"CLINICAL OUTCOME OF MANAGEMENT OF DISTAL RADIUS FRACTURES TREATED WITH DISTAL RADIUS PLATE"

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Under the Guidance of

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Is a bonafide and genuine research work carried out by me under the guidance of

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INTRODUCTION

The fracture of the distal radius is the most common fracture we treat. Distal end radial fractures represent approximately one-sixth of all fractures treated in emergency department.[1]

Fractures of the distal aspect of the radius continue to pose a therapeutic challenge. Some of these fractures are caused by severe high energy trauma, resulting in intra-articular involvement and comminution. Treatment of such injuries is difficult. These fractures often are unstable, are difficult to reduce anatomically, and are associated with a high prevalence of complications of post-traumatic osteoarthrosis after intra articular fracture of the distal aspect of the radius. It is also known that extra-articular malalignment can lead to decreased grip strength and endurance as well as limited motion and carpal instability. The results of closed reduction, percutaneous pin fixation, pins and plaster, and internal and external fixation have been variable and have been determined largely by the pattern of the fracture. The goal of treatment is to restore congruity of the radiocarpal and distal radioulnar joint surfaces and to restore and maintain the length of the radius.

Many things are subject to trend and fashion, and the treatment of distal radial fractures is no exception. Pins and plasters gave way to external fixation, and now internal fixation has begun to supplant all other treatment modalities.

External fixator is based on ligamentotaxis, in which the fracture fragments are moulded by traction forces across the ligaments. In addition, external fixation is unable to prevent dorsal collapse of the radius or maintain the normal palmar tilt of the radiocarpal joint surface. This complication may predispose to posttraumatic wrist instability and arthritis. The problems with external fixation have prompted a search for a better treatment option.

An internal fixator placed through limited incisions on the dorsal aspect of the radius and spanning the fracture site can, in theory, provide the benefits of external fixation without the associated morbidity. In addition, these internal devices theoretically act as a mechanical dorsal buttress that prevents dorsal collapse and loss of palmar tilt in a manner analogous to volar buttress plate. An internal fixator is a reasonable alternative to external fixation if it is biomechanically equivalent in maintaining distraction and withstanding applied loads.

The use of precontoured angular stable plate fixation is characterized by higher stability even in osteopenic bone and in altered bone architecture as it is seen in osteoporosis. These implants afford osseous fixation that allows early motion and rehabilitation. Also their precontoured shape maintains desirable patterns of alignment, congruency and inclination of the distal radius after corrective osteotomy because of their ability to ensure angular and axial stability. These properties reduce the probabilities of screw loosening and consequent loss of reduction.[2]

Locking compression plate (LCP) is a new screw-plate system developed by combining the traditional plating techniques with the principles of AO internal fixator. The distal radius is the foundation of the wrist joint and an indispensable part of ligamentous support, reconstruction of articular congruity and stable fixation reduces the incidence of post-traumatic osteoarthritis and allows early Functional rehabilitation.[3]

Difficulty in the inter observer reliability of fracture classification, an unclear definition of instability, and a variety of commonly used scoring systems pose a confusion to a consensus opinion regarding surgical management of these injuries.

Over the past decade, there has been increasing interest in plate fixation, especially volar plate fixation of distal radius fractures.

The purpose of this study is to evaluate the functional & anatomical outcome of distal radius fractures treated by volar plating (Ellis/locking compression plate).

OBJECTIVES

1. To assess the efficacy of the volar plating in distal end of radius fractures.

2. To evaluate the clinical outcome of Intra- and extra -articular fractures of distal radius fractures.

REVIEW OF LITERATURE

HISTORICAL ASPECTS

Fractures of the distal end radius were not recognized until beginning of 18th century "Petit" was the first person to describe these fractures.

Hippocrates (400 BC) first described a distal radius fracture. He did not identify this injury as a fracture through the metaphysis of the radius, but considered it a dislocation of the carpus or radiocarpal joint. He stated that "The joint of the hand is dislocated inward or outward, most frequently inward."

Fracture of distal radius were described by Ponteau in 1783. Abhram Colles of Dublin in 1814 described a fracture of carpal end of radius that had previously been thought to be dislocation.

Abraham Colle's published "on the fracture of the carpal extremity of the radius in Edinburg medical journal (1814).His description of the fracture "this fracture takes place at about an inch and half above the carpal extremity of the radius & exhibits the following appearances. The posterior surface of the limb presents a considerable deformity, for a depression is seen in the forearm about an inch and half above this bone, while considerable swelling occupies the wrist & metacarpus. Indeed the carpus and base of the metacarpus appear to be thrown backwards as much as on first view to excite a suspicion that the carpus has been dislocated forward. On viewing the anterior surface of the limb, we observe considerable fullness, as if caused by the flexor tendons being thrown forwards. This fullness extends upwards to about the third of the length of the forearm and terminates below, at the upper edge of the annular ligament of the wrist. The extremity of the ulna is seen projecting towards the palm and inner edge of the limb, the degree however in which this projection takes place is different instances. If the surgeon proceeds to investigate the nature of this injury he will find the end of ulna admits of being readily moved backwards and forwards".

1821 AD Barton Described a greenstick fracture in children and the dorsal and the volar marginal shearing fracture of the distal radius that was named for him.

1826 AD Malgaigne French surgeon described various distal radius fractures. 1832 AD Goyrand French surgeon described a dorsally and volarly angulated fracture of the distal radius.

1847 AD Smith Described the Colles and Smith fracture (volar angulated distal radius fracture) that was named for him.

1860 AD Hamilton American surgeon who performed the first outcome study and described the evolution of splinting of distal radius fractures in North America including the use of prefabricated splints.

1904 AD Lambotte Reported on the operative treatment of fractures and coined the terms Osteosynthesis and fixateur externe (external fixator).

In 1929, Bohler published his original technique of transfixation with skeletal pins and incorporation in plaster cast to maintain the reduction of fracture; the so called "pin and plaster method" and showed significantly better results than the century old method.

In 1944, Anderson and O'Neil reported on the use of external skeletal fixation to maintain fracture reduction by ligamentotaxis in a distal radius fracture.

In the early 1950s, James Ellis from England began using a specially designed T plate to buttress the small marginal fragment in volar Barton's fractures.

In the 1970s, the AO group designed plates specifically for the treatment of distal radius fractures.

Ellis in 1965 was one of the earliest to recommend open reduction and internal fixation of Smith's fracture and of volar Barton's fracture. He devised a T- plate which acted as an excellent volar buttress preventing the deformities.[4]

John K.Bradway et al. (1989) retrospectively reviewed the results in 16patients with fractures of the distal radius treated by open reduction and internal fixation and concluded that open reduction and internal fixation is the treatment of choice for displaced, comminuted intra-articular fractures of distal radius when alignment of the articular surface cannot be obtained by closed means and anatomical restoration of the articular surface is required to prevent the sequela of post-traumatic arthritis.[5]

Knirk and Jupiter reported in their series patients had satisfactory original reduction followed by late collapse resulted intra-articular incongruity treated by casting.[6]

Jesse B.Jupiter, et al. (1996) retrospectively reviewed the results of operative treatment of 49 volar, intra-articular fractures of the distal end of the radius. They graded their results according to the system described by Gartland and Werley and the modified system of Green and O'Brien. Two factors were found to have a significant association with a fair or poor outcome: evidence of osteoarthrosis on the most recent follow-up radiographs and reversal of the normal volar tilt of the distal end of the radius. Restoration of radial length, radial tilt angle and congruity of articular surfaces is important for good functional results.[7]

Fitoussi F, et al. (1997) in their study of 34 patients with intra-articular fractures of the distal radius treated with open reduction and internal fixation with buttress plate and screws, concluded that the potential for restoration of normal alignment and stability of fixation are the main advantages of internal fixation with plates.[8]

Carter P.R, et al. (1998), evaluated a new method of open reduction and internal fixation of unstable distal radius fractures using an anatomically preshaped, rigid dorsal low profile plate with recessed screw holes in conjunction with an autogenous bone graft. They concluded that patients with severe and unstable fractures prone to poor results and complications from external fixators had non-union and infection rates of 0 (zero) with the new plate.[9]

Jakob M, et al. (2000) conducted a study on 76 patients and recommended a double plating method with 2mm titanium plates, for dorsally displaced fractures, where open reduction is indicated to restore congruency and extra-articular anatomy. It is reliable in providing stable internal fixation and allowing early function.[10]

Harish Kapoor, et al. (2000) comparatively evaluated the results following closed reduction, external fixation and open reduction with internal fixation in 90 patients with displaced intra-articular fractures of distal radius. They concluded that plaster case is insufficient to maintain the reduction in the majority of displaced intra-articular fractures. Open reduction and internal fixation provides the best articular anatomy and therefore patients treated by this method have the least chance of developing secondary osteoarthritis as suggested by the literature. It is the treatment of choice if there is a residual articular step-off > 2 mm. Good results are seen with the use of external skeletal fixation in displaced intraarticular fractures. It maintains the radial length best due to sustained counter-traction utilizing the principle of ligamentotaxis. Best results in severely comminuted fractures are seen with a fixator. The complications with this procedure are minimal with meticulous pin insertion and pin site care.[11]

Mercer states that open reduction and internal fixation of distal radius fractures with a buttress plate or volar locking plate allows anatomical reduction of fragments, Bone grafting to elevate the articular surface and immediate stability to initiate early range of motion exercises.[12]

Schlitz M, Kolbeck S (2003) published his first clinical experiences of Palmar plating with the locking compression plate for dorsally displaced fractures of the distal radius. He stated that the preliminary results demonstrate the option of early functional treatment using the locking compression plate. Most of the patients had a good to excellent range of motion of the injured wrist which resulted in an early return to former activity. There were few intra- and postoperative complications. No irritation of the median nerve, no infection was observed. In one case a screw which was placed intra -articularly was removed prematurely. The palmar locking compression plate has been proven as a safe and effective implant for the treatment of dorsally displaced fractures of the distal radius.[13]

Beharrie et.al (2004) studied functional outcomes after open reduction and internal fixation for treatment of displaced distal radius fractures in patients over 60 years of age, 18 patients with an average of 71 years (range 60-86).[14]

Louis W. Catalano, et al (2004) assessed the articular displacements of distal radius fractures and stated that current operative indications include fractures with radiocarpal or distal radioulnar joint step or gap deformities greater than 1-2mm, gross distal radioulnar joint instability, or those with extensive metaphyseal comminution rendering them particularly unstable after closed reduction. In general, there is tendency to lean toward operative fixation in younger, more active patients.[15]

David Ring, et al. (2004) evaluated 25 patients with AO C3-2 fractures treated with combined dorsal and volar plate fixation at an average of 25 months after injury and concluded that combined dorsal and volar plate fixation can achieve a stable, mobile wrist in patients with very complex fractures. A second operation for implant removal was common, and there was a small risk of tendon - related complications. [16]

KK Wong, et al. (2005) evaluated the functional and radiological results of treating unstable fractures of the dorsal distal radius with a volar locking plate in 30 patients. Radiological scores demonstrated 22 excellent and 8 good outcomes. No nonunion or infection occurred. They concluded that Volar locking compression plating is a safe and effective treatment for unstable fractures of the dorsal distal radius.[17]

Strohm PC (2007) He concluded that 3.5 mm T-LCP is a good implant for the stabilization of displaced distal radius fractures if the fragments are not too small for the 3.5 mm screws.[18]

Rohit Arora, et al.(2007) analyzed the clinical and radiological outcomes of patients with displaced, unstable distal radius fractures treated with Open reduction and palmar internal fixation with 2.4 mm Locking Compression Plate. 114 patients followed up for a minimum of 12 months and Concluded that Fixation of unstable dorsally displaced distal radius fractures with a fixed angle plate provides sufficient stability with minimal loss of reduction. Very distal palmar plate position can interfere with the flexor tendon system, too long screws can penetrate the extensor compartments, and distal screws in comminuted fracture patterns can cut through the subchondral bone and penetrate into the radiocarpal joint.[19]

RE Anakwe (2010) Conducted a study on locked volar plating for complex distal radius fractures. Over a 12 month period 21 patients with type C distal radius fractures were treated using locked volar plating and stated that Locked volar plating for complex distal radius fractures produces good results when assessed using patient reported measures of outcome.[20]

Jupiter JB (2010) conducted a multicenter prospective study of 150 patients with distal radius fractures treated with 2.4mm locking compression plate and concluded that Internal fixation of displaced distal radial fractures with implants featuring locking screw fixation can result in good-to-excellent outcomes with a limited number of complications.[21]

Minegishi H (2011) one study evaluated the functional and radiological results in 15 patients and followed up for a minimum of 1 year. Operative techniques have to be carefully performed to prevent complications.[22]

kenny K (2011) In another study the importance of restoring the anatomical alignment and articular congruity in the fixation of distal end radius fractures was stressed. Full restoration of hand function is the desired outcome of distal radius fracture fixation. This study has demonstrated a good clinical outcome with no loss of radiographic reduction using the 2.4-mm locking plate system in the fixation of distal radial fractures.[23]

Phadnis J (2012) in a study of 180 patients with distal radial fractures demonstrated good to excellent results in the majority of patients with volar locking plate. [24]

Gyaneshwar T (2013) in this study of 80 patients with distal end radius fractures and treated with volar fixed-angle locking plates showed excellent to good anatomical restoration and excellent functional outcome. These results suggest that stabilizing the fracture with volar plating is a very effective method.[25]

Gogna P(2013) In a study of 33 patients with dorsally comminuted distal radius fractures treated with open reduction and internal fixation with AO 2.4mm volar locking distal radius plate resulted in good to excellent functional outcomes despite a high incidence of loss of reduction and fracture collapse.[26]

Karantana A (2013) Use of a volar locking plate resulted in a faster early recovery of function compared with use of conventional methods. However, no functional advantage was demonstrated at or beyond twelve weeks. Use of the volar locking plate resulted in better anatomical reduction and grip strength, but there was no significant difference in function between the groups at twelve weeks or one year. The earlier recovery of function may be of advantage to some patients.[27]

O.B. Pattanashetty(2013) ,conducted a study in adults treated with volar buttress plate and achieved excellent to good results in 65.6%patients and concluded that it can be used as alternative to other procedures in treating comminuted intraarticular fractures of distal radius.[28]

Fletcher C (2015) concluded that the most recent data suggests that volar plating is associated with reduced pain, superior ROM in all directions and improved functional scores. There is also level one evidence demonstrating that locked volar plating is associated with better patient reported outcomes compared to external fixation in the first three months postoperatively. It is therefore advantageous in patients requiring an accelerated functional recovery and also associated with fewer complications.[29]

ANATOMY OF THE WRIST

The Bones:

The Distal end of Radius:

The distal end of Radius, is the widest part, is four sided in section. Its lateral surface is slightly rough, projecting distally as a styloid process palpable when tendons around it are slack. Distal, is the smooth carpal articular surface, divided by a ridge into medial and lateral areas, the medial quadrangular, and the lateral triangular and curving on to the styloid process.

The anterior surface is a thick, prominent ridge, palpable even through overlying tendons, 2 cm proximal to the thenar eminence.

The medial surface is the ulnar notch, smooth, antero-posteriorly concave for articulation with the ulnar head.

The posterior surface displays a palpable dorsal tubercle (Lister's tubercle), limited medially by an oblique groove and in the line with the cleft between the index and middle finger. A wide, shallow groove, lateral to it, is divided by a faint vertical ridge. A similar but undivided groove is medial to the tubercle.

The radial styloid process projects beyond that of the ulna, its apex concealed by tendons of the abductor pollicis longus and extensor pollicis brevis. The carpal lateral ligament is attached to its tip. The lateral surface, near the styloid, receives the brachioradialis and is crossed obliquely, down and forwards, by tendons of the abductor pollicis longus and extensor pollicis brevis.

The terminal ridge on the anterior surface of the lower end is an attachment for the palmar radiocarpal ligament. To a smooth ridge distal to the ulnar notch the base of the triangular articular disc of the inferior radio-ulnar joint is attached. From the latter, a narrow protrusion of synovial membrane extends proximally anterior to the lower end of the interosseous membrane.

The lateral part of the carpal articular surface joins with the scaphoid and the medial part of the surface with the lateral part of the lunate bone; in full adduction the latter’s proximal surface is wholly in contact with the radius.

The radial dorsal tubercle receives a slip from the extensor retinaculum and is grooved medially by the tendon of the extensor pollicis longus. The wide groove lateral to the tubercle contains tendons of the extensor carpi radialis longus laterally, extensor carpi radialis brevis medially and their synovial sheaths. Medially the dorsal surface is grooved by the tendons of extensor digitorum, but extensor indicis and the posterior interosseous nerve separate these from the bone. Attached to the distal margin of this surface is the dorsal radiocarpal ligament.

Ossification

The radius ossifies at three centers, in the shaft, appearing centrally in the eight week and in each end. Near the end of the first postnatal year ossification begins in the distal epiphysis, and in the proximal at the fourth year in females, fifth in males. The proximal fuses in the fourteenth year in females seventeenth in males, the distal in the 17th and 19th years respectively. A fourth Centre sometimes appears in the tuberosity about the 14th or 15th year.

DISTAL END OF ULNA

The distal end, is a little expanded, has a head and styloid process. The ulna head is visible in pronation on the postero-medial carpal aspect and can be gripped when the supinated hand is flexed. Its lateral convex articular surface fits the radio ulnar notch. Its smooth distal surface is separated from the carpus by an articular disc, the apex of which is attached to a rough area between the articular surface and styloid process. The latter, a short, round, postero-lateral projection of the ulna's distal end, is palpable (most readily in supination) about 1 cm proximal to the plane of the radial styloid. A dorsal vertical groove is present between the head and styloid process.

Ossification

The ulna ossifies from 4 main centers, one each in the shaft and distal end and two in the olecranon. Ossification begins in mid-shaft about the eighth fetal week, extending rapidly. In the fifth (females) and sixth (males) years a center appears in the distal end, extending into the styloid process. The distal olecranon is ossified as an extension from the shaft, the remainder from two centers, one for the proximal trochlear surface, and a thin scale-like proximal epiphysis on its summit.

The latter appears in the ninth year in females, eleventh in males; the whole proximal epiphysis has joined the shaft by the 14th year in females, 16th in males. The distal epiphysis unites with the shaft in the 17th year in females, 18th in males.

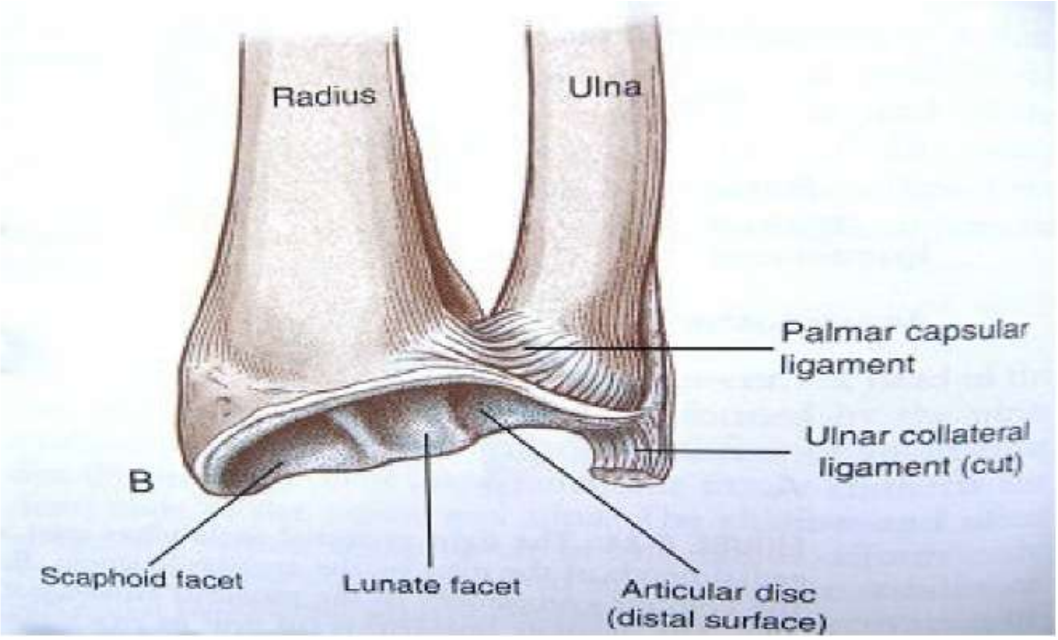


Fig: 1 DISTAL ASPECT OF RADIUS & ULNA

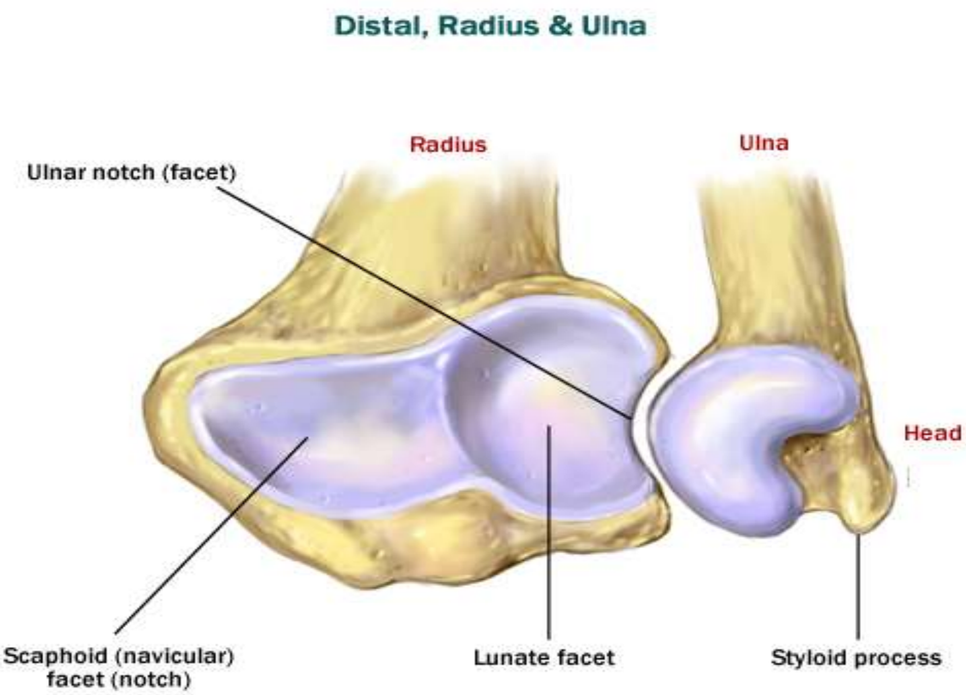


Figure: 2 ARTICULAR SURFACE

The Carpal bones:

The carpus contains 8 bones in proximal and distal rows. Proximally, in lateral to medial border, are the scaphoid, lunate, triquetral and pisiform bones; in the distal row are the trapezium, trapezoid, capitate and hamate bones. The pisiform articulates with the palmar surface of the triquetral, thus separated from other carpal bones, all of which articulate with their neighbors. The three proximal bones form on arch proximally convex, articulating with the radius and articular disc of the inferior radio-ulnar joint. The arch's concavity is a distal recess embracing, proximally, the projecting aspects of capitate and hamate bones; the two rows are thus mutually and firmly adapted without any loss of movement.

The dorsal carpal surface is convex and the palmar forms a deeply concave carpal groove, accentuated by the palmar projection of the lateral and medial borders. The medial projection is formed by the pisiform bone and the Hamulus, and uniform palmar process of the hamate bone. The pisiform is at the proximal border of the hypothenar eminence, medial in the palm; it is easily felt in front of the triquetral. The Hamulus is concave laterally, its tip palpable 2.5 cm distal to the pisiform, in line with the radial border of the ring finger.

The ulnar nerve's superficial division can be rolled on it. The lateral border of the carpal groove is formed by the tubercles of the scaphoid and trapezium. The former is distal on the anterior scaphoid surface and palpable, sometimes also visible, as a small medial knob at the proximal border of the palmar thenar eminence, lateral to the tendon of the flexor carpi radialis.

The trapezial tubercle is a vertically rounded ridge on the bone's anterior surface, slightly hollow medially and just distal and lateral to the scaphoid tubercle; it is difficult to palpate.

The carpal groove is made into on Osseo fibrous CARPAL TUNNEL by a fibrous retinaculum attached to its margin; the tunnel carries flexor tendons and the median nerve into the hand. The retinaculum strengthens the carpus and augments flexor efficiency. Palmar and dorsal surfaces of carpal bones, apart from the triquetral and pisiform, are attachments of the radiocarpal, intercarpal and carpometacarpal ligaments.

THE DISTAL RADIO ULNAR JOINT

This is a uniaxial pivot between the ulna's convex distal end (head) and the concave ulnar notch of the radius; these surfaces are enclosed by a capsule and connected by an articular disc. The fibrous capsule is thicker in front and behind, proximally lax and lined by synovial membrane projecting proximally between radius and ulna as a recess sacciformis in front of the distal part of the interosseous membrane.

The articular disc is fibrocartilaginous (Collagen and elastic fibers in the young) and is triangular, binding the distal ends of ulna and radius. Its periphery is thicker, its center sometimes perforated. It is attached by a blunt, thick apex to a depression between the ulnar styloid process and distal articular surface and by its wider thin base to the prominent edge between the ulnar notch and carpal articular surface of the radius. Its margins are united to adjacent carpal ligaments, its surfaces smooth and concave; the proximal articulates with the ulnar head, the distal is part of the radiocarpal joint, articulating with the lunate bone and when the hand is adducted, the triquetral.

THE RADIOCARPAL JOINT

The radiocarpal joint, biaxial and ellipsoid, is formed by articulation of the distal end of radius and the triangular articular disc with the scaphoid, lunate and triquetral bones. The radial articular surface and distal discal surface form an almost elliptical, concave surface with a transverse long axis; but the radial surface is bisected by a low ridge into two concavities. A similar ridge usually appears between the medial radial concavity and the concave distal discal surface. Proximal articular surfaces of scaphoid, lunate and triquetral bones and their interosseous ligaments form a smooth convex surface, received into the proximal concavity. Surface projection of the joint is a line, convex upwards, joining radial and ulnar styloid processes.

The articular surface is lined by synovial membrane which is usually separate from that of the inferior radio – ulnar and intercarpal joints; but a protruding prestyloid recess, ventral to the articular disc, is present and ascents close to the styloid process. The recess is bounded distally by a fibrocartilaginous meniscus, projecting from the ulnar collateral ligament between the tip of the ulnar styloid process and the triquetral; both are clothed with hyaline articular cartilage. The meniscus may ossify. The capsule is strengthened by palmar radiocarpal and ulnocarpal, dorsal radiocarpal and radial and ulnar collateral ligaments.

The Palmar Radiocarpal Ligament, a broad membranous band, is attached to the anterior margin of the distal end of the radius and its styloid process, its fibres passing distomedially to the anterior surfaces of scaphoid, lunate and triquetral bones, some reaching the capitate, it is partly intracapsular.

The Palmar Ulnocarpal Ligament is a rounded fasciculus from the base of the ulnar styloid process and anterior margin of the articular disc to the lunate and triquetral bones. Lewis et al and Mayfield et al regard both palmar carpal ligaments as intracapsular ; the latter also divide the radio carpal ligaments into 3 parts and ulnocarpal ligament into 2 parts each named by its attachments. The palmar carpal ligaments are perforated by vessels and are related anteriorly to tendons of flexors digitorum profundus and pollicis longus.

The Dorsal Radiocarpal Ligament, thinner than the palmar, is attached to the posterior border of the distal end of the radius, its fibers descending distomedially to the dorsal surfaces of scaphoid, lunate and triquetral bones and continuing into the dorsal intercarpal ligaments. It is related posteriorly to the carpal and digital extensor tendons, their synovial sheaths and the posterior interosseous nerve; anteriorly it is blended with the disc of the distal radio-ulna articulation.

The Ulnar Collateral Carpal Ligament is attached to the apex of the ulnar styloid process; it divides into two fasciculi, one attached to the medial side of the triquetral, the other to the pisiform bone.

The Radial Collateral Carpal Ligament extends from the tip of the radial styloid process to the radial side of the scaphoid bone; some fibres are prolonged to the trapezium. It is related to the radial artery, curving round laterally between the ligament and tendons of abductor pollicis longus and extensor pollicis brevis. Both collateral ligaments are relatively weak.

MOVEMENTS:

Flexion:

Muscles responsible

Flexor carpi ulnaris.

Flexor carpi radialis

Palmaris longus.

Assisted by:

Flexor digitorum superficialis

Flexor digitorum profundus.

Extension:

Muscles responsible

Extensor digitorum.

Extensor digiti miinimi.

Extensor indices.

Extensor pollicis longus.

Adduction:

Flexor carpi ulnaris

Extensor carpi ulnaris.

Abduction:

Flexor carpi radialis.

Extensor carpi radialis longus and brevis.

Abductor pollicis longus and extensor pollicis brevis

Pronation:

The muscles producing pronation is pronator quadratus (mainly), aided during rapid movement and against resistance by pronator teres. Gravity also assists.

Supination:

Supinator, in slow unassisted movements and biceps in fast movements with the elbow flexed especially when the resistance is encountered.

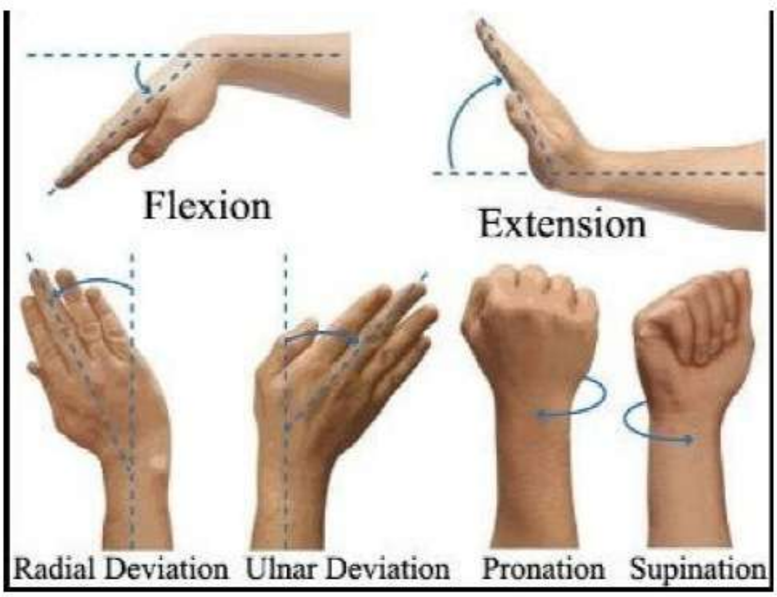


Figure: 3 MOVEMENTS

BLOOD SUPPLY TO THE DISTAL RADIUS

Blood supply to the distal radius is mainly from the anterior interosseous artery and radial artery.

The ulnar artery and the posterior interosseous artery are involved indirectly via the anastomoses between the carpal arteries.

The vascularity arises from:

a) Nutrient arteries.

b) Metaphyseal and epiphyseal perforating arteries.

c) Periosteal plexus.

KINEMATICS

The global motion of the wrist is composed of flexion, extension and radio ulnar deviation at the radio carpal joint and axial rotation around the distal radio ulnar joint.

The radio carpal joint acts as a universal joint, allowing a small degree of intercarpal motion around the longitudinal axis related to rotation of the individual carpal bones.

The Forearm accounts for the most of the rotation (about 140 degree) and supplies the hand with the strength necessary to apply vigorous torque.

Radio carpal joint motion is primarily Flexion – Extension of nearly equal proportions (70 degrees each), radial and ulnar deviation of 15° and 45° respectively. Most adduction occurs at the radiocarpal joint; the lunate bone, articulating with both radius and articular disc when the hand is in mid-position, in adduction passes off the disc to articulate solely with the radius.

Abduction occurs almost entirely at the mid-carpal joint. Circumduction of the hand is not rotatory but successive flexion, adduction, extension and abduction or the reverse.

Abduction – adduction movements are of special functional value. The hand is commonly used with the carpus slightly extended and the forearm in mid-position. Skilled abduction, adduction movements manipulate a large variety of precision tools, from fine needles to hammer.

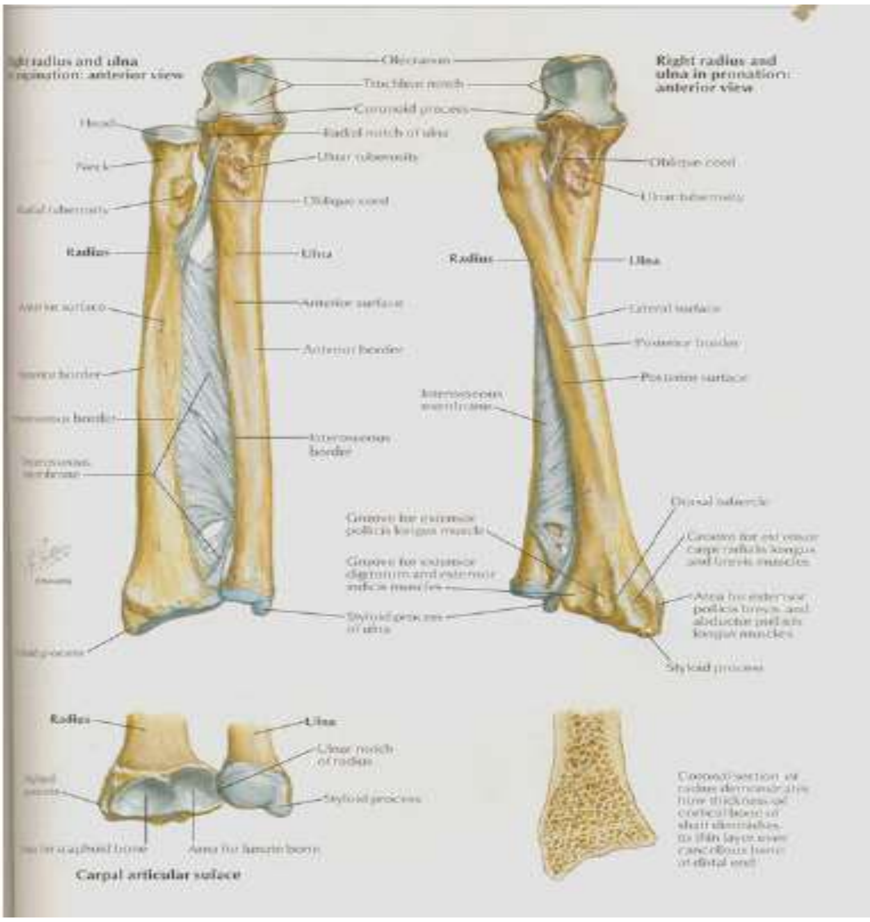


Fig: 4 ANATOMY

CLINICAL FEATURES

Patient comes with history of fall on outstretched hand or road traffic accident comes with pain, swelling and deformity of the wrist.

Clinical signs: Bony tenderness, swelling, abnormal mobility, Crepitus, bony irregularity, range of movements painful and restricted.

IMAGING TECHNIQUES

Fractures of the distal radius are the most common fractures of the upper extremity and account for 17% of all fractures treated in the emergency room. Initially thought to be simple fractures, they are now recognized as complex injuries with a high percentage of long term complications.

The carpus and the distal radius and ulna are intimately connected by a complex array of palmar and dorsal ligaments such that distal radial and ulnar fractures may be associated with carpal fractures and dislocations.

In patients with uncomplicated and simple fractures, conventional roentgenograms in two planes are usually sufficient to make diagnoses. However, in patients with intra-articular and comminuted fractures, in patients with associated injuries of the wrist, as well as in post-operative follow-up, advanced imaging techniques such as computed tomography (CT), magnetic resonance imaging (MRI) and Scintigraphy may be necessary.

RADIOGRAPHY

A routine roentgen graphic examination should be performed first and is in many patients with distal radius fractures sufficient for correct diagnosis and adequate treatment. It is easy to perform, universally available and inexpensive.

The routine minimal evaluation for distal radius fractures must include two views,

a) Postero anterior. b) Lateral

A semi supinated oblique view can be obtained to help detect and depict various fracture lines.

The PA view should be obtained with the humerus abducted 90 degrees from the chest wall so that the elbow is at the same level as the shoulder and flexed 90 degrees. The palm of the hand maintained flat against the film cassette.

Fig: 5

For the lateral view, the humerus is adducted against the chest wall and the elbow flexed 90 degrees. The wrist and hand are maintained flat against the film cassette.

Tear drop angle – is measured as a tangent to the articular surface of the volar tear drop respect to the longitudinal axis of radius. Increased angle is seen with displaced volar marginal fracture. Decreased angle with dorsally angulated extra articular fractures.

Freiberg and lundstrom have found that lateral views taken with the central ray directed 15 degrees proximally provide significantly more exact measurement of the palmar tilt of the distal radial joint surface in comparison with a projection obtained with the central ray perpendicular to the forearm. The reason for this is that a perpendicular projection is not tangential to the plane of the distal radius slope and, therefore, will yield less easily defined measuring points than the other projection.

In a standard lateral projection, the radiograph beam is oriented perpendicular to the long axis of the radial shaft. Because the radial inclination of the ulnar two third of the articular surface is 10˚to the long axis of the shaft, this results in an oblique projection of the joint surface on the standard lateral view.

The 10˚lateral projection positions the articular surface in profile, allowing direct visualization of any offset in the sagittal plane and accurate identification of the apical ridges of the dorsal and volar rims. This projection is performed simply by elevating the distal forearm 10˚from horizontal or by aligning the beam 10˚ proximally.

The radial styloid is visualized on the lateral projection as a V-shaped outline superimposed over the lunate with a base extending from the dorsal and palmar margins of the distal radius.

Four measurements obtained from the PA and lateral views are important for accurate treatment and sufficient radiological follow up after distal radius fractures.

The four measurements are

The radial angulation (or inclination) describes the relative angle of the distal radial articular surface on the PA view to a line perpendicular to the long axis of the radius. This angle should be between 16 and 28 degrees, averaging around 20 degrees. Loss of this angle indicates a radial fracture, generally with impaction or overlap of fragments.

Fig: 6(a) Radial inclination (b) PA with X measuring the radial inclination

A second measurement of distal articular surface of the radius is palmar tilt this is measured on lateral radiographs, as the angle created between the articular surface of the distal radius and a line perpendicular to the long axis of the radius and is between 0 and 22 degrees (mean, 14.5 degrees and standard deviation, 4.3 degrees)

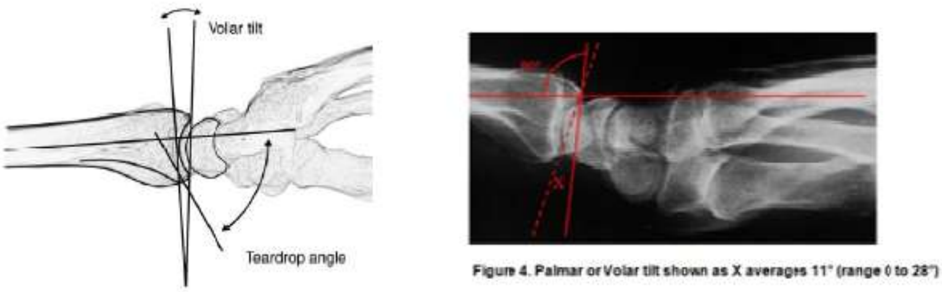


Fig: 7(a) Volar tilt (b) Lateral view with X measuring volar tilt/palmar tilt

The radial length, also measured on PA radiograph, relates the length of the radius to the ulna by the distance between two perpendicular lines to the long axis of the radius, one joining the tip of the radial styloid process and the other, surface of the ulna head. Normally the radial length averages 11 to 12 mm.

Fig: 8 PA view with X measuring the radial length

Another measurement of the accuracy of reduction for articular fractures is the vertical distance between the distal ends of the medial corner of the radius and the ulna head.

Another radiographic measurement on the PA view is the radial shift (or radial width)

Fig: 9

This is the distance between the longitudinal axis through the centre of the radius and the most lateral point of the radial styloid process. Both the injured and uninjured wrists are measured and compared. The measurement should be within 1 mm of each other in length.

Measure	Description	Normal Values	Acceptable Reduction
Radial Inclination (PA View)	Angle between a line drawn from the tip of the radial styloid to the most distal ulnar aspect of the lunate facet and a line perpendicular to the longitudinal axis of the radius.	13-30° Average=23°	>15°
Radial Length (PA View)	Longitudinal difference between a line perpendicular to the long axis of the radius drawn at the radial styloid and another line tangential to the distal articular surface of the ulna.	8 18mm Average=11mm	Loss of <5mm
Palmar Tilt (Lateral View)	The angle between a line joining the dorsal and volar margins of the articular surface and the long axis of the radius.	0 28° Average=11°	0 20° volarly
Radial Shift (PA View)	The distance between the long axis of the radius and the most radial point of the styloid	*Bilateral comparison*	
Intra-articular Step Off (PA View)	Incongruity in the articular surface (radio carpal and DRUJ articular surface)		<2mm

Fig: 10 Table shows radiographic measurements normal values & acceptable values

Fernandez reports that a dorsal tilt of the distal radial surface of more than 25 degrees becomes symptomatic, whereas Pogue reports that 20 degrees of dorsal inclination causes problems.

Taleisnik and Watson report that even small changes in palmar tilt lead to radiocarpal dysfunction.

Similarly, there are different interpretations concerning radial shortening as the primary cause of poor end results ; some investigators suggest that 2 or 2.5 mm of radial shortening leads to changes in loads within the wrist.

Involvement of the distal radioulnar joint in fractures of the distal radius (Frykman fracture types V to VIII) can usually be recognized adequately on routine PA and lateral views. On the PA radiograph, the distal radioulnar joint should measure approximately 2 mm. Incongruity at this joint may cause diastasis or narrowing of this joint space, but if it does not, subluxation or dislocation of the distal radioulnar joint may be overlooked.

Computed Tomography

In selected difficult instances, such as complex or occult fractures, in evaluation of the distal radioulnar joint and distal radial articular surface, as well as in the assessment of fracture, healing and post-surgical evaluation, CT may be useful and may add significant information in comparison with that obtained with conventional radiography.

CT may be indicated for the confirmation of occult fractures suspected on the basis of the findings of physical examination and focally hot to very hot bone scintigrams when plain films are normal, for the preoperative evaluation of complex distal radius fractures which are comminuted, and for the exact evaluation of the distal articular surface of the radius.

The axial plane is useful to show the configuration of the fracture patterns involving the distal radial articular surface.

The sagittal and coronal planes are useful for demonstration of the congruity and angulation of the radiocarpal joint surface, the degree of dorsal and ventral surface comminution, as well as elevation or depression of the distal radial articular surface.

CT is the modality of choice for corroborating distal radioulnar in congruency.

MAGNETIC RESONANCE IMAGING:

Although MRI cannot be used as the first choice modality for evaluating acute fractures, it is a powerful diagnostic tool to assess bony, ligamentous and soft tissue abnormalities that frequently are related to distal radius fractures.

MRI has proved to be a very important diagnostic tool for evaluating occult fractures and post traumatic or avascular necrosis of carpal bones.

BIOMECHANICS OF THE WRIST

The movements of radiocarpal and intercarpal joints are considered together as a common mechanism acted on by the same muscles. Active movements are flexion (85°), Extension (85°), adduction [ulnar deviation], abduction (radial deviation) and circumduction.

In carpal flexion, radiocarpal and mid-carpal joints are involved, the range being greater at the latter, in extension the reverse occurs, with more movement at the radiocarpal. Hence the proximal surfaces extended further posteriorly on the lunate and scaphoid bones. These movements are limited chiefly by antagonistic muscles, therefore the range of flexion is perceptibly diminished when the fingers are flexed, due to increased tension in the extensors. Only when the joints are forced to the limits of flexion or extension are dorsal or palmar ligaments fully stretched.

Adduction of the hand [45°] is considerably greater than abduction [15°], perhaps due to the more proximal site of the ulnar styloid process. Most adduction occurs at the radiocarpal joint, the lunate bone, articulating with both radius and articular disc when the hand is in mid-position, in adduction passes off the disc to articulate solely with the radius. Much of the proximal articular surface of the scaphoid becomes sub-capsular beneath the radial collateral ligaments and forms a smooth, convex, palpable prominence in the floor of the anatomical “Snuff” box.

Abduction occurs almost entirely at the mid-carpal joint, radiographs of abducted hands show that the capitate rotates round on AP axis so that its head passes medially and the hamate conforms to this, the distance between lunate and the apex of hamate is increased. The scaphoid rotates around a transverse axis; its proximal articular surface has retreated from the capsule and is now in sole articulation with the radius. Movements are limited by antagonistic muscles and at extremes by the collateral carpal ligaments.

Circumduction of the hand is not rotatory but successive flexion, adduction, extension and abduction or the reverse.

Abduction – adduction movements are of special functional value. The hand is commonly used with the carpus slightly extended and the forearm in mid-position. Skilled abduction – adduction movements manipulate a large variety of precision tools.

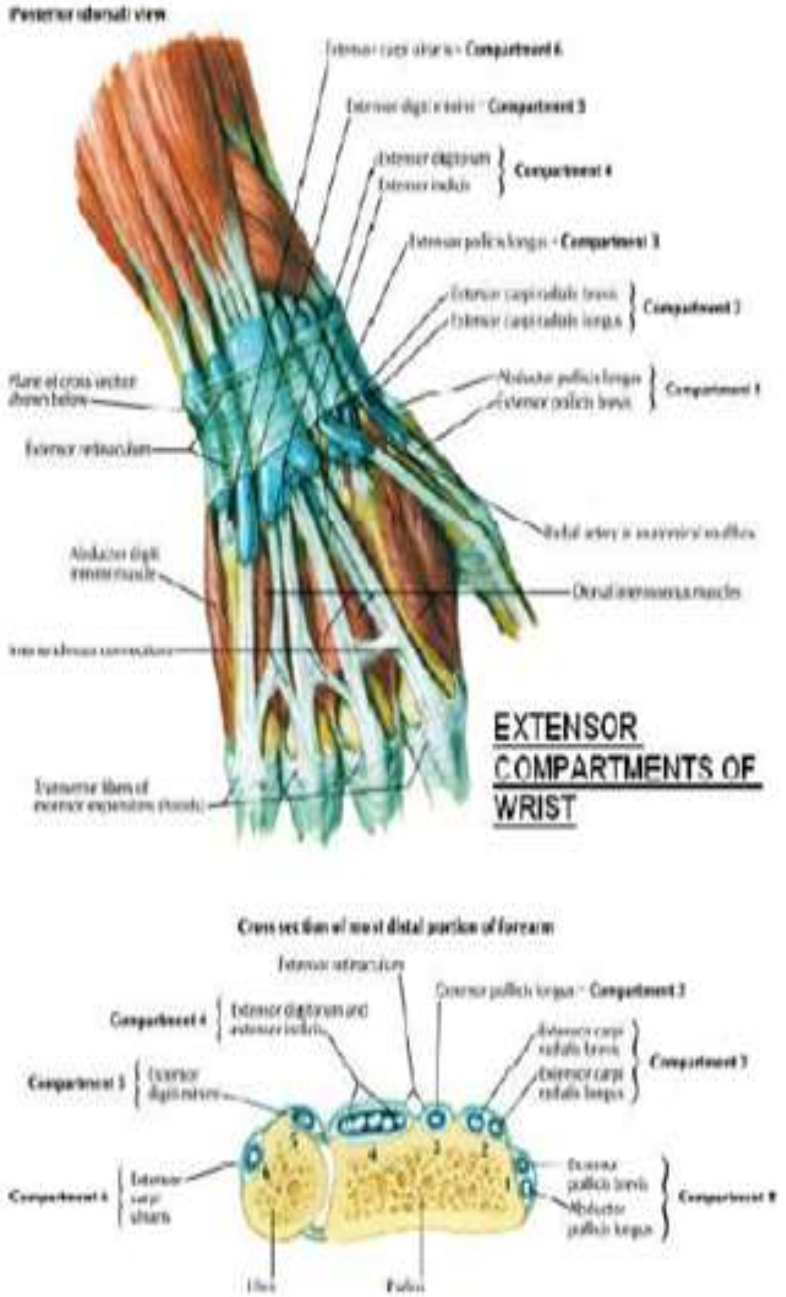


Fig: 11 EXTENSOR COMPARTMENTS OF WRISTMECHANISM OF INJURY

MECHANISM OF INJURY

The most common mode of injury is a fall on the outstretched hand. The amount of impact depends on the body weight and the distance through which the body falls. The energy is distributed throughout the soft tissue, bones and joints. If the force on the wrist is attenuated by the coordinated absorption of energy by the proximal musculo-tendinous units as in the athlete who “knows how to fall”, no injury will occur.

In the elderly with osteoporosis of bones, diminished muscle strength and poor neuromuscular co-ordination such a fall is likely to produce a fracture through the cancellous bone of the distal Radius. Sometimes associated with fracture Neck Femur or opposite side Colles’ fracture. Before epiphyseal closure, the same injury produces epiphyseal separation through the zone of provisional calcification.

There is a lot of controversy about the mechanism of these injuries. Many authors have based their theories on cadaver experiments (Lewis 1950, Nelaton 1844, Lecomte 1861.) The chief value of these studies is their demonstration that the direction of the traumatic force determines the type of wrist injury. There are main theories in the literature concerning the mechanism of injury in the distal fractures of the distal radius.

Volar displacement of the distal fragment is produced by supination of the proximal Radius (Smith’s fracture). Dorsal displacement of the distal fragment is produced by pronation of the proximal Radius (Colles’ fracture).

The Blow and Counterblow Theory-advanced by Dupuytren (1843) suggests that the body’s weight generates a counter blow from surface of impact and is thereby transmitted through the carpal bones directly to the distal radius. When the hand is dorsiflexed, the carpal bones come up against the surface of impact at the moment of fracture at the same time as the head Radius is pressed against the Humerus, thus causing the force to be transmitted directly to the distal radius, which fractures where the cortex of bone is thinnest.

The avulsion theory-suggested by Linhart (1852) and analysed by Lecomte (1861) says that the Ulna is probably along (Because of intimate contact with Humerus) in absorbing the impact of a fall on the hand, the force is transmitted to Radius via the interosseous membrane and the strong volar ligaments. Then the fracture is produced by avulsion due to traction in the strong volar radio- carpal ligament.

The bending fracture theory-The theory put forward by Meyer (1925) and later supported by Lewis (1950) says that the course of a fracture is determined by three factors. The position of the hand, the surface of impact and the magnitude of force. The absence of abrasions on the palm suggests that at the moment of fracture the hand stays put on the surface of impact; the kinetic energy causes the forward movement of the body to continue, the wrist becomes hyper extended and the patient falls over the hand; this loads the volar ligament and the radius is pressed against the carpal articular surface, the force being stopped by the Scaphoid and Lunate bones; it is then transmitted to Radius, which fractures at its weakest point in the same manner as a beam that is loaded beyond the limit of its elasticity. Lewis so considers this fracture as a ‘bending fracture’.

Biomechanical experiments have shown that distal radius fractures were obtained when the wrist was loaded in 40-90° dorsiflexion and 0-35°ulnar/radial deviation. The greater the degree of dorsiflexion, the larger force required to produce a fracture.

Considerable force appears to be required to produce a distal Radius fracture with a mean of 195 kg for women and 282 kg for men. The extent of injury depends on the amount and direction of force also in addition to the position of wrist. When a hand in volar flexion was loaded from the dorsal side, volar fractures were produced with volar displacement. Static and dynamic experiments have lent support to two of the fracture mechanisms, namely- the blow and counter blow theory and the bending fracture theory.

When a person falls on the outstretched hand, the Radius through the rigidly bonded carpus bears the brunt force transmitted through the thenar eminence. A great strain is thrown upon the palmar carpal ligaments and the line of force drives the carpus upon the Radius. Radius first fractures on the volar surface in tension (because of a high tensile loading of the palmar radiocarpal ligament). Then the fracture propagates dorsally where the bending moment forces induce compression stresses resulting in dorsal cortex comminution or the fracture lines proceeding along 45° shear stress lines. Cancellous bone is compacted further reducing dorsal stability. Charnley has shown that the dorsal comminution is the cause of late collapses of the radius during the periods of immobilization for these fractures.

This fracture occurs while the triangular fibrocartilaginous disc of the inferior

Radio- ulnar joint is still intact, therefore the distal fragment rotates on this hinge with the center of rotation at the ulnar styloid in the direction of supination. If the force is excessive and continues to act, the strain thrown upon the disc may bring about a fracture of the ulnar styloid. When the disc, ulnar collateral ligaments and other ligaments of the inferior radioulnar joint are torn, the ulnar head shifts ventrally and is prominent under the skin. Tension usually hyperextension is commonly considered the major force causing these fractures. However, compression is an even more significant force causing articular fractures. Stevens and Scheck compared the Lunate to a die punch, compressing and disrupting the articular surface of the Radius. A compression force transmitted primarily by the Lunate accounts largely for the fracture planes that occur across the distal radial articular fractures. Accordingly four basic fragments occur-radial shaft, radial styloid, dorsal and ventral medial fragments, variations, in this basic pattern may occur. The type and direction of force account for the diversity of articular fractures. The dorsal medial fragment has been referred to as the 'Die-punch' fragment. The carpus is nearly always displaced with one or both of the medial fragments owing to the strong soft tissue attachments. The deformity may be due to a tear of resisting forces or due to crushing of compression resisting structures or both.

As Colles' fractures is caused by a fall on the palm of the outstretched hand, it might appear that Smith's fracture would be due to a fall on the back of the hand. But such is not the case, when the motion that occurs at the distal radioulnar joint is examined it is only in one plane through an arc of 180 degrees about the ulnar head. Once the Radius is fractured distally, if the hand is firm on the ground, as the forearm supinates the proximal Radius will rotate dorsally. But the distal fragment remains fixed so that it will come to lie volar to the shaft. By contrast, if the forearm pronates, the proximal radius rotates volarly and the distal fragment will lie dorsal to it when rotation is completed. In both cases the hand was dorsiflexed. As the pronation injury is more frequent, Colles' fracture is more frequent than the Smith's fracture.

Both the dorsal and volar lip fracture dislocations of the distal radius are caused by sever angulation of the dorsiflexed and palmar flexed hand with little rotary component (cf. Colles' & Smith's fractures) when one falls on the palm of the hand, the scaphoid and lunate are wedged against distal Radius. If the volar radiocarpal ligaments remain intact, the carpus may strike the dorsal lip of the Radius causing a dorsal lip fracture or the carpus may be wedged against the volar lip of the distal Radius causing a volar lip fracture. The same injury could avulse the volar lip of the Radius by traction on the volar ligaments. Similarly a fall on the dorsum of the palmar flexed hand can cause an avulsion (Barton's I fracture-Dorsal) or impaction (Barton's II fracture- volar). In either case the carpus is no longer fully stabilized by the distal Radius and will displace with the fracture fragment.

Morbid Anatomy (Fracture anatomy)

Six displacements of the distal fragment occur- impaction, dorsal shift, dorsal tilt, lateral shift, lateral tilt, and supination. To this may be added subluxation of the Inferior

Radioulnar joint. The degree of displacement, the amount of communication and associated soft tissue injury depends on the amount of force and the strength of the bone and its environs.

The lower fragment is compressed within the shaft of the Radius, and also rotated dorsally. So there is dorsal angulation and Radial shortening resulting in the classical "Dinner or silver fork deformity". The compression of the cancellous portion is there. This is not the only deformity seen- if there is volar displacement- 'Garden spade deformity' seen. But any degree of displacement can occur. Fracture can extend into radiocarpal and/or distal radio ulnar joints.

Instability of the fracture fragments; commonly the medial fragments are displaced as a single unit. This is sometimes associated with displacement of an additional fragment which rotates into a vertical position and projects as a spike causing injury to the median nerve or the flexor tendons. Rarely, a dorsal spike fragment can cause acute extensor tendon injury, when the displacement is sever, there is splitting with wide separation of the medial fragments (usually due to a major compression injury) which may also rotate as much as 180 degrees. This occurs only with serious concomitant soft tissue damage, often the nerves as well as the tendons.

The Ulnar styloid is fracture secondarily to the major fracture of the Radius when a force is transmitted through and intact fibrocartilage. This is seen in about 60% of all cases and 90% of unstable type of fractures. Many times the triangular ligament is completely ruptured resulting in inferior Radio ulnar instability. The ulnar styloid may be displaced anteriorly.

The displaced fracture causes extravasations of blood and swelling of soft tissues. The carpus is always displaced with the medial fragments due to the strong soft tissue attachments. De Palma had demonstrated that even with the most severely comminuted fractures, the ligaments of the wrist remain intact. This is important to maintain reduction by ligamentotaxis. The periosteum may or may not be damaged. The sensory branches of the Radial nerve and also the ulnar nerve can be damaged by the displaced fragments.

CLASSIFICATION OF DISTAL RADIUS FRACTURES

Eponyms such as Colle's, Smith & Barton fracture have been used to describe fractures of the distal end of the radius and continue to be used in the current literature. Unfortunately, the confusion resulting from this inaccurate method of classification has resulted, at times, in the publication of conflicting recommendations with regard to treatment and expected outcomes.

Gartland and Werley in 1951 and Lidstrom in 1959, developed systems of classification that were based on the presence, but not the extent of displacement of the site of the fracture and of the involvement of the radiocarpal joint.

In 1965, Older et al, published an extremely useful system of classification of metaphyseal colle's – type fractures that was based on extent of displacement, dorsal angulation, shortening of the distal fragment of the radius, and presence and extent of comminution of the dorsal metaphyseal cortex. They divided fractures into four groups, ranging from relatively non – displaced fractures (Type I) to considerably displaced fractures with extensive comminution, extension into the radiocarpal joint, and shortening of the distal fragment of two to eight millimetres proximal to the distal radio-ulnar joint (Type IV).

In 1967, Frykman established a system of classification that identified involvement of the radiocarpal and radioulnar joint, as well as the presence or absence of a fracture of the ulnar styloid process. Although this has been accepted by many authors, the system does not include the extent or direction of the initial displacement, dorsal comminution, or shortening of the distal fragment. As such, it has less prognostic value in evaluating the outcome of the treatment.

FRYKMAN CLASSIFICATION:

Type I	Extraarticular radial fracture
Type II	Extraarticular radial fracture + Ulnar styloid fracture
Type III	Intra articular fracture of the radio carpal joint.
Type IV	Intra articular fracture of the radiocarpal joint + Ulnar styloid fracture.
Type V	Fracture of the radioulnar joint
Type VI	Fracture of the radioulnar joint + Ulnar styloid fracture.
Type VII	Intra articular fracture involving both radiocarpal and radioulnar joints.
Type VIII	Intra articular fracture involving both radiocarpal and radioulnar joints with an ulnar styloid fracture.

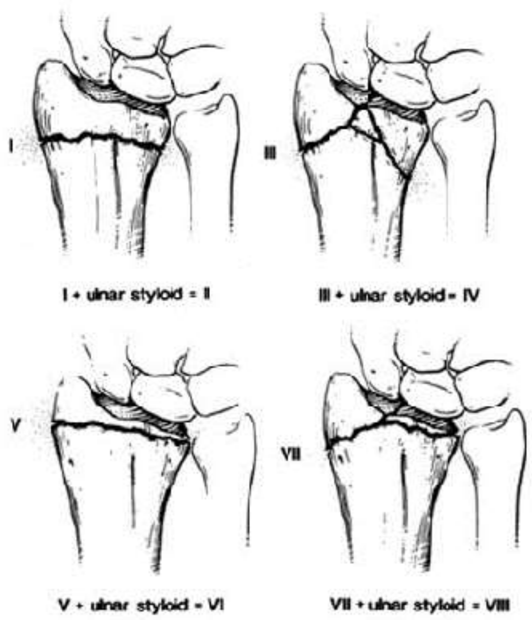


Fig: 12 FRYKMAN'S CLASSIFICATION

Fernandez: subdivided fractures of the distal end of the radius according to the mechanism of injury.

1) Bending	Metaphysis fails due to tensile stress (Colle's and Smith fractures).
2) Shearing	Fracture of the surface of the joint (Barton & Chauffeur's fracture)
3) Compression	Fracture of the surface of the joint with impaction of subchondral and metaphyseal bone (So-called die-punch fracture)
4) Avulsion	Fracture of ligamentous attachments (Fracture of the ulnar and radial styloid processes).
5) Combined	Complex high velocity

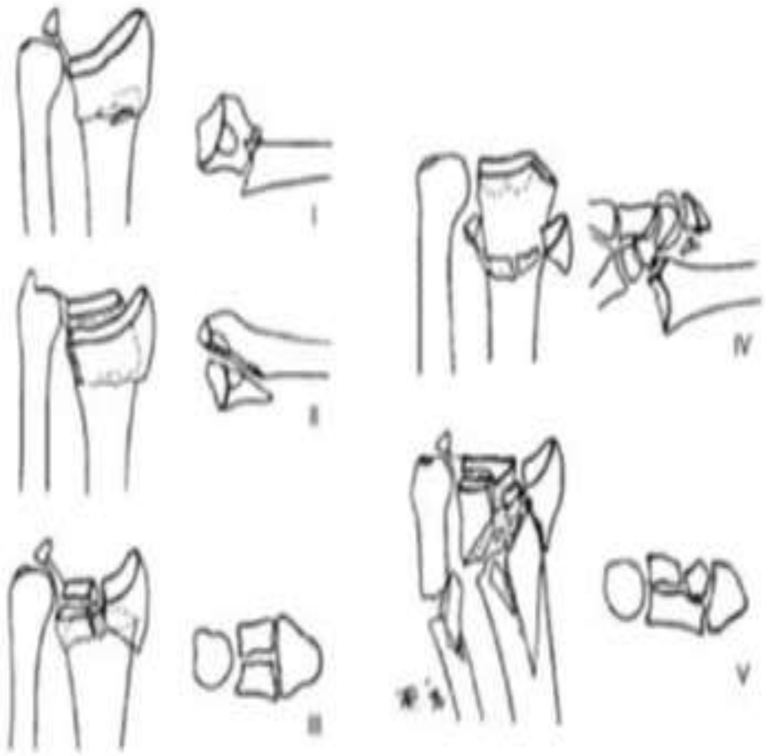


Fig: 13 Fernandez classification

Mc Murry and Jupiter defined intra-articular fractures on the basis of the number of their parts.

1) Two parts	The opposite portion of the radiocarpal joint remains intact (dorsal / palmar, Barton, Chauffeur and die-punch fracture)
2) Three parts	The lunate and scaphoid facets separate from each other and the proximal portion of the radius
3) Four parts	The same as the three parts, except the lunate facet is further fractured into dorsal and volar fragments.
4) Five parts or more	Including a wide variety of comminuted fragments.

MELONES CLASSIFICATION

1. Minimal comminution – stable
2. Comminuted – Stable displacement of medial complex posterior: die punch,

Barton anterior, Smith.

3. Displacement of medial complex as a unit + anterior spike.

4. Wide separation or rotation of the dorsal fragment & palmar fragment rotation.

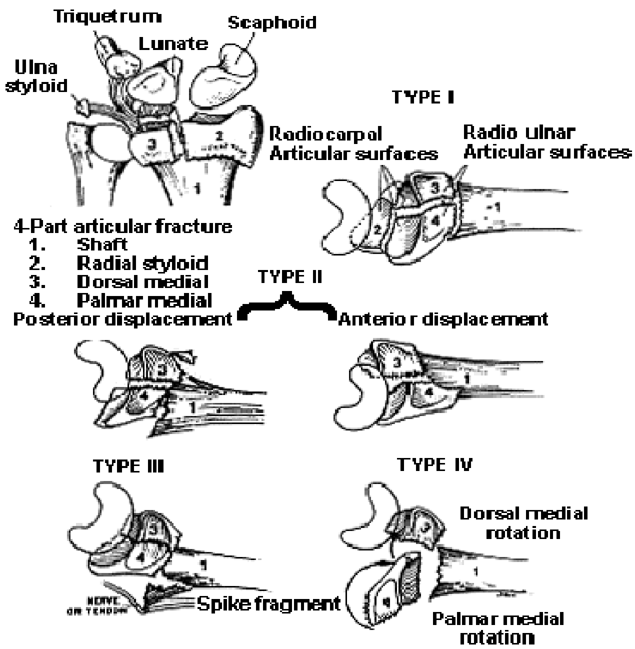


Fig: 14 MELONE 'S CLASSIFICATION

Classification of Mayo, Intra articular Fractures

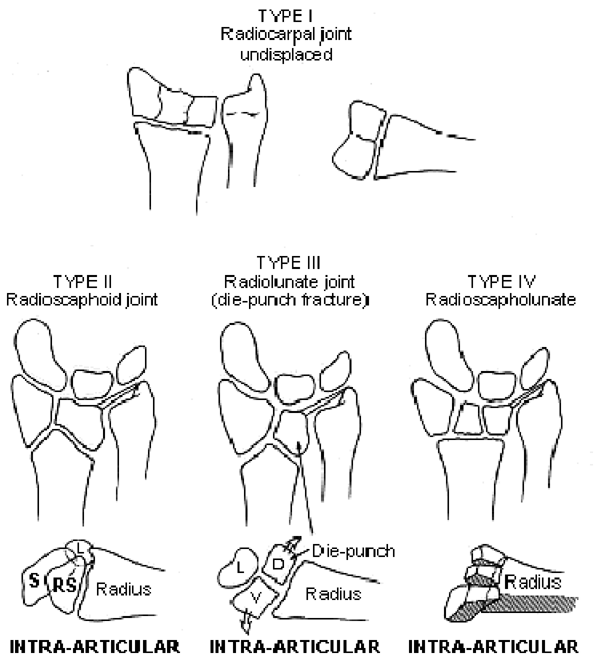


Fig: 15 MAYO CLASSIFICATION

AO CLASSIFICATION

The most detailed classification, to date, is the AO classification, which is organized in order of increasing severity of the osseous and articular lesions.

Type A Extra articular

Type B Partial articular

Type C Complete articular

C1 Simple articular and metaphyseal

C2 Simple articular with complex metaphyseal

C3 Complex articular and metaphyseal fractures.

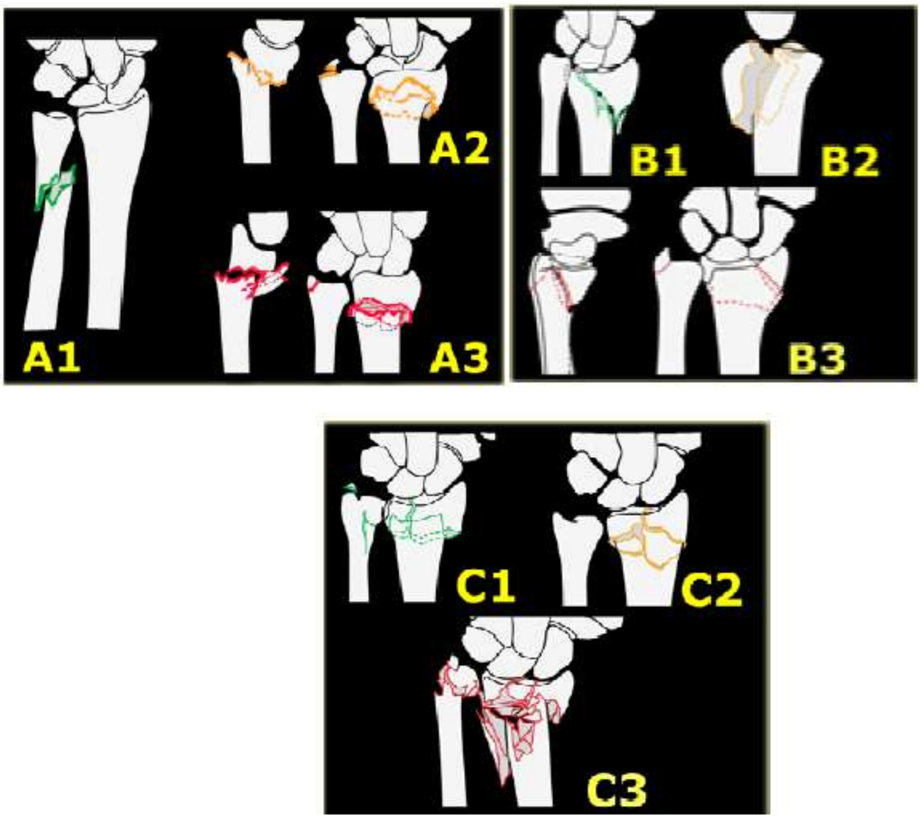


Fig: 15 AO CLASSIFICATION

A = extra-articular fracture

A1 = ulna, radius intact A2 = radius, simple and impacted, A3 = radius, multi fragmentary

B = partial articular fracture

B1 = radius, sagittal, B2 = radius, frontal, dorsal rim, B3 = radius, frontal, volar rim

C = complete articular fracture of radius

C1 = articular simple, metaphyseal simple, C2 = articular simple, metaphyseal multi fragmentary, C3=articular, multi fragmentary

VARIOUS MODALITIES OF TREATMENT OF DISTAL RADIUS FRACTURES

CONSERVATIVE:

Different types and positions of immobilization of the wrist and hand have been described; straight, in flexion- ulnar deviation, in extension; with or without permanent cast, with a below or over the elbow cast; with the forearm pronated or supinated. It seems that re displacement during healing is not correlated with the type of immobilization but only with the dorsal comminution and the initial displacement.

PERCUTANEOUS DIRECT PINNING:

An early technique, infact one of the first used for fixation of distal radius fractures, was percutaneous pinning, usually entering at the level of the radial styloid process. Some variations in the point of penetration and the direction of the pins were presented, but the aim was always to fix the mobile fragment to the opposite cortex proximal to the fracture. This type of pinning could not prevent re displacement of certain fragments, and this was particularly true of intra-articular fractures. Direct pinning of the fragments, especially the postero-medial fragment (which can involve the DRUJ) through the distal ulna, added stability to the structure.

ELASTIC INTRA FOCAL OR EXTRA FOCAL PINNING:

This method is popular and considered to be a reliable treatment for extra articular fractures. The fracture is first reduced by external manoeuvres. The K- wire is then moved dorsally through the fracture site to penetrate the opposite cortex in a 45° proximal direction.

The elastic force of the K-wire gives a persistent reduction and prevents re displacement. The exact placement and direction of each K-wire is very important; two or three are inserted through separate, short approaches after protection of the nerves and tendons. One of the main complications of this technique is over reduction if the K-wires are inserted too vertically.

EXTERNAL FIXATION:

It is based on the principle of capsuloligamentotaxis. By distracting the joint area, the fragments are reduced by traction on the capsuloligamentous attachments. By maintaining the traction throughout the healing process, the fragments are kept aligned.

When excessive traction is needed to maintain reduction, additional fixation by K-wires should be used in order to allow for lower distraction forces. In case of high-energy fractures with meta-diaphyseal comminution and/or bone loss, the fixator can be used to bridge the defect and to act as a buttress.

It can be useful in comminuted fractures to use the external fixator as temporary reduction and fixation tool to allow for more precise evaluation of the fracture and the associated soft tissue lesions. Then a more accurate definitive treatment can be installed. The aim is to realign and not to distract. Hinged external fixators, by providing early motion of the wrist, can reduce stiffness and help to prevent the onset of osteodystrophy.

EXTERNAL FIXATION AND DIRECT PINNING:

The best technique which might be used to try to obtain perfect reduction in an intra-articular fracture is external fixation associated with a short, direct and open reduction of the non-reduced fragment and direct pinning. Sometimes, reduction is possible by manipulation combined with percutaneous pinning. This relatively aggressive, open reduction procedure is reserved for comminuted intra-articular fractures in young people.

BONE GRAFTING:

In cases, where there is excessive comminution, and bone loss that persists after reduction, a cortico-cancellous or cancellous graft is certainly the best tool to prevent proximal migration of a central fragment. This migration can occur in a die punch fracture, or in elderly people with osteoporotic bone. The results of bone grafting can be almost perfect and healing is faster. In some instances, packing the bone graft may cause displacement of the palmar fragments, which requires the addition of 'K' wire fixation. In these cases, some authors have proposed the use of bone cement instead of bone graft in elderly people to allow immediate mobilization, but this is rarely recommended.

PLATE FIXATION:

This is indicated in fractures with volar displacement, such as Barton's and

Smith's fractures and in selected cases of dorsal displacement where rigid fixation can provide for early wrist motion. Plate fixation can provide either a buttress effect or hold the distal epiphysis by cortico cancellous screws. Premoulded plates reproducing the distal curvature of the radius are best, as they give an anatomic reduction. Since its introduction in 2000, volar fixed-angle fixation technique has provided an effective alternative for the management of dorsal and volar fractures. The need for fixed-angle plates arose from the failure of conventional buttress plates to achieve stable fixation.

Conventional screws toggle as purchase on the weak bone of the distal fragment is usually poor. Fixed-angle implants do not depend on screw purchase; they depend on direct bone support through an interference effect.

WRIST ARTHROSCOPIC REDUCTION:

The last refinement developed to achieve perfect reduction of intra-articular fragments is wrist arthroscopy with a triangulation probe. This can detect a step-off of 1-2 mm, which is not always visible on radiographic examination; the fragments can then be directly reduced and fixed by fine K-wires.

Wrist arthroscopy provides an excellent view for restoration of the articular surface with minimal soft tissue dissection. It also allows for detection of a wide spectrum of carpal interosseous ligament tears and osteochondral loose bodies.

PRINCIPLES OF MANAGEMENT OF DISTAL RADIAL FRACTURES

GOALS OF TREATMENT

The goals of treatment are to restore maximum function, maintain strength, limit the development of post-traumatic arthritis, and avoid complications. Achievement and maintenance of a satisfactory reduction until healing occurs, followed by rehabilitation of the wrist to restore motion and strength is the ultimate goals of treatment of distal radial fractures.

CRITERIA FOR ACCEPTABLE REDUCTION:

Criteria for an acceptable reduction, and the optimum techniques to achieve and maintain it, are not clear for all fracture types in all age groups. The main extra-articular criteria include the volar tilt, radial inclination, and the radial height. Although extra articular Criteria are important, there is a great deal of evidence that the most important criterion for success is intra-articular reconstruction, that is, the accuracy of the restoration of the articular surface. In fact, the largest tolerable articular step-off is 2 mm. Loss of the normal palmar tilt, decreased radial inclination, and radial shortening all have been implicated as causes of poor out-come, as has loss of articular congruity. Displacement of >2mm, shortening of >5mm, and dorsal angulation of >20° have shown to cause an increased incidence of arthritis, decreased wrist motion, 50% decrease in grip strength and wrist instability in the long run.

Residual deformity also can affect the distal radioulnar joint, leading in some cases to persistent pain and loss of forearm rotation. In a laboratory study, the effects of four common types of radial deformity on distal radioulnar joint mechanics were investigated. Radial shortening caused the greatest disturbance in kinematics and the greatest distortion of the triangular fibrocartilage. Decreased radial inclination and dorsal angulation caused intermediate changes, whereas dorsal displacement produced minimal changes. Radial deformity by itself did not produce distal radioulnar joint dislocation.

GUIDELINES FOR REDUCTION OF DISTAL RADIUS FRACTURES:

1. Radial shortening <5mm at distal radioulnar joint

2. Radial inclination on postero-anterior radiographs > 15 degree

3. Sagittal tilt on lateral projection between 15 degrees dorsal tilt and 20 degree volar tilt

4. Intraarticular step-off or gap <2mm of radiocarpal joint

5. Articular incongruity <2mm of sigmoid notch of distal radius

COMPLICATIONS OF DISTAL RADIUS FRACTURE

1) Compressive Neuropathy

Median nerve involvement (carpal tunnel syndrome) the most common, usually associated with reduction of the fracture in the emergency room under local anesthesia. Radial neuropathy can arise as a result of improper immobilization and from external pin fixation.

2) Arthrosis after Fracture

This is associated with painful motion of the wrist or forearm. Radio-ulnar arthrosis was more common than radiocarpal arthrosis. Frykman Type VI, VII and VIII fractures most often elicit this complication.

3) Malunion

Malunion commonly results when the fracture is unstable and comminuted.

4) Tendon injuries

Rupture of the extensor pollicis longus and rupture of the index flexor digitorum profundus or flexor pollicis longus. The rupture is related to bone fragments from displaced fractures that abrade the tendon during the weeks after healing of the fracture.

5) Volkman's Ischemic Contracture

This can arise as a result of application of a constricting cast.

6) Shoulder – Hand Syndrome

This is more appropriately called upper-limb dystrophy or pain-dysfunction. It includes predominant sympathetic components of change in skin temperature, colour and texture, pain and loss of motion in the shoulder and stiffness of the hand or special local trigger areas of exquisite pain and tenderness (or both).

7) Stiff hands

It is manifested by pain and swelling limited to the hand, with loss of finger motion and occasionally loss of motion of the wrist.

8) Unrecognized Associated injuries

These include scaphoid fractures, radial head fractures, Bennett's fracture and intercarpal ligament injuries.

MATERIALS AND METHODS

Thirty patients with extra - and intra articular fractures of distal end of radius were treated with open reduction and internal fixation with volar plate in Department of Orthopedics, R L Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College, Tamaka, Kolar.

Study design: A prospective study

Study period: The study was conducted from December 2013 to May 2015

Sample size: 30 cases in a period of 2 years.

SELECTION CRITERIA

Inclusion Criteria:

- Age group: 18yrs and above
- Fracture distal end radius with or without articular extension.
- Closed/Open Gustilo -Anderson Type I, II, type III A.

Exclusion criteria:

- Pathological fractures
- Open -Gustilo-Anderson type III B, III C.

There are 20 males & 10 females in the study between the age group of 20 - 65 years. 20 patients had right side involvement and 10 patients had left side involvement.

Of the 30 cases, injury occurred due to road traffic accident in 18 patients and fall on

Outstretched hand in 8 patients, 4 patients fall from height.

6 patients had associated injuries which include maxillo-facial injury, medial malleolus fracture, superior and inferior pubic rami fracture and tibia fracture.

None of the patients had median nerve involvement.

These 30 patients underwent surgery with volar plate (Ellis/LCP)

PRE-OPERATIVE EVALUATION:

Immediate Management:

Following admission to the hospital, a careful history was elicited from the patients and attendants to reveal the mechanism of injury and the severity of trauma. All patients were thoroughly examined. Their general condition, associated systemic diseases and associated injuries were noted. All the findings were duly recorded in the patient proforma.

Careful inspection of the deformity, swelling and ecchymosis were done. Clinically tenderness, bony irregularity, crepitus and the relative position of radial and ulnar styloid process were elicited. Movements of the wrist and forearm were checked and found to be painful and limited. Distal vascularity was assessed by radial artery pulsations, capillary refilling, pallor and paraesthesia over finger tips.

The involved forearm was immobilized in a below elbow POP slab and kept elevated. Pain and inflammation were managed using anti-inflammatory drugs.

Pre-operative planning:

Routine examination of blood was done for hemoglobin percentage, total and differential WBC counts, fasting blood sugar, blood urea, serum creatinine, bleeding and clotting time, HIV and HbsAg. Examination of urine was done for presence of albumin and sugar. All adult aged above 35 years were sent to cardiology department for fitness for surgery. All diabetic patients were sent to endocrinologist for fitness. Blood pressure was recorded in all patients. Preparation of the part was done on the day before surgery. Tetanus toxoid injection and intravenous antibiotic were given to all patients pre-operatively. Fitness for surgery was obtained for all patients. Informed consent for surgery was taken and patients were operated after a pre-anaesthetic checkup.

RADIOGRAPHIC EXAMINATION:

Standard radiographs in PA and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. Oblique views were also taken in a few patients who had complex comminuted fractures. The fracture fragments were analyzed and involvement of radiocarpal and distal radioulnar joints & ulnar styloid were assessed and classified according to the Frykman's.

SURGICAL PROCEDURE:

The duration from the date of admission to date of surgery range from 1 to 10 days.

Anesthesia:

The operations were performed under brachial plexus block/GA.

Position and tourniquet:

The patient was placed supine on the operating table. The affected limb was elevated for 2-3 minutes and exsanguinated. Then a mid-arm tourniquet was applied and the limb was placed on a side arm board. Forearm and hand were thoroughly scrubbed, painted with betadine and spirit and draped.

APPROACH:

All cases are treated with a volar plate using a volar Henry approach.

INSTRUMENTS AND IMPLANTS USED:

Volar LCP/Ellis plates of varying length

2.7mm & 3.5mm drill bit and sleeve system

Hand drill / power drill

Tap for 3.5mm cortical screws and 3.5mm depth gauge

Hexagonal screw driver for 3.5mm cortical screws and locking screw driver.

General instruments like retractors, periosteal elevators, reduction clamps, bone

Levers etc.

Pneumatic tourniquet/esmarch bandage.

TECHNIQUE:

The incision for volar fixation of the distal radius is typically performed through the distal extent of the Henry approach. An incision is made between the flexor carpi radialis (FCR) tendon and the radial artery. This interval is developed, revealing the flexor pollicis longus (FPL) muscle at the proximal extent of the wound and the pronator quadratus muscle more distally. The radial artery is carefully retracted radially, while the tendons of the FCR and FPL are retracted ulnarly.

The pronator quadratus is divided at its most radial aspect, leaving a small cuff of muscle for later reattachment. Any elevation of the muscle of the FPL should be performed at its most radial aspect, as it receives its innervation from the anterior interosseous nerve on its ulnar side. After the pronator quadratus has been divided and elevated, the fracture is readily visualized, and reduction maneuvers can be accomplished under direct vision.

After exposure of the fracture site, the fracture is reduced and provisionally fixed under C –arm with K-wires, reduction forceps. Reduction aids should be placed so as not to interfere with placement of the plate.

The appropriate plate is selected following fracture reduction.

First, a standard cortical screw was applied to the most distal oval hole of the

Vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allowed subsequent proximal and distal plate adjustment. After fixing the distal fragment with subchondral screws, radial length was gained, when necessary, by pushing the plate distally. The first standard screw can be either left in situ or exchanged with another screw; the oval hole is a combination hole designed for locking head screw placement at the distal end and standard screw placement at the proximal end of the same hole.

The optimal placement of the distal screws is important: they must be inserted at the radial styloid, beneath the lunate facet, and near the sigmoid notch. The distal screws can be of either mono cortical or bi cortical engagement. More volar tilt can be achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant. Moreover, radial length can be further improved by pushing the whole plating system distally while using the oval plate hole and screw as a glide. The final position of the plate was confirmed using c -arm.

Pronator quadratus muscle was used at the time of closure, to cover, in part, the implants that were applied to the anterior surface of the radius.

Once stable fixation was achieved, tourniquet is removed hemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

Post-Operative care and Rehabilitation.

Immediate post-operative check x-rays were taken in both PA and lateral views.

Active exercises of all the fingers, Elbow and shoulder were carried out. Dressings were carried out on 2nd postoperative day. Sutures were removed at 12th post-operative day. At 3 weeks patient was reviewed volar slab was removed, check x-rays were taken and wrist mobilization exercises was taught and was given wrist brace up to 6 weeks.

PHOTOGRAPHS OF INSTRUMENTS

CLINICAL PHOTOGRAPHS OF SURGICAL TECHNIQUE

Draping & Positioning

Skin incision & exposure

Distal radius after retracting pronator quadratus

LCP on distal radius

Wound closure

CHECK UNDER C-ARM   AP VIEW

CHECK UNDER C-ARM   LATERAL VIEW

OBSERVATION AND RESULTS

The present study consists of 30 cases of distal radial fractures treated at R.L.JALAPPA HOSPITAL and RESEARCH CENTER attached to SRI DEVARAJ URS MEDICAL COLLEGE, tamaka, Kolar, Karnataka during the period of December 2013 to May 2015.

28 cases were closed fractures and 2 were open fractures. All cases were followed up periodically during the period of 2013 to 2015. The following are the observations made and the available data are analyzed as follows.

Statistical Methods:

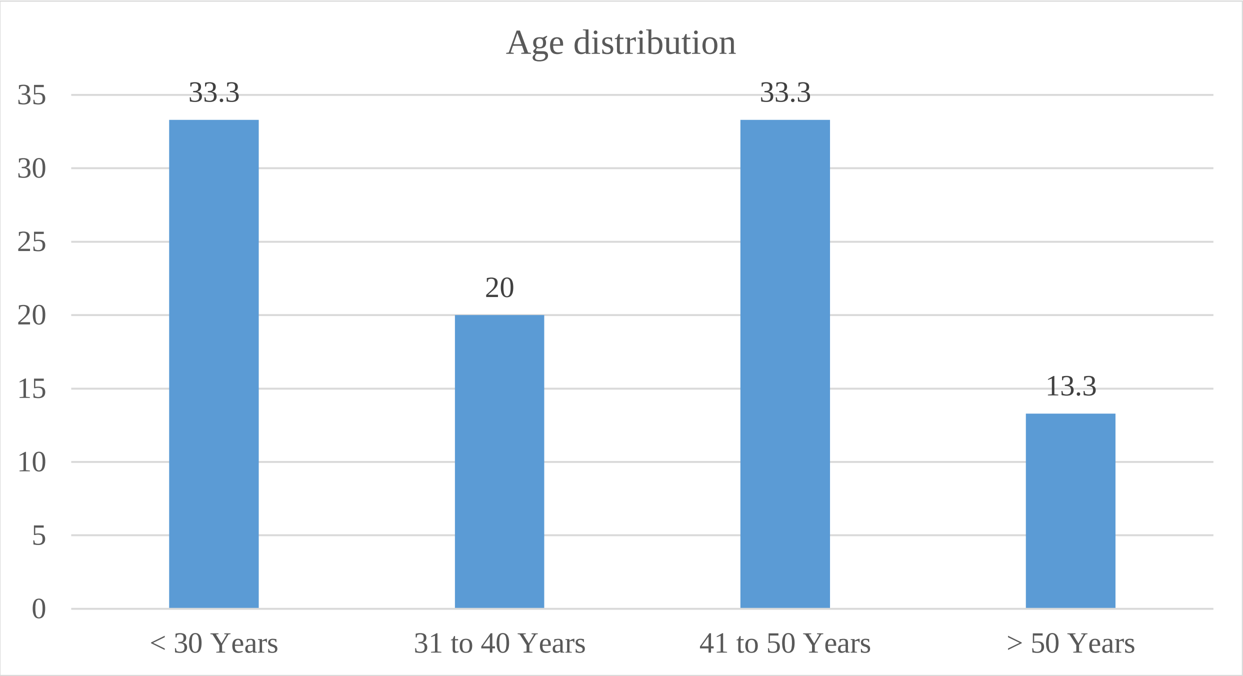
Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square was used as test of significance. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two groups. ANOVA (Analysis of Variance) was the test of significance to identify the mean difference between more than two groups. P value <0.05 was considered as statistically significant.

Results:

Table 1: Age distribution of subjects

		Frequency	Percent
Age	< 30 Years	10	33.3
	31 to 40 Years	6	20.0
	41 to 50 Years	10	33.3
	> 50 Years	4	13.3
	Total	30	100.0

Majority of subjects were in the age group < 30 years & 41 to 50 years (33.3%) respectively.

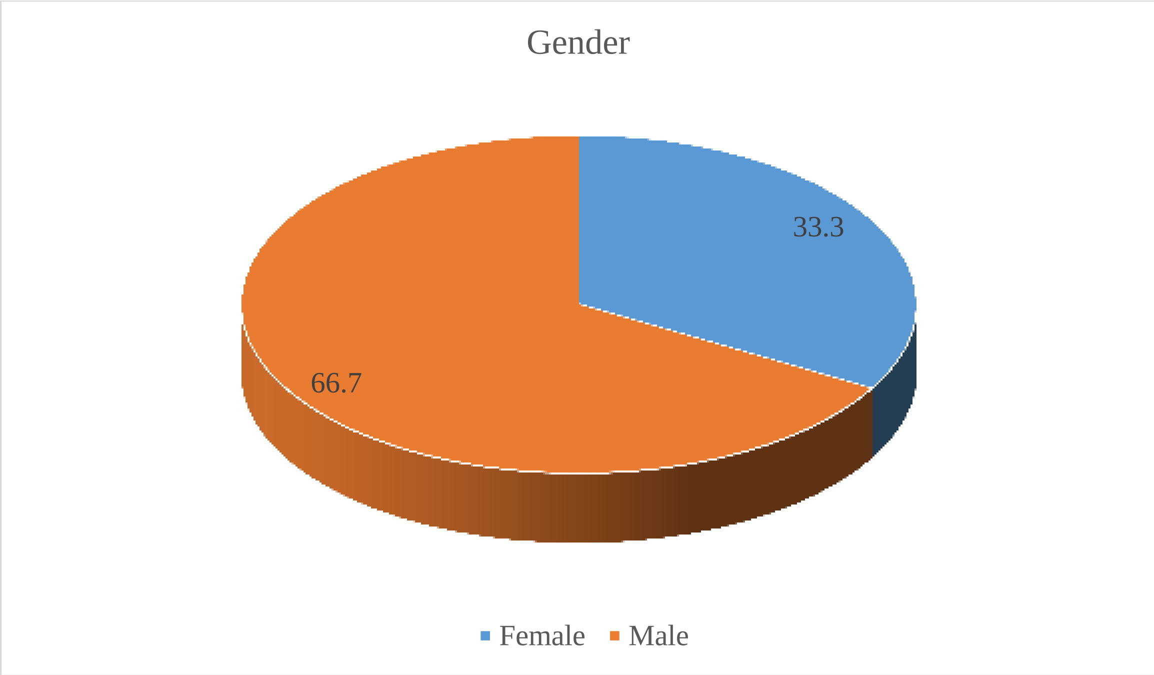


Graph 1: Bar diagram showing Age distribution of subject

Table 2: Gender distribution of subjects

		Frequency	Percent
Gender	Female	10	33.3
	Male	20	66.7
	Total	30	100.0

66.7% of subjects were males & 33.3% were females.

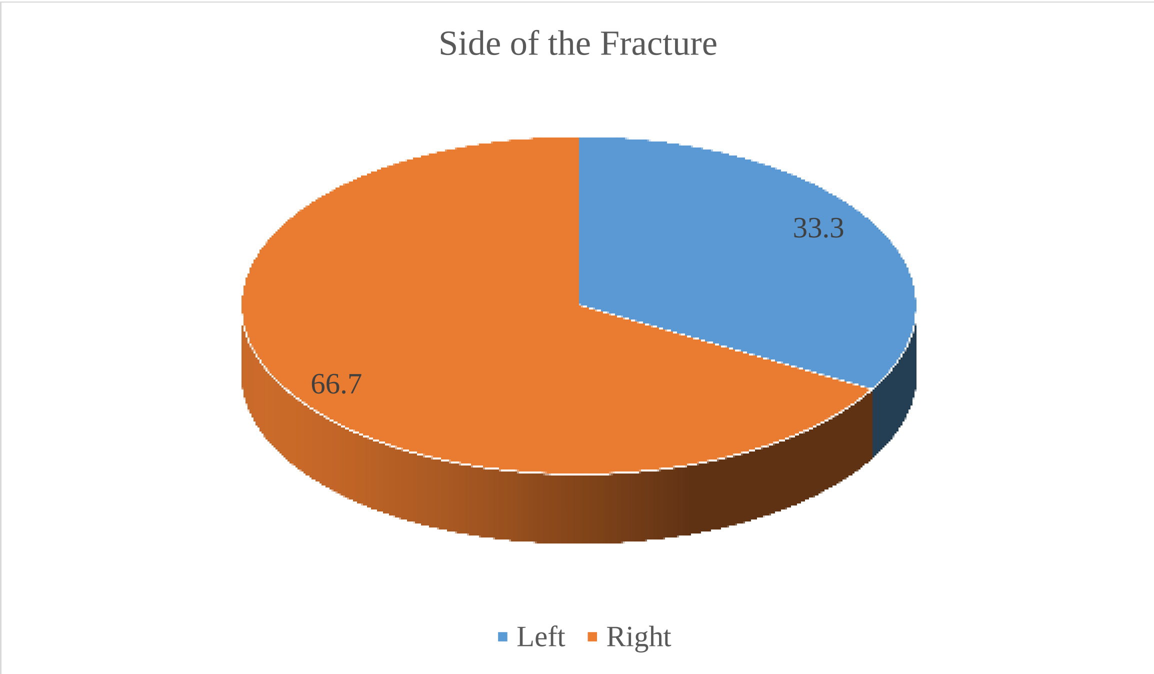


Graph 2: Pie diagram showing Gender distribution of subjects

Table 3: Distribution according to Side of the Fracture

		Frequency	Percent
Side of the Fracture	Left	10	33.3
	Right	20	66.7
	Total	30	100.0

66.7% of fracture were on right side & 33.3% on left side.

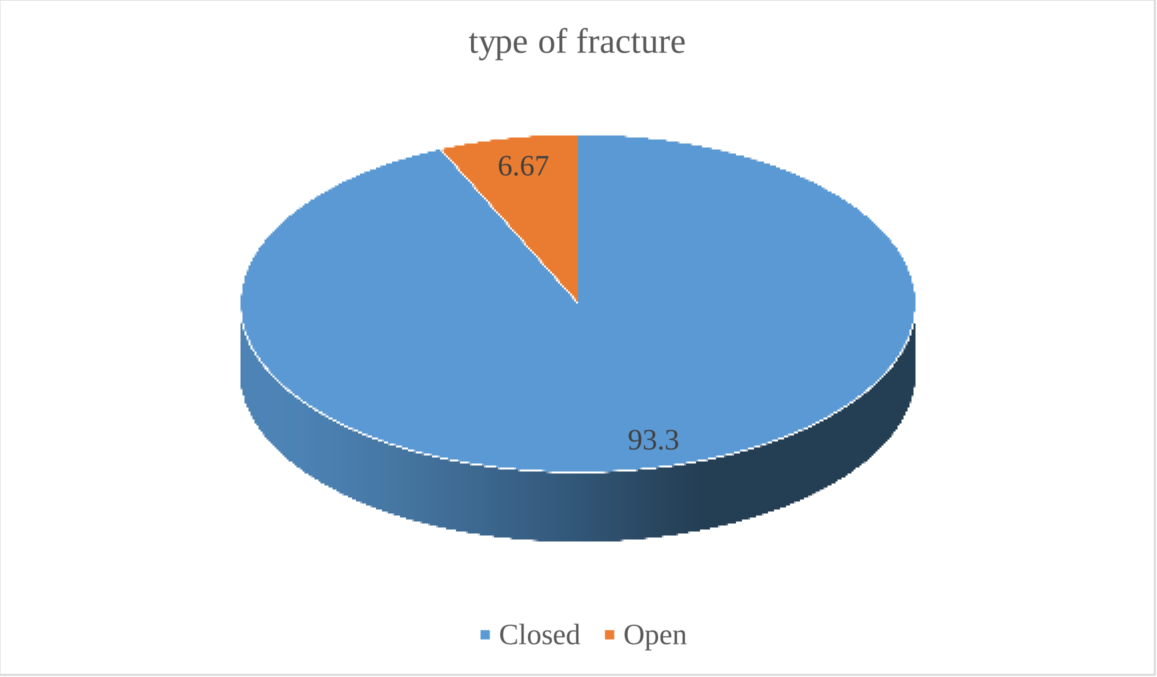


Graph 3: Pie diagram showing Side of Fracture

Table 4: Type of Fracture

		Frequency	Percent
Type of Reduction	Closed	28	93.3
	Open	2	6.67
	Total	30	100.0

In 93.3% of fractures closed type & in 6.67% open type.

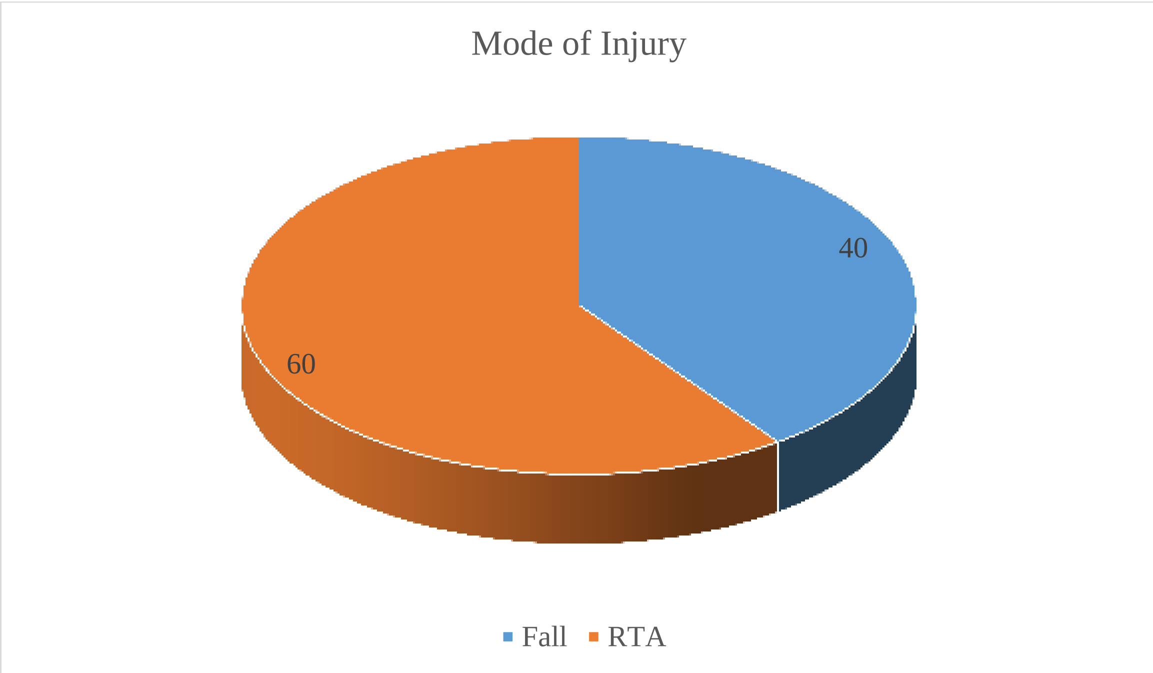


Graph 4: Pie diagram showing Type of fracture

Table 5: Mode of Injury

		Frequency	Percent
Mode of Injury	Fall	12	40.0
	RTA	18	60.0
	Total	30	100.0

60% of subjects had fracture due to RTA and 40% due to fall.

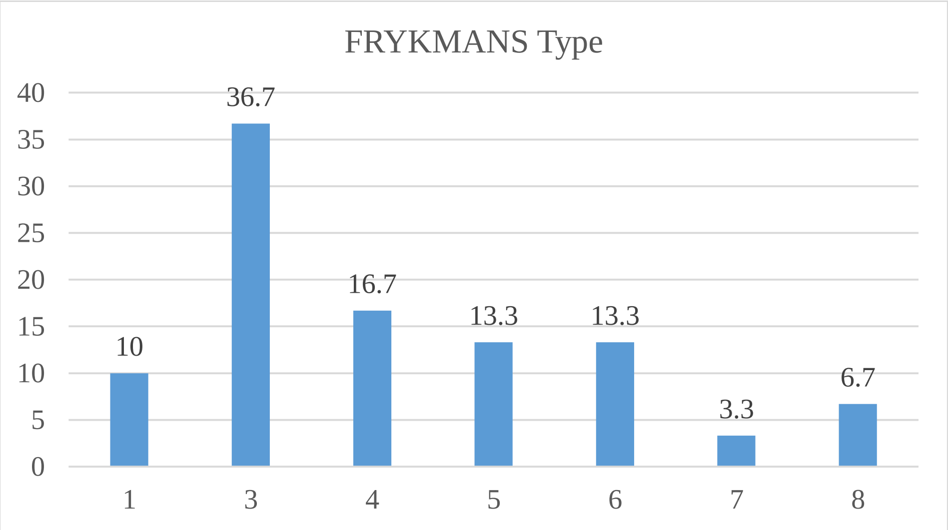


Graph 5: Pie diagram showing Mode of Injury

Table 6: FRYKMANS TYPE of Fracture

		Frequency	Percent
FRYKMANS Type	1	3	10.0
	3	11	36.7
	4	5	16.7
	5	4	13.3
	6	4	13.3
	7	1	3.3
	8	2	6.7
	Total	30	100.0

FRYKMANS Type 3 fracture was the most common fracture in the study (36.7%).

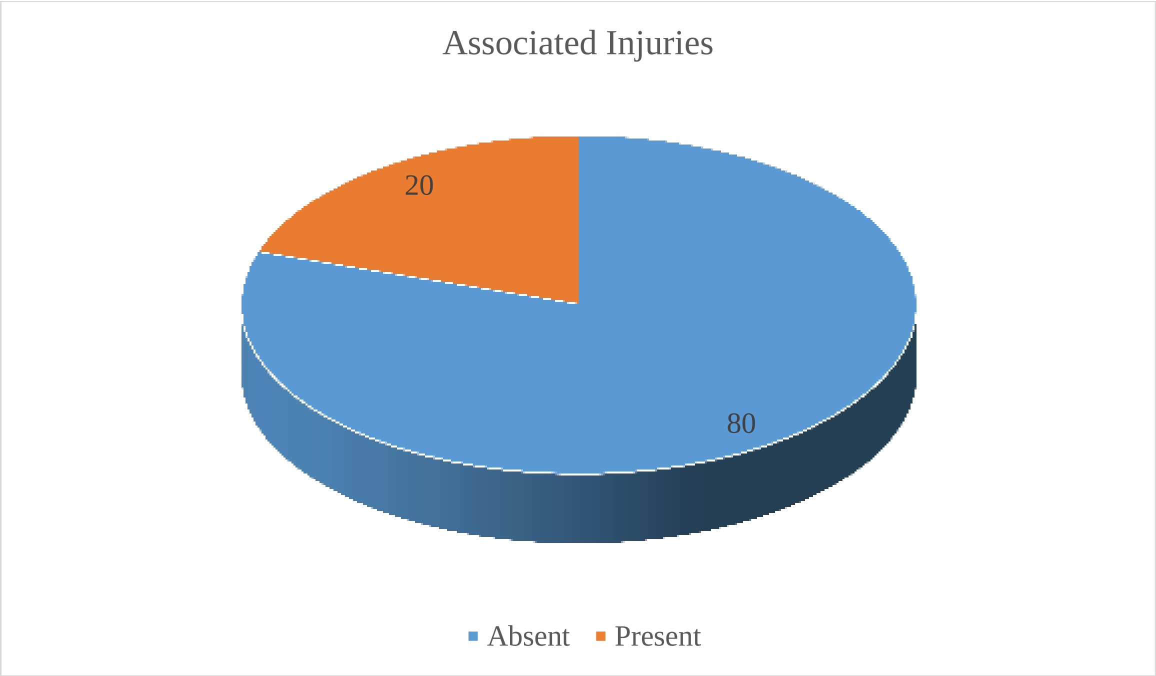


Graph 6: Bar diagram showing FRYKMANS Type of Fracture

Table 7: Associated Injuries in subjects

		Frequency	Percent
Associated Injuries	Absent	24	80.0
	Present	6	20.0
	Total	30	100.0

In 20% of subjects there was associated injuries.

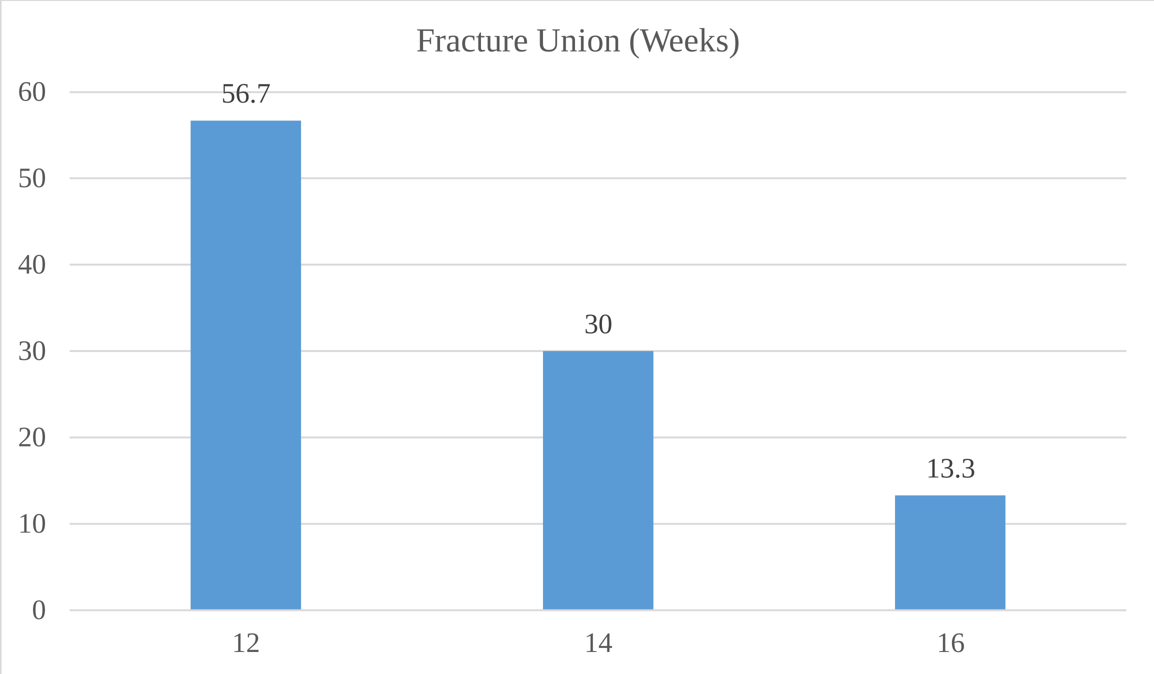


Graph 7: Pie diagram showing Associated Injuries in subjects

Table 8: Fracture Union Distribution

		Frequency	Percent
Fracture Union (Weeks)	12	17	56.7
	14	9	30.0
	16	4	13.3
	Total	30	100.0
	Mean	13.13	
	SD	1.456	
	Median	12.00	
	Minimum	12	
	Maximum	16	
	Range	4	

In majority of subjects (56.7%) fracture was united in 12 weeks, in 30% union took place in 14 weeks and in 13.3% at 16 weeks.



Graph 8: Bar diagram showing Fracture Union time in weeks

Table 9: Degrees of Movements in the subjects

		Count	%
Dorsiflexion	> 45 degree	30	100.0%
	< 45 degree	0	0.0%
Palmar Flexion	> 30 degree	30	100.0%
	< 30 degree	0	0.0%
Radial Deviation	> 15 degree	19	63.3%
	< 15 degree	11	36.7%
Ulnar Deviation	> 15 degree	30	100.0%
	< 15 degree	0	0.0%
Pronation	> 50 degree	30	100.0%
	< 50 degree	0	0.0%
Supination	> 50 degree	30	100.0%
	< 50 degree	0	0.0%

In the study all the Movements achieved normal range of movements except for radial deviation were in 36.7% had < 15 degree of movements.

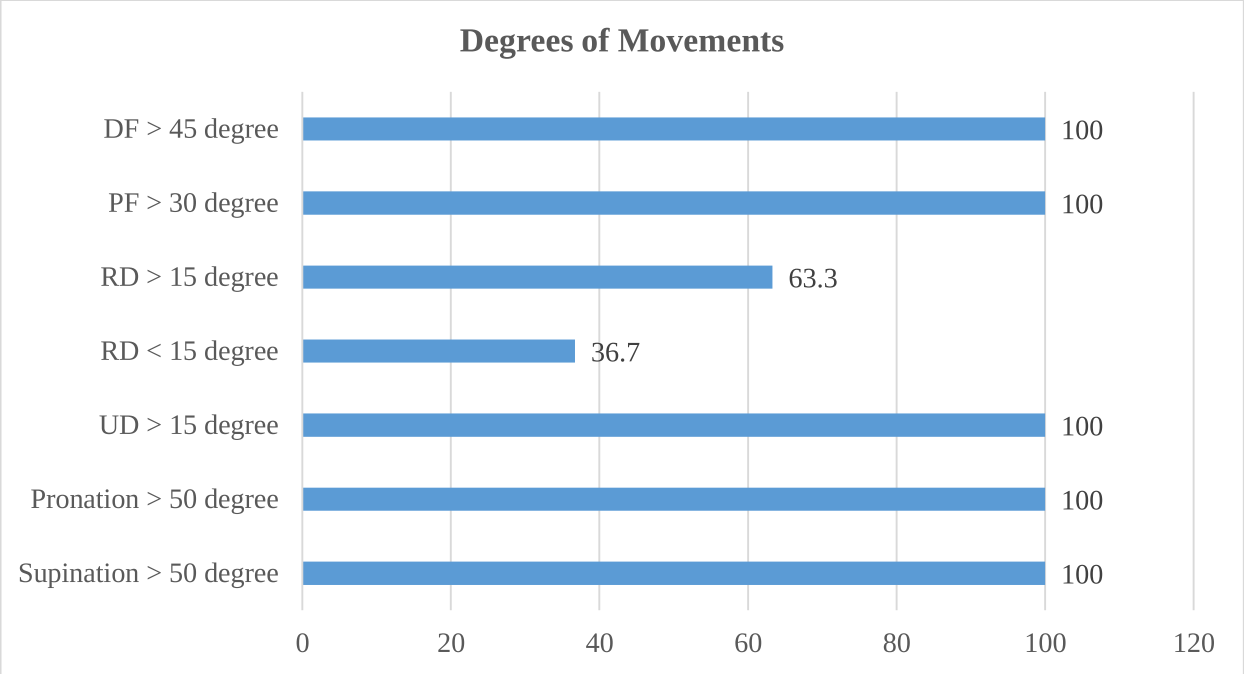
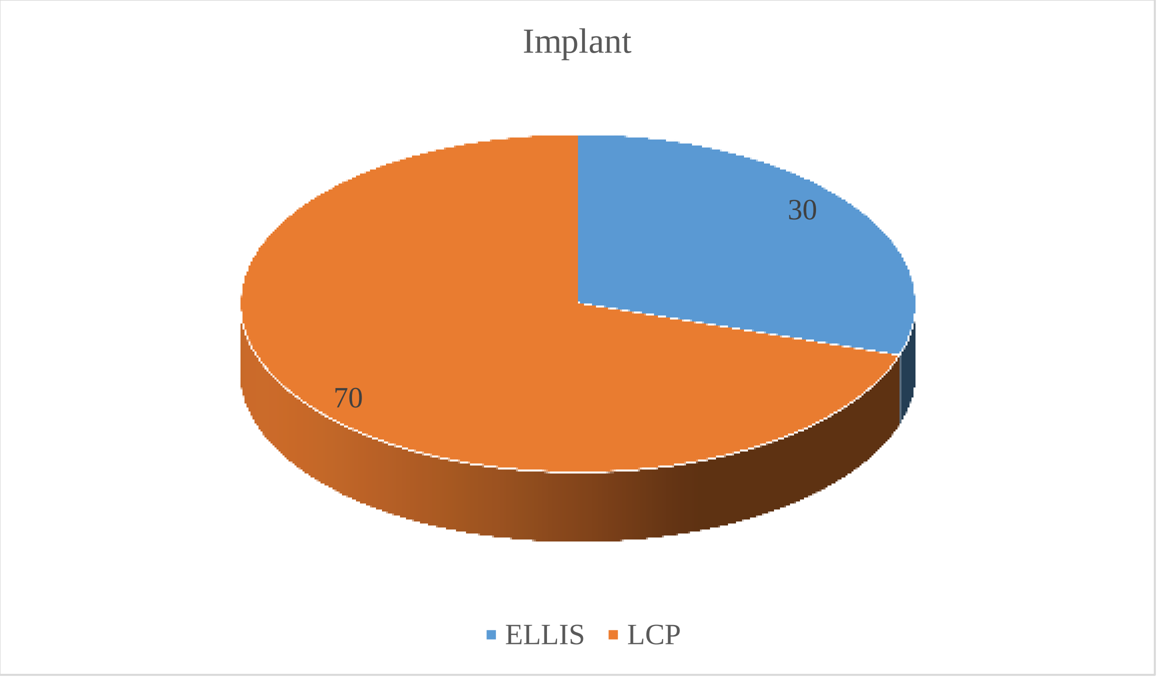


Figure 9: Bar diagram showing degree of movement in the subjects

Table 10: Implant Used in the subjects

		Frequency	Percent
Implant	ELLIS	9	30.0
	LCP	21	70.0
	Total	30	100.0

In 70% of subjects LCP was used as implant and in 30% Ellis was used as implant.



Graph 10: Pie diagram showing Implant Used in the subjects

DEMERIT-POINT SYSTEM OF GARTLAND AND WERELY

CATEGORY	POINTS
RESIDUAL DEFORMITY(range 0 to 3 points)	
Prominent ulnar styloid process	1
Residual dorsal tilt	2
Radial deviation of hand	2 or 3
SUBJECTIVE EVALUATION(range 0 to 6 points)	
Excellent: no pain, disability, or limitation of motion	0
Good: occasional pain, slight limitation of motion, and no weakness	2
Fair: occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful, and activities slightly restricted	4
Poor: Pain, limitation of motion, disability, and activities more or less markedly Restricted	6
OBJECTIVE EVALUATION (range 0 to 5 points)	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss radial deviation	1
Loss of circumduction	1
Pain in distal radioulnar joint	1
Grip strength 60% or less than on opposite side	1
Loss of pronation	2
COMPLICATIONS(range 0 to 5 points)	
Arthritic changes	1
Slight	3
Slight, with pain	2
Moderate	4
Moderate, with pain	3
Severe	5
Severe, with pain	1 to 3
Nerve complications(median)	1 or 2
Poor function of fingers due to cast	0 to 2
FINAL RESULT-Excellent	0 to 2
Good	3 to 8
Fair	9 to 20
Poor	>21

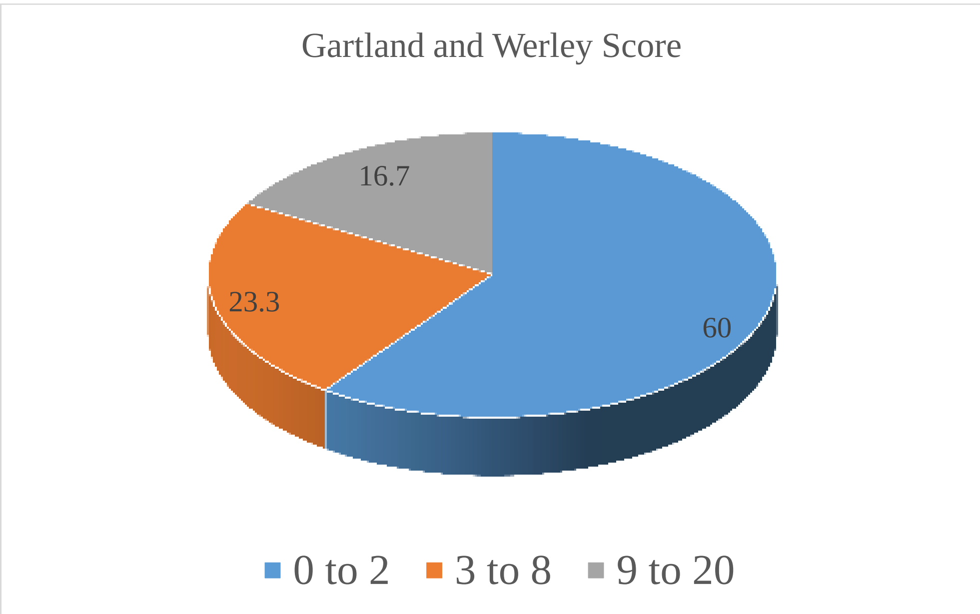
Table 11: Gartland and Werley Score in subjects

		Frequency	Percent
Gartland and Werley Score	0 to 2	18	60.0
	3 to 8	7	23.3
	9 to 20	5	16.7
	Total	30	100.0

Gartland and Werley SCORE

N	Mean	SD	Median	Minimum	Maximum	Range
30	4.60	3.856	2.00	2	14	12

In the study 60% of subjects had 0 to 2 Gartland and Werley Score & 23.3% had 3 to 8 score and 16.7% had 9 to 20 score.



Graph 11: Pie diagram showing Gartland and Werley Score

LIDSTROM'S CRITERIA FOR ANATOMICAL RESULTS:

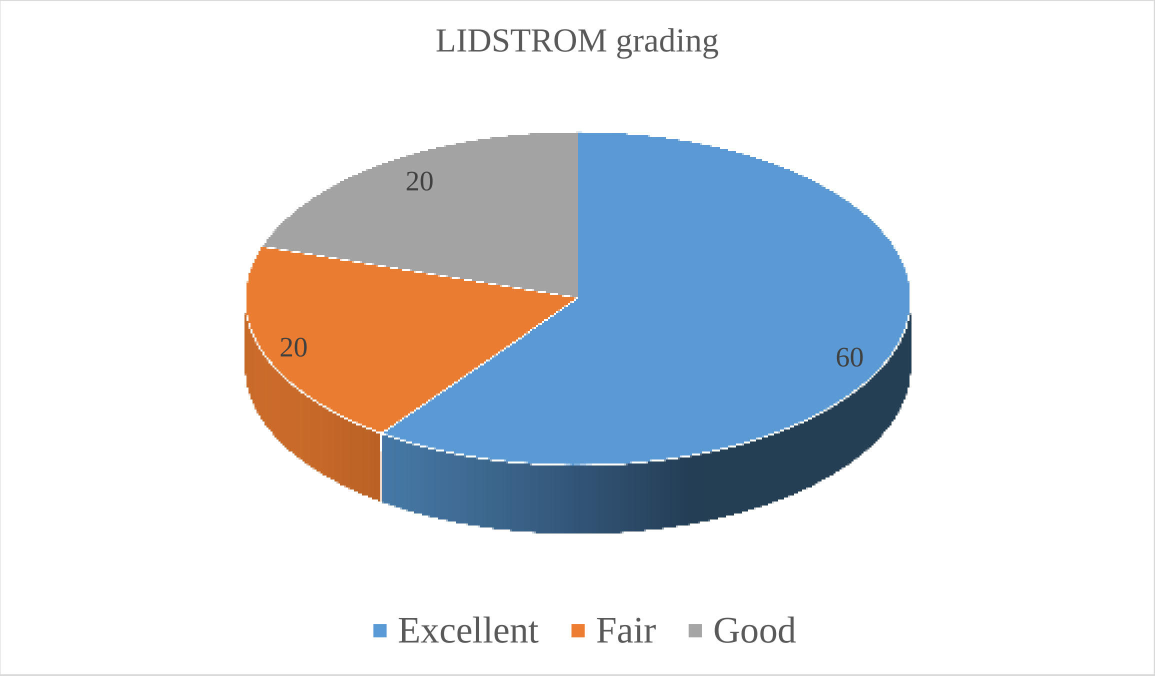
LIDSTROM – anatomical outcome

EXCELLENT	No significant deformity. Dorsal angulation not exceeding neutral position. Radial shortening less than 3mm
GOOD	Mild deformity. Dorsal angulation 1 to 10 degrees. Radial shortening 3 to 6 mm.
FAIR	Moderate deformity. Dorsal angulation 11 to 14 degrees. Radial shortening 7 to 11mm.
POOR	Severe deformity. Dorsal angulation> 15 degrees. Radial shortening >12mm.

Table 12: LIDSTROM grading

		Frequency	Percent
LIDSTROM grading	Excellent	18	60.0
	Fair	6	20.0
	Good	6	20.0
	Total	30	100.0

LIDSTROM grading showed 60% had excellent grade, 20% had good and fair score respectively.

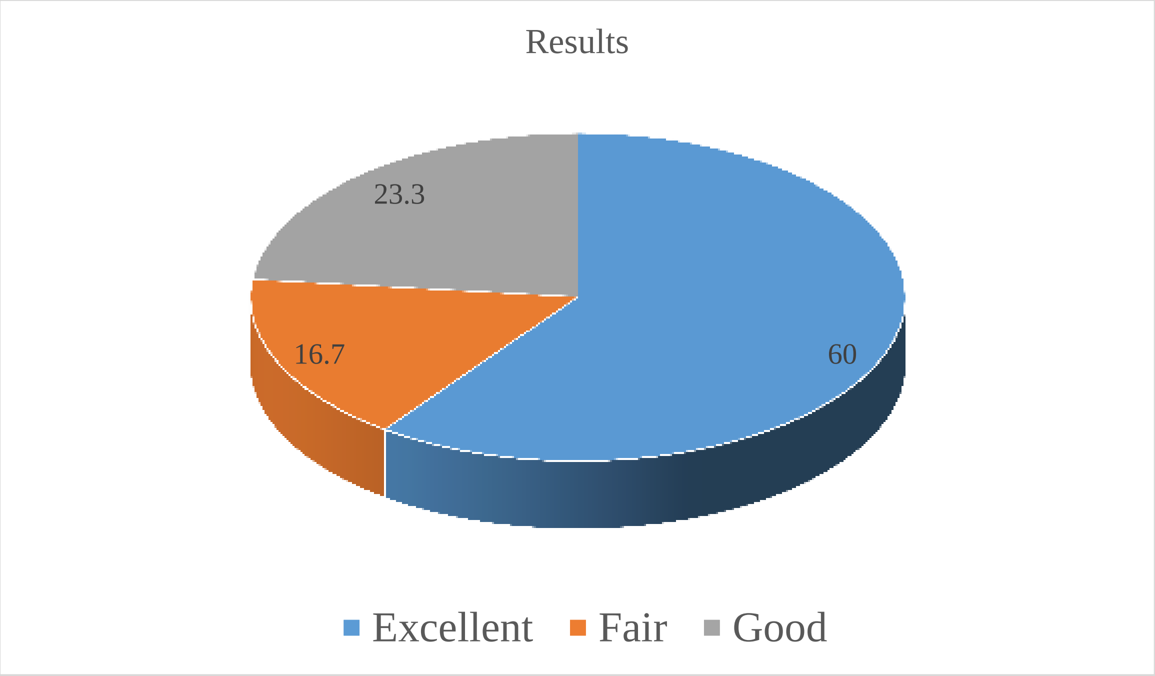


Graph 12: Pie diagram showing LIDSTROM grading

Table 13: Results in subjects

		Frequency	Percent
Results	Excellent	18	60.0
	Good	7	23.3
	Fair	5	16.7
	Total	30	100.0

In the study 60% had excellent results, 23.3% had Good results and 16.7% had Fair results.



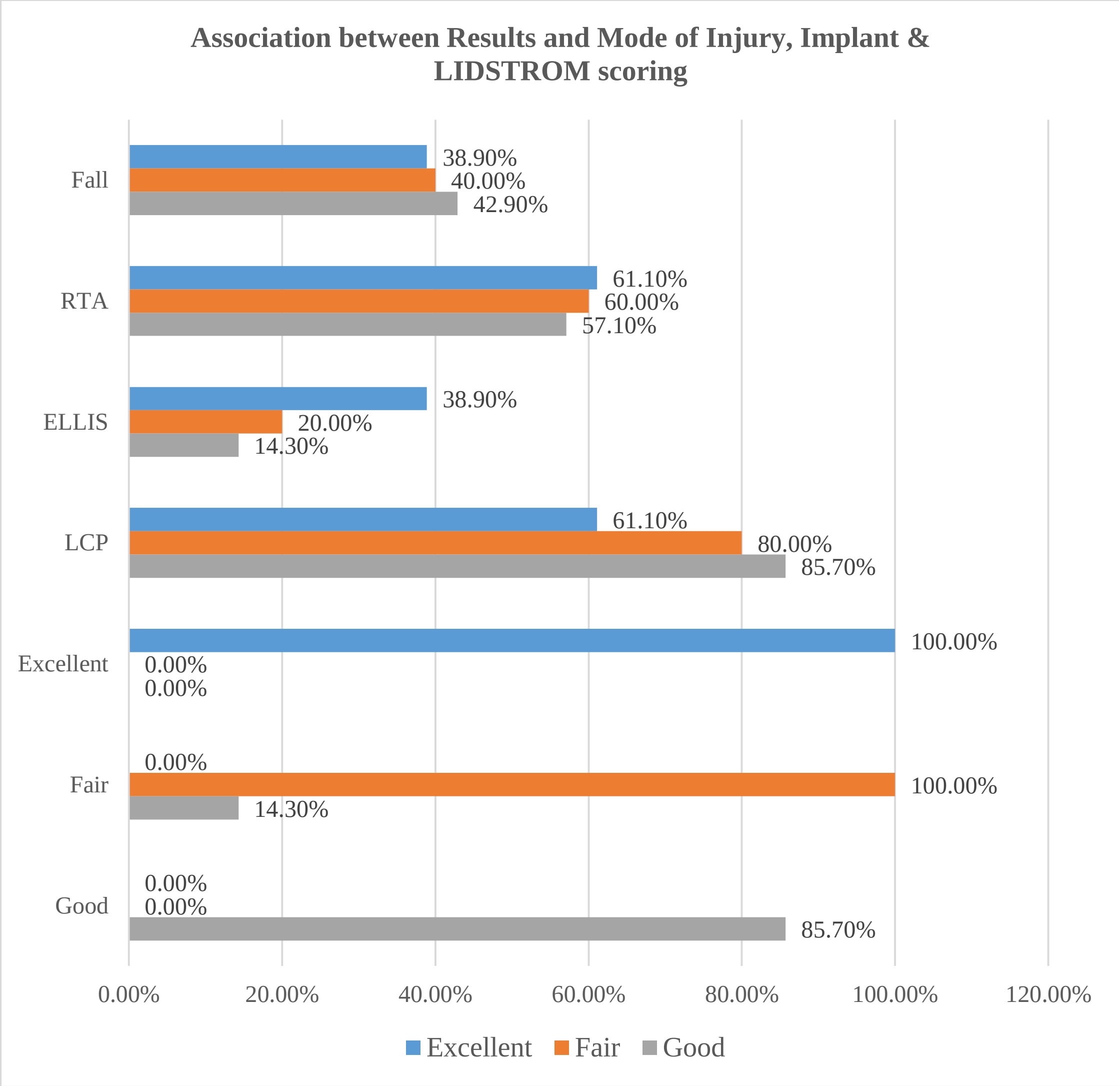
Graph 13: Pie diagram showing Results in subjects

Table 14: Association between Results and Mode of Injury, Implant & LIDSTROM scoring

		Results						P value
		Excellent		Fair		Good		
		Count	%	Count	%	Count	%	
Mode of injury	Fall	7	38.9%	2	40.0%	3	42.9%	0.984
	RTA	11	61.1%	3	60.0%	4	57.1%	
Implant	ELLIS	7	38.9%	1	20.0%	1	14.3%	0.419
	LCP	11	61.1%	4	80.0%	6	85.7%	
LIDSTROM	Excellent	18	100.0%	0	0.0%	0	0.0%	<0.001*
	Fair	0	0.0%	5	100.0%	1	14.3%	
	Good	0	0.0%	0	0.0%	6	85.7%	

In the study there was no significant association between Mode of Injury, Implant and Results.

There was significant association between LIDSTROM score and results. I.e. When Score was excellent 100% of them had excellent results.

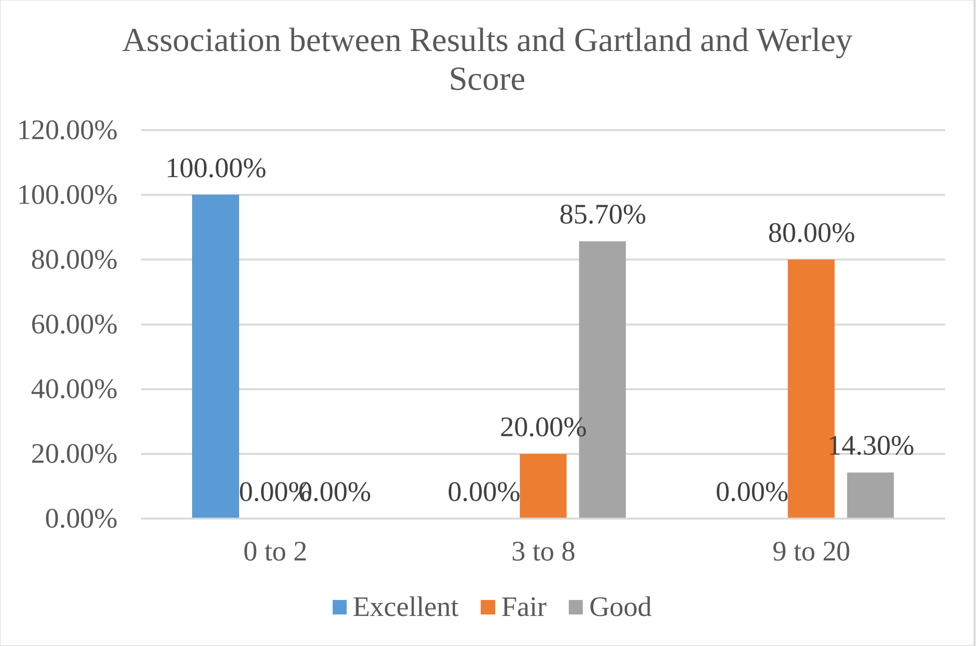


Graph 14: Bar diagram showing Association between Results and Mode of Injury, Implant & LIDSTROM scoring.

Table 15: Association between Results and Gartland and Werley Score

		Results						P value
		Excellent		Fair		Good		
		Count	%	Count	%	Count	%	
Gartland and Werley Score	0 to 2	18	100.0%	0	0.0%	0	0.0%	<0.001*
	3 to 8	0	0.0%	1	20.0%	6	85.7%	
	9 to 20	0	0.0%	4	80.0%	1	14.3%	

There was significant association between Gartland and Werley Score and Results. I.e. when score was 0 to 2 results was excellent in 100%, when score was 3 to 8 results were good in 85.7% and when score was 9 to 20 results was fair in 80%. This observation was statistically significant.

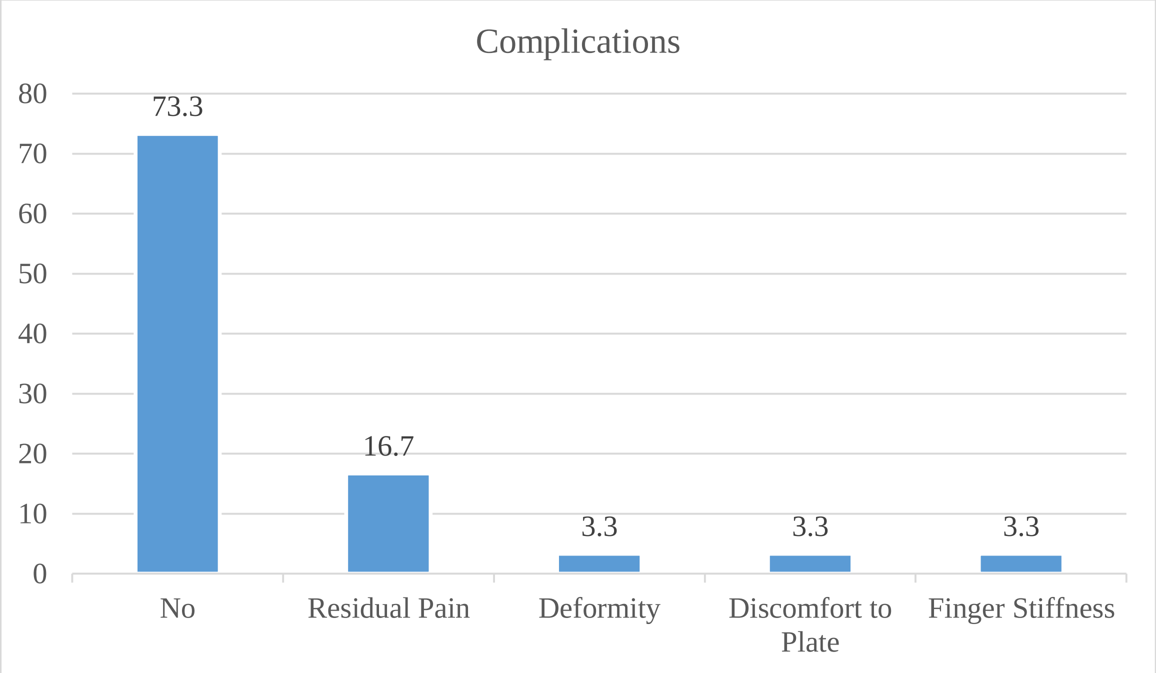


Graph 15: Bar diagram showing Association between Results and Gartland and Werley Score

Table 16: Complications in subjects

		Frequency	Percent
Complications	No	22	73.3
	Residual Pain	5	16.7
	Deformity	1	3.3
	Discomfort to Plate	1	3.3
	Finger Stiffness	1	3.3
	Total	30	100.0

In the study 73.3% had no complications, 16.7% had residual pain, and 3.3% of them had deformity, Discomfort to Plate & Finger Stiffness respectively.



Graph 16: Bar diagram showing Complications in subjects

DISCUSSION

Displaced comminuted intra articular fractures of distal end of radius are difficult fractures to treat. These fractures are inherently unstable and are difficult to reduce anatomically and result in high incidence of complications.

Studies have shown that extra-articular fractures as well as impacted stable fractures with minimal shortening can be managed conservatively. However, more often than not, distal radius fractures involve the radiocarpal joint and/or the distal radioulnar joint. These require an anatomical reduction of the joint surface to reduce the incidence of post-traumatic arthritis and successful outcome.

In contrast, the results of conservative treatment of intra-articular fractures, especially in young individuals have been poor. Thus, intra-articular fractures that cannot be reduced by conservative methods and are comminuted, displaced and unstable, require operative treatment. With the advent of newer techniques and implants like locking distal radius plates and volar plating technique these fractures can be treated successfully with less number and severity of complications.

Distal radius fractures tend to occur in a bimodal age distribution. They are seen most frequently in young patients due to RTA and in old osteopaenic patients due to accidental fall on outstretched hand.

There is consensus regarding the description of the condition and the appropriate outcome. Most authors agree that fundamental principle of treatment is the restoration of articular congruity with the goal of restoring functional, painless motion of the wrist and fingers.

The operative method selected to achieve the treatment objectives requires a careful study of the individual fracture pattern, level of activity, quality of bone and general medical condition. Recognition of fracture patterns, screw fixation of fractures and maintenance of reduction is the key for successful management of more complex fractures of distal radius.

In this study we have prospectively evaluated functional outcome of 30 patients with displaced Intra articular fractures of distal end of radius between December 2013 to May 2015 at Department of Orthopedic Surgery,R.L.JALAPPA HOSPITAL, attached to SRI DEVRAJ URS MEDICAL COLLEGE. We have used volar locking compression distal radius plates and screws for the fixation. The patients were followed up for an average of 6-7 months. The outcome was assessed by using Lidstorms –anatomical outcome, functional results were made using Gartland & Werly.

We have analyzed our results and compared them with studies conducted by other authors who used similar kind of treatment modalities.

1. Age distribution

In present study, distal radial fracture was more common in the 4th and 5th decade with an average of 40.66 years.

Table 17: Age Distribution

Series	Minimum age in years	Maximum age in years	Average in years
John k.Bradway et al25	18	75	40
Jesse B.Jupiter et al63	16	76	42
Louis Catalano III et al64	17	42	30
PattanaShetty et al65	20	69	39.37
Present study	20	65	45

The average age in present study is comparable to the studies of John K.Bradway et al (1989), Jesse B.Jupiter et al (1996) and Pattanashetty et al (2013) who had an average age of 40 Years, 42 Years and 39.37Years respectively.

Louis Catalano III et al (1997) had an average age of 30 Years in their series. But their study was limited to young adults who were less than 45 Years. Majority of injuries in younger patients are secondary to motor vehicle accidents, increased outdoor activity , alcohol intake , heavy manual labour, youth involved in sports, who sustained a relatively high energy fall due to football, skiing, dancing, rugby, snowboarding.

2) Sex distribution

Present study had a male preponderance with 66.7% male patient and 33.3% female patients and is comparable to the following previous studies mentioned in the table below.

Table 18: Sex Distribution

Series	Males in percentage	Females in percentage
John K.Bradway et al25	56	44
Jesse B.Jupiter et al63	60	40
Louis Catalano III et al64	67	33
Harish Kapoor et al38	72	28
PattanaShetty et al65	53.1	46.9
Present study	66.7	33.3

Increased incidence in males is probably due to their involvement in outdoor activities and heavy manual labour.

Incidence of distal radius fracture in male more due to high energy injuries in female (more in elderly) due to low energy injuries.

3) Involved side

The right side (dominant wrist) was involved in 66.7% of the cases in our study.

Table 19: Involved Side Distribution

Series	Right in percentage	Left in percentage
John K.Bradway et al25	50	50
Jesse B.Jupiter et al63	61	39
Louis Catalano III et al64	48	52
Harish Kapoor et al38	65	35
PattanaShetty et al65	71.8	28.2
Present study	66.7	33.3

Right side is more common may be because of more number of right handed persons using right hand first for protecting themselves while fall on the ground.

4) Mode of injury

In present study 60% of the patients had road traffic accident and 40% had a fall from height.

Table 20: Mode of Injury Distribution

Series	Road traffic accident (%)	Direct blow (%)	Fall from height (%)
John K.Bradway et al25	31	-	-
Jesse B.Jupiter et al63	67	-	-
Louis Catalano III et al64	10	14	-
PattanaShetty et al65	40.7	12.5	21.8
Present study	60.0	-	40.0

Present series is comparable to that of Harish Kapoor et al (2000), pattanashetty et al (2013) as it was also done in the Indian subcontinent and in a similar setup.

Road traffic accidents are common due to disobeying traffic rules, road conditions, and vehicle conditions, driving under influence of alcohol, fast careless driving, inflation and increase in number of vehicles, increased per capital income.

5) Type of Fracture

Based on Frykman's classification, present study had 16 (53.3%) patients Type III and IV fractures, 11 (36.6%) Type V, VI, VII & VIII fractures. 3 (10%) Type I.

Table 21: Type of Fracture Distribution

Series	Type I, II (%)	Type III, IV (%)	Type V.VI, VII, VIII (%)
John K.Bradway et al25	-	-	100
Jesse B.Jupiter et al63	-	4	96
Louis Catalano III et al64	-	-	100
PattanaShetty et al65	6.25	37.5	56.25
Present study	10.0	53.3	36.6

John K. Brad way et al (1989) and Louis Catalano III et al (1997) reported only Type VII and VIII fractures as their study was limited to these sub types.

Jesse B. Jupiter et al (1956) reported 96% Type VII and VIII fractures.

Pattanashetty et al (2013) who had also reported more number of type VII and VIII injuries and no type II fractures.

Present series is comparable to Pattanashetty et al (2013) series as it was done in the same region and in a similar setup and had the same findings for age and sex incidence, involved wrist and mode of injury, as that of present study. Type V to VIII fractures common because of high energy trauma due to RTA, direct blow to the wrist while fall on the ground. Hand and wrist positions relative to the body at the time of the injury influence the pattern of the fracture lines.

6) Complications

In this present study 73.3% had no complications, 16.7% had residual pain, and 3.3% of them had deformity, Discomfort to Plate & Finger Stiffness respectively Present study did not have nonunion, arthritis or nerve related complications.

One Patient underwent open reduction with internal fixation had superficial infection treated with appropriate antibiotics and regular sterile dressings. One patient had malunion may be due to delayed for surgery, non-compliant patient, lack off regular follow up, physiotherapy. Deep infections can be controlled by debridement, regular sterile dressings, and appropriate intravenous antibiotics.

John K. Brad way et al (1989) and Jesse B. Jupiter et al (1996) reported a complication rate of 30% and 36% respectively.

Pattanashetty et al (2013) who had complications in 3 patients (9.3%) malunion, 7 patients (21.8%) finger and wrist stiffness.

7) RESULTS

Results as per Gartland and werley score system

In present study had 60% excellent, 23.3% good, 16.7% fair and 0% poor results. Patients, who obtained excellent results, had no residual deformities or pain. Range of motion was within the normal functional range. They had no arthritic changes or other complications. They were operated within 1-3 days after injury. Radial length, volar tilt and articular step –off were within acceptable limits. They were co-operative to physiotherapy.

Patients with good results had minimal residual deformities, pain and slight limitations. Results of their findings were within acceptable parameters.

Patients with fair results along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications. Few of their movement were less than that required for normal function.

One patient who had poor result was operated on the 7thday after injury as she had hypertension, diabetes mellitus, renal failure, and anemia. After controlling hypertension, blood sugar levels with physician advice and treatment, anemic status also improved with blood transfusions then undertaken for the surgical procedure. Because of soft tissue adaptations during these 7 days her radial length could not be restored to acceptable measurement. She had residual dinner fork deformity, pain, limitation, disability and weakness. Most of her movements were not within the range required for normal function. She was non-compliant with regard to post-operative physiotherapy. She also had malunion due to radial shortening.

TABLE 22: RESULTS COMPARISION AS PER DEMERIT SCORE Series

	Excellent	Good	Fair	Poor
John K.	56	25	19	0

Bradway et al25				
Jesse B. Jupiter63	63	20	17	0
PattanaShetty et al65	18.75	46.88	18.72	15.65
Present study	60.0	23.3	16.7	-

Present series is comparable to those of John k. Brad way et al (1989) Jesse B. Jupiter et al (1996) and Pattanashetty et al (2013) who had more percentage of excellent and good results.

These studies had more percentage of excellent, good results in distal radius fractures treated with plating compare to other methods of fixation, this means plating gives relatively better results in comminuted intra articular fractures of distal radius This does not mean that plating is the gold standard in treatment of comminuted intraarticular fractures of distal radius, but as an alternative method in treating these injuries with good outcome in majority of patients.

LIMITATIONS OF STUDY

- The mean duration of our study is 9.3 months with a minimum of 6 months and maximum of 14 months. We feel that this duration is inadequate to assess the arthritic changes and to assess the permanent disability from these kind of fractures.
- We have included 30 patients in our study. We agree that it is a small sample of patients and is insufficient to estimate the demographic characteristics of these kind of fractures.

CONCLUSION

This study comprised of thirty cases of distal radial fractures in adult treated with open reduction and internal fixation with volar locking compression plating and screws. The follow–up ranged from 6-14 months.

The average age was 40.66 years with the fracture being more common in the 4th and 5th decades.

Males were predominant with right wrist affection than left.

All fracture were either due to road traffic accidents or fall on the outstretched hand, with road traffic accidents being more common of the two.

Most of the fractures were of Frykman’s Type III, VI, V, and VI. There were no Type II fractures.

The average duration from the date of injury to the date of surgery was 1.9days. Surgery was delayed till the 7th day in 1(3.33%) patient who had medical comorbidity.

More percentage of the patients had their range of motion within the normal functional range. None of the patients had wrist stiffness. Complications were minimal. There were no instances of delayed union or nonunion. Malunion was found to be within acceptable limits in all cases except one (3.33%).

Using the Demerit score system of Gartland and Werley, we had 18(60%) excellent results, 7 (23.3%) good results, 5(16.7%) fair results and 0(0%) poor results.

1. Volar plating for radius lower end fractures is the good choice for treatment of radius lower end injuries.

2. Locking screw and locking plate mechanics are put into consideration for fixation of LCP.

3. Plate fixation helps in mobilizing patient early and get the good anatomical and functional outcome.

4. There are less incidence of malunion and the deformity if the fixation done by volar plate.

5. There is very minimal risk of nerve compression, stiffness, fracture re displacement, infection after volar plate fixation.

6. Properly planned post-surgical rehabilitation give full range of movements and good results

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ANNEXURE – I

STUDY PROFORMA:

CASE No:

NAME:

AGE/SEX:

OCCUPATION:

ADDRESS:

HOSPITAL NO:

DATE OF ADMISSION:

DIAGNOSIS:

DATE OF SURGERY:

DATE OF DISCHARGE:

DURATION OF TREATMENT**:**

MODE OF INJURY:

a. Road traffic accident

b. Industrial accident

c. Agricultural accident

d. Assault

e. Fall from height

f. sports injury

g. Miscellaneous

HISTORY OF PRESENTING ILLNES:

1) Mechanism of trauma

2) Duration

3) History of previous illness if any

METHOD OF FIRST AID GIVEN:

GENERAL PHYSICAL EXAMINATION:

Built- well/ moderate/ poor

Nourishment- well/ moderate/ poor

Pallor, Icterus, Cyanosis, Clubbing, lymphadenopathy, oedema

Temperature- febrile/ non febrile

Pulse rate-

Blood pressure-

Respiratory rate-

SYSTEMIC EXAMINATION:

1) R.S

2) C.V.S.

3) P/A

4) C.N.S.

5) SPINE

6) PELVIS

ON EXAMINATION:

SYMTOMS-

SWELLING

PAIN

DEFORMITY

LOSS OF FUNCTION

ASSOCIATED SOFT TISSUE AND SKELETAL INJURY

SIGNS-

SWELLING

DEFORMITY

TENDERNESS

ABNORMAL MOBILITY

CREPITUS

Movements:

Wrist	-	Flexion
	-	Extension
	-	Radial deviation
	-	Ulnar deviation
Forearm	-	Supination
	-	Pronation
Elbow	-	Flexion
	-	Extension
Fingers	-	Flexion
	-	Extension

- Adduction
- Abduction

Associated complaints:

Neurological - Ulnar nerve

- Median nerve
- Radial nerve

Vascular :

Muscular :

Other bone injuries -

X-ray of forearm, wrist and hand:

- A.P.

- Lateral

Treatment:

Surgery:

Open reduction/ internal fixation with volar plate

Anesthesia

Duration of surgery

Antibiotics

COMPLICATION OF SURGERY:

POST-OPERATIVE PROTOCOL:

Protective slab immobilization for - weeks

MOBILIZATION STARTED AT -

FOLLOW UP:

Follow up at 1 month - Findings

Follow up at 3 months - Findings

Follow up at 6 months - Findings

Follow up of the patients will be done at the end of 6 months and the following scores will be used

1). Demerit Point System of Gartland and Werley

2). Lidstroms scoring system

COMPLICATIONS:

FOLLOW-UP WITH X-RAY:

A.P. view:

Lateral view:

1) Duration after surgery :

2) Signs of union of fracture :

a) Clinical signs

- Tenderness at fracture site : Present/ Absent

b) Radiological signs

- Callus : Present/ Absent
- Alignment : Present/ Absent
- Angulations : Present/ Absent
- Non-union : Present/ Absent
- Arthritic changes : Present/ Absent

FUNCTIONAL EVALUATION BY (Gartland & werley score)

WKS	FOLLOW UP	TENDERNESS	LEVEL OF BOTH STYLOID PROCESS	D.F	P.F	SUPINATION	PRONATION	U.D	R.D
1 wk.									
6 wk.									
8 wk.									
3 months									

6 months										

FOLLOW UP WITH X RAYS AT 1, 6, AND 8 WEEKS AND 3, 6, MONTHS

ANNEXURE- II

CLINICAL PHOTOGRAPHS

Case: 25

Pre-operative AP view & LATERAL views

Post-operative AP & LATERAL views

Dorsiflexion Palmar flexion Supination

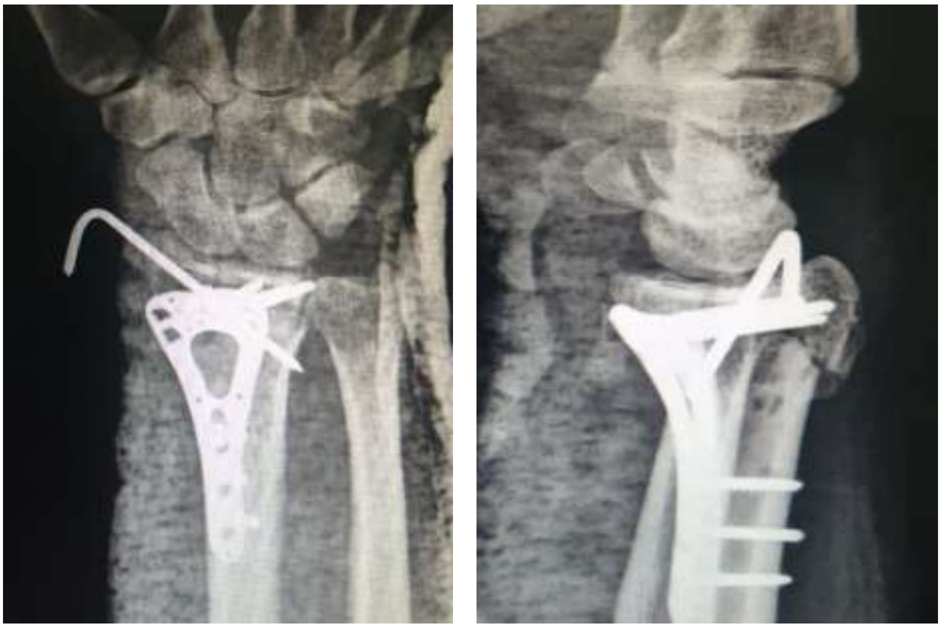
Pronation

Ulnar Deviation

Radial Deviation

Case: 7

Pre-operative AP & LATERAL views



Post-operative AP & LATERAL views

Dorsiflexion

Palmar Flexion

Supination

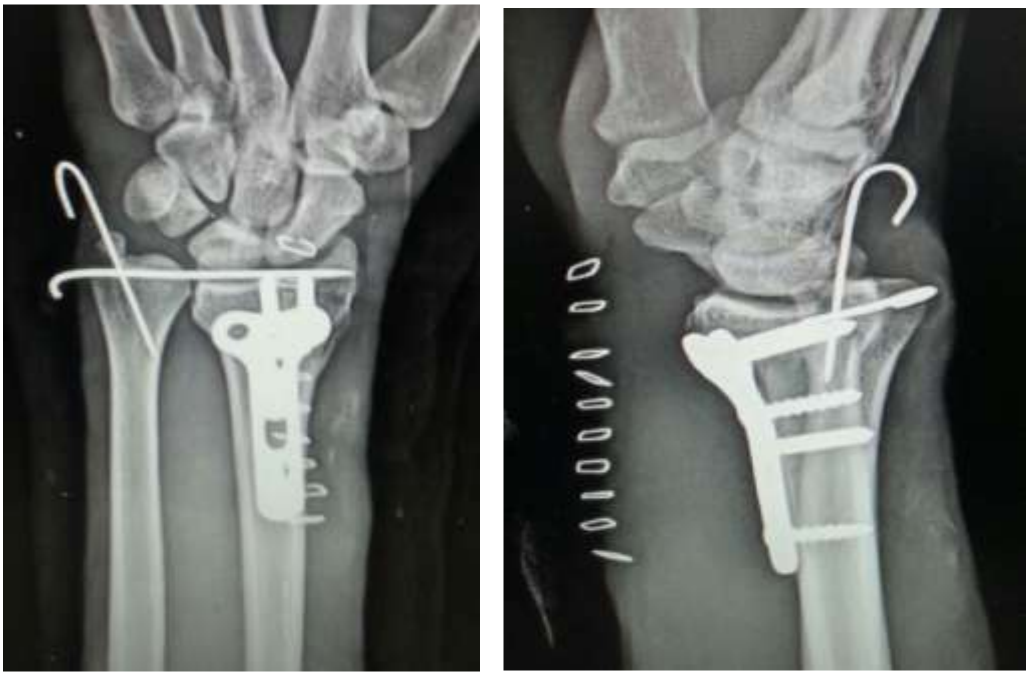
Pronation

Ulnar Deviation

Radial Deviation

Case: 2

Pre-operative AP view & LATERAL view



Post-operative AP & LATERAL view

Dorsiflexion Palmar flexion

Supination Pronation

Case: 3

Pre-operative AP & LATERAL views

Post-operative AP & LATERAL views

Dorsiflexion

Palmar flexion

Supination

Pronation

ANNEXURE-III

PATIENT INFORMATION SHEET:

Respected ________________

We request you to participate in our study as you are eligible to be included. During the study you will be asked questions regarding your present and past medical history and you are supposed to answer to the best of your knowledge.

Your participation in this study is voluntary. If you decide to participate you are free to withdraw at any point of time.

INTRODUCTION AND PURPOSE:

Distal radius fracture is one of the most common fractures of the hip especially in the elderly with osteoporotic bones, usually due to low-energy trauma like simple falls and in young adults it is due to high velocity injuries like road traffic accidents. Problems of these fractures are (1) association with substantial morbidity (2) malunion, (3) Limitation of movements (4) financial burden to the family and (5) associated medical problem like diabetes, hypertension.

The main purpose of the current study is to, assess the functional outcome and complications of these patients with distal radius fractures treated with volar locking compression plate with regard to functional mobility, stability and the range of movements using gartland and werley –functional outcome score

PROCEDURE:

If you CONSENT to be in this study, the relevant data is collected as per the proforma, and the final diagnosis is confirmed after correlating both clinical and radiological evidences. The subject is then posted for the proposed surgery after obtaining the fitness for surgery and proposed procedure open reduction internal fixation with volar locking compression plate done. Patient will be discharged accordingly and would be followed up with post-operative X-rays and regular physiotherapy. The patients will be followed up at 2 weeks, 6 weeks, 3 months and 6 months, till radiological union was seen. Radiographs will be taken in AP and Lateral views to look for signs of radiological union. At every follow up clinical examination would be done. Clinical union would be there if fracture site becomes stable and pain free. The time taken for radiological and clinical union would be noted down.

You will also be observed for any kind of complication and if present will be treated.

ALTERNATIVES:

Even if you decline the participation in study, you will get the routine line of management.

VOLUNTARY PARTICIPATION/WITHDRAWAL:

Taking part in this study is voluntary. I may choose not to take part in this study, or if I decide to take part I can later change my mind and withdraw from the study. My decision will not change the present or future health care or other services that I receive.

COMPENSATION:

As the subject voluntarily consents to be a part of the study, no compensation will be given.

CONFIDENTIALITY:

All information collected about the subject during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify the subject in this research record. Information from this study may be published but the subject's identity will be confidential in any publication.

INFORMED CONSENT FORM:

Name of the Participant: ---

Name of the Institution: ---

Documentation of the informed consent

I,…………………………….have read the information in this form(or it has been read to me).I was free to ask any questions and they have been answered. I have given my consent to be included as a participant in the study.

• I have read and understood this consent form and the information provided to me.

• I have been explained about the nature of the study

• I am also aware that the investigators may terminate my participation in the study at any time, for any reason, without my consent.

• I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the regulatory authorities and ethics committee understand that they may inspect my original records.

• My identity will be kept confidential if my data are publicly presented.

• I have been explained that this study is not harmful, and does not cause economic burden to me.

• I have had my questions answered to my satisfaction.

• I have decided to be in the research study.

Name &signature/thumb impression of the participant:

______________ (name) ____________ (signature) Date:

Name & signature/thumb impression of patient attendant/witness

______________ (name) ____________ (signature) Date:

Name & signature of the investigator or his representative obtaining consent

______________ (name) ____________ (signature) Date

KEY TO MASTER CHART

S.NO	: serial number
Lt	: left
Rt	: right
MOI	: mode of injury
Ass. Inj	: associated injuries
RTA	: road traffic accidents
FOOH	: fall on outstretched hand
FFH	: fall from height
MFI	: maxilla facial injury
MM #	: medial malleolus fracture
DF	: dorsiflexion
PF	: palmar flexion
RD	: radial deviation
UD	: ulnar deviation
SUP	: supination
PRO	: pronation

G & W	: gartland & werley
IAS	: intra articular step
UV	: ulnar variance
RL	: radial length
RI	: radial inclination
PT	: palmar tilt
DT	: dorsal tilt
NEU	: neutral tilt
LCP	: locking compression plate
FPL	: flexor pollices longus
US	: ulnar styloid
DRUJ	: distal radio ulnar joint

MASTER CHART