up for the first month, three months and six months, which was the study's end point. Patients were clinically evaluated at each follow-up appointment, with a thorough assessment of their range of motion and any symptoms that may have existed. X-rays were taken in the lateral and anteroposterior views, and evidence of union were observed. When callus was seen to be spanning the fracture site and there was no visible fracture line, the fracture was said to be radiologically united. The lack of both functional pain and local tenderness at the previous fracture site was considered clinical healing of the fracture.

Using a goniometer, the wrist's range of motion was determined.

The wrist's range of motion is contrasted with the typical range listed below:

Dorsiflexion: 0 ˚ -75˚

Palmar flexion: 0 ˚ -80 ˚

Radial deviation: 0 ˚ -20 ˚

Ulnar deviation: 0 ˚ -35 ˚

Pronation: 0 ˚ -70 ˚

Supination: 0 ˚ -85 ˚

Range of movement is scored on 26 point scale and were graded as excellent, good , fair and poor based on the total score.[52]

SCORING OF THE ACTIVE RANGE OF MOVEMENTS IN THE WRIST						
	Dorsiflexion	Palmar flexion	Ulnar deviation	Radial deviation	Pronation	Supination
Max Score	6	5	3	2	5	5
0	< 10	< 10	< 5	< 5	< 10	< 10
1	>= 10	>= 10	>= 5	>= 5	>= 10	>= 10
2	>= 20	>= 20	>= 15	>= 15	>= 20	>= 20
3	>= 30	>= 30	>= 25		>= 40	>= 40
4	>= 40	>= 40			>= 60	>= 60
5	>= 50	>= 60			>= 70	>= 70
6	>= 70					

OM SCORE	**RESULT**
>= 24	Excellent
20-23	Good

16-19	Fair
<= 15	Poor

The Patient-rated Wrist Evaluation (PRWE) questionnaire was used to evaluate the functional outcome. The result was rated as excellent, good, fair, and poor based on the PRWE score.

Questionnaire for Patient-rated Wrist Evaluation (PRWE)

There are 3 steps to score PRWE.

Step 1: Calculate each item's pain score out of five.

1. PAIN	
Rate the **average** amount of pain in your wrist over the past week by circling the number that best describes your pain on a scale from 0-10. A zero **(0)** means that you **did not** have any pain and a **ten (10)** means that you had the **worst pain you have ever experienced** or that **you could not do the activity because of pain.**	
RATE YOUR PAIN: Sample Scale ☞	0 1 2 3 4 5 6 7 8 9 10 No Pain ... Worst Ever
At rest	0 1 2 3 4 5 6 7 8 9 10
When doing a task with a repeated wrist movement	0 1 2 3 4 5 6 7 8 9 10
When lifting a heavy object	0 1 2 3 4 5 6 7 8 9 10
When it is at its worst	0 1 2 3 4 5 6 7 8 9 10
How often do you have pain?	0 1 2 3 4 5 6 7 8 9 10 Never ... Always

Step 2: Divide the function score obtained from each of the 10 components by 2.

2. FUNCTION	
A. SPECIFIC ACTIVITIES *Rate the **amount of difficulty** you experienced performing each of the items listed below - over the past week, by circling the number that describes your difficulty on a scale of 0-10. A **zero** (0) means you did not experience any difficulty and a **ten** (10) means it was so difficult you were unable to do it at all.* Sample scale →	0 1 2 3 4 5 6 7 8 9 10 No Difficulty ... Unable To Do
Turn a door knob using my affected hand	0 1 2 3 4 5 6 7 8 9 10
Cut meat using a knife in my affected hand	0 1 2 3 4 5 6 7 8 9 10
Fasten buttons on my shirt	0 1 2 3 4 5 6 7 8 9 10
Use my affected hand to push up from a chair	0 1 2 3 4 5 6 7 8 9 10
Carry a 10lb object in my affected hand	0 1 2 3 4 5 6 7 8 9 10
Use bathroom tissue with my affected hand	0 1 2 3 4 5 6 7 8 9 10
B. USUAL ACTIVITIES *Rate the **amount of difficulty** you experienced performing your **usual** activities in each of the areas listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0-10. By "usual activities", we mean the activities you performed **before** you started having a problem with your wrist. A **zero** (0) means that you did not experience any difficulty and a **ten** (10) means it was so difficult you were unable to do any of your usual activities.*	
Personal care activities (dressing, washing)	0 1 2 3 4 5 6 7 8 9 10
Household work (cleaning, maintenance)	0 1 2 3 4 5 6 7 8 9 10
Work (your job or usual everyday work)	0 1 2 3 4 5 6 7 8 9 10
Recreational activities	0 1 2 3 4 5 6 7 8 9 10

Step 3: Score the function and discomfort together.

Total Score = Sum of pain+ function scores (Best Score = 0, Worst Score = 100)

Low score = better outcome.

PRWE SCORE	RESULT
0-25	Excellent
26-50	Good
51-75	Fair
76-100	Poor

FIGIURE 13 :CLINICAL AND RADIOLOGICAL PHOTOGRAPHS OF OPEATIVE CASES

Instruments and preparation :

General instruments

2.7 mm Distal radius system

Torniquet applied

Painted and draped

Approaches :

Volar –Henry incision

Dorsal Incision

Direct lateral incision

Exposure and reduction :

FCR retracted and pronator quadratus exposed

Pronator quadratus cut and distal radius exposed

Reduction using K-wire

Reduction held with multiple k wires

Plate fixation :

Plate in position with help of C Arm

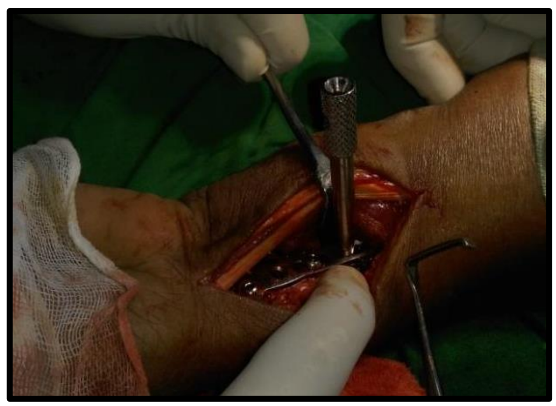
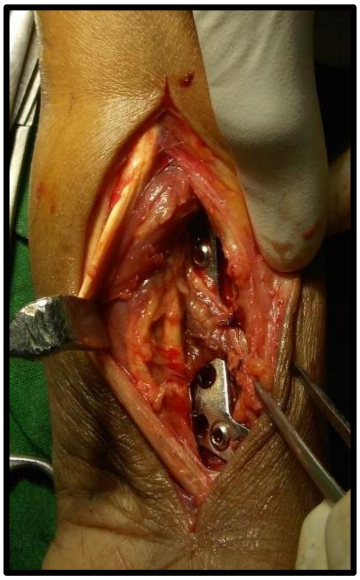


Plate fixed using drill sleeve and screws

Plate/s with screws in situ & final reduction

Closure :



Pronator quadratus closed

Sub-cutaneous closure

Skin Stapled

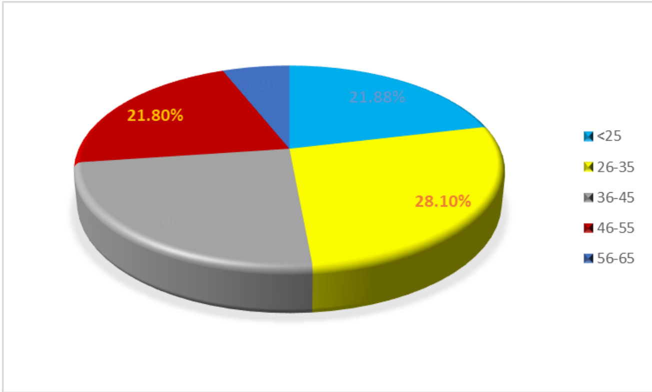
RESULTS

In this research, we analyzed the data from 32 patients with distal radius fractures who were treated at BLDE's Shri BM Patil Medical College between August 2022 and January 2024. We followed up with these cases regularly for a minimum of 6 months, from 2022 to 2024, in order to assess their functional outcomes and results. After analyzing the data, we obtained the following findings.

Table 1: Incidence of age

Age (years)	No. of Cases	Percentage%
<25y	7	21.88
26-35y	8	28.1
36-45y	8	25
46-55y	7	21.8
56-65y	2	6.25
Total	32	100

Graph 1: Age distribution

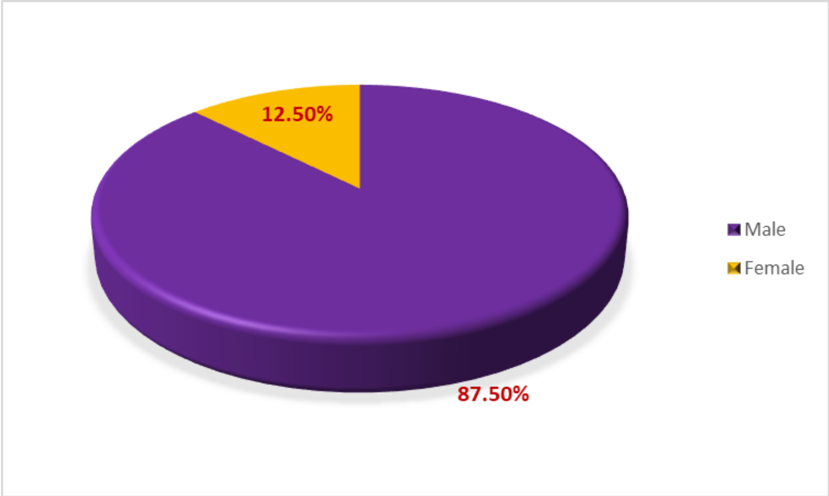


The table shows the age distribution of the 32 patients in the study. The largest group was 26-35 years old (28.1%), followed closely by 36-45 years (25%) and <25 years (21.88%). The 46-55 age group made up 21.8%, while only 6.25% were 56-65 years old. The average age was 38.59 years, with a range of 20-65 years. This indicates that distal radius fractures in this study primarily affected younger and middle-aged adults, with fewer cases in older adults.

Table 2: Gender Division

Sex	No. of cases	Percentage(%)
Male	28 cases	87.5
Female	4 cases	12.5
Total	32 cases	100

Graph 2: Gender Distribution

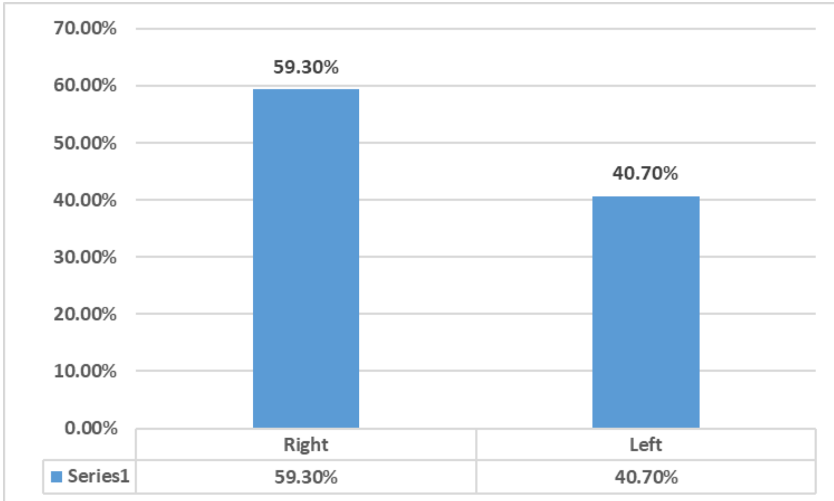


Gender distribution showing a strong male predominance. Out of 32 patients, 28 (87.5%) were male and only 4 (12.5%) were female. This significant gender disparity suggests that males in this population may be at higher risk for distal radius fractures, possibly due to occupational or lifestyle factors.

Table 3: Side Involved

Side(right or left)	No. of cases	Percentage(%)
Right side	19	59.3
Left side	13	40.7
Total	32	100

Graph 3: Side involvement

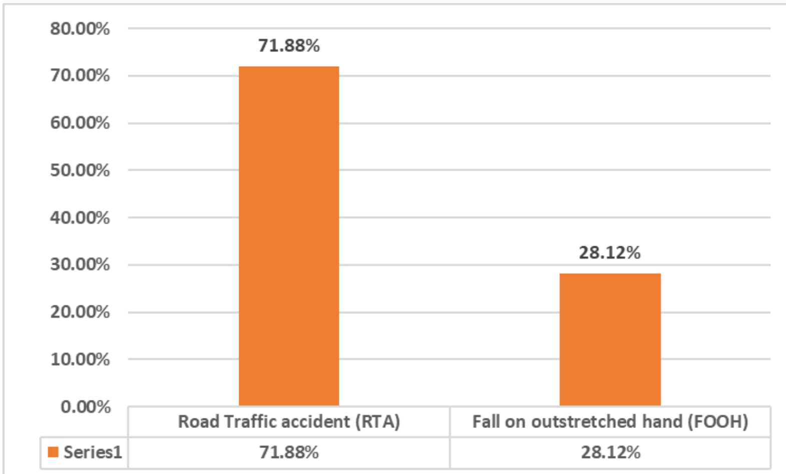


This table details the side of involvement, with the right side (dominant wrist) affected in 59.3% of cases and the left side in 40.7%. This slight predominance of right-sided injuries could be related to handedness or the mechanics of injury.

Table 4: Mode of injury

Mechanism of injury (MOI)	No. of cases	Percentage(%)
Road Traffic accident (RTA)	23	71.88
Fall on outstretched hand (FOOH)	9	28.12
Total	32	100

Graph 4: Mode of injury



Road traffic accidents (RTA) were the predominant cause, accounting for 71.88% of cases, while falls on outstretched hands (FOOH) caused 28.12% of injuries. This highlights the significant role of vehicular accidents in causing these fractures in the study population.

Table 5: Fracture classification based on AO

AO type	No. of cases	Percentage(%)
B1	3	9.38
B2	3	9.38
B3	11	34.37
C1	10	31.25
C2	4	12.5
C3	1	3.12
Total	32	100

Graph 5: Type of fractures according to AO classification

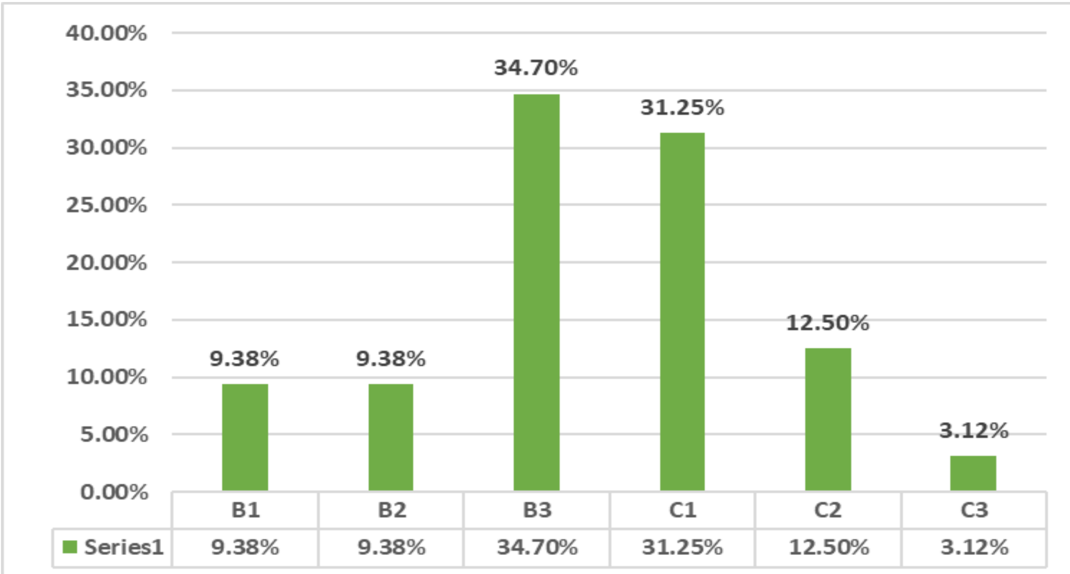
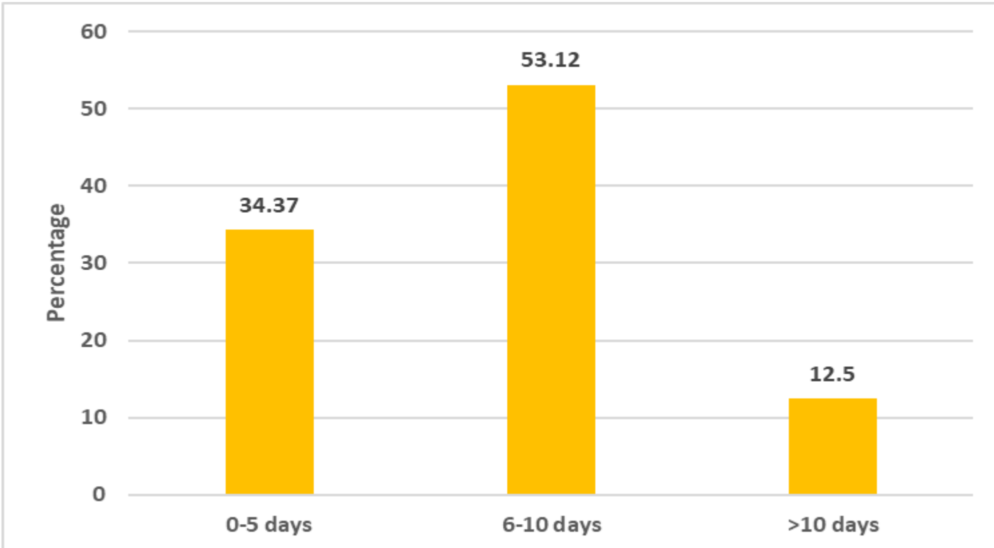


Table 5 classifies the fractures according to the AO classification system. Type B3 fractures were most common (34.37%), followed by C1 (31.25%). Types B1 and B2 each accounted for 9.38%, C2 for 12.5%, and C3 for 3.12%. This distribution indicates a prevalence of partial articular (type B) and complete articular (type C) fractures in the study group.

Table 6: Duration of operation from date of injury

Duration (days)	No. of cases	Percentage(%)
0-5	11	34.37
6-10	17	53.12
>10	4	12.5
Total	32	100

Graph 6: Duration of operation from date of injury



Most patients (53.12%) had surgery 6-10 days after injury, 34.37% within 0-5 days, and 12.5% after 10 days. The average time to surgery was 7.06 days, suggesting that most patients received treatment within a week of injury.

Functional Assessment :

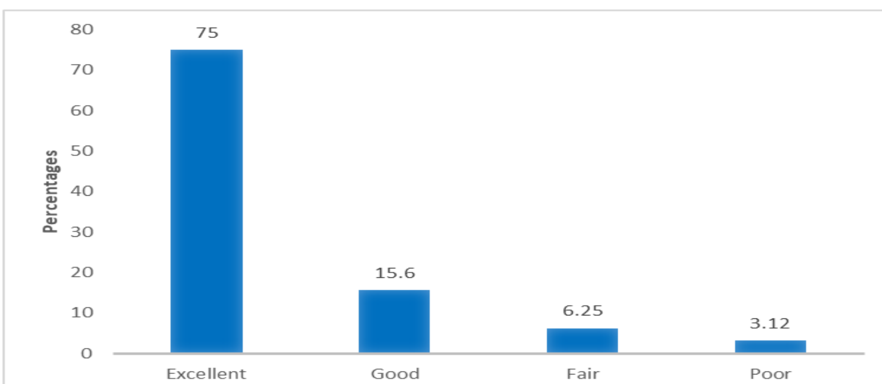
A patient-rated wrist evaluation questionnaire was used to evaluate the functional findings. The questionnaire investigated how patients assessed their level of pain in different contexts and how it affected their ability to do both routine and targeted tasks.

Grades Based on PRWE scores as excellent, good, fair and poor.

Table 7: Functional outcome based on PRWE score

Functional outcome	Number of cases	Percentage
Excellent	24	75
Good	5	15.6
Fair	2	6.25
Poor	1	3.12
Total	32	100

Graph 7: Functional outcome based on PRWE score



This table presents the functional outcomes of the 32 patients in the study, as assessed using the Patient-Rated Wrist Evaluation (PRWE) score. The PRWE is a validated tool that measures wrist pain and disability from the patient's perspective. The results are categorized into four groups:

1. Excellent: 24 patients (75%)
2. Good: 5 patients (15.6%)
3. Fair: 2 patients (6.25%)
4. Poor: 1 patient (3.12%)

The data shows that the vast majority of patients (90.6%) achieved excellent or good functional outcomes according to the PRWE score. This suggests that the fragment-specific fixation technique used in this study was highly effective in restoring wrist function for most patients. Only a small proportion of patients (9.37%) had fair or poor outcomes.

These results indicate that the surgical technique employed in this study led to satisfactory functional outcomes for the majority of patients with distal radius fractures. The high percentage of excellent outcomes (75%) is particularly noteworthy, suggesting that many patients regained a high level of wrist function post-surgery.

Range of movements :

Based on the degree of dorsiflexion, palmar flexion, radial deviation, ulnar deviation, pronation, and supination, the range of motion was rated on a 26-point scale. The final score was then classified as excellent, good, fair, or poor.

Twenty (62.5%) of the 32 patients in our series had exceptional range of motion, nine (28.12%) had good range, one (3.13%) had fair range, and two (6.25%) had poor range of motion.

The typical wrist motion was identified as follows: 59.22° extension (range: 10-75°), 72.35° pronation (range: 50–83°), 75.5° supination (range: 30-90°), and 28.94° ulnar deviation (range: 15–38°).

Table 8: Range of movements outcome

Range of movements outcome	No. of cases	Percentage(%)
Excellent	21	65.6
Good	8	25
Fair	1	3.12
Poor	2	6.25
Total	32	100

Graph 8: Range of movements outcome

This table presents the outcomes based on the range of motion (ROM) achieved by patients after surgery. The ROM was scored on a 26-point scale, considering various wrist movements such as dorsiflexion, palmar flexion, radial deviation, ulnar deviation, pronation, and supination. The outcomes are categorized as follows:

1. Excellent: 21 patients (65.6%)
2. Good: 8 patients (25%)
3. Fair: 1 patient (3.12%)
4. Poor: 2 patients (6.25%)

Similar to the PRWE scores, the range of motion outcomes were predominantly positive. 90.6% of patients achieved excellent or good range of motion, which aligns closely with the functional outcomes measured by the PRWE score.

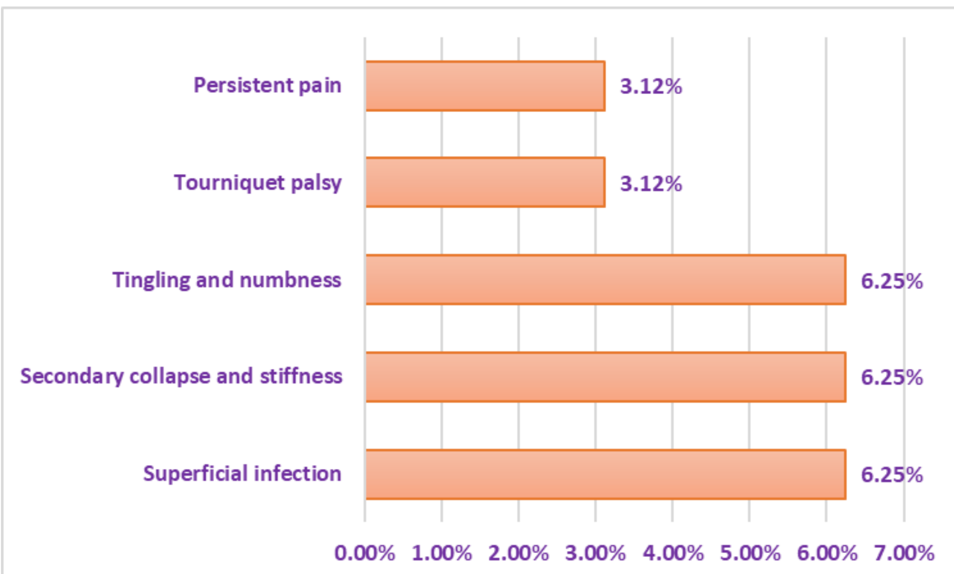
Union of fracture and back to work :

Thirty-one of the thirty-two patients had fracture union within three months, and the patient with the delayed union had a good functional result and union at the end of six months after a short time of immobilization. Thirty of the thirty patients (93.75%) were able to resume their pre-injury daily activities. One of the two patients who did not recover well required a secondary fixation treatment and did not resume their pre-injury level of activity. Due to weak grip strength and discomfort and stiffness, the other patient—a manual labour—was unable to do all the activities as intended.

Table 9: Complications

Complications	No. of cases	Percentage(%)
Superficial infection	2	6.25
Secondary collapse and stiffness	2	6.25
Tingling and numbness	2	6.25
Tourniquet palsy	1	3.12
Persistent pain	1	3.12

Graph 9: Complications



Complications:

Intra-operative: There were no intraoperative complications.

Post-operative:

Superficial infection : After receiving a course of antibiotics, two individuals with superficial infections achieved great results.

Secondary collapse of fracture with stiffness : Two patients experienced this as a result of improper load bearing and mobilization, and after being immobilized for extended periods of time, they became stiff. They were followed up with physiotherapy and had fair to poor outcomes.

Tingling and numbness : Two patients who received 75 mg of pregabalin once daily experienced brief tingling and numbness, which they recovered from in eight weeks.

Tourniquet palsy : Within 12 weeks, a patient with tourniquet palsy made a full recovery. The patient achieved outstanding functional results and a good range of motion.

.

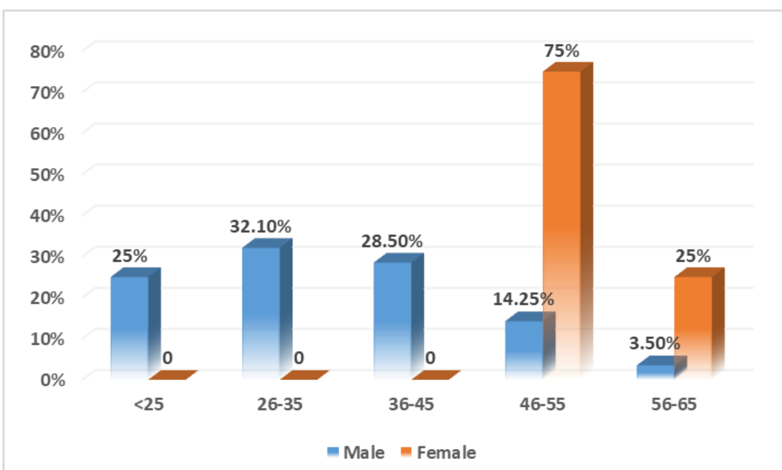
Persistent pain : One patient complained of ongoing pain, which was treated with the right amount of analgesics.

Functional outcome evaluation

Table 10 : Association between Gender and Age groups

Age	**Male**	**Female**	**P -value (Fisher exact test applied)**
<25	7 (25%)	0	0.0036 Significant
26-35	8 (32.1%)	0	
36-45	8 (28.5%)	0	
46-55	4 (14.25%)	3 (75%)	
56-65	1 (3.5%)	1 (25%)	
Total	28 (100%)	4 (100%)	

Graph :10 Association between Gender and Age groups



Age distribution in males: The majority of male patients (85.6%) were under 45 years old, with the highest concentration in the 26-35 age group (32.1%), followed closely by the 36-45 age group (28.5%) and the <25 age group (25%). There were fewer male patients in the older age groups.

Age distribution in females: All female patients were over 45 years old, with 75% in the 46-55 age group and 25% in the 56-65 age group.

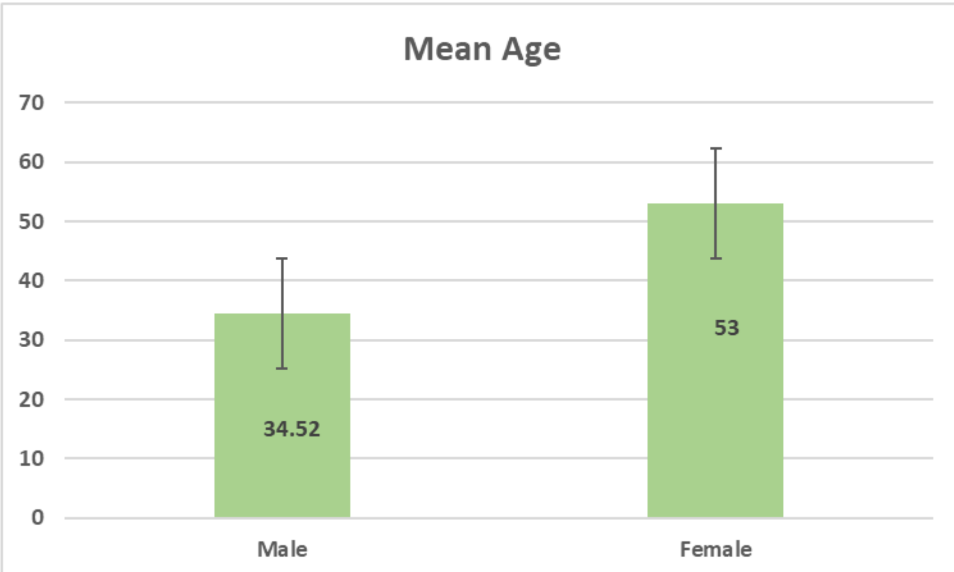
Gender disparity: There's a notable absence of female patients in the younger age groups (<45 years), while male patients are predominantly younger.

Statistical significance: The p-value for this distribution is 0.0036, as determined by Fisher's exact test. This very low p-value (<0.05) indicates that the observed difference in age distribution between males and females is statistically significant.

Table 11 : Mean age difference among men and women

Gender	**Male**	**Female**	**P-value (Student -t test was applied)**
Mean Age	34.52	53	< 0.05
Standard Deviation	11.15	4.33	

Graph : 11 Mean age difference among men and women



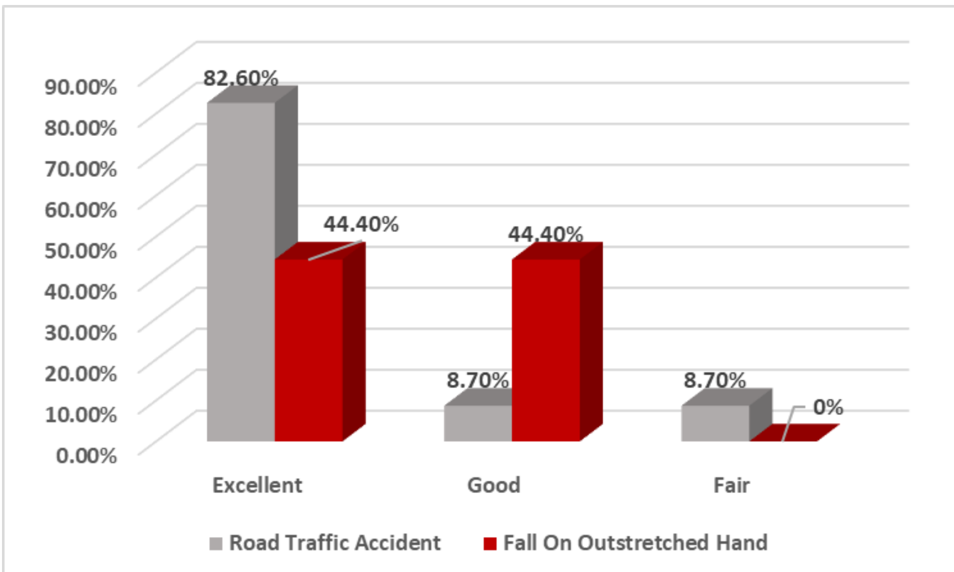
The table examine age and gender associations. There was a significant difference in age distribution between genders (p=0.0036), with males being younger on average (mean age 34.52 years) compared to females (mean age 53 years). This difference was statistically significant ($p<0.05$).

Table 12 : Functional outcome based on injury

Functional Outcome	Road Traffic Accident (RTA)	Fall On Outstretched Hand(FOOSH)	P -value (Fisher exact test applied)
Excellent	82.6%	44.4%	
Good	8.7%	44.4%	

Fair	8.7%	0%	0.029 Significant
Poor	0%	11.1%	

Graph 12: Functional outcome based on injury

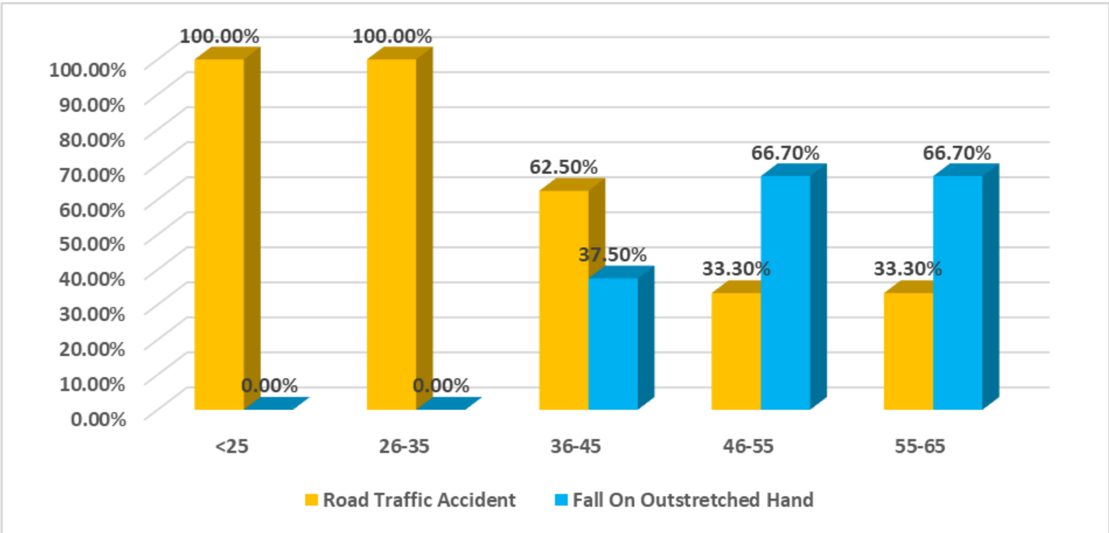


The Cramer's V test results from the table show that a greater proportion of patients with RTA (82.6%) than those who experienced a fall (44.4%) had favorable outcomes. However, no patient with RTA had a poor outcome, compared to a lower percentage of patients (11.1%) who sustained a fall. This disparity might be explained by the fact that most of our patients were male younger patients who participated in RTAs, which produced superior results. This correlation's computed p value of.029 shows that the result is statistically significant.

Table 13: Relationship between age and mechanism of injury

Age	<25	26-35	36-45	46-55	55-65	P value (Fisher exact test applied)
Road Traffic Accident(RTA)	100.00%	100.00%	62.50%	33.30%	33.30%	0.012 Significant
Fall On Outstretched Hand(FOOSH)	0.00%	0.00%	37.50%	66.70%	66.70%	

Graph 13: Relationship between age and mechanism of injury



The table above makes it evident that every patient under the age of 35 had a traumatic brain injury (RTA), and 66.70% of patients between the ages of 46 and 65 had an injury caused by falling on an outstretched hand. At p = 0.012, this was statistically significant.

Table 14: Functional outcome based on age

Age	<25	26-35	36-45	46-55	55-65	P -value (Fisher exact test applied)
Excellent	71.40%	87.50%	100.00%	50.00%	0.00%	0.018 Significant
Good	14.30%	0.00%	0.00%	50.00%	66.70%	
Fair	14.30%	12.50%	0.00%	0.00%	0.00%	
Poor	0.00%	0.00%	0.00%	0.00%	33.30%	

Graph 14: Functional outcome based on age

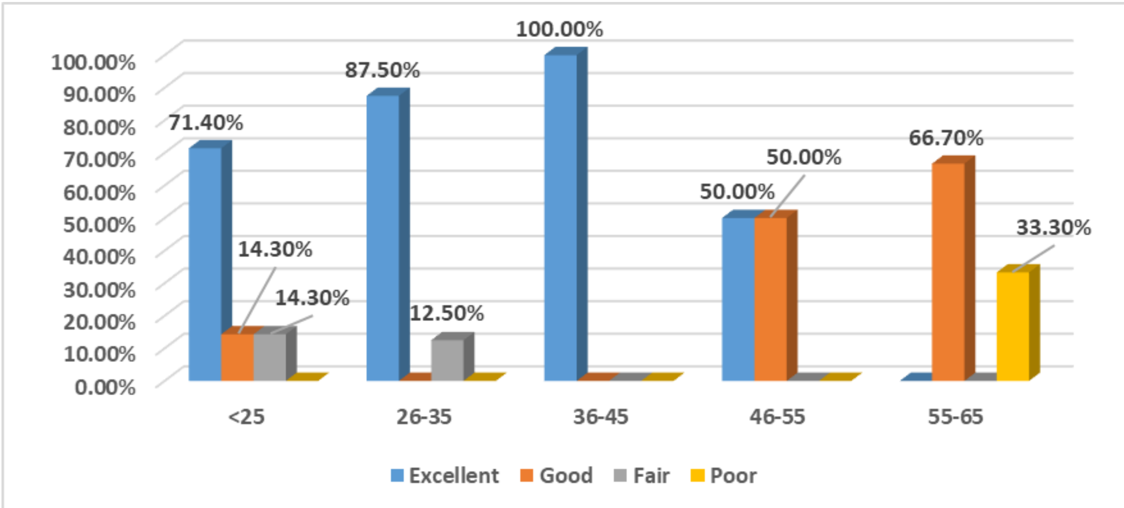


Table 14 examines the effect of age on functional outcomes. The data shows a clear trend of better outcomes in younger patients. All patients (100%) in the 36-45 age group achieved excellent outcomes, followed by 87.50% in the 26-35 group, and 71.40% in the under-25 group. The outcomes begin to decline in older age groups, with only 50% achieving excellent results in the 46-55 group, and no excellent outcomes in the 55-65 group. Notably, poor outcomes only appear in the oldest age group (55-65), affecting 33.30% of these patients. The 46-55 age group shows an even split between excellent and good outcomes (50% each). This age-related trend is statistically significant (p=0.018), suggesting that age is a crucial factor in predicting functional outcomes after distal radius fracture treatment.

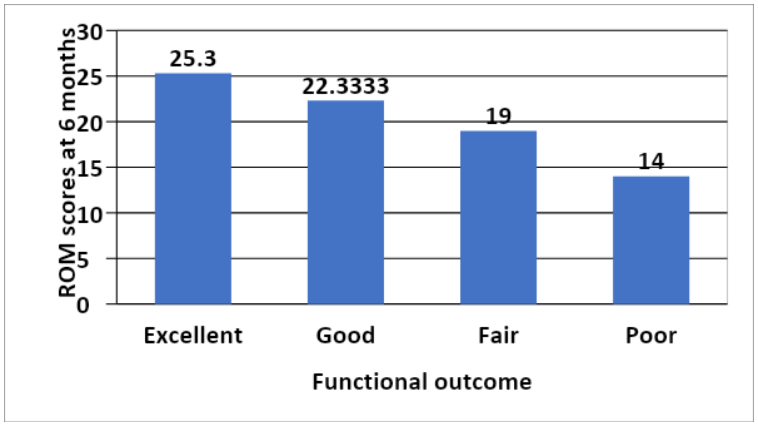
Table 15: Association between range of movement (ROM) and functional outcome

Functional Outcome	ROM score
Excellent	25.3
Good	22.3333
Fair	19
Poor	14

ROM Outcome	Functional Outcome				
		Excellent	Good	Fair	Poor
	Excellent	90%	10%	0%	0%
	Good	55.6%	33.3%	11.1%	0%
	Fair	0%	100%	0%	0%
	Poor	0%	0%	50%	50%

It is clear aforementioned evidence that there is a correlation between range of motion and functional outcome. Better ROM scores translate into more functional results for patients. Cramer's V test was used to evaluate the aforementioned data, and the statistical significance was $p = 0.000$.

Graph 15: Correlation between range of movement and functional outcome



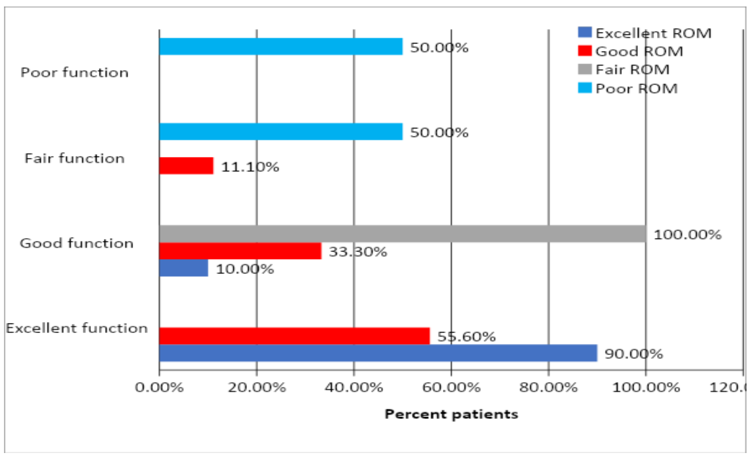
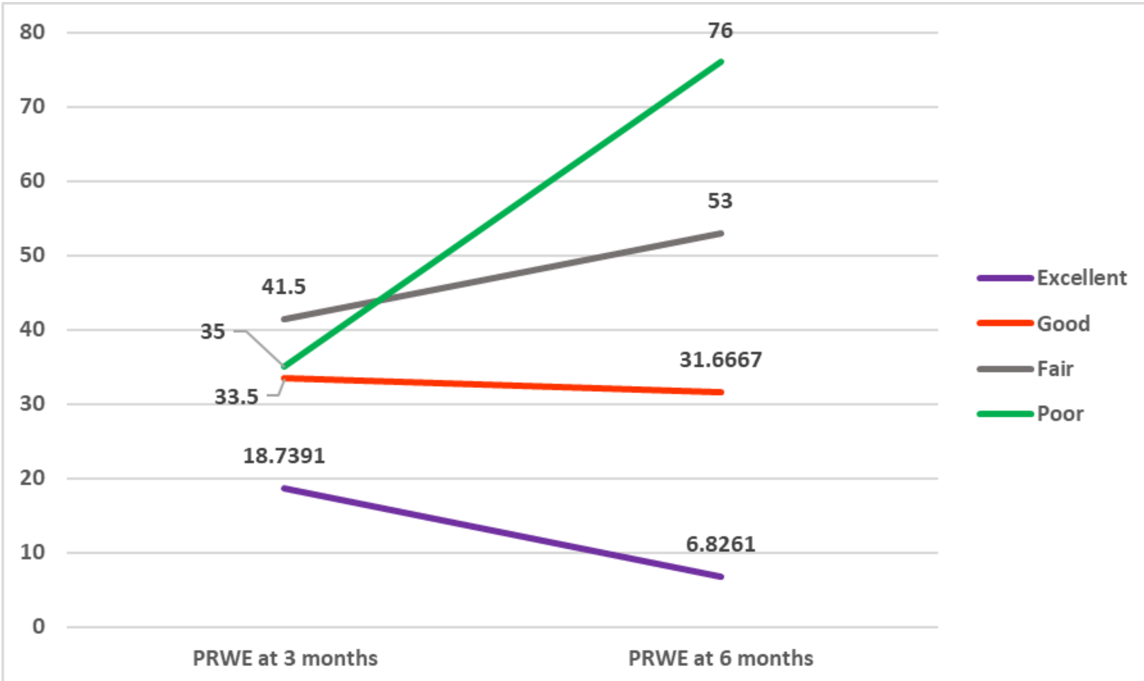


Table 16: Correlation between PRWE scores and functional outcome

Functional outcome	PRWE at 3 months	PRWE at 6 months
Excellent	18.7391	6.8261
Good	33.5	31.6667
Fair	41.5	53
Poor	35	76

Graph 16: Correlation between PRWE scores and functional outcome



It is evident that patients with unfavorable outcomes had higher PRWE scores at three months, comparable to those with good outcomes, whereas patients with positive results have lower PRWE ratings after three months and improved scores after six months. But over the course of the three months, their scores steadily decline, leading to subpar functional outcomes.

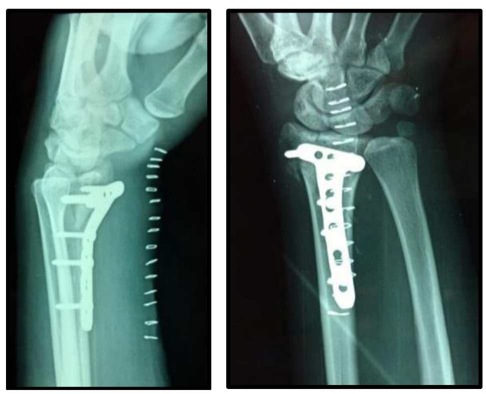
The following characteristics did not significantly correlate with each other in our study: The relationship between age and ROM, age and AO type, AO type and functional outcome, surgical time and functional outcome, and age and injury etiology. The presence of an ulnar styloid fracture had no effect on the final functional result.

The ultimate ROM or functional result was unaffected by the type of implant utilized alone or in combination.

FIGURE 11:-Clinical and Radiological Photographs OF OPERATED CASE

CASE NO. 5

Pre Operative X ray and CT Image



Immediate Post Operative

3 Months follow up

6 Months follow up

Clinical Photographs

Dorsiflexion

Palmarflexion

Ulnar deviation

Radial deviation

Pronation

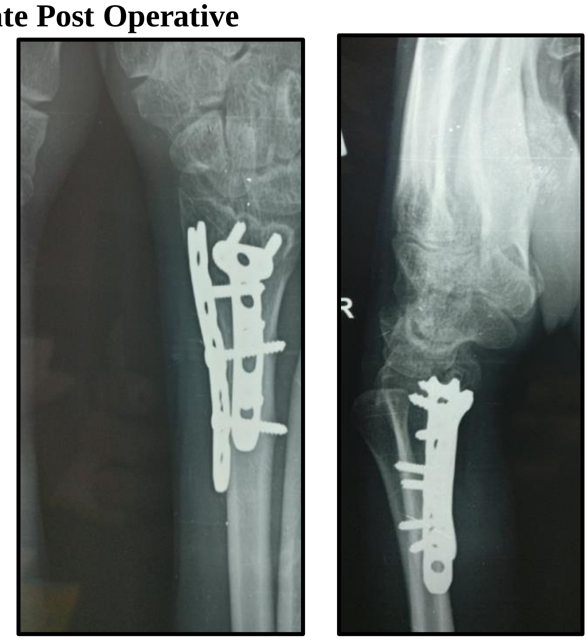
Supination

CASE NO. 10

Pre Operative X ray and CT Image

Immediate Post Operative

3 Months follow up



6 Months follow up

Clinical Photographs

Dorsiflexion

Palmarflexion

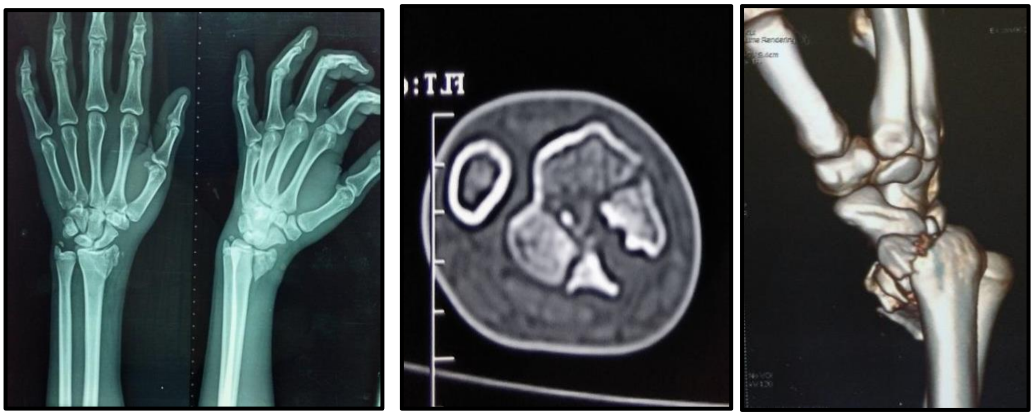
Ulnar deviation

Radial deviation

Pronation

Supination

CASE NO. 13



Pre Operative X ray and CT Image

Immediate Post Operative

3 Months follow up

6 Months follow up

Clinical Photographs

Dorsiflexion

Palmarflexion

Ulnar deviation

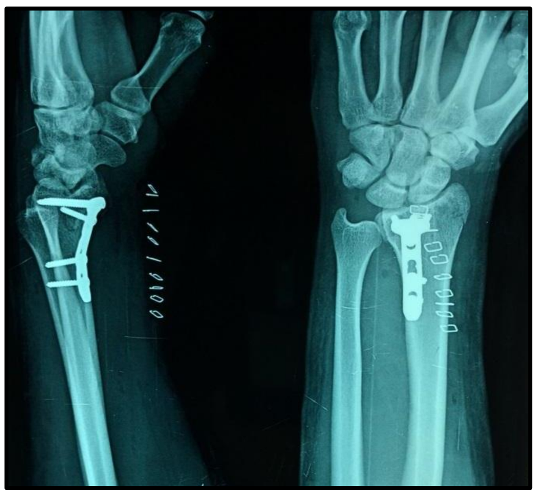
Radial deviation

Pronation

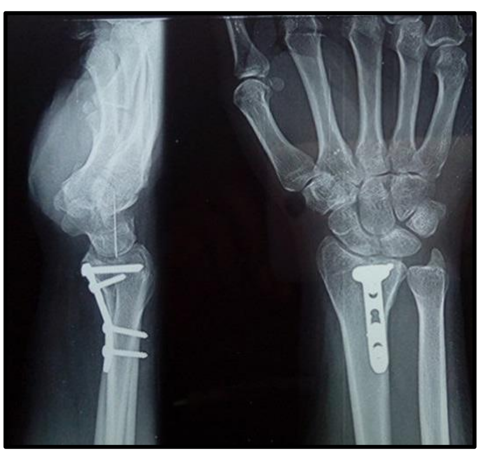
Supination

CASE NO. 15

Pre Operative X ray and CT Image



Immediate Post Operative



3 Months follow up

6 Months follow up

Clinical Photographs

Dorsiflexion

Palmarflexion

Ulnar deviation

Radial deviation

Supination

Pronation

DISCUSSION:

Our study, conducted at BLDE's Shri BM Patil Medical College from August 2022 to January 2024, investigated the outcomes of distal radius fracture treatment in 32 patients. The findings provide valuable insights into the effectiveness of surgical management, particularly using volar locking plates, and how various factors influence patient outcomes.

The distal radius fracture was initially documented by Abraham Colles in 1814. These fractures are the most frequently occurring upper extremity fractures, comprising 17 percentage of all fractures and 75 percentage of all forearm fractures. It's noteworthy that this type of fracture is particularly challenging to treat for surgeons.

Anatomical alignment of the joint surface using strong fixation is the primary objective when treating intra-articular fractures. Studies have demonstrated that any remaining joint incongruity can result in long-term posttraumatic arthritis. Improved undestanding of wrist anatomy and function from recent research, along with higher patient expectations, has broadened the scope for surgical intervention.

In the case of irreducible compression fractures of the joint surface (also known as pilon fractures of the distal radius, or C3 fractures), open reduction, stable internal fixation, and functional after-treatment have replaced the previous therapeutic strategies of pins, bridging external fixation, and bone grafting. While many research demonstrate similar long-term functional outcomes, initial functional outcomes reveal a preference for internal fixation (ORIF) and open reduction over exterior fixation.

The use of the mini plating system is beneficial for reducing both larger and smaller fragments. This promotes adequate reduction of articular fragments and lowers the possibility of subsequent difficulties by making it simple to reduce fragments while immediately examining them. Depending on the particular plate being used, several surgical techniques may be chosen.

Demographic Characteristics:

The average age of participants in our research was 38.59 years, which is younger than the findings of Rizzo et al. (48 years for the ORIF group) and Anakwe et al. (48 years), but similar to Raamji et al. (39.90 ± 10.84 years). This variance may be due to the higher incidence of road traffic accidents (RTAs) in our study group, which generally involve younger individuals. The gender distribution in our study (87.5% male) is notably different from other research, such as Anakwe et al. (38% male) and Javed et al. (35.5% male). This difference could be a result of regional disparities in road usage habits and occupational exposures. [56, 57, 58]

Table 17: Age distribution's incidence in relation to other studies

Series	Minimum age in years	Maximum age in years	Average in years
Anakwe et al.[57]	22	67	48
Saw et al.[59]	18	58	32.3
Jacobi et al.[60]	20	82	54
Mandalia et al.[61]	-	-	39.27
Javed et al.[62]	17	86	52.5

Present study	20	65	38.59

Side affected:

The right hand was found to be the dominant wrist in our study, consistent with previous research, which can be attributed to the fact that the majority of individuals are right-handed.

Table 18: Side distribution's incidence in relation to other studies

Series	Right (%)	Left (%)
Anakwe et al.[57]	71.42	28.58
Saw et al.[59]	-	-
Jacobi et al.[60]	60	40
Mandalia et al.[61]	62.5	37.5
Javed et al.[62]	-	-
Present study	59.3	4

Injury Characteristics and Classification:

The majority of injuries in our research were caused by road traffic accidents (RTAs), which aligns with the findings of Raamji et al. who also reported a high percentage of RTA-related injuries. The prevalence of RTAs in our study could be linked to the higher occurrence of intricate fracture patterns, particularly Type B3 (34.37%) and C1 (31.25%) as per the AO classification. In contrast, Anakwe et al. found a greater number of more complex C2 and C3 fractures. These variations in fracture patterns may impact the overall results and complication rates. [57, 58]

Table 19: Mode of injury incidence in comparison to other studies

Series	RTA/High energy trauma (%)	FOOH (%)	Others (%)
Anakwe et al[57]	66.66	33.33	-
Saw et al.[59]	50	13.63	36.36
Jacobi et al.[60]	40	60	-
Mandalia et al.[61]	40	60	-
Javed et al.[62]	-	-	-
Present study	71.88%	28.12%	-

Functional Outcomes:

Our research showed that 75% of patients had excellent functional outcomes, and 15.6% had good outcomes, as determined by the Patient-Rated Wrist Evaluation (PRWE) score. These results are similar to those reported by Paramesha KC et al., who found 71.88% excellent and 18.75% good outcomes. However, it should be noted that Paramesha KC et al. used a different scoring system, which may limit direct comparison. The average PRWE score at 6 months in our study was not explicitly stated, but Paramesha KC et al. reported an average score of 16.53 at 6 months. Javed et al. reported mean PRWE scores of 14 ± 18 for low-risk fractures and 19 ± 22 for high-risk fractures at one year. Our study's overall favorable outcomes align with these findings, implying that volar locking plate fixation is an effective treatment approach for distal radius fractures. [27, 62]

Range of Motion:

The results of our investigation revealed an average extension of 59.22°, flexion of 65.10°, ulnar deviation of 28.94°, and radial deviation of 17°. These findings are similar to those documented by Rizzo et al. for their ORIF group (extension 69°, flexion 64°, ulnar deviation 34°, radial deviation 23°) and slightly superior to their external fixation group. The resemblance in results implies that volar locking plate fixation can accomplish a range of motion that equals or surpasses other fixation techniques. Raamji et al. recorded slightly lower average values for palmar flexion (56.77° ± 3.51°) and dorsiflexion (62.90° ± 3.21°) compared to our study, which may be attributed to disparities in rehabilitation protocols or patient demographics. [56, 58]

Complications:

The study we conducted found a complication rate of 25%, which included superficial infection (6.25%), secondary collapse and stiffness (6.25%), and tingling and numbness (6.25%). This rate is higher than what Anakwe et al. reported, as they did not encounter any cases of wound infection or tendon injury/irritation. However, our complication rate is similar to the one reported by Javed et al. (23%), although the types of complications were different. The higher complication rate observed in our study compared to some others may be due to the complexity of fractures, as a significant portion of our cases were Type B3 and C1 fractures. Javed et al. noted higher complication rates in high-risk fractures (33%) compared to low-risk fractures (18%), which is consistent with our findings. [57, 62]

Factors Influencing Outcomes:

Our study found significant associations between age, gender, and functional outcomes. Younger patients and those injured in RTAs had better outcomes, which is a novel finding not extensively discussed in the compared studies. This could be due to better bone quality and healing potential in younger patients, as well as potentially less severe injuries in RTA cases compared to falls in older patients.

The strong correlation between range of motion and functional outcomes in our study underscores the importance of postoperative rehabilitation. This finding is consistent with general principles of fracture management but was not specifically reported in the compared studies.

Time to Union and Return to Work:

In our research, 31 out of 32 individuals experienced bone mending within a 3-month period, which aligns with the results of Anakwe et al. and Paramesha KC et al. The high percentage of patients returning to their pre-injury activity levels (93.75% within 6 months) in our study is also similar to the findings reported by Paramesha KC et al. (93.75% within 6 months). These results indicate that using a volar locking plate for fixation enables early mobilization and a return to normal function, which are vital for patient satisfaction and economic considerations. [27, 57]

Limitations and Future Directions:

Our study was limited by its relatively small sample size and the lack of a control group. Future research should consider larger, multi-center studies with longer follow-up periods to better assess long-term outcomes and complications. Additionally, comparing volar locking plate fixation with other treatment modalities in a randomized controlled trial could provide more robust evidence for treatment selection.

SUMMARY

- Study conducted on [32] patients with distal radius fractures at BLDE's Shri BM Patil Medical College.
- Study period was from [August 2022 to January 2024] with a minimum follow-up of [6 months].
- Largest age group was [26-35 years] ([28.1%]) with an average age of [38.59 years].
- Gender distribution: [Male: 28 (87.5%)], [Female: 4 (12.5%)].
- Side of involvement: [Right: 19 (59.3%)], [Left: 13 (40.7%)].
- Most common mode of injury was [Road Traffic Accident (RTA)] ([71.88%]).
- Most common AO Classification type was [B3] ([34.37%]), followed by [C1] ([31.25%]).
- Average time to surgery was [7.06 days], with most patients [53.12%] having surgery [6-10 days] after injury.
- Functional outcomes (PRWE Score): [Excellent: 24 (75%)], [Good: 5 (15.6%)], [Fair: 2 (6.25%)], [Poor: 1 (3.12%)].
- Range of Motion outcomes: [Excellent: 21 (65.6%)], [Good: 8 (25%)], [Fair: 1 (3.12%)], [Poor: 2 (6.25%)].

- Mean wrist motion ranges: [Extension: 59.22°], [Flexion: 65.10°], [Ulnar deviation: 28.94°], [Radial deviation: 17°], [Pronation: 72.35°], [Supination: 75.5°].
- [31/32] patients had fracture union within [3 months].
- [30/32] patients [93.75%] returned to normal pre-injury activity level.
- Main complications: Two (6.25%) cases of superficial infection, two cases of secondary collapse and stiffness, and two cases of tingling and numbness.
- Significant age difference between genders: [Males (34.52 years)], [Females (53 years)] ($p<0.05$).
- RTA patients had better outcomes [82.6% excellent] compared to FOOH- Fall on outstretched hand [44.4% excellent] ($p=0.029$).
- All patients [<35 years] had RTA, while [66.70%] of patients between [46-65 years] had FOOH ($p=0.012$).
- Better outcomes in younger patients [100% excellent in 36-45 age group] with declining outcomes in older age groups ($p=0.018$).
- Strong correlation between better ROM scores and better functional outcomes ($p=0.000$).
- Lower PRWE scores at [3 and 6 months] correlated with better functional outcomes.

CONCLUSION

This study sought to assess the functional outcome of utilizing fragment-specific fixation with one or more plates in the surgical treatment of distal radial fractures in adults. The conclusions that followed were drawn in light of the findings.

Distal radial fractures are most frequently seen in individuals aged 20 to 50 years, with a higher incidence in males due to their participation in physically demanding activities. Younger individuals often sustain these fractures from motor vehicle accidents or high-energy trauma, resulting in displaced fractures that involve the joint. In contrast, older individuals may experience distal radial fractures from minor falls onto an outstretched hand, causing fractures that are located outside of the joint and are more common in those with osteoporosis.

Distal radial fractures are frequently observed in individuals aged 40 to 60 years, and our study focused on the effectiveness of surgical management using a specific fixation method for these fractures. We specifically included cases that required surgery caused by high-energy trauma in younger individuals, specifically those with comminuted and intra-articular fractures.

Either accident or falling on an outstretched hand were the most common ways injuries occurred. Fractures in the distal radius that resulted from accidents, which are considered AO type B or C fractures with high energy trauma were typically displaced, unstable, partly articular or intra-articular. In this investigation, type A fractures were not taken into account.

The use of mini plates, either alone or in combination, is an effective method for treating unstable fractures of the distal radius, particularly those involving the joint. This approach allows for proper alignment of the bones and early movement of the joint due to the strong fixation provided by the plates. The plates can be placed close to the joint and can be screwed in different orders, which gives them biomechanical advantages. The volar approach, which involves accessing the distal radius with minimal surgical trauma and fixing the fracture with better adaptation to surrounding tissues, was the most commonly used and successful in achieving anatomical alignment, regardless of the direction of fracture angulation. The majority of patients in the study were young adults and experienced a 90% recovery, allowing them to return to their daily activities.

There has been a lot of discussion regarding how to properly treat and manage fractures in the distal radius. There are numerous options for fixation, and no one option has proven to be better than the others. The most important factor is achieving stable fixation and ensuring that the joint surface is properly aligned to reduce any discrepancy. The choice of plate used, whether a single plate or a combination, is not as important as achieving a good reduction and stable fixation. It is crucial to select the appropriate plate based on the fracture pattern and the needs of each individual patient. The outcomes of the procedure can also vary based on the surgical techniques employed and the experience of the surgeon. Fixing the fragments of the distal radius specifically can yield excellent results and effectively restore and maintain the anatomy of the area.

The utilization of mini plates in the treatment of distal radius fractures allows for faster recovery of joint mobility and overall daily functioning.

REFERENCES

1. Solomon L, Warwick D, Nayagam S. Apley's System of Orthopaedics and Fractures. 9th ed Florida: CRC press; 2001. p. 615-8
2. Thakur, Anand J. *The elements of fracture fixation, 4e*. Elsevier Health Sciences, 2019.
3. Avgerinou C, Petersen I, Clegg A, West RM, Osborn D, Walters K. Trends in incidence of recorded diagnosis of osteoporosis, osteopenia, and fragility fractures in people aged 50 years and above: retrospective cohort study using UK primary care data. Osteoporos Int. 2023 Aug;34(8):1411-1427. doi: 10.1007/s00198-023-06739-1. Epub 2023 May 10. PMID: 37162537; PMCID: PMC10382342.
4. Metri, Chidanand R. *Intra Articular Fracture of Distal End of Radius Treated by Open Reduction and Internal Fixation with Buttress Plate-A Clinical Study*. MS thesis. Rajiv Gandhi University of Health Sciences (India), 2014.
5. Hoare CP, Dickson DR, Armstrong DJ, Nuttall D, Watts AC. Internal fixation for treating distal radius fractures in adults. Cochrane Database Syst Rev. 2017 Sep 26;2017(9):CD011213. doi: 10.1002/14651858.CD011213.pub2. PMCID: PMC6483690.
6. Mathews AL, Chung KC. Management of complications of distal radius fractures. Hand Clin. 2015 May;31(2):205-15. doi: 10.1016/j.hcl.2014.12.002. Epub 2015 Feb 28. PMID: 25934197; PMCID: PMC4417479.

7. Corsino CB, Reeves RA, Sieg RN. Distal Radius Fractures. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK536916/
8. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. Hand Clin. 2012 May;28(2):113-25. doi: 10.1016/j.hcl.2012.02.001. Epub 2012 Apr 14. PMID: 22554654; PMCID: PMC3345129.
9. Robert W. Bucholz, James D Heckman: Rockwood Greens Fractures in Adults. 5th edition, Lippincott Williams & Wilkins 2001 Volume I: 815 – 867.
10. Bholer L, Treatment of fractures, 4th ed. Baltmore: William wood. 1929.
11. Ruch David S “Fractures of the distal Radius and Ulna”, Chapter 26 in Rockwood and Green’s Fractures in Adults, Philadelphia: Lippincott Williams & Wikins; 2006. 6thEd: 909-964.
12. Ruch DS, Papadonikolakis A. volar verses dorsal plating in the management of intraarticular distal radius fracture. J Hand Surg Am.2006; 31:9-16.
13. Gruber G, Bernhardt G A, Kohler G, Gruberk. Surgical treatment of distal radial fracture with an angled fixed bar palmar plating system. Arch Orthop Trauma Surg.2006.
14. Kamath A F, Zurakowski D, Day C S. Low profile dorsal plating for dorsally angulated distal radius fractures. J Hand Surg Am.2006; 31:1061-7.
15. Konrath GA, Bahler S. Open reduction and internal fixation of unstable distal radius fractures: results using the trimed fixation system. J Orthop Trauma. 2002 Sep;16(8):578-85. doi: 10.1097/00005131-200209000-00007. PMID: 12352567.
16. Bae DS, Koris MJ. Fragment-specific internal fixation of distal radius fractures. Hand Clin. 2005 Aug;21(3):355-62. doi: 10.1016/j.hcl.2005.04.007. PMID: 16039447.

17. Vlček M, Landor I, Višňa P, et al. [Multidirectional screw fixation in the treatment of distal radius fractures using angle-stable plates]. Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca. 2011 ;78(1):27-33. PMID: 21375962.
18. Helmerhorst GT, Kloen P. Orthogonal plating of intra-articular distal radius fractures with an associated radial column fracture via a single volar approach. Injury. 2012 Aug;43(8):1307-12. doi: 10.1016/j.injury.2012.04.022. Epub 2012 May 29. PMID: 22648016.
19. Emet A, Veizi E, Karaman Y, Akgun E, Tolunay T, Firat A. Volar fixed plating of distal radius fractures: optimizing plate position for enhanced clinical outcomes. BMC Musculoskelet Disord. 2024 Apr 23;25(1):320. doi: 10.1186/s12891-024-07415-z. PMID: 38654260; PMCID: PMC11036783.
20. Benson, Leon S., et al. "The outcome of intra-articular distal radius fractures treated with fragment-specific fixation." The Journal of hand surgery 31.8 (2006): 1333-1339.
21. Ferozkhan S, Manohar M, Vaasan LS. Functional Outcome for Fragment-specific Fixation of Distal Radius Fracture – An Observational Study. Apollo Medicine. 2024;21(1):15-18. doi:10.4103/am.am_87_23
22. Medoff RJ. Essential radiographic evaluation for distal radius fractures. Hand Clin 2005;21:279-88.
23. Jawed A, Ansari MT, Gupta V. TFCC injuries: How we treat? J Clin Orthop Trauma 2020;11:570-9.
24. Saw N, Roberts C, Cutbush K, Hodder M, Couzens G, Ross M. Early experience with the TriMed fragment-specific fracture fixation system in intraarticular distal radius fractures. J Hand Surg Eur Vol 2008;33:53-8.

25. Beck JD, Harness NG, Spencer HT. Volar plate fixation failure for volar shearing distal radius fractures with small lunate facet fragments. J Hand Surg Am 2014;39:670-8.
26. Jupiter JB, Fernandez DL, Toh CL, Fellman T, Ring D. Operative treatment of volar intra-articular fractures of the distal end of the radius. J Bone Joint Surg Am 1996;78:1817-28.
27. Paramesha KC, Bansal R. Functional outcome in patients with distal radius fractures treated with fragment specific fixation at tertiary care teaching hospital. Int J Orthopaed 2018;4:893-6.
28. Ganesan M, Mohan N. Functional outcome of comminuted intraarticular distal radius fractures treated with fragment specific fracture fixation. J Evol Med Dent Sci 2018;7:690-7.
29. Gavaskar AS, Muthukumar S, Chowdary N. Fragment-specific fixation for complex intra-articular fractures of the distal radius: results of a prospective single-centre trial. Journal of Hand Surgery (European Volume). 2012;37(8):765-771. doi:10.1177/1753193412439677
30. Babikir, E.M.E., Al-Maqdassy, E.D., Hasan, K. et al. Efficiency of fragment specific fixation plates in the treatment of comminuted distal radial fractures. International Orthopaedics (SICOT) 41, 1763–1769 (2017). https://doi.org/10.1007/s00264-017-3516-0
31. Landgren, Marcus, et al. "Fragment-specific fixation versus volar locking plates in primarily nonreducible or secondarily redisplaced distal radius fractures: a randomized controlled study." The Journal of hand surgery 42.3 (2017): 156-165.
32. Richard L D, Wayne Volg, Adam WM. Gray’s anatomy for students 686-689.

33. Berger RA, Gracia Elias M. General anatomy of the wrist. Chapter 1 in Biomechanics of the wrist joint. Springer-Verlag publication. 1991.

34. Palmer AK, Werner FW. The triangular fibrocartilage complex of the wrist – Anatomy and function. J Hand Surg. 1981; 6: 153-162.

35. Simic PM, Weiland AJ. Fractures of the distal aspect of the Radius: Changes in Treatment Over the past two decades. J Bone Joint Surg (Am). 2003; 85-A: 552-564.

36. Ark J, Jupiter JB. The rationale for precise management of distal radius fractures.

37. Orthop Clin North Am. 1993 April; 24(2): 205-210.

38. Yamamoto K, Masaoka T, Shishido T, Imakiire A. Clinical results of external fixation for unstable Colle's fractures. Hand Surg. 2003; 8 (2): 193-200.

39. Frykman G. Fracture of the Distal Radius Including Sequelae—Shoulder- Hand- Finger Syndrome, Disturbance in the Distal Radio-Ulnar Joint, and Impairment of Nerve Function: A Clinical and Experimental Study. Acta Orthop Scand. 1967; 108(Suppl):1–153.

40. Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colle's Fractures: Functional Bracing in Supination. J Bone Joint Surg. 1975; 57-A: 311–317.

41. Fernandez DL. Fractures of the distal radius: Operative treatment. Instr Course Lect. 1993; 42: 73-88.

42. McMurtry, R.Y. and Jupiter, J.B.: Fractures of the Distal Radius. In: Skeletal Trauma, ed. Browner, B.D., Jupiter, J.B., Levine, A.M. and Trafton, P.G. Philadelphia, W.B. Saunders; 1992: 1063-1094.

43. Melone CP. Articular fractures of the distal Radius. Orthop Clin North Am. 1984; 15: 217-236.

44. Cooney W.P, Agee, J.M, Hastings, H.I, Melone, C.P.J and Rayhack J.M.: Management of Intraarticular Fractures of the Distal Radius. Contemp Ortho: 1990; 21:71-104.

45. Lidstrom A. Fractures of the Distal End of the Radius: A Clinical and Statistical Study of End Results. Acta Orthop Scand. 1959; 41(Suppl): 1–118.

46. Muller, M.E., Nazarian, S. and Koch, P.: Classification AO des Factures. Paris, Springer Verlag, 1987.

47. Muller M.E, Nazarian S, Koch P and Schatzker J: The Comprehensive Classification of Fracture of Long Bones. Berlin, Springer Verlag, 1990.

48. Nana AD, Joshi A, Lichtman DM. Plating of the distal radius. J Am Acad Orthop Surg 2005; 13:159–71.

49. Hardy DH, Totty G, Renuis WR et al: Posterioanterior wrist radiography: Importance of arm positioning. J. Hand Surg.1987; 12A; 504.

50. Cassebaum W. Colle's fracture. A study of end results. JMJA 1950; 143:963.

51. Sarminto A, Zagorski JB, Sinclair WF. Functional bracing of colle's fractures. A prospective study of immobilization in supinaton Vs pronation. Clin Orthop 1980; 146: 175-183.

52. De palma AF; Comminuted fractures of distal radius treated by ulnar pinning. J Bone Joint Surg 1952; 43A: 651-662.

53. Chapman DR, Bennet JB, Bryan WJ et al. Complication of distal radius fracture; Pins and plaster treatment. J Hand Surg 1982; 7A:509-517.

54. Weber SC, Szabor M. severely comminuted distal radial fracture as an unsolved problem; Complication associated with external fixation and pins and plaster

techniques. J Hand Surg 1986; 11A: 157-165.

55. Lee BP, Tan CT. Comminuted Intra – articular fracture of the distal radius –results of early open reduction and internal fixation. Singapore Med J. 1992 Dec; 33(6); 612-5.

56. Rizzo M, Katt BA, Carothers JT. Comparison of Locked Volar Plating Versus Pinning and External Fixation in the Treatment of Unstable Intraarticular Distal Radius Fractures. Hand. 2008; 3 (2): 111-117.

57. Anakwe et al.: Locked volar plating for complex distal radius fractures: Patient reported outcomes and satisfaction. Journal of Orthopaedic Surgery and Research 2010 5:51.

58. Ramji M, Muralidhar N, Lingaiah P, Bhaskar S, Ranganath K, Kumar R. Evaluation of clinical, biochemical and imaging findings in early diagnosis of peri-implant diseases. J Clin Diagn Res. 2016;10(6)

59. N. Saw, C. Roberts, K. Cutbush, M. Hodder, G. Couzens and M. Ross. Early experience with the trimed fragment specific fracture fixation system in intra articular distal radius fractures. The journal of hand surgery. 2008;33(1):53-58.

60. Matthias Jacobi, Peter Wahl, Georges Kohut. Repositioning and stabilization of the radial styloid process in comminuted fractures of the distal radius using a single approach: the radio-volar double plating technique. Journal of Orthopaedic Surgery and Research. 2010;5:55.

61. Manthan Mandalia, Sharvil Gajjar, Tailor Anand, Shrey Saxena. Results of distal end radius volar plating. International Journal of Orthopaedics Sciences. 2017;3(1):395-401.

62. Saqib Javed, Rizwan Shahid, Ravi Thimmiah, Muj El-deen. Volar locking plate osteosynthesis for distal radial fractures. Journal of Orthopaedic Surgery. 2015;23(3):323-326.

ANNEXURE – I

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

Azadi Ka Amrit Mahotsav

BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956
Accredited with 'A' Grade by NAAC (Cycle-2)
The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 722/2022-23 30/8/2022

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Friday, 26th August, 2022 at 3.30 p.m. in the Department of Pharmacology** scrutinizes the Synopsis of Post Graduate Student of BLDE (DU)'s Shri B.M.Patil Medical College Hospital & Research Centre from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "Functional outcome in patients with distal end radius fractures treated with fragment specific fixation : a prospective study"".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR AMRUTHANAND R

NAME OF THE GUIDE: Dr.Ashok Nayak, Associate professor, Dept. of Orthopedics. .

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA
Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA
MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
BLDE (DU): Phone: +918352-262770, Fax: +918352-263303, Website: www.bldedu.ac.in, E-mail:office@bldedu.ac.in
College: Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

ANNEXURE – II

PLAGIARISM CERTIFICATE

iThenticate

Similarity Report ID: oid:3618:63473505

PAPER NAME
FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRA GMENT SPECIFIC FIXATION

AUTHOR
Amrut R

WORD COUNT
16201 Words

CHARACTER COUNT
91555 Characters

PAGE COUNT
122 Pages

FILE SIZE
20.1MB

SUBMISSION DATE
Jul 27, 2024 5:17 PM GMT+5:30

REPORT DATE
Jul 27, 2024 5:18 PM GMT+5:30

9% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 4% Internet database
- 9% Publications database
- Crossref database
- Crossref Posted Content database

Excluded from Similarity Report

- Submitted Works database
- Bibliographic material
- Quoted material
- Cited material
- Abstract
- Methods and Materials
- Small Matches (Less then 14 words)

Summary

ANNEXURE - III

B.L.D.E. (DEEMED TO BE UNIVERSITY)

SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, VIJAYAPURA-586103

INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/RESEARCH

I, the undersigned,_______________ , S/O D/O W/O ________________, aged ____years, ordinarily resident of ____________ do hereby state/declare that **Dr. Amruthanand r** of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on ______________ at ______________ (place) and it has been explained to me in my own language that I am suffering from ________________ disease (condition) and this disease/condition mimic following diseases. Further **Dr. AMRUTHANAND R** informed me that he/she is conducting dissertation/research titled "**FUNCTIONAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH FRAGMENT SPECIFIC FIXATION**" under the guidance of **DR. ASHOK NAYAK**. requesting my participation in the study. Apart from routine treatment procedure, the pre-operative, operative, post-operative and follow-up observations will be utilized for the study as reference data.

The Doctor has also informed me that during the conduct of this procedure like adverse results may be encountered. Among the above complications, most of them are treatable but are not anticipated; hence there is a chance of aggravation of my condition. In rare circumstances, it may prove fatal despite the anticipated diagnosis and best treatment made available. Further Doctor has informed me that my participation in this study help in the evaluation of the results of the study, which is a useful reference to the treatment of other similar cases soon, and also I may be benefited in getting relieved of suffering or cure of the disease I am suffering.

The Doctor has also informed me that information given by me, observations made/ photographs/ video graphs taken upon me by the investigator will be kept secret and not assessed by the person other than my legal hirer or me except for academic purposes.

The Doctor did inform me that though my participation is purely voluntary, based on the information given by me, I can ask for any clarification during the course of treatment/study related to diagnosis, the procedure of treatment, result of treatment, or prognosis. I have been instructed that I can withdraw from my participation in this study at any time if I want, or the investigator can terminate me from the study at any time from the study but not the procedure of treatment and follow-up unless I request to be discharged.
After understanding the nature of dissertation or research, diagnosis made, mode of treatment, I the undersigned Shri/Smt ______________________________ under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of the patient:

Signature of Doctor:

Witness: 1.
2.

Date:

Place :

ANNEXURE – IV

PROFORMA

Case No.

Name: Age/Sex I.P. No:

Address:

Date of injury:

Date of Admission:

Date of discharge:

Presenting complaints mechanism of injury:

General physical examination:

LOCAL EXAMINATION

Side : Left/Right bilateral

Deformity : Present/Absent

Swelling : Present/Absent

Tenderness : Present/Absent

Radio ulnar styloid height : Unaltered/altered in mm

Associated injuries : Present/Absent

Wound: Present/Absent

INVESTIGATIONS

X-ray forearm lower 3rd with wrist joint Postero anterior and lateral views

CT Scan with 3D reconstruction

Type of fracture based on AO classification

Any associated fractures

PRE-OPERATIVE TREATMENT

Closed reduction: done/not done

OPERATIVE TREATMENT

Operated on ___________

Fixator applied with wrist in

Neutral volar flexion/dorsiflexion

Radial/ulnar deviation

Type of implant used _________________________

Associated fracture treated with _____________

Post-operative finger movements

Good/fair/poor

Post – operative immobilization

Radio-ulnar styloid height: maintained/not maintained

Immediate post operative -

1. Check X-ray

a. Articular congruity

b. Radial inclination

c. Radial height

d. Palmar angulation

2. Movements

3. Complications

Follow up:

	2 weeks	4 weeks	8 weeks	12 weeks	4 months	5 months	6 months
Complaints (if any)							
Check Xray							
PRWE score							
Dorsiflexion							
Palmar flexion							
Radial deviation							
Ulnar deviation							
Pronation							
Supination							
ROM score							

Advise (physiotherapy)							
Complications (if any)							

FUNCTIONAL OUTCOME AND ROM ASSESSMENT

PRWE SCORE	RESULT
0-25	Excellent
26-50	Good
51-75	Fair
76-100	Poor

ROM SCORE	RESULT
>= 24	Excellent
>= 20	Good
>= 16	Fair
<= 15	Poor

ANNEXURE – V

KEY TO MASTER CHART

AO - Arbeitsgemeinschaft fur Osteosynthesefragen

DU – Dorsoulnar plate

F – Female

FOOH – Fall on outstretched hand

UHID number – In patient number

JO – Juxta-articular oblique plate

JT – Juxta-articular T plate

KW – K wire

L– Left side

M - Male

MOI – Mechanism of injury

PRWE – Patient rated wrist evaluation

RC – Radial column plate

ROM – Range of movements

R – Right side

RTA – Road traffic accident

S no. - Serial number

ST – Small straight T plate

s no	UHID	Age /Sex	Mode of Injury	A.O Type	side	Days to Surgery	Functional outcome range of Motion	Functional out come	Procedure	Complications	PRWE Score
1	2021090014	32/M	RTA	2R3C1	L	1	75	Excellent	DU	-	14.2
2	2021111089	34/M	RTA	2R3B1	L	7	70	Good	JT		22.7
3	2021220988	35/M	RTA	2R3B3	R	2	70	Good	RT	-	7.2
4	2021080198	17/M	RTA	2R3C2	L	7	70	Excellent	RC	-	9.1
5	2022060263	28/M	FOOSH	2R3B3	L	11	65	Excellent	JO	-	9.9
6	2022061054	24/F	RTA	2R3C2	L	2	35	Fair	ST	SUPERFICIAL INFECTION	9.3
7	2022050977	36/M	FOOSH	2R3C1	R	7	65	good	RC	-	8.1
8	2022240120	40/M	RTA	2R3B3	R	2	40	Fair	JO	PERSISTANT PAIN	19.8
9	2022096996	24/M	FOOSH	2R3B1	R	8	65	good	JT	-	11.6
10	2022700148	43/M	RTA	2R3B3	R	7	85	Excellent	RT	-	15.3
11	2022090314	22/M	FOOSH	2R3C1	L	7	65	Excellent	DU	-	17.6
12	2022220429	29/M	RTA	2R3B2	R	9	35	Fair	JO	SUPERFICIAL INFECTION	9.7
13	2022310198	32/F	RTA	2R3C1	R	11	70	Excellent	RC	-	9.0
14	2022090396	50/F	FOOSH	2R3B3	L	2	65	Excellent	ST	-	7.1
15	2022280891	38/M	FFH	2R3B1	R	7	80	Excellent	RC	-	14.7
16	2022830167	32/M	RTA	2R3C1	R	1	70	Good	ST	-	8.2
17	2022060135	43/M	RTA	2R3B3	R	13	65	Excellent	RC	-	9.1
18	2022030889	37/F	FOOSH	2R3B3	L	7	75	Good	JO	-	10.6
19	2023090999	40/M	RTA	2R3C1	R	7	65	Excellent	RC	-	12.1
20	2022750159	46/M	FOOSH	2R3B2	R	8	85	Excellent	DU	-	10.9
21	2022241044	32/M	RTA	2R3C1	R	9	75	Excellent	JO	-	9.1
22	2023041035	19/M	RTA	2R3B3	R	2	70	Excellent	ST	-	9.3
23	2023290232	44/M	FOOSH	2R3B3	L	7	20	poor	ST	TOURNIQUET PALSY	12.6
24	20230070297	47/M	RTA	2R3C1	L	8	75	Excellent	JO		38.4
25	2023270014	43/M	RTA	2R3B3	R	1 12	70	Excellent	RC	-	18.7
26	2023240066	28/M	RTA	2R3B2	L	1 7	35	Fair	RC	STIFFNESS	28.4
27	2023281020	20/M	RTA	2R3C2	R	2 1	40	Fair	JT	TINGLING AND NUMBNESS	8.8
28	2023150094	39/M	FOOSH	2R3C1	L	1 2	15	poor	JO	STIFFNESS	9.4
29	2023190317	53/F	RTA	2R3B3	R	1 8	75	Good	RC		15.7
30	2023500030	19/M	RTA	2R3C2	R	0 7	60	Good	RC	-	13.6
31	2023022429	59/M	RTA	2R3C3	L	1 8	40	Fair	ST	TINGLING AND NUMBNESS	14.2
32	2023024067	64/M	RTA	2R3C1	R	1 2	65	Excellent	ST	-	7.9