"A PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF COMMUNITED INTRAARTICULAR DISTAL RADIUS FRACTURE USING LIGAMENTOTAXIS"

By

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IN

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ABSTRACT

INTRODUCTION

Fractures of distal end radius are common fractures of the upper limb, and constitute 17 % of all fractures and 75% of all forearm fractures[1] Osteoporosis and tendency to fall on outstretched hand constitute major risk factors[2]. The treating orthopedician has an armada of treatment options to select from to accomplish this Non-operative management is reserved for undisplaced stable fractures and require no fixation[6] Operative management of fracture include closed, or open reduction. To reduce fracture fragments and maintain alignment, principle of ligamentotaxis is used by external fixation.Reasons for using external fixation include the continuity of reduction under fluoroscopic control, improved reduction by ligamentotaxis, and the ability to protect the reduction until healing occurs. The advantages of external fixation are the relative ease of application, minimal surgical exposure, and reduced surgical trauma.[5]

OBJECTIVE OF THE STUDY

To study the functional outcome of intraarticular fracture of distal radius treated with external fixator and ligamentotaxis.

MATERIALS AND METHODS

Patients admitted in Department of Orthopaedics in BLDEU'S Shri B.M.Patil's Medical College, Hospital and Research Centre, Bijapur with diagnosis of intraarticular fracture of distal radius were treated with bridging external fixation using principal of ligamentotaxis. The patients will be informed about study in all respects and informed written consent will be obtained. Period of study will be from

1st December 2015- 31st January 2017. Patients were followed up till 6 weeks, 3 months and 6 months.

RESULTS

Majority in our cases were males with mean age of 41.3 years. Road traffic accidents were seen in majority of cases and self fall being majority of mode of injury in old patients. Functional outcome at end of 6 months as assessed by Demerit Point System of Gartland and Werley was 72% Excellent to Good Results while 22% cases had Fair to Poor results with union occurring at 6 weeks in majority of cases. 30 cases had complications in our study- 2 patients had malunion with some degree of residual dorsal angulation however it did not have a significant effect on functional outcome. 2 patients had pin loosening which resolved without any intervention. 12 patients suffered from pin tract infection and superficial infection which was treated by regular dressing.

CONCLUSION

External fixation offers good mode of treatment in communited fractures as they allow gradual distraction providing better functional and anatomical results in communited intraarticular wrist injuries. It provided early mobilization and reduces edema stiffness of joints thus leading to better and early functional recovery.

KEYWORDS: Distal Radius, External Fixation, Ligamentotaxis

LIST OF ABBREVATIONS

DER	Distal end radius
EF	External Fixation
CRIF	Closed reduction internal fixation
ORIF	Open reduction internal fixation
RTA	Road traffic accidents
ASS	Assault
GA	Gustillo Anderson
ROM	Range of Motion
MM	Milimeters
Hb	Haemoglobin
HIV	Human Immudefiency Virus
TFCC	Triangular Fibrocartilage Complex
VLCP	Volar Locking Compression Plate
CP	Chronic pain

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INTRODUCTION

Fractures of distal end radius are common fractures of the upper limb, and constitute 17 % of all fractures and 75% of all forearm fractures[1]

This fracture shows bimodal distribution of age with the fracture more commonly seen in children and elderly. Reduced amount of stronger cortical bone and increased amount of weaker cancellous bone at the metaphyseal broad area of distal radius predisposes to distal end radius fracture. Osteoporosis and tendency to fall on outstretched hand constitute major risk factors[2]. Falls on outstretched hand results frequently in a distal radius fracture. In an active and independent individual, wrist fracture indicates early manifestation of osteoporosis which predicts hip fracture in later years[3]. The societal burden of these fractures increases in the future as the aging population grows rapidly. Therefore, in perspective of patients and the society, it is important to study the epidemiology and treatment of these fractures to optimize outcome.

Classification of distal end radius is done according to direction of displaced fragments. Dorsally angulated extraarticular fracture often known by eponym “Colles’ Fracture” is the most common type. Typically the deformity that results after fall on outstretched hand is a dinner fork deformity. 97% of all distal end radius fractures are Colles’ fracture[5].

The objectives of management for a distal end radius fracture should be restoration of range of motion and grip strength while facilitating the patient’s early reinstation to normal daily activities and minimizing the chances of post traumatic arthritis. The treating orthopedician has an armada of treatment options to select from to accomplish this. Regardless of these fractures being common, there is no clear consensus on their treatment as there is no clear clinical-based evidence in the literature. Non-operative management is reserved for undisplaced stable fractures and require no fixation[6]. Symptomatic relief is achieved by immobilization with below elbow cast. In intraarticular, unstable fractures, operative fixation is imperative in maintaining an acceptable reduction. Various methods for surgical management are available. Operative management of fracture include closed, or open reduction.

For several decades, closed reduction and bridging external fixator for 4-6 weeks has been a well-established treatment of distal end radius fracture[7]. To reduce fracture fragments and maintain alignment, principle of ligamentotaxis is used by external fixation. After removal of external fixator, it is possible that there may be redisplacement of fracture fragments[8]. Pin site infection, radial nerve lesions, pin loosening, iatrogenic fracture, redisplacement and complex regional pain syndrome (CRPS)[9] are known complication of external fixation. Non-bridging external fixation is favourable for rehabilitation as it allows wrist mobilization during the fixation[10] though it requires a sizable distal fracture fragment. It has been concluded in Cochrane review that there is not enough proof to conclude the relative effects of the different methods of external fixation[11]. Percutaneous pinning and cast following closed reduction is another commonly used modality of treament. K wires can be inserted by an array of techniques; across fracture site in crossed manner or using intrafocal Kampandji technique[12]. Percutaneous pinning is indicated for non-communited extra-articular fractures. Complications of K wiring and external fixation are similar. Temporary wrist stiffness following a similar period of immobilization have been observed in both the methods. Both methods are often combined. The percutaneous pins fixation provides additional stability[13], especially in intra-articular fractures where pins augment the reduction of intra-articular displacement[14]. For the management of unstable, dorsally displaced, fractures of distal radius, open reduction and internal fixation using volar locked plates have gained popularity in recent times and has shown promising results in patients of varied ages[15 16 17]. External fixation or percutaneous pinning are less invasive and cheaper as compared to volar plating. The advantage of volar plating is that it provides exact reduction of fracture fragments and allowing immediate functional loading of wrist. Flexor and extensor tendon irritations and ruptures, carpal tunnel syndrome, fracture redisplacement, screw loosening and CRPS[18] are the complications associated with volar plate. Since the introduction of volar plates the use of Dorsal (buttress) plating has become almost obsolete. There has been good results for dorsal plate has been reported for communited fractures[19] but it carries significant risk of extensor tendon injuries[20]. Low profile fragment specific plates have been introduced recently has been assessed by authors[21 22]. Promising results have been reported for intramedullary fixation devices which uses subchondral screws for locing in the stem[23]. Dorsal bony defects can be filled with bone grafts, principally in osteoporotic bone. While bone grafting may improve anatomical results but it is yet to be proven that it contributes to improvement of final functional results[24]. Several studies comparing dorsal plating [25 26], fragment specific systems[23], or a mixture of dorsal and volar plating techniques[27 28] with external fixation, however, these studies have not shown considerable evidence to support the use of one method over the other. Studies comparing volar locked plating with external fixation, have not given suggestion of superiority for either method over the other[29 30 31]. External fixation has been reported to be superior[32 33] and beneficial in the long term[34] and shows similar results when compared to percutaneous pinning[35].

Owing to the remodelling ability of growing bone in paediatric age group, they are less susceptible to stiffness following immobilization and generally have favourable results. Non-union occurs infrequently due to the natural healing ability of metaphyseal bone. However residual pain, stiffness and decreased grip strength are extremely common because of fracture, associated soft tissue injury and mandatory period of immobilization following fracture. Subsequently, the rehabilitation following the fracture should be aggressive and takes considerable time. Favourable results are seen in almost all patients after a year[36] but restoration to complete normal function follows till 2-4 years and may be delayed even more in malunited fractures[37]. Occasionally, distal end radius fractures result in permanent residual pain and impairment of function[38]. Generally, malunion to a varying degree ensues after distal radius fractures. The correlation between resulting bony deformity (measured radiologically) and objective physical variables (grip strength and ROM) is debated[39, 40]. It is uncertain if and how conventional radiological outcome and the physical-rated results are associated[41 42 43 44]. Likewise, there is unclear association between articular integrity and patient-rated outcomes[45]. Interestingly, after a distal end radius fracture, certain individual might remain asymptomatic despite obvious radiological deformity whereas others encounter substantial disability despite a good anatomical position. Owing to the uncertainty of which patient develops symptoms, it is challenging to treat all patients should at a suitable level. Treatment must be motivated but overtreatment prevention should be done.

AIMS AND OBJECTIVES

To study the functional outcome and duration for union in intraarticular distal radius fractures treated with external fixator using ligamentotaxis.

REVIEW OF LITERATURE

In 2012, **Zhao et al** in their comparative study between internal and external fixation for treatment of unstable distal radius fractures concluded that external fixation gives similar results to internal fixation with no any statistical significance without complications like tendon irritation.[46]

In 2012, **Sebastian- Castanon et al** in prospective comparative study between external fixation and volar plate for treatment of complex distal radius fractures found no statistical difference in both groups when measured by Visual Analog Scale and McDermid et al. scale. They concluded that there was no difference between both groups regarding pain and residual disability. [47]

In 2013, **Yang X et al** while comparing unilateral external fixators and locking compression plate found that while LCP had short term efficacy, both groups show similar long term results. They concluded for serious radius communited fracture which unable to plate internal fixation, external fixation is a better choice.[48]

In 2013 **Praveen Anvekar** reported that 70% had good or excellent results according to the scoring system of Gartland and Werely point system, 25% had fair and 5% had poor results of which one patient had radiocarpal arthritis.[49]

In 2013 **Gradl et al** reported that among 102 patients treated with external fixation and volar plating observed 100% excellent to good results in patients treated with external fixation and 97.5% excellent to good results in patients treated with volar plate. They concluded that external fixation is a subtle option for treatment of distal radius even in osteoporotic bone.[50]

In 2014 **Shukla et al** reported in110 patients with in displaced intra-articular (Cooney's type IV) distal radius fractures randomized to treatment with external fixation and volar plating 85.5 % of patients treated with external fixation and 73.3 % of patients treated with volar plating had an excellent or good result according to GREEN O'BRIAN SCORE. They concluded that external fixation has superiority over volar locked plating techniques at final outcome at 1 year follow-up.[51]

In 2014 **Deepak CD, Gopalakrishna G, Ravoof A et. al.** assessed the results of 20 cases of unstable distal end radius fractures with / without intra-articular extension were treated with uniplanar static type of external fixation using the principle of ligamentotaxis and augmentation by K-wires. According to Gartland and Werley score for the outcome, 85%had excellent to good results while 20% had fair results and concluded that External fixation and ligamentotaxis provides better functional and anatomical results in communited intra-articular and unstable extra-articular wrist injuries.[52]

In 2014 **Makhdoom et al** reported 22 patients with unstable distal radius fractures were managed with "Penning Dynamic Wrist Fixator" had improvement in forearm supination and pronation at 8-14 weeks and grip strength improvement by 10-22 weeks. No patient in the study suffered from deep infection. The concluded that Penning Dynamic wrist fixator demonstrates good outcomes with minimal risk. Patient may return rapidly to function as compared with other methods of treatment.[53]

In 2015 **Dr Rakesh Yalavath Dr Amar Vishal** reported that of 33 patients fracture distal radius were treated with ligamentotaxis 23(69.7%) had excellent results, 6(18.1%) patients had good ,4(12.2%) had fair to poor as per the criteria suggested by Gartland and Werley (Functional).[54]

In 2015 **Harmindar Singh Devindra Kaur** treated 20 patients with closed reduction and external fixator cum distractor and 20 patients with closed reduction and cast immobilization concluded that External fixator allows much better anatomical result and superior hand grip. The ligamnetotaxis by means of external fixator is a simple procedure having high percentage of excellent and good results with minimal complications appears to be better method than pop cast immobilization.[55]

In 2015 **Bajwa AS et al.** in a prospective comparative series for treatment of unstable distal radius fractures: non-invasive dynamic external fixator versus volar locking plate concluded that fractures treated with non-invasive external fixator can give better functional results superior to ORIF at 3 months and trend is maintained at one and two year post operatively.[56]

In 2015, **Li-hai et al.** in analysed 445 distal radius fracture meta analytical study of Volar plate versus external fixation for treatment of distal radius fractures. They concluded that external fixation has less reoperative rate due to complications and has similar functional recovery at 12 months post operatively.[57]

In 2015, **Sha L**, in a comparative study between external fixation and volar locking plate for treatment of Type C Distal Radius Fractures concluded that external fixation has less invasion, shorter hospitalization days, minor complications and faster fracture union.[58]

In 2016, **Chuang Ma et al.** found higher complications in patients who underwent volar or dorsal locking plate. Also greater anatomical reduction did not necessarily show better functional outcome.[59]

In 2017, **Tang Z, Liu J, Yang H** compared the outcome of C2-3 distal radius fractures treated with VLCP and PKEF found no difference in terms of volar inclination, ulnar angulation and ulnar variance. They concluded that PKEF leads to better functions than VLCP.[60]

RELEVANT ANATOMY

Anatomy[61]

The distal end of radius, the widest part is four sided in section. Its lateral surface is slightly rough, as a pyramidal styloid process.

Inferiorly, lays the smooth carpal articular surface, separated by a ridge into medial and lateral concave areas. Ulnar or medial portion is quadrangular and articulates with lunate bone. The concave area is triangular in shape, with its apex at the styloid process which articulates with scaphoid.

The ulnar surface of radius has a notch for articulating with ulnar head. Above this is a triangular area surrounded by anterior and posterior ridges. The interosseous membrane is attached to posterior ridge.

Anterior surface is a dense, projecting ridge, palpable even though overlying tendons, 2cm proximal to the thenar eminence.

The posterior surface presents with a prominent palpable dorsal tubercle of Lister, in line with second web space. Posterior interosseous nerve lies on posterior surface below extensor digitorum tendons.

The extensor retinaculum, a thickened deep fascia, is attached to the prominent ridge lateral to the pronator hollow (i.e. on the anterior surface of radius) and sweeps obliquely across to the radius, creating compartments for the extensor tendons. Four compartments lie over the distal radius and fifth over radioulnar joint. The sixth compartments lie over the ulnar head. This expanded lower end of radius (via the thenar eminence) takes the full load of a fall on the outstretched hand and may result in the distal end of radius fracture.

ANATOMY OF WRIST JOINT[62]

The radiocarpal of wrist joint is a bi-axial, commonly classified as ellipsoid. Distal end of radius and its articular disc and scaphoid, lunate and triquetral bones below constitute the radiocarpal joint. The articular surface of the radius and the distal surface of the articular disc constitute together an elliptical, concave surface with its long axis transversely disposed. The radial surface bears two concavities as it is divided into two by a low ridge. A similar ridge is commonly distinguishable between medial concavity on to the radius and the concave distal surface of the articular disc. The smooth convex surface created by the carpal bones- scaphoid, lunate and triquetral is well received in the proximal concavity of radius. The line of the joint corresponds to a line, convex upwards, joining the styloid process of the radius to that of the ulna.

The articular capsule is covered by synovial membrane which is usually divided from that of the inferior radio-ulnar and intercarpal joints, but a protuberant pre styloid recess, ventral to the articulates disc, is present and ascends adjacent to styloid process. The recess is bound distally by a fibro cartilaginous meniscus, projecting from the ulnar collateral ligament between the tip of ulnar styloid process and triquetral

The palmar radio carpal ligament, a broad membranous band is attached to the anterior margin of the distal end of radius and its styloid process, its fibres passing dorsomedially to anterior surface of scaphoid, lunate and triquetral bones, some reaching the capitate.

The palmar ulnocarpal ligament is rounded fasciculus which runs from the base of the styloid process of the ulna and anterior margin of the triangular articular disc of the distal radio-ulnar joint to the lunate and triquetral bones. The palmar ligaments of the wrist are perforated by apertures for the passage of vessels and are in relation, in front, with the tendons of the flexor digitorum profundus and flexor pollicis longus.

The dorsal radiocarpal ligament, the narrower and delicate as compared to palmar are attached, above to the posterior border for the distal end of the radius; its fibres are directed obliquely downwards and medially, and are secured below the dorsal surfaces of scaphoid, lunate and triquetral bones being continuous with the dorsal intercarpal ligaments. It lies behind, along with the extensor tendons of the wrist and fingers and the posterior interosseous nerve; in front, it is merged with articular disc of the inferior radio-ulnar articulation.

The ulnar collateral ligament is fixed to the end of the styloid process of the ulna which divides into two fasciculi, one is attached to the medial side of the triquetral, the other to the pisiform.

The radial collateral ligament encompasses from the tip of styloid process of the radius to the radial side of the scaphoid bone, some of the fibres being extends to the trapezium. The ligament is in relation with radial artery as it winds around the lateral side of the wrist separating the ligament from the tendons of adbuctor pollicis longus and extensor pollicis brevis. Both collateral ligaments are relatively poorly developed.

Blood Supply:

Chief arteries supplying the wrist are anterior interosseous artery, anterior and posterior carpal branches of radial artery, anterior and posterior carpal branches of ulnar arteries, palmar and dorsal metacarpal recurrent branches of the deep palmar arch.

Anatomic Relations of Median nerve:

The median nerve arises at the wrist from under the muscular belly of the flexor digitorum superficialis and progresses to lie beneath the index finger and lateral to the middle tendons to FDS. The artery of the medial nerve, a branch of the anterior interosseous artery, lies directly on the median nerve and serves as a landmark of nerve orientation. The median nerve lies on the anterior aspect of the distal radius, with pronator quadratus between the nerve and the bone. Distally, the nerve lies near the radio carpal joint capsule, before entering beneath the flexor retinaculum. It then enters into the carpal tunnel, keeping the same relationship with tendons and the synovial sheaths of the flexor tendons to divide into terminal branches as it emerges from the carpal tunnel. It sheath is surrounded by a net of sympathetic fibres going to the hand.

The Ulnar Nerve:

In the distal radius fractures, the ulnar nerve is less exposed to injury than the median nerve. It is not directly on the fracture line and not involved in compression syndromes in the carpal tunnel, being outside in the Guyon's canal. When distal radius fractures are associated with ulnar fractures or dorsal or palmar dislocation, then the ulnar nerve injury is more common.

The Sensory branch of the Radial Nerve:

The sensory portion of the radial nerve perforates the superficial aponeurosis behind the tendon of the brachioradialis and penetrates the wrist area before crossing this tendon. Just proximal to the distal radius of radius, the radial sensory nerve divides into three terminal branches; lateral, middle and medial. It runs lateral to the radial artery and just superficial to abductor pollicis longus and extensor pollicis brevis tendons.

A direct injury to the radial nerve is not uncommon at the time of distal radius fractures. In addition, it can be injured when reducing and stabilizing the fracture by pinning. Longitudinal incisions are necessary to carefully retract and preserve branches of the radial nerve. Percutaneous pinning should be avoided in these to prevent painful neuromas, which are difficult to cure.

Radiocarpal and intercarpal movements:

Movements of radiocarpal and intercarpal joints are regarded as a common mechanism performed by the same muscles. Flexion (palmar flexion)(Range 60°-65°),extension(dorsiflexion)(range 70°-75), adduction(ulnar deviation)(30- 35), adduction(radial deviation(range 20-25) and circumduction are the movements performed at .

In carpal flexion, radiocarpal and midcarpal joints are involved, the range being greater at midcarpal joint and in extension, the reverse occurs with more movement at radiocarpal joint. Hence the proximal surfaces spreads out more posteriorly over the lunate and scaphoid bones. These movements are restricted chiefly by the action of antagonist muscles; therefore the range of flexion in perceptibly reduced with flexion of fingers, owing to the increased tension in extensors.

Adduction of the hand is more than abduction owing to further proximal position of ulnar styloid process. Further adduction happens at the radiocarpal joint. The lunate articulates with together with radius and articular disc while the hand is in midposition, but in adduction lunate slips off the articular disc to articulate solely with the radius. Most of the proximal articular surface of a scaphoid turns subcapsular underneath the radial collateral ligament and develops a smooth convex palpable prominence in the floor of anatomical snuffbox.

Abduction occurs more or less completely at the midcarpal joint. While abducting capitate rotates round an anteroposterior axis so as to pass its head medially. The space between the lunate and apex of hamate is enlarged. The scaphoid rotates round a transverse axis, its proximal articular surface is withdrawn from the capsule and is now articulates only with the radius. Movements are limited by actions of antagonistic muscles and at extremes by the collateral carpal ligaments.

Distal radioulnar joint:

The distal radioulnar joint is a pivot or trochoid joint, in which the circular head of the ulnar articulates with the shallow sigmoid notch on the ulnar aspect of the distal radius. The radius rotates around ulna, but this movement is accompanied by translation, so that in supination, ulna is somewhat volar whole in pronation it is more dorsal relative to the radius.

Ligamentous anatomy of distal radioulnar joint has been more clearly defined in recent years. Triangular fibro-cartilage was thought for many years to be key element in maintaining integrity and stability of the joint. Kauer[55] 62was the first to challenge the traditional concept, demonstrating that this cartilage is only part pf extensive fibrous system origination from the distal end of the radius and extending to base of the fifth metacarpal. His concepts have been supported and expanded upon by independent studies by Bowers, Palmar and Werner[56]63. The TFCC incorporates the dorsal and volar radioulnar ligaments, the ulnar collateral ligaments, the meniscus homologue- articular disc, the sheath of extensor carpi ulnaris tendon and the ulno-lunate and ulnotriquetral ligaments. The complex originates from the ulnar aspect of lunate fossa of radius and inserts into fovea at base of ulnar styloid. It flows distally (joined by fibres arising from ulnar aspect of ulnar styloid) becomes thickened and inserts distally into lunate, triquetrem, hamate and base of 5^{th} metacarpal.

The portion of TFCC called the articular disc or triangular fibro cartilage arises from sigmoid notch of the radius and inserts into base of ulnar styloid. It is biconcave being thicker at the periphery and thinner at centre. Only the outer portion is vascular; the remainder is avascular, which suggest the tear in the central, avascular portion do not have potential to heal.

The functions of TFCC are to:

1) Provide a continuous gliding surface for flexion, extension and translation of carpus on forearm.
2) Impart stability to radioulnar joint to allow rotational movements of forearm.
3) Suspend the ulnar carpus from dorsal surface of radius
4) Cushion the forces transmitted through the ulnocarpal axis.
5) Solidly connect ulnar axis to volar carpus.

Complex disruption of radioulnar joint is a frequently accompanied by distal radius fracture. This necessitates restoration of full length of radius in distal radius fracture.

MUSCLES:

ANTERIOR ANTEBRACHIAL MUSCLES:

A) Superficial flexor group(attached to humerus)

Name of Muscle	Origin	Insertion	Nerve supply	Root Value	Action
Pronator teres a) Humoral head b) Ulnar head	Medial epicondyle of humerus Medial border of cornoid process of ulna	Lateral aspect of shaft of radius	Median nerve	C6,C7	Pronation and flexion of forearm
Flexor carpi radialis	Medial epicondyle of humerus	Bases of second and third metacarpal bones	Median nerve	C6,C7	Flexes and abducts at wrist joint
Palmaris longus	Medial epicondyle of humerus	Flexor retinaculum and palmar apneurosis	Median nerve	C7,C8	Flexes hand
Flexor carpi ulnaris A) Humeral head B) Ulnar head	Medial epicondyle of humerus Medial aspect of oleclenon process and posterior border of ulna	Pisiform bone, hook of hamate, Base of fifth metacarpal bone	Ulnar nerve	C8, T1	Flexes and abducts hand at wrist joint
Flexor digitorum superficialis a) Humeroulnar Head b) Radial head	Medial epicondyle of humerus; medial border of coronoid process of ulna Oblique line of anterior surface of shaft of radius	Middle phalynx of medial four fingers	Median nerve	C7, C8, T1	Flexes middle phalynx of fingers and supports in flexing proximal phalynx and hand

B) Deep flexor group(attached to radius and ulna)

Name of Muscle	Origin	Insertion	Nerve supply	Nerve roots	Action
Flexor pollicis longus	Anterior surface of shaft of radius	Distal phalynx of thumb	Anterior interosseous branch of median nerve	C8, T1	Flexes distal phalynx of thumb
Flexor digitorum profundus	Anteromedial surface of shaft of ulna	Distal phanlenges of medial four fingers	Ulnar(medial half) and median (lateral half) nerves	C8, T1	Flexes distal phalanx of fingers; then assists in flexion of middle and proximal phalynx
Pronator quadratus	Anterior surface of shaft of ulna	Anterior surface of shaft of radius	Anterior interosseous branch of median nerve	C8, T1	Pronates forearm.

The distal radio-ulnar joint is a complex joint involved in pronation, supination and ulnar carpal motion and support. The ulnar head, in a rolling sliding motion moves from dorsal to volar rim of the sigmoid notch as the joint moves from pronation to supination. The triangular fibrocartilage is taut first dorsally and then volarly in the same sequence.

Wrist function is dependent on integrity and alignment of the radius with its carpal and ulnar articulation[63]. Radiocarpal and medial midcarpal complex are suggested to be in form of a “Link Joint” like a bicycle chain. This is stable only when under tension and ‘On Center’ with links in line; unless strengthened by a ‘Stop’ device it buckles under longitudinal compression, especially when ‘Off Center’. But some advantages are inherent, since the range of movement at each unit is less than the total, articulator surfaces can be flatter than in a single joint of the same total range and are better adapted to pressure. Further overlying tissues are less disturbed by squeezing at the extremes of movement.

The carpus is envisaged in four functional units:

1. Trapezium
2. Scaphoid
3. Hamate, capitate and trapezoid
4. Triquetrum and lunate

In most manual positions, carpal bones are laxly packed and comparatively mobile. They convert into a rigid block only in complete extension (the snugly packed location for radiocarpal and most carpal joints). Snug packing is achieved in two stages

From flexion to extension, stages considered to occur are:

I. Initially the distal row(3)moves on proximal row(2&4) till hand and forearm are in the same line; hamate; capitate and trapezoid, and scaphoid coming into mutual tight pack to form a rigid mass(i.e. 2&3)
II. Later this mass moves upon the triquetrum and lunate, which moves at the radiocarpal joint till full extension is achieved, with tight packing of radiocarpal and carpal joints (i.e. except articulation of pisiform and trapezium). In this position adopted only for distinct effort, very large forces can be transmitted via the articular structures. A comparable position is often adopted to counteract falls on outstretched hand, and frequently results in supination fracture or distal radius fracture.

Ulnar variance:

There is a significant difference in the relative lengths of the 2 forearm bones as measured at the wrist. By convention an ulnar variance of 0 is one in which the distal cortical surface of the ulnar pole is level with the cortical surface of the most proximal aspect of lunate fossa on a perpendicular to longitudinal axis of forearm when the x-ray is taken with the wrist and forearm at neutral extension and deviation and with the x ray tube perpendicular to the plane of the radiocarpal joint. A minus variant indicates an ulna shorter and a plus an ulna longer then corresponding radius.

Stability:

Stability is provided by contour of joints, the surrounding ligaments and the overlying tendons. The incisura of sigmoid notch is shallow and provides a minimal constraint to subluxation of distal radio ulnar joints. The dorsal and volar radio ulnar ligaments at the perimeter of the TFCC provide the primary constraints to the distal radioulnar joint. In pronation the dorsal radioulnar ligament is under tension and in supination the volar radioulnar ligament is under tension. Paradoxically it is the volar radioulnar ligament that prevents dorsal subluxation of ulnar head if the dorsal radioulnar ligament is cut and vice versa. The dorsal and volar radioulnar ligaments provide only modest longitudinal stability allowing 5 mm of play between radius and ulna.

Avulsion of radio ulnar ligaments from either the radial or ulnar origins results in increased mobility of the ulnar head on the radius which may be perceived by ballottement test such as “piano key sign”. The distally anchored ulno carpal ligaments also provide some constraints to the ulnar head. The ligamentous continuation of the TFCC which includes the fibrous floor of the sixth dorsal compartment and the meniscal and styloid periosteal extension sometimes refers to as the ulnar collateral ligament also provides carpal stability. The dorsal retinaculum which is important to radiocarpal stability bypasses the ulnar head distally.

PATHOANATOMY

The type of fracture produced depends upon the position of the wrist at the time of injury the magnitude and direction of force and the physical properties of the bone.

The distal radius fracture is caused by a fall on the outstretched hand. When a person falls on to the outstretched hand, the prominent thenar eminence takes the brunt of force. The fractures of the lower end of radius occurs while the triangular fibrocartilage is still intact, therefore there is a rotary element with center of rotation at the ulnar styloid; the lower end of radius rotation in supination. If the forces continues, the ulnar styloid is avulsed. Therefore there can be a wide variety of displacements of lower end of radius, but basically six positions are recognized. These are impaction, lateral displacement, lateral rotation, dorsal displacement, dorsal rotation and supination. The brachioradialis is the only muscle inserts to the distal radius acts as a deforming force.

When a person falls on and outstretched hand, there is transmission of 80% axial load to distal radius and 20% axial load to distal ulna/TFCC. 90% of wrist injuries are caused by stress loading with wrist in dorsiflexion (fall onto outstretched). Wrist in 40d). Wrist in 40 -90 dorsiflexion produces distal radius fracture. Wrist in >90 dorsiflexion produces carpal injury. The palmar tensile force fails then dorsal compression force produces comminution of dorsal cortex.

Comminution of distal radial metaphysis is defined as 'involvement of >50% of the diameter of metaphysis as seen on any radiograph, communition of at least two cortices of metaphysis, or >2mm of shortening of radius.[56]63

Majority of distal radius fracture are extra articular, 60% associated with ulnar styloid fracture, 50% associated with TFCC tears, 12% associated with carpal fractures. Distal radius fractures that have a shear or compression component produce intra-articular fractures. Concomitant ligamentous injuries are therefore to be expected[63].in elderly extra articular metaphyseal fractures and in younger communited, intraarticular fractures are common.

The amount of force necessary to produce distal radius fracture varies in dorsiflexed wrist from 105-440 kg with mean of 195 kg for women and 282 kg for men.

Chauffer's fracture

Radial styloid fractures results from an avulsion force generated through palmar radio carpal ligaments.

Colle's fracture

Fall on outstretched hand; the prominent thenar eminence takes the brunt of the force. The fractures of lower end of the radius occurs while the TFCC is still intact, thus there is a rotatory element with the centre of rotation at the ulnar styloid, the lower end of the radius rotating into supination. If the force continues the ulnar styloid is avulsed. Six deformities occur-

1. Impaction
2. Lateral displacement

3. Lateral rotation
4. Dorsal displacement
5. Dorsal rotation
6. Supination

CLASSIFICATION:

Classification of distal radial fractures has largely occurred in the past two Hundred years. Fracture eponyms pay tribute to those who initiated the process: Pouteau, Colles, Barton, Goyrand, and Smith. Each described one or more Specific fractures that they characterized by clinical evaluation or laboratory dissection, without the aid of X-rays.

With this foundation, many investigators progressively contributed to the breadth and depth of understanding of distal radial fractures based on fracture attributes and severity each method of classification had its champions, who touted its strengths, but always there were critics which identified weaknesses as well.

Classification of Gartland

Group 1 Simple Colles' fracture

Group 2 Comminuted Colles' fracture with undisplaced intraarticular fragments

Group 3 Comminuted Colles' fracture with displaced intraarticular fragments. Classification of Frykman,

Groups 1 & 2- Extraarticular without and with fracture of the distal ulna,

Groups 3 & 4- Intraarticular involving the radiocarpal joint without and with fracture of the distal ulna, Groups 5 & 6- Intraarticular involving the distal radioulnar joint without and with fracture of the distal ulna,

Groups 7 & 8- Intraarticular involving both radiocarpal and distal radioulnar joints without and with fracture of the distal ulna[19]

Classification of Sarmiento,

Group 1- Non displaced fractures without radiocarpal joint involvement,

Group 2- Displaced fractures without radiocarpal joint involvement,

Group 3- Non displaced fractures with radiocarpal joint involvement,

Group 4- Displaced fractures with radiocarpal joint involvement

Classification AO.

Group 1 Extraarticular,

Group 2::Partial articular,

Group 3 Complete articular: C 1 simple articular and metaphyseal, C2 - simple articular and complex metaphyseal, C3 - Complex articular and complex metaphyseal + fracture distal end

Classification of Melone

Type 1 Minimal comminution, stable,

Ty.pe 2 Comminuted - Stable, displacement of medial complex:

Type 3 Displacement of medial complex as a unit + anterior spike,

Type 4 Wide separation or rotation of the dorsal fragment and palmar fragment rotation

Type 1 and 2: Reducible

Type 3: Percutaneous pinning or external fixation

Type 4: Open reduction

TREATMENT ALTERNATIVES AND RESULTS

Although anatomic reduction remains the goal, surgical techniques are evolving in an attempt to minimize postoperative stiffness, decrease surgical risk, and reduce the quantity of internal and external fixation hardware. Several treatment alternatives to closed reduction and casting are available; these include pins and plaster technique, closed reduction and percutaneous pinning, intrafocal pinning (Kapandji's method, closed reduction and external fixation, limited open reduction, and open reduction and internal fixation with or without bone grafting. Augmentation of the external fixation using percutaneous Kirschner (K) wires and arthroscopically assisted reduction of intraarticular fractures have been shown to be useful.

Conservative

Closed reduction and cast immobilization is still the mainstay of treatment for nondisplaced, stable fractures. This fracture type is characterized by minimal radial metaphyseal communition, minimal or no loss of height, and no substantial displacement or angulation. A well-padded splint with the wrist in neutral position, the metacarpophalangeal joints completely unobstructed, and the overlying wrap loosely approximated provides adequate immobilization of a truly stable and nondisplaced fracture, without contributing to hand swelling and stiffness. In an attempt to prevent displacement of the reduced fracture during immobilization in a splint or plaster cast, placement of the wrist in the position of acute flexion, extreme pronation, and ulnar deviation (the Cotton-Loader position) has been used in the past. Excessive wrist flexion compromises the carpal tunnel and interferes with normal function of the flexor tendon. This position is no longer popular because of the problems encountered with median nerve compression and stiffness of the fingers and wrist. The pins-and-plaster technique of external fixation was first introduced by Bohler in 1929. Pins are placed at sites that are distal and proximal to the fracture and are then held in place externally with a plaster overwrap. Although appealing in concept, it is often difficult in practice. Application of the plaster around the pins may prolong the procedure sufficiently to prevent adequate moulding of the cast. Subsequent dorsal redisplacement and angulation of the distal fragment has been one reason that the pins-and-plaster technique is now infrequently used

Operative Treatment

Surgical management is recommended for difficult fractures because it offers the potential to minimize residual deformity and loss of function[11]

In addition, surgical management is a more reliable method of reduction for significantly displaced intraarticular fractures and, thus, should decrease the risk of posttraumatic arthritis.

Closed Reduction and Intrafocal Pinning (Kapandji's Technique)

Intrafocal pinning originally was described in 1976 by Kapandji and has been used widely in Europe. Essentially a variation of percutaneous pinning, the technique consists of limited open placement of buttressing K wires. The original indication was an unstable extraarticular fracture in a young adult; however, the indications have been extended to include elderly patients and intraarticular fractures with minimal displacement. Contraindications are significant intraarticular involvement, volar comminution, advanced osteopenia, and the inability to achieve a satisfactory reduction by closed manipulation before pinning. The current technique uses three 0.062-inch K wires inserted through small incisions directly over the fracture between the first and second, the third and fourth, and the fourth and fifth dorsal wrist compartments.

Pins initially are inserted directly into and parallel to the fracture and then are directed 45degree obliquely and proximally to engage the opposite cortex. This manoeuvre reduces the fracture additionally and provides a buttress for the distal fragment. Although no cast immobilization was used in the original description, a cast now is used commonly for 6 weeks. Several series from Europe have shown good results using this method. A recent report from the United States using Kapandji's technique in 23 patients claimed good and excellent radiographic results in 79% of patients younger than 65 years of age and 100% of those older than 65 years of age. The technique seems to offer many advantages for simple to moderately difficult fractures that cannot be managed by cast treatment alone.

Closed Reduction and External Fixation

External fixation devices are an excellent means of overcoming the displacing forces of the forearm muscles that can pull communited distal radial fractures into a collapsed, shortened position. With severe communition of the metaphysis, the reconstructed articular surface cannot be stabilized to the shaft of the radius. An external fixator can provide the stability when both volar and dorsal cortices are comminuted.[12 13] External fixation is a valuable instrument for fracture reduction and stabilization. Limited open incisions, early range of motion, and treatment of complex wounds are few of the benefits of external fixation.[14 23]There has been a constant evolution in technique and device design since the original idea of maintaining skeletal traction 'with an external frame was described, in 1944, by Anderson and O'Neil. Much has been learned and improved upon since then. The initial practices of excessive distraction, positioning of the wrist in extreme flexion and ulnar deviation, and long period of wrist immobilization (over eight weeks) created frequent problems with postoperative pain, wrist and hand stiffness, disuse atropy, nonunion and reflex. Sympathetic dystrophy. Experience and an understanding of the involved physiologic and biomechanical principles allowed these complications to be minimized. The realization that ligamentotaxis does not always accomplish anatomic reduction of all intra-articular and extra-articular fracture components spurred the development of new techniques and improvements in devices. In the case of unstable fracture fragments, the addition of percutaneous pinning or internal fixation techniques allowed for external fixation with only moderate distraction to prevent metaphyseal shortening and to neutralize the extensor and flexor forces across the fracture site. The need for positioning the wrist in extreme flexion and ulnar deviation to provide reduction also was diminished or eliminated. The wrist may initially be over distracted to aid in reduction, but it must subsequently be decreased to an acceptable amount following fixation.

A large variety of devices are available for external fixation of fractures of the distal aspect of the radius. All involve distraction across the wrist joint with placement of pins in the radius and the metacarpals. Newer external fixation devices are lighter, easier to assemble and implant, adjustable once the device is secured, and they are radiolucent.

The deduction and observation that longitudinal distraction alone cannot restore palmar tilt has led to improvements in devices and their application. Palmar translation in addition to longitudinal distraction can often restore the palmar tilt as well as maintain radial height. The ability to position and adjust the amount of palmar translation across the fracture site with use of more sophisticated external fixation devices provides improved reduction and allows the wrist to be placed in the optimal physiologic position of extension:

External Fixation with Distraction and Bone Grafting

Shows excellent results. The indications included fractures with comminution, displacement, and intraarticular involvement. Distraction with external fixation is used to achieve and maintain extraarticular reduction by ligamentotaxis. A dorsal incision is made over the fracture site, and iliac crest graft pushed into the fracture. The contour of the carpal surface serves as a mould to realign the articular surface.

Arthroscopic Assisted Reduction

Percutaneous and limited open reduction techniques combined with wrist arthroscopy in the management of displaced distal radial fractures has been described recently by Geissler and Freeland. They showed that wrist arthroscopy provides an excellent view for restoration of the articular surface with minimal soft tissue dissection. Twenty-five of 33 patients with various fracture patterns had an anatomic articular reduction. Wrist arthroscopy also allowed for- detection of a wide spectrum of carpal interosseous ligament tears and osteochondral loose bodies.[25]

Open Reduction and Internal Fixation

Open reduction and internal fixation using a wider exposure is indicated for communited intraarticular fractures and shear fractures, such as volar Barton's fractures. These types of fractures cannot be reduced by ligamentotaxis and are more unstable after reduction. Bone - grafting, various types of hardware, and external fixation should be considered. The main objectives are to reduce the articular surface and to neutralize the forces that cause displacement during fracture healing. However, indiscriminate use of hardware will increase the risk of complications.

New Alternatives

Various new techniques have been described recently for the treatment of distal radial fractures.

Micronail[15]

With the advent of this new device, a decrease in soft tissue complication is expected. The implant utilizes the principles of load sharing, subchondral screw divergence, and locked fixed-angle fixation. It is inserted through a small skin incision at the radial styloid and does not further devascularize the fracture fragments. The limited surgical dissection and rigid fracture fixation allow for minimal postoperative immobilization and an early return of function.

Combined Internal and External Fixation

Blair et al reported on combined internal and external fixation for the treatment of 10 AO-C3 fractures of the distal radius with an average follow-up of 5 years. They showed that this surgical strategy can produce predictably satisfactory 26 results in a specific subset of complex and very difficult to treat intraarticular distal radial fractures.

In Situ Screw Placement

Persoons and Wagner reported on an original method allowing immediate fracture stability using a specially designed peg screw. The screw has a conical design to reduce the bone gap in the posterior cortex, and a polished head to avoid tearing the extensor tendon. The peg screw must be introduced in the fracture site dorsally toward the anterior cortical fracture. In a series of 50 patients treated consecutively Persoons and Wagner obtained a high rate of satisfactory results.

METHODOLOGY

The present study was carried out from 1ST December 2015 to 31ST January 2017 at Orthopaedic Department in Shri B. M. Patil Medical College Hospital and Research Center, Vijayapur. During this period 100 patients of intraarticular communited distal end radius fractures were treated surgically.

INCLUSION CRITERIA

1. Patient aged 18 years and above.
2. Intraarticular fractures of distal radius.
3. Communited fractures of distal radius.
4. Open fractures of distal radius.
5. Patients willing for treatment and giving informed and written consent.

EXCLUSION CRITERIA

1. Patients below the age of 18 years.
2. Pathological fractures.
3. Neurovascular deficit

General information like name, age, sex, occupation and address were noted. Then a detailed history was elicited regarding mode of injury like Road traffic accident, direct injury to shoulder and fall on outstretched hand. Enquiry was made to note site of pain and swelling over the affected wrist. Past medical illness and family history were also recorded.

General condition of the patients was examined for pallor, pulse rate and blood pressure. Respiratory and cardio vascular system were examined for any abnormalities.

Local examination was done in the following steps:

1. **On inspection the following points were noted:**

   Patients with fracture distal radius often support the flexed elbow of the injured side with the other hand. Abnormal swelling was present the distal forearm and wrist. The condition of the skin over the wrist was noted for any abrasion, laceration and contusion.

2. **On palpation the following points were noted:**

   Palpation of the affected wrist for tenderness. The fractured radius was also palpated for any abnormal mobility and crepitus.

3. **Movements:**

   - The movements of the affected side wrist were restricted due to pain.
   - The distal neurovascular status of the affected upper limb was examined and also the associated injuries along with fractured radius were noted.
   - Plain radiograph of wrist in anteroposterior view was taken to assess the site of fracture and the fracture type (displacement and comminution). The fractures were classified according to Frykman's classification.
   - The affected upper limb was immobilized by below elbow slab supported by arm sling.

- Routine investigation like Hb%, Total count, Differential count, ESR, Blood urea, Sugar, Serum creatinine and ECG were done. HBsAg and HIV test were done before surgery on all patients.
- All patients were operated as early as possible once the general condition of the patients were stable and the patients were fit for surgery as assessed by the physician.

Preoperative preparation of patients:

- Patients were kept fasting for 6 hours before surgery.
- A written informed consent for surgery was taken.
- The wrist and forearm prepared. Tranquilizers were given as advised by the anesthetist.
- A systemic antibiotics usually Inj. Ceftriaxone Sulbactum 1.5gm intravenously were administered 30 minutes before surgery to all patients.
- Patients were operated under brachial block/ general anesthesia.

Statistical analysis

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean, standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries. Chi-square (χ^2)/ Freeman-Halton Fisher exact test was employed to determine the significance of differences between groups for categorical data. f the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analysed using SPSS software v.23.0. and Microsoft office.

Figure 1 : Instuments

INSTRUMENTS

1) 2.5mm 3.5mm Schanz pin
2) Connecting rod with/ without distractor
3) Connecting clamps
4) Hand drill/ pneumatic drill/ power drill
5) 1.8mm, 2mm K wire
6) General instruments like scalpel, artery forceps, towel clips.

SURGICAL TECHNIQUE

i. Patient in supine position affected limb over side table. Upper limb from elbow to hand were prepared and draped.

ii. About 1 cm incision was made just dorsal to midline, 8-10cm proximal to wrist.

iii. Two 3.5-mm half-pins, 1 cm apart at a 30-degree angle dorsal to the frontal plane of the forearm were inserted. The pins should perforate the medial cortex of the radius confirmed with fluoroscopy.

iv. A 2- to 3-cm incision over the dorsoradial aspect of the index metacarpal base and use blunt dissection with scissors to expose the metacarpal.

v. 2.5-mm self-tapping half-pins at a 30- to 45-degree angle dorsal to the frontal plane of the hand and forearm were inserted and confirmed by fluoroscopy.

vi. Reduction was achieved by traction and manipulation, confirmed by fluoroscopy.

vii. Schanz pins were connected with clamps and connecting rods.

viii. Wound irrigation was done and skin sutures were applied.

OPERATIVE PHOTOGRAPHS

Figure 2 : Placement of proximal 3.5mm Schanz pins

Figure 3 : Placement of distal 2.5mm Schanz pins

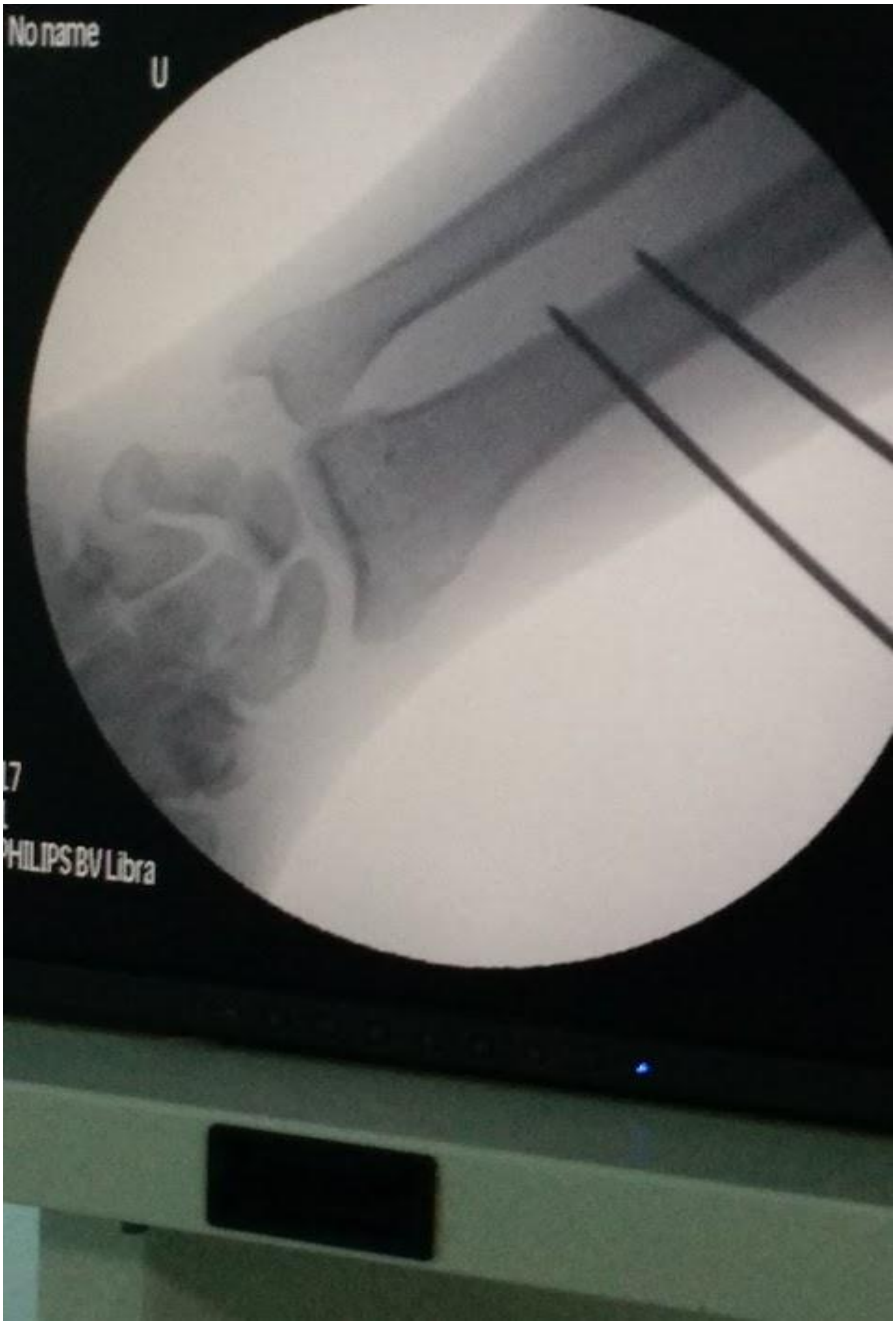


Figure 4 : Reduction confirmed in AP views

Figure 4.1 : Reduction confirmed in LATERAL views

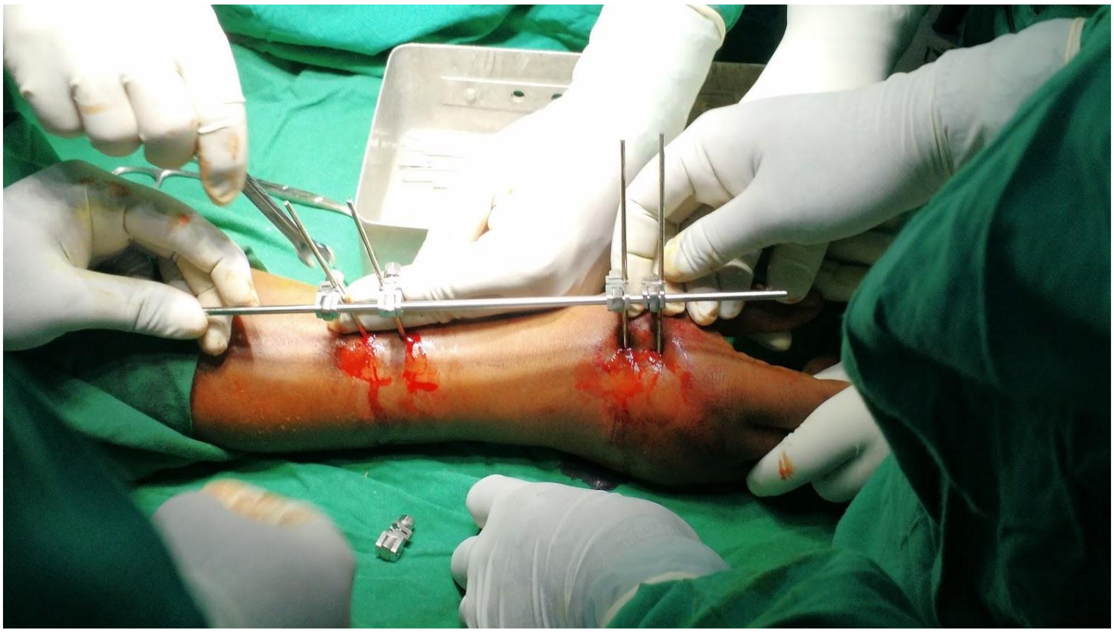


Figure 5 : Schanzs pins connected by clamps and connecting rod.

Post-Operative care:

Patients were kept nil orally for 4 to 6 hours post-operatively. Intravenous fluids were given as needed.

Antibiotics were continued for 10 days.

Analgesics and tranquilizers were given according to the needs of the patient.

The operated upper limb was immobilized in an arm pouch.

Check X- rays were taken to study the alignment of fracture fragments.

The wound was inspected at 2nd postoperative day.

Suture removal was done on 10th postoperative day. Patients were discharged with the arm sling. Rehabilitation of the affected wrist was started at the end of 2 weeks. Grip strength exercises were started. At 6 weeks gentle active range of motion of the wrist was allowed. At 6 to 8 weeks active range of motion in all planes were allowed.

Follow up:

- Regular follow up for every 6 weeks, 3 months and 6 months was done.
- Local examination of the affected wrist for tenderness, instability deformity and wrist movements were assessed.
- X-rays were taken at each follow up visits to known about progressive fracture union and pin position.
- Rehabilitation of the affected extremity were done according to the stage of fracture union and time duration from day of surgery.
- Patients were followed up till radiological union.
- The functional outcome were assessed by Modified Demerit Point System of Gartland and Werley.

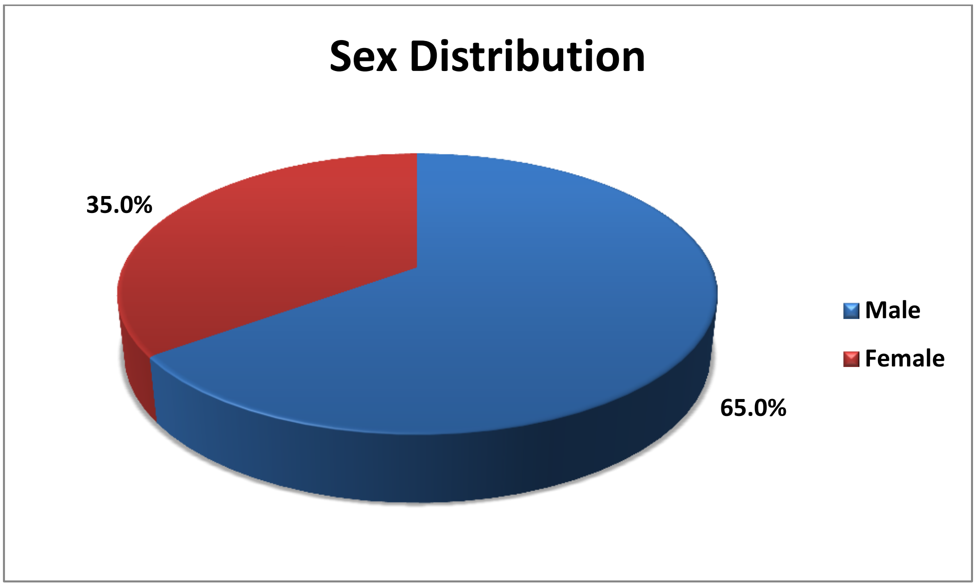
RESULTS

Following table shows the distribution of cases by gender. The increased incidence of male sex in distal end radius can be attributed to an over whelming large proportion of male patients, because in our Indian setup, the female population largely work indoors or in the agricultural fields.

Table 1 : Distribution of cases by sex

Sex	N	Percent
Male	65	65.0
Female	35	35.0
Total	100	100.0

Graph 1 : Distribution of cases by sex



The following table shows distribution of fractures according to age. In our series, the majority of the patients are found to be between the age group of 41-50 years (26) and 51-60 years (18). Mean age was 41.3 years

Table 2 : Distribution of cases by Age

Age (Yrs)	N	Percent
18-20	14	14.0
21-30	16	16.0
31-40	16	16.0
41-50	26	26.0
51-60	18	18.0
>60	10	10.0
Total	100	100.0

Graph 2 : Distribution of cases by Age

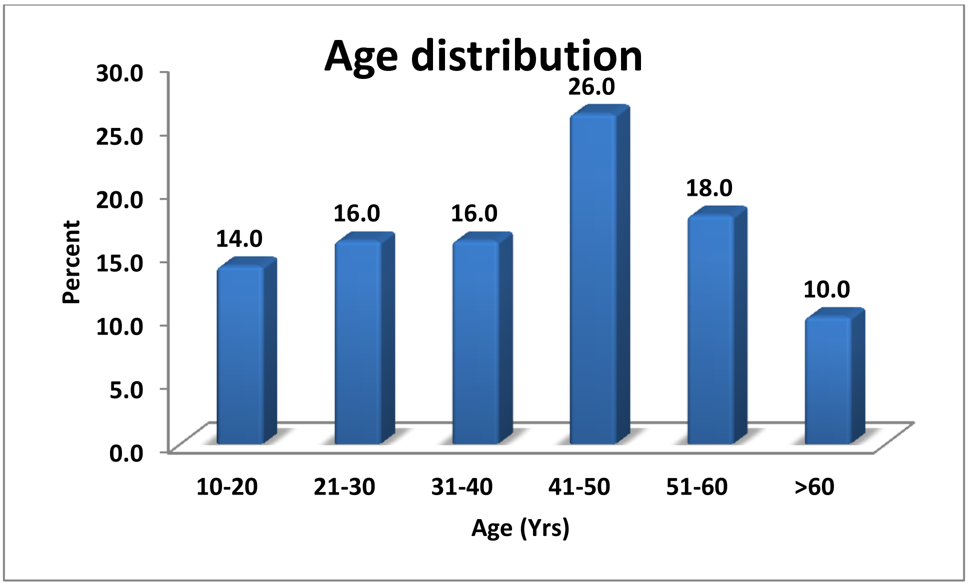


Table 3 : Mean Age of cases

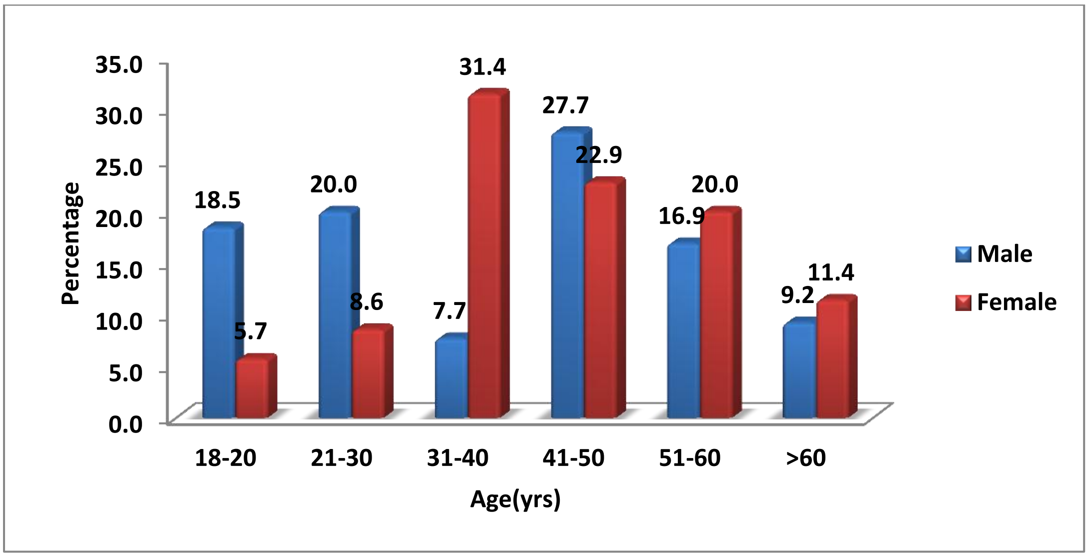
	Minimum	Maximum	Mean	SD
Age (Yrs)	18	74	41.3	15.4

Table 4: Distribution of Age by sex

Age (Yrs)	Male		Female		Total		p value
	N	%	N	%	N	%	
18-20	12	18.5	2	5.7	14	14.0	0.024*
21-30	13	20.0	3	8.6	16	16.0	
31-40	5	7.7	11	31.4	16	16.0	
41-50	18	27.7	8	22.9	26	26.0	
51-60	11	16.9	7	20.0	18	18.0	
>60	6	9.2	4	11.4	10	10.0	
Total	65	100.0	35	100.0	100	100.0	

Note:*significantly distributed at 5% level of significance

Graph 3 : Distribution of Age by sex

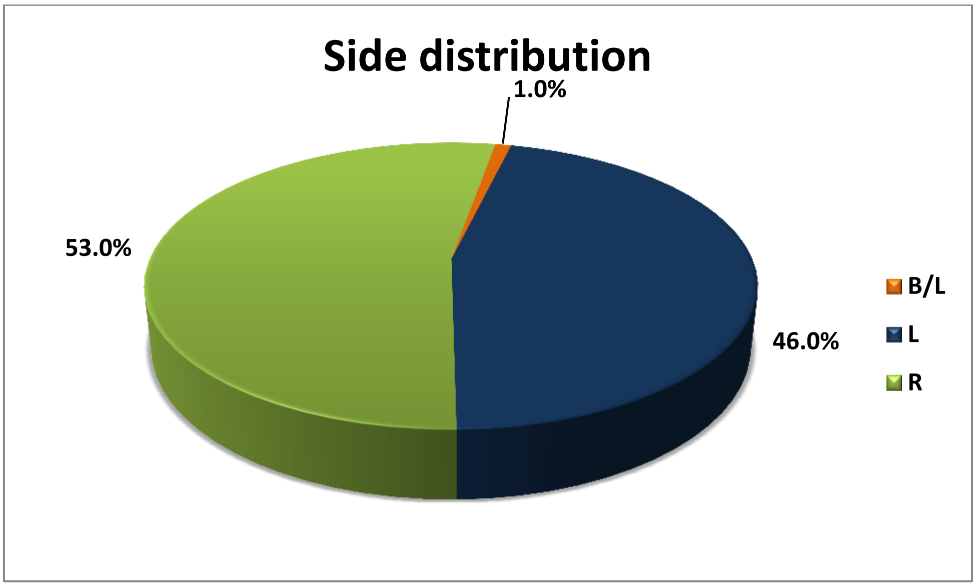


The following table shows distribution by side. 53% of dominant hand was involved in this study.

Table 5 : Distribution of cases by Side

Side	N	Percent
B/L	1	1.0
L	46	46.0
R	53	53.0
Total	100	100.0

Graph 4 : Distribution of cases by Side

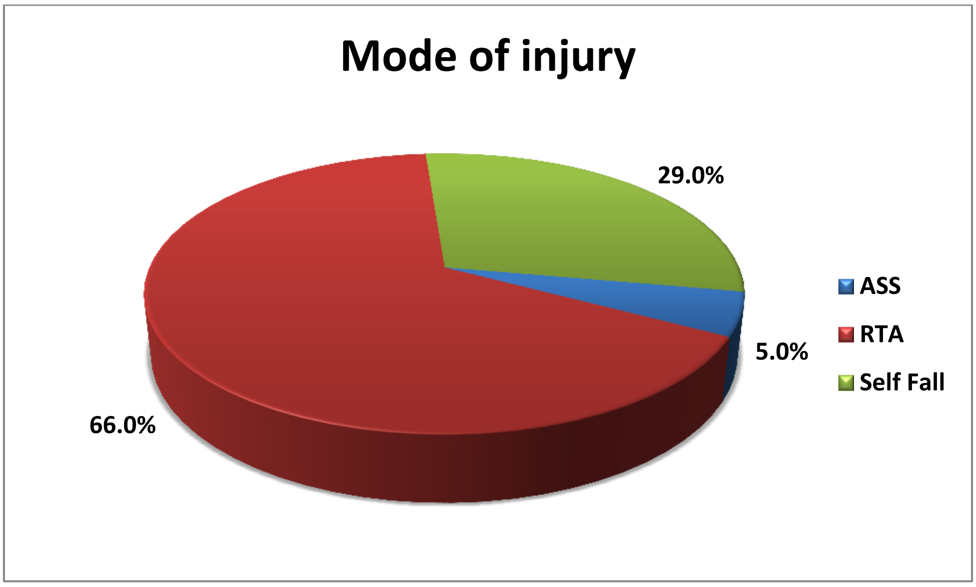


The following table shows distribution according to mode of injury. Majority of cases in our study attributed to Road Traffic Accidents(66%). It is also worthwhile to note that most of fractures were seen in young active individuals were pertaining due to road traffic accidents while in age group above 50 years were due to self-fall experienced at home.

Table 5 : Distribution of cases by Mode of injury

Mode of injury	N	Percent
ASS	5	5.0
RTA	66	66.0
Self-Fall	29	29.0
Total	100	100.0

Graph 5 : Distribution of cases by Mode of injury

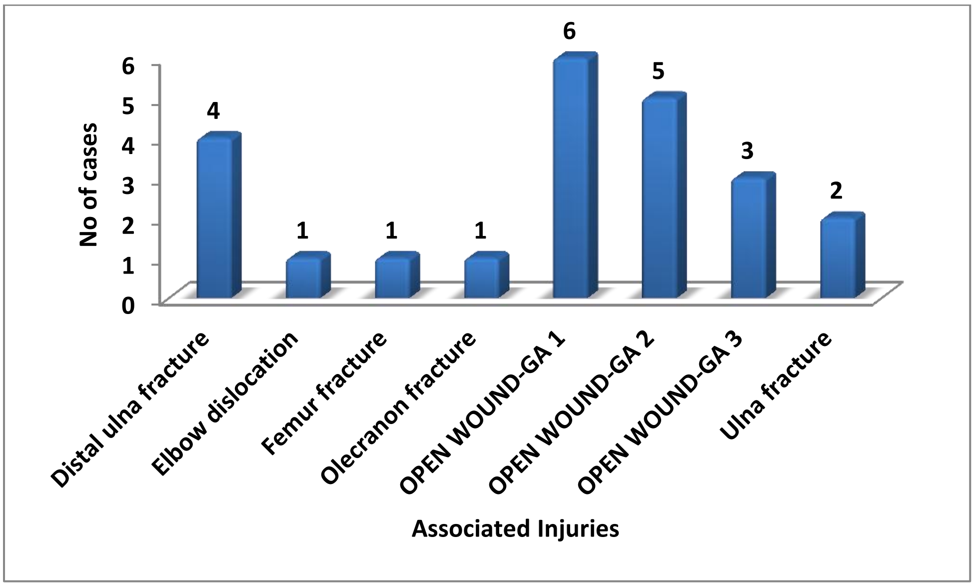


Following table shows associated injuries in our study. Total 9% associated injuries were noted.

Table 7 : Distribution of cases by Associated Injury

Associated Injury	N	Percent
Distal ulna fracture	4	17.39
Elbow dislocation	1	4.34
Femur fracture	1	4.34
Olecranon fracture	1	4.34
OPEN WOUND-GA 1	6	26.08
OPEN WOUND-GA 2	5	21.73
OPEN WOUND-GA 3	3	13.04
Ulna fracture	2	8.69
Total	23	100.0

Graph 6 : Distribution of cases by Associated Injury

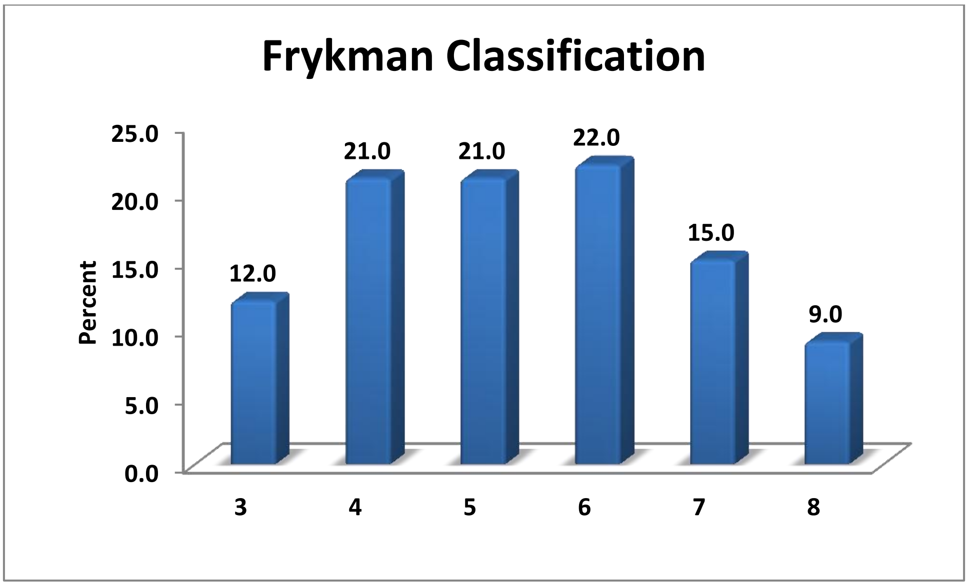


Following table shows distribution of cases according to Frykman Classification. Majority of cases were of Frykman 5 and 6(43%) and the least being Frykman 8 (9%). The type fracture depends upon mode of injury, age of patient and quality of bone.

Table 8 : Distribution of cases by Frykman Classification

Frykman Classification	N	Percent
3	12	12.0
4	21	21.0
5	21	21.0
6	22	22.0
7	15	15.0
8	9	9.0
Total	100	100.0

Graph 7 : Distribution of cases by Frykman Classification



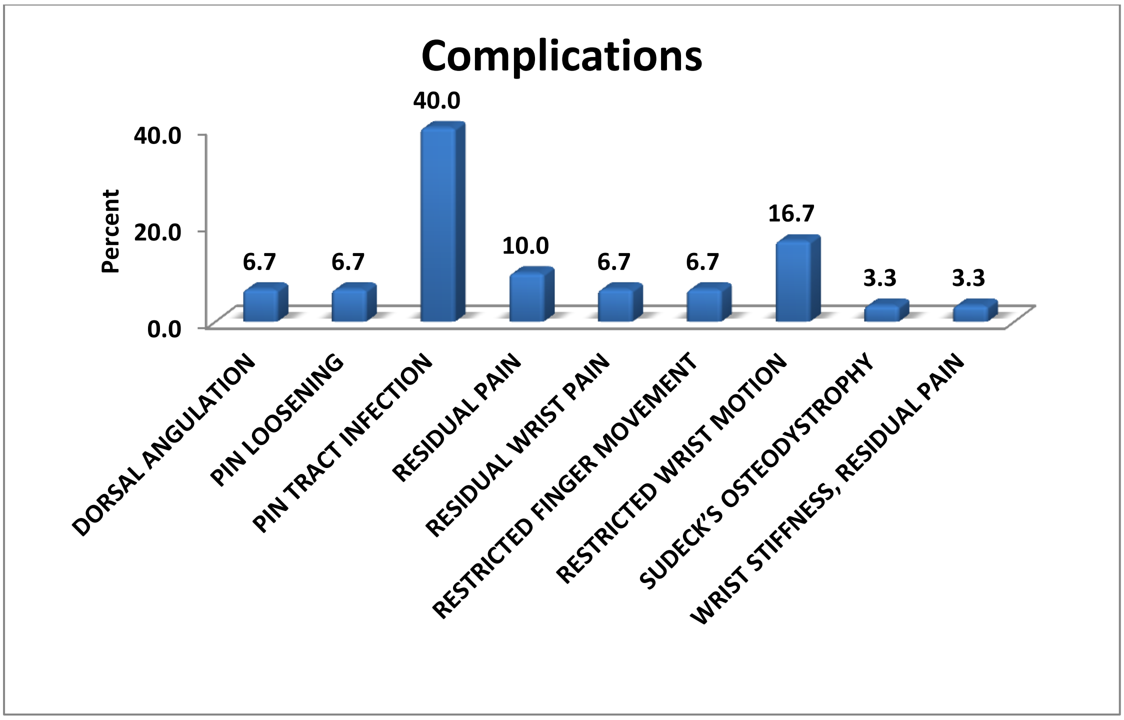
The following table shows the incidence of complications during our study

Table 9 : Distribution of cases by Complication

Complication	**N**	**Percent**
DORSAL ANGULATION	2	6.7
PIN LOOSENING	2	6.7
PIN TRACT INFECTION	12	40.0
RESIDUAL PAIN	3	10.0
RESIDUAL WRIST PAIN	2	6.7
RESTRICTED FINGER MOVEMENT	2	6.7
RESTRICTED WRIST MOTION	5	16.7
SUDECK'S OSTEODYSTROPHY	1	3.3
WRIST STIFFNESS, RESIDUAL PAIN	1	3.3
Total	30	100.0

2 patients had malunion with some degree of residual dorsal angulation however it did not have a significant effect on functional outcome. 2 patients had pin loosening which resolved without any intervention. 12 patients suffered from pin tract infection and superficial infection which was treated by regular dressing. 5 patients had residual wrist pain after 2 months after external fixator removal which was treated with analgesics and resolved by 6 months. 5 patients had restricted wrist motion 2 months after external fixation removal which was treated with aggressive physiotherapy and analgesics and was resolved with 1 month of physiotherapy.

Graph 8 : Distribution of cases by Complication

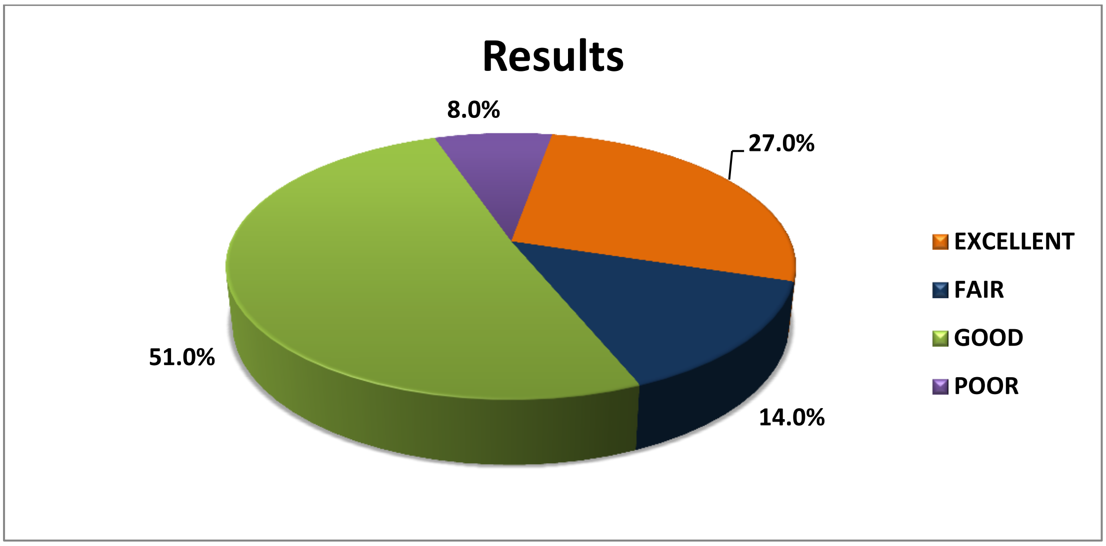


The following table shows final results according to Demerit system of Gartland and Werley. We found 78% Excellent to Good results. 14 patients had Fair results while 8 patients had Poor results.

Table 10 : Distribution of cases by Result

Result	N	Percent
EXCELLENT	27	65.0
FAIR	14	12.0
GOOD	51	17.0
POOR	8	6.0
Total	100	100.0

Graph 9 : Distribution of cases by Result



The following table shows the time period required for achieving union.

Table 11 : Distribution of cases by Period for union (weeks)

Period for union (weeks)	N	Percent
5	2	2.0
6	60	60.0
7	11	11.0
8	22	22.0
9	3	3.0
10	2	2.0
Total	100	100.0

Graph 10 : Distribution of cases by Period for union (wks)

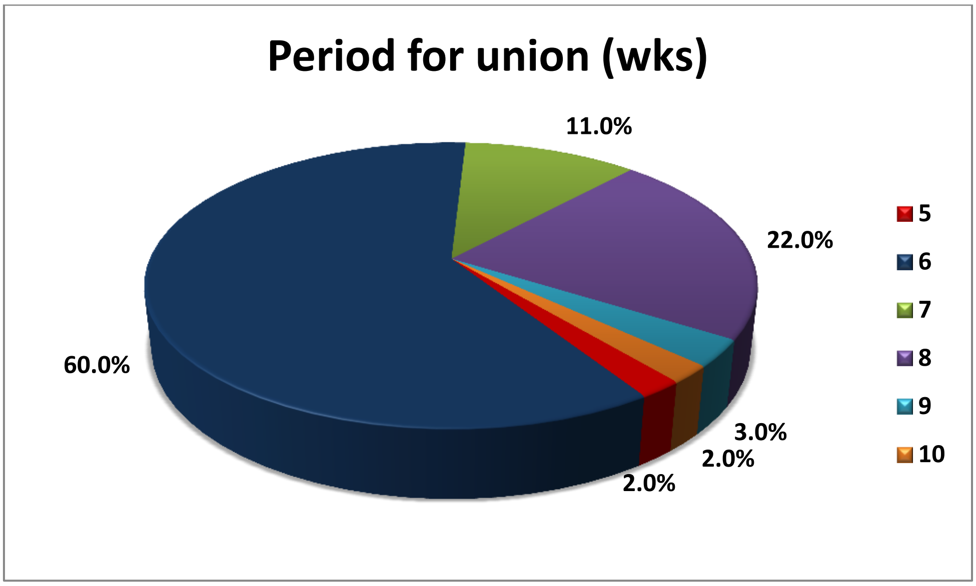


Table 12 : Distribution of Side by Frykman Classification

Frykman Classification	3-4		5-6		7-8		Total		p value
Side	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
B/L	0	0.0	0	0.0	1	4.3	1	1.0	0.444
L	16	48.5	21	47.7	9	39.1	46	46.0	
R	17	51.5	23	52.3	13	56.5	53	53.0	
Total	33	100.0	44	100.0	23	100.0	100	100.0	

Graph 11 : Distribution of Side by Frykman Classification

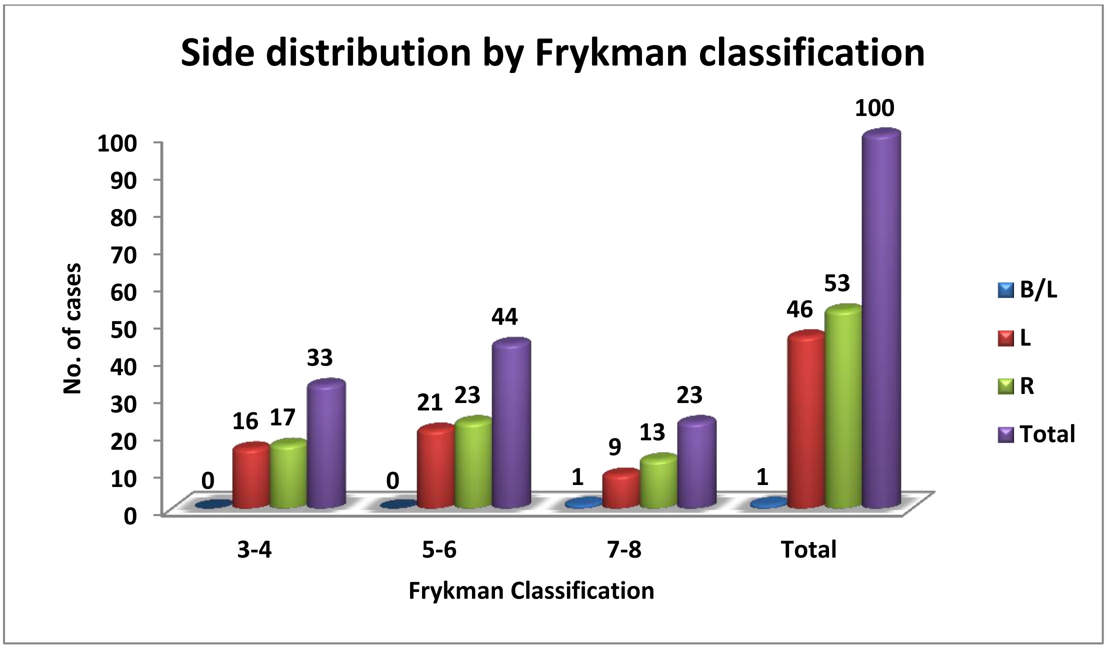
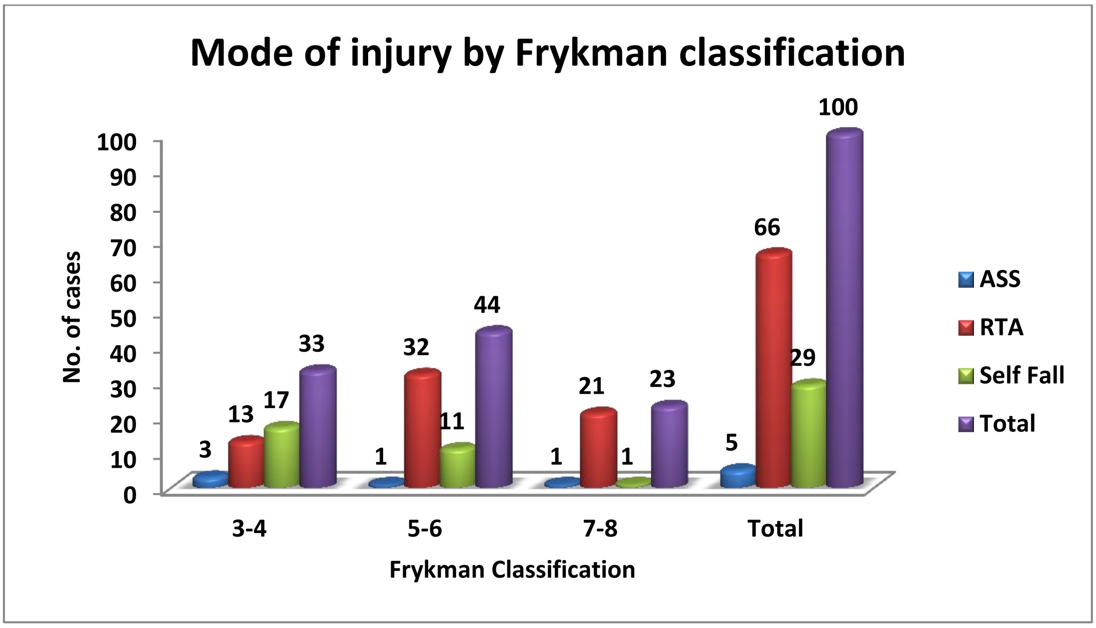


Table 13 : Distribution of mode of injury by Frykman Classification

Frykman Classification	3-4		5-6		7-8		Total		p value
Mode of injury	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
ASS	3	9.1	1	2.3	1	4.3	5	5.0	0.001*
RTA	13	39.4	32	72.7	21	91.3	66	66.0	
Self Fall	17	51.5	11	25.0	1	4.3	29	29.0	
Total	33	100.0	44	100.0	23	100.0	100	100.0	

Note:*significantly distributed at 5% level of significance

Graph 12 : Distribution of mode of injury by Frykman Classification



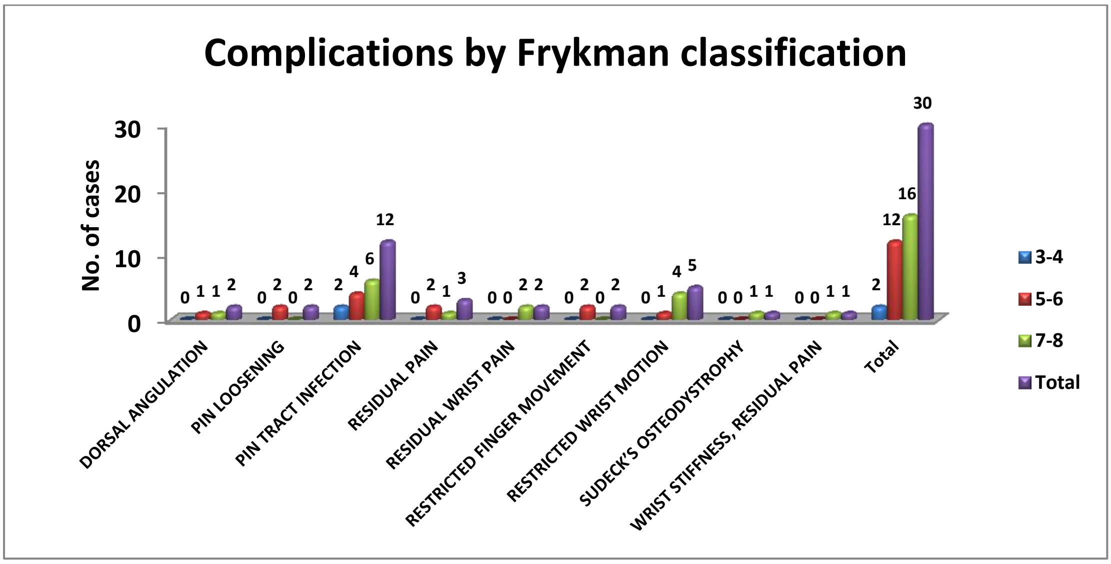
The association of Frykman Classification has been illustrated in the table and graph above. It has been noted that majority of patients with Frykman 3-4 were attributed to self-fall while more severe fractures Frykman type 5-6 7-8 were attributed to Road Traffic Accidents.

Table 14 : Distribution of Complications by Frykman Classification

Frykman Classification	3-4		5-6		7-8		Total		p value
Complication	N	%	N	%	N	%	N	%	
DORSAL ANGULATION	0	0.0	1	8.3	1	6.3	2	6.7	<0.001*
PIN LOOSENING	0	0.0	2	16.7	0	0.0	2	6.7	
PIN TRACT INFECTION	2	100.0	4	33.3	6	37.5	12	40.0	
RESIDUAL PAIN	0	0.0	2	16.7	1	6.3	3	10.0	
RESIDUAL WRIST PAIN	0	0.0	0	0.0	2	12.5	2	6.7	
RESTRICTED FINGER MOVEMENT	0	0.0	2	16.7	0	0.0	2	6.7	
RESTRICTED WRIST MOTION	0	0.0	1	8.3	4	25.0	5	16.7	
SUDECK'S OSTEODYSTROPHY	0	0.0	0	0.0	1	6.3	1	3.3	
WRIST STIFFNESS, RESIDUAL PAIN	0	0.0	0	0.0	1	6.3	1	3.3	
Total	2	100.0	12	100.0	16	100.0	30	100.0	

Note:*significantly distributed at 5% level of significance

Graph 13 : Distribution of Complications by Frykman Classification



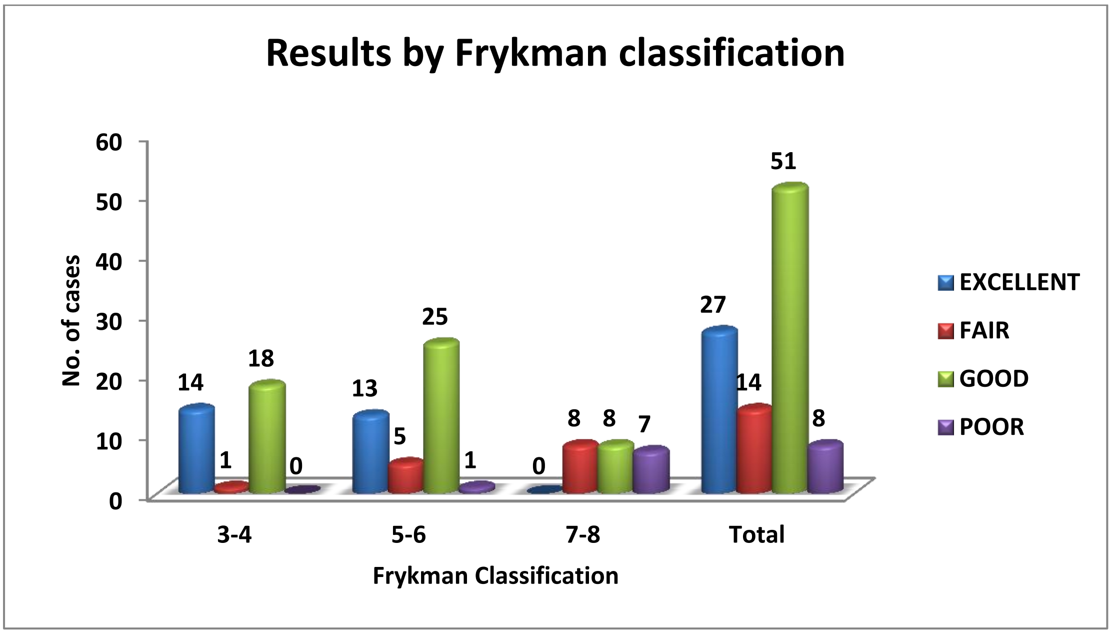
Most common complication seen in our study were Pin Tract Infection (12%) and Restricted Wrist Motion (5%). It was also noted that as the severity of fracture increased, so did the rate of complications. So while fractures with Frykman 3-4 had 2% complications and Frykman 7-8 had complications in 16 cases.

Table 15 : Distribution of Result by Frykman Classification

Frykman Classification	3-4		5-6		7-8		Total		p value
Result	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
EXCELLENT	14	42.4	13	29.5	0	0.0	27	27.0	<0.001 *
FAIR	1	3.0	5	11.4	8	34.8	14	14.0	
GOOD	18	54.5	25	56.8	8	34.8	51	51.0	
POOR	0	0.0	1	2.3	7	30.4	8	8.0	
Total	33	100.0	44	100.0	23	100.0	100	100.0	

Note:*significantly distributed at 5% level of significance

Graph 14 : Distribution of Result by Frykman Classification



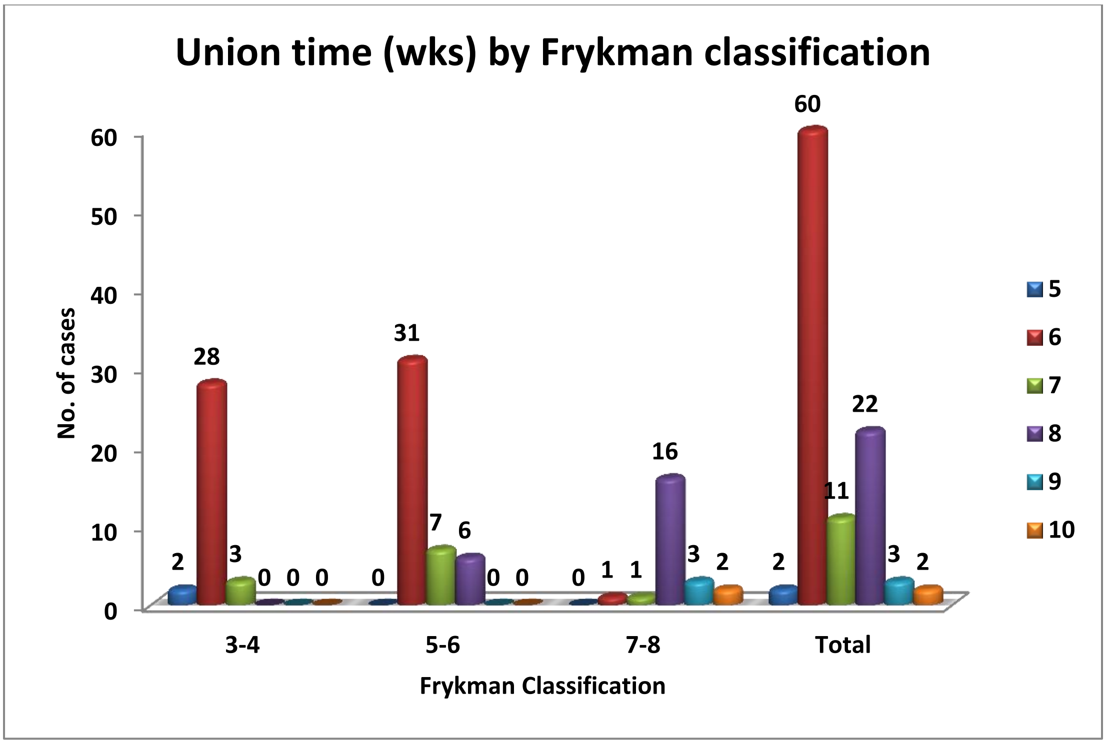
Distribution of results has been illustrated in the following table and graph. While Frykman 3-4 and 4-5 had better functional outcome with Excellent to Good Results observed in 97% and 87.3% respectively while Frykman 7-8 had Excellent to Good results observed in 34.5% of cases. While there were no Poor results seen in patients with Frykman 3-4 fractures, patients with Frykman 5-6 had 1 case (2.3%) and Frykman 7-8 had 7 cases(30.4%) with Poor Results

Table 16 : Distribution of Period for union (wks) by Frykman Classification

Frykman Classification	3-4		5-6		7-8		Total		p value
Period for union (wks)	N	%	N	%	N	%	N	%	
5	2	6.1	0	0.0	0	0.0	2	2.0	<0.001 *
6	28	84.8	31	70.5	1	4.3	60	60.0	
7	3	9.1	7	15.9	1	4.3	11	11.0	
8	0	0.0	6	13.6	16	69.6	22	22.0	
9	0	0.0	0	0.0	3	13.0	3	3.0	
10	0	0.0	0	0.0	2	8.7	2	2.0	
Total	33	100.0	44	100.0	23	100.0	100	100.0	

Note:*significantly distributed at 5% level of significance

Graph 15 : Distribution of Period for union (wks) by Frykman Classification



The distribution of period of union observed according to Frykman Classification is shown. While patients with Frykman 3-4(84.8%) and Frykman 5-6(70.5%) had union in 6 weeks, patients with Frykman 7-8 fractures had average time of union of 8 weeks(69.6%)

CASE 1

Figure 6.1 : PREOPERATIVE XRAY

Figure 6.2 : POST-OPERATIVE X RAY

Figure 6.3 : ONE MONTH FOLLOW UP XRAY

Figure 6.4 : FOLLOW UP AT 6 MONTHS

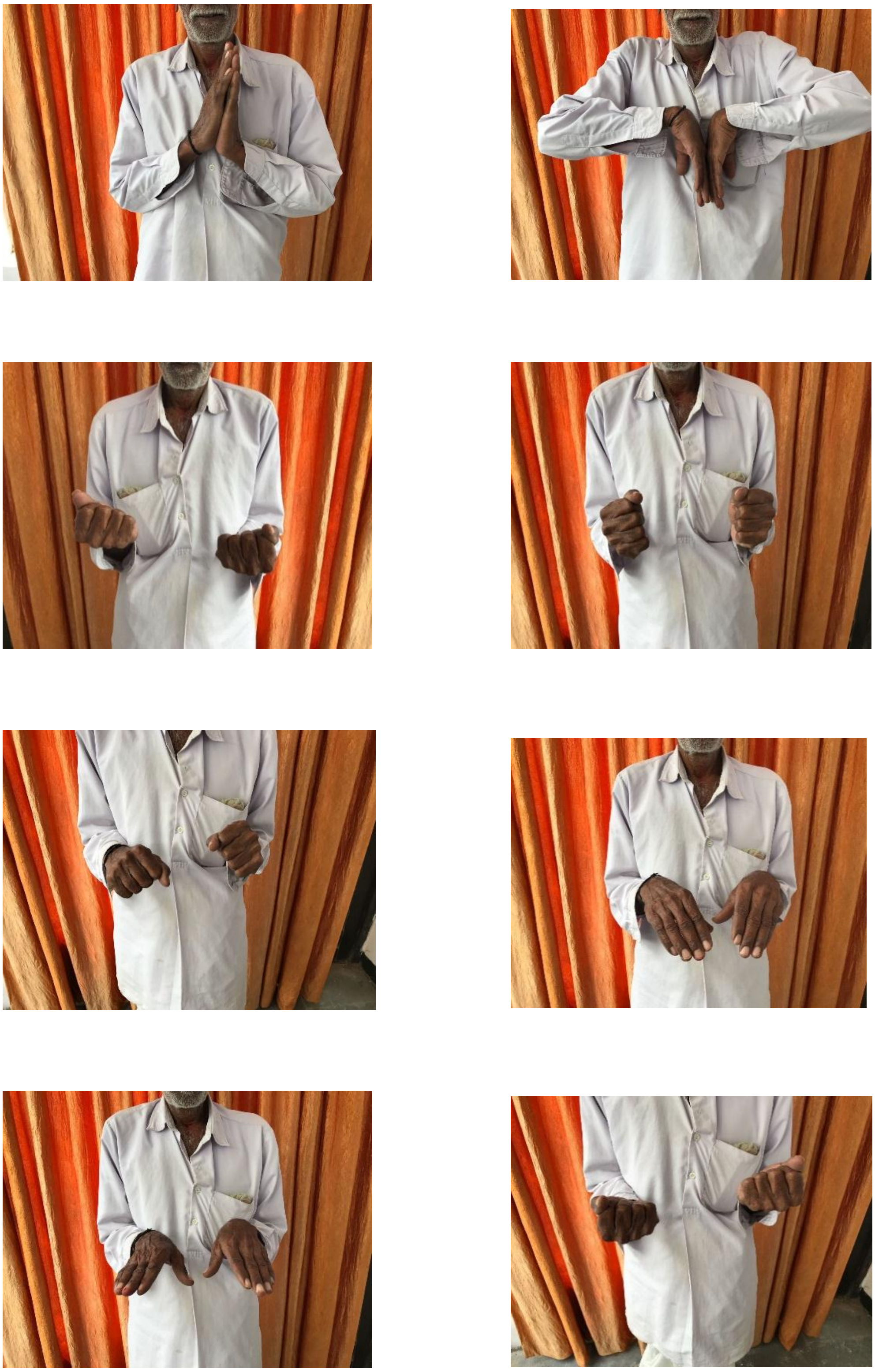


Figure 7 : CLINICAL PHOTOGRAPHS

CASE 2

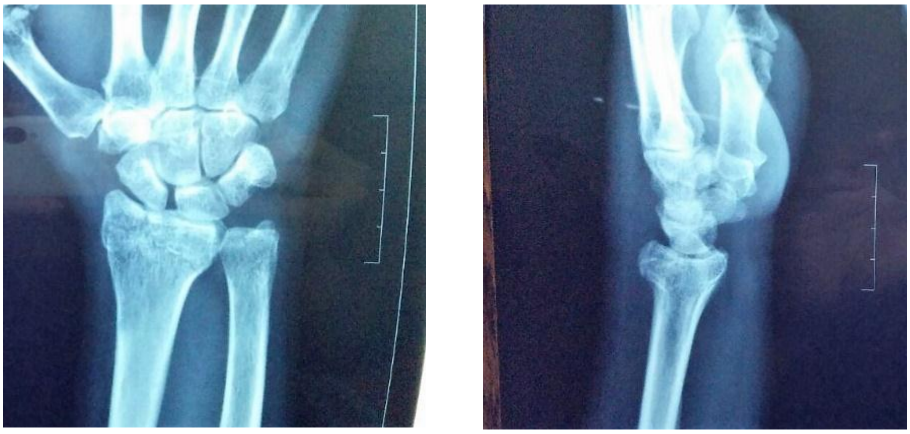


Figure 8.1 : PREOPERATIVE XRAY

Figure 8.2 : POST OPERATIVE X RAY

Figure 8.3 : UNION AT 6 MONTHS FOLLOWUP

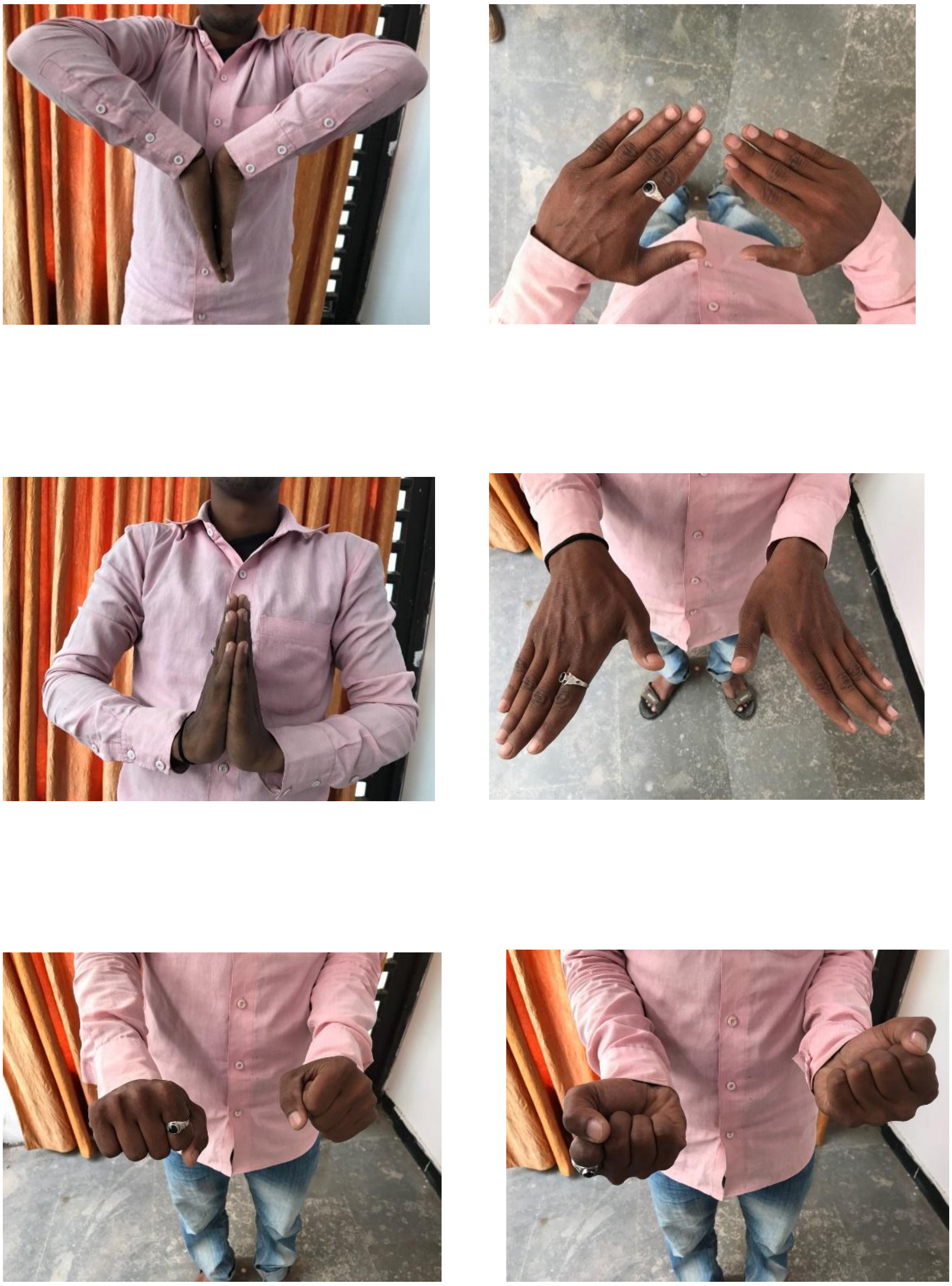


Figure 9 : Clinical Photographs

CASE 3

Figure 10.1 : PREOPERATIVE XRAY

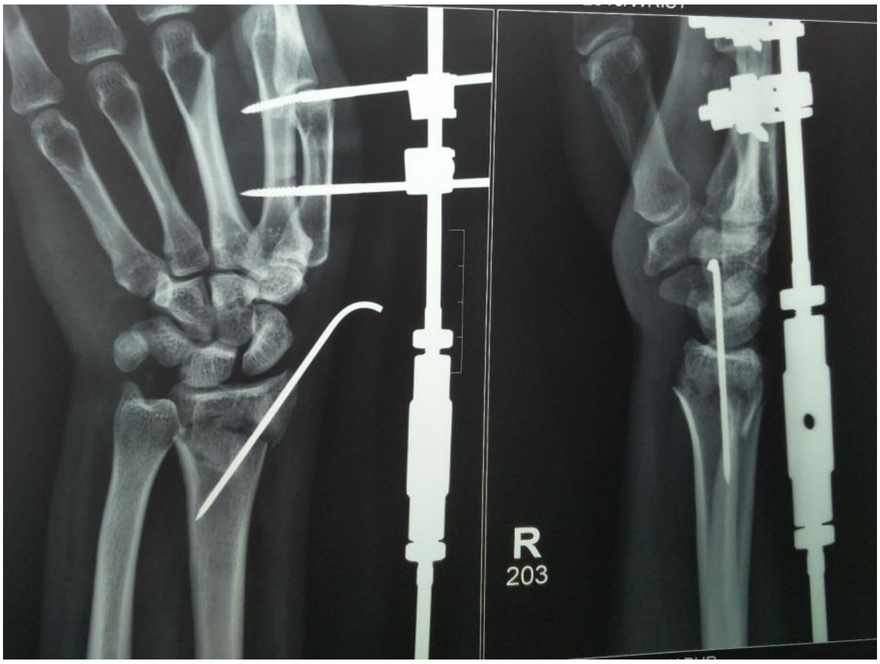


Figure 10.2 : POSTOPERATIVE XRAY

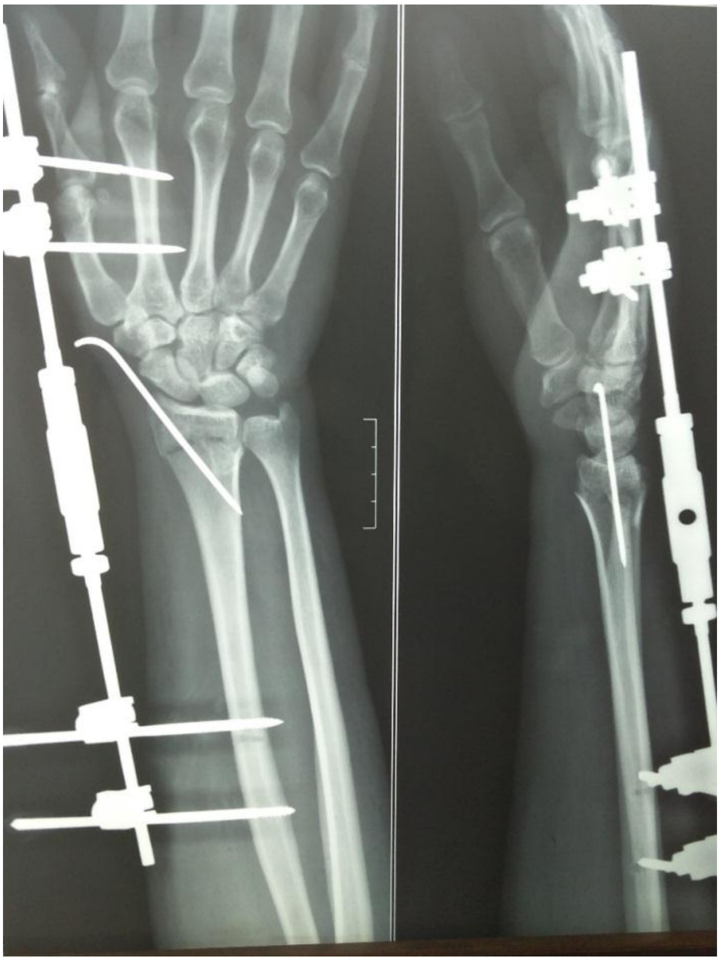


Figure 10.3 : POST OPERATIVE XRAY AT ONE MONTH

Figure 10.4 : X RAY AT 3 MONTH FOLLOWUP

Figure 11 : CLINICAL PICTURES

DISCUSSION

This is a short term study which with mean follow-up of 18.2 months so this is a preliminary study. The aim of the following study is to evaluate the functional outcome of treatment of distal radius fractures particularly intra-articular, communited and compound fractures using ligamentotaxis. Ligamentotaxis using bridging external fixator was done for fractures that met the inclusion criteria. From 1ST December 2015 to 31ST January 2017 we treated 100 intraarticular distal radius fractures were treated with spanning external fixator with or without augmentation with K wires. Mean age of patients in our study was 41.3 years ranging from 18-60 years of age. The table below depicts the mean age in years in various studies. Mean age in most studies shows the increased incidence of intraarticular fractures in the 4th decade of life. This attributes mostly to active lifestyle which is more prone to high velocity injuries such as road traffic accidents.

Table 17 : Comparison of mean age group of patients

Study Group	**Mean Age Group (Years)**
Our study	41.3
Lueng et al(1989)[61]	35.6
Gunaki RB(1998)[62]	34.8
Agarwal et al(2004)[63]	45
Chung Ma el al(2015)[59]	67.2
Bajwa et al(2015)[56]	53

There is increased prevalence of these fractures in males (65/100). This increased incidence is attributed to ambulant and active lifestyle which predisposes them to high velocity injuries. Another factor that attributes to increased incidence is more accessibility to medical services. High incidence of males having intraarticular distal radius fractures is evident in other studies.

Table 18 : Comparison of Sex incidence in the study

Study group	**Males (%)**	**Females (%)**
Our study	65%	35%
Lueng et al(1989)[64]	73.6%	26.4%
Jain BK et al(1998)[67]	63.63%	36.36%
Yamamoto et al(2003)[68]	54.5%	45.5%
Deepak CD et al(2014)[52]	90%	10%
Chung Ma et al(2015)[59]	48.2%	51.8%

It was noted in this study that there is more incidence in dominant hand (53%). This is attributed to stretching the dominant hand as a reflux to avoid injury to head and face.

Table 19 : Comparison of Distribution of Side Involved

Study Group	**Right**	**Left**
Our study	53	46
Lueng et al(1989)[64]	61.11%	38.88%
Harish Kapoor(2000)[69]	65	35
Deepak CD et al(2014)[52]	80	20
Chung Ma et al(2015)[59]	44.8	55.2

Of 100 patients, 66% of fractures were attributed to RTA, 29% patients were attributed to self-fall and 5% of injuries were due to assault. Deepak CD et al[52] and Gunaki et al[62] reported similar results in their studies.

Table 20 : Comparison of Mode of Injury

Mechanism of Injury	Our Study	Deepak C D(2014)[52]	Gunaki et al(1998)[65]	Yamamoto et al(2003)[67]	Aggarwal et al(2004)[66]
Road traffic accident	66%	60%	60%	20.45%	30%
Self fall	29%	40%	40%	63.63%	60%
Others	5%	0		16%	16%
Total cases	100	20	30	88	50

23 patients in our study had associated injuries. 14 patients had open factures. 1 patient had femur fracture and 1 had elbow dislocation. Generally, those with open wounds presented with poor prognosis due to soft tissue and tendon injuries.

While comparing the distribution of fractures in our study, the results were comparable to that in other studies. Most of the cases in our study were of Type IV-V (42%). Discrepancy of results in our study to that of some studies can be attributed to difference in number of cases included in their studies.

Table 21 : Comparison of studies based on Frykman type of fractures

Frykman type	Our Study	Rakesh Yalawarthi (2015)[54]	Deepak C D (2014)[52]	Cooney et al (1979)[71]	Leung et al(1989)[64]	Nagi et al(2004)[70]
Type I	0%	6.1%	0%	5%	1.4%	0
Type II	0%	3%	0%	7%	4.2%	0
Type III	12%	6.1%	15%	5%	8.3%	8.5%
Type IV	21%	6.1%	10%	12%	18%	11.4%
Type V	21%	9.1%	5%	10%	11.1%	5.7%
Type VI	22%	15.1%	20%	13%	9.7%	0
Type VII	15%	21.2%	35%	20%	20.8%	17.1%
Type VIII	9%	33.3%	15%	26.4%	26.4%	57.1%
Total cases	100	33	20	60	72	35

Fixator was removed after observing radiological and clinical union. The removal was done on outpatient basis. Physiotherapy in form of hot fomentation and Range of motion exercises were started thereafter. Majority of cases achieved union within 6 weeks (62%) while longest period for achieving union which was 10 weeks was seen in 2 cases.

All patients were followed up for minimum 6 months. Longest follow-up was up to 12 months. Mean follow up was for 32.7 weeks.

Table 22 : Comparison of Range of Motion with other studies

Movement	Our study	Gunaki et al[65]	Normal
Palmar flexion	58.2	59	70
Dorsi flexion	49.67	52	60
Radial deviation	18	18.83	25
Ulnar deviation	23	23.5	30
Supination	73.46	75.16	85
Pronation	69	73.83	85

Range of motion achieved in our study was sufficient enough for patient to carry out daily activities without hindrance. Grip strength achieved was measured subjectively. In our study we found 7 patients had reduced grip strength, 2 of them associated with finger stiffness. Normal grip strength achieved in our study was 83%.

Table 23 : Comparisons of complications

Complication	Our study	Leung KS et al (1989)[64]	Gunaki RB et al (1998)[65]	Jain BK et al (1998)[67]	Harish Kapoor (2000)[69]	Chuang Ma et al (2015)[59]	Rakesh Yalawarthi (2015)[54]
Residual pain	3(3%)	0	8(25%)	5	2(7.1%)	1 (1.72%)	6(18.2%)
Pin tract infections	12 (12%)	0	2 (6.25%)	3	1(3.5%)	8(13.8%)	3(9.1%)
Wrist stiffness	5 (5%)	0	0	3		-	3(9.1%)
Pin tract loosening	2 (2%)	0	1(3.12%)	0		-	-
Sudecks' dystrophy	1(1%)	2	0	0	1(3.5%)	1(1.72%)	-
Carpal tunnel syndrome	1(1%)	2	0	0		1(1.72%)	-
Total cases	100	72	30		18	132	33

12 patients were seen to have pin tract infection which subsided by daily dressing on subsequent follow-ups. None of patients developed osteomyelitis. 3 patients had residual pain which was treated by analgesics, but the pain was not as disabling enough to hinder daily activities of patient. Restricted wrist motion was seen in 5 patients which was treated with aggressive physiotherapy which included hot fomentation and range of motions exercises. 1 patient developed mild form of Sudeck's Dystrophy which subsided on eventual follow up with conservative management. None of patients reported non-union.

Demerit system of Gartland and Werley were used to assess functional outcome at 6 months follow up. The results in our study were comparable to standard studies. Poor functional outcome was seen in open fractures and sever communition owing to severe damage to surrounding soft tissues.

Table 24 : Functional results compared with standard studies

Study Group	Excellent to Good results	Fair to Poor results	Total cases
Our study	77%	22(22%)	100
Cooney et al (1979) [71]	110(85%)	20(15%)	130
Lueng KS et al (1989)[64]	57(80%)	15(20%)	72
Gunaki et al (1998)[65]	26(86.6%)	4(23.2%)	30
Jain BK et al(1998)[67]	16(72.8%)	6(23.2%)	22
Yamamoto et al(2003)[68]	88(95.6%)	4(4.4%)	92
Nagi et al(2004)[70]	26(74.28%)	9(25.72%)	35
Yalawarthi et al(2015)[54]	29(87.8%)	4(12.2%)	33
Zhibing Tan et al [60]	19(86.3%)	3(13.7%)	22
Kapoor et al[69]	14(77.7%)	4(18.2%)	18

CONCLUSION

By observing the results of our study with standard studies following conclusions are drawn-

1. Fractures of distal end radius continue to be most common fractures seen and managed in emergency rooms.
2. Males are more commonly affected owing to the ambulant lifestyle
3. These fractures occur in younger age group because of increase in incidence of road traffic accidents.
4. Fractures occurring due to RTA are more commonly communited intra-articular and those occurring due to self fall are less likely to be communited.
5. External fixation offers good mode of treatment in communited fractures as they allow gradual distraction providing better functional and anatomical results in communited intraarticular wrist injuries. It provided early mobilization and reduces edema stiffness of joints thus leading to better and early functional recovery.
6. External fixation allows wound observation and coverage procured during open fractures without compromising the reduction achieved
7. It is a useful mode of treatment in bilateral cases as it is unacceptable to apply POP cast bilaterally.
8. It is an incomplete solution to treatment of intraarticular fractures and may be augmented by percutaneous K wires.
9. The final functional result of treatment of distal radius fractures not only depends on the anatomical restoration of the articular surface but also on the associated soft tissue injuries and articular damage.

SUMMARY

100 patients with Intraarticular communited distal end radius fractures were treated with bridging external fixator using the principal of ligamentotaxis. Following data was obtained from our study-

1. Majority of the patients were males(65%) owing to large population of males and active lifestyle
2. Mean age of patients was 41.3 years with range from 18-74 years
3. Dormant hand was involved (53%) in majority of cases. This could be due to tendency to outstretch dominant hand for protection of head and face during fall.
4. Road traffic accidents were seen in most of the cases(66%) mostly young adults. Main mode of injury seen in old patients was self fall.
5. 23 cases had associated injury with 13 patients having open wounds. Another major associated injury was distal ulna fracture (4 cases).
6. According to Frykman's classification majority of cases were Frykman 5 and 6(43%)
7. 30 patients had complications with pintract infection (12 cases), restricted wrist motion(5 cases), residual wrist pain(2 cases) and residual pain(3 cases).
8. 78% cases had Excellent to Good results according to Demerit System of Gartland and Werley while 22% cases had Fair to Poor results.
9. 60% cases achieved union within 6 weeks postoperatively. Longest duration of union seen in our study was 10 weeks.

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ANNEXURES

ETHICAL CLEARANCE CERTIFICATE

B.L.D.E.UNIVERSITY'S

SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR – 586103

INSTITUTIONAL ETHICAL COMMITTEE

No/558/2015
20/11/15

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 17-11-2015 *at* 03 pm *scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has accorded Ethical Clearance.*

Title "A prospective study of functional outcome of intra articular fracture of distal radius by external fixation and ligamentotaxis"

Name of P.G. Student : Dr Gupta Tapan Sanjeev
Dept of Orthopaedics

Name of Guide/Co-investigator : Dr Dayanand.B.B.
Associate professor orthopaedics

DR.TEJASWINI VALLABHA
CHAIRMAN

CHAIRMAN
Institutional Ethical Committee
BLDEU's Shri B.M. Patil
Medical College,BIJAPUR-586103.

Following documents were placed before E.C. for Scrutinization.

1)Copy of Synopsis/Research Project

2)Copy of informed consent form.

3)Any other relevant documents.

SCORING SYSTEM

Modified Demerit Point System Of Gartland And Werley

Residual deformity (0-3 Points)	
Prominent ulnar styloid process	1
Residual dorsal tilt	2
Residual deviation of hand	2-3
Subjective evaluation (0-6 points)	
Excellent: No pain, disability or limitation of motion	0
Good: Occasional pain, some limitation of motion and no disability	2
Fair: Occasional pain, some limitation of motion, weakness in wrist, activities slightly restricted.	4
Poor: Pain limitation of motion, disability, Activities more or less markedly restricted.	6
Objective evaluation (0-5 points)	
Loss of dorsiflexion	5
Loss of ulnardeviation	3
Loss of supination	2
Loss of Palmarflexion	1
Loss of radial deviation	1
Loss of circumduction	1

Pain in distal radioulnar joint	1
Grip strength 60% or less than opposite side	1
Loss of pronation	2
Arthritic changes	
Minimum	1
Minimum with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications (Median)	1-3
Poor finger functions due to cast	1-2

Table - 2 Grading

Excellent	0-8
Good	3-8
Fair	9-20
Poor	>21

B.L.D.E.U.'s SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, BIJAPUR-586103

INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/RESEARCH

I, the undersigned,________________ , S/O D/O W/O _________________, aged ____years, ordinarily resident of _____________ do hereby state/declare that Dr. Gupta Tapan Sanjeev of Shri. B. M. Patil Medical College Hospital and Research Centre has examined me thoroughly on _______________ at _______________ (place) and it has been explained to me in my own language that I am suffering from _________________ disease (condition) and this disease/condition mimic following diseases. Further Dr. Gupta Tapan Sanjeev informed me that he/she is conducting dissertation/research titled "A Prospective Study Of Functional Outcome Of Intraarticular fracture of distal radius Treated With External Fixator and Ligamentotaxis" under the guidance of Dr. Dayanand BB requesting my participation in the study. Apart from routine treatment procedure, the pre-operative, operative, post-operative and follow-up observations will be utilized for the study as reference data.

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

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

The Doctor did inform me that though my participation is purely voluntary, based on information given by me, I can ask any clarification during the course of treatment / study related to diagnosis, procedure of treatment, result of treatment or prognosis. At the same time I have been informed that I can withdraw from my participation in this study at any time if I want or the investigator can terminate me from the study at any time from the study but not the procedure of treatment and follow-up unless I request to be discharged.

After understanding the nature of dissertation or research, diagnosis made, mode of treatment, I the undersigned Shri/Smt ______________________________ under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of patient:

Signature of doctor:

Witness: 1.

2.

Date:

Place

SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE, BIJAPUR - 586103

PROFORMA

CASE NO. :

NAME :

AGE/SEX :

I P NO :

DATE OF ADMISSION :

DATE OF SURGERY :

DATE OF DISCHARGE :

OCCUPATION :

RESIDENCE :

Presenting complaints with duration :

History of presenting complaints :

Family History :

Personal History :

Past History :

General Physical Examination

Pallor:	present/absent
Icterus:	present/absent
Clubbing:	present/absent
Generalized lymphadenopathy:	present/absent
Built:	poor/moderate/well
Nourishment:	poor/moderate/well

Vitals

PR: RR:

BP: TEMP:

Other Systemic Examination:

Local examination:

Right/ Left Leg

Gait:

Inspection:

a) Attitude/ deformity

b) Abnormal swelling

- Site
- Size
- Shape
- Extent

c) Skin

d) Compound injury if any

Palpation:

a) Local tenderness

b) Bony irregularity

c) Abnormal movement

d) Crepitus

e) Swelling

Movements:		Active	Passive
Wrist:	Palmar Flexion		
	Dorsi Flexion		
	Radial deviation		
	Ulnar deviation		
	Pronation		
	Supination		

MASTER CHART

Sr	Name	Age	Sex	IP no	Side	MOI	Frykman	Complication	Result	ASSOCIATED INJURY	Period for union (in weeks)
1	Deepa	18	F	24942	R	RTA	4		GOOD		6
2	Ganagawwa	74	F	29877	L	Self fall	6	PIN LOOSENING	FAIR	Distal ulna fracture	7
3	Shantabai	65	F	32887	L	RTA	5		EXC		6
4	Kamala	30	F	33135	L	RTA	3		GOOD		6
5	Basavraj	28	M	33190	L	RTA	8	DORSAL ANGULATION	FAIR	Elbow dislocation	9
6	Tanaji	46	M	33992	R	RTA	7	RESIDUAL PAIN	GOOD		8
7	Kamala	50	F	35090	L	Self Fall	6		EXC		6
8	Siddharth	42	M	37752	R	RTA	6		EXC		6
9	Guru	45	M	32065	R	RTA	7	PIN TRACT INFECTION	FAIR	OPEN WOUND-GUS AND2	7
10	Yamanappa	51	M	38961	R	Self Fall	5		EXC		6
11	Timappa	43	M	38768	L	RTA	6		EXC		7
12	Pratik	19	M	39794	R	ASS	3		EXC		6
13	Sharnawwa	40	F	40012	L	RTA	5	RESTRICTED FINGER MOVEMEN	GOOD		6
14	Shremanth	55	M	41566	R	Self fall	6		EXC		8
15	Ramya	36	F	928	R	RTA	7		EXC		8
16	Mahananda	35	F	1632	R	RTA	6	RESIDUAL PAIN	GOOD		6
17	Shamrao	58	M	2237	L	RTA	6		EXC		7
18	Tanamay	45	M	2530	R	Self fall	5		EXC		6
19	Laxman	58	M	2939	R	RTA	7	RESTRICTED WRIST	FAIR	OPEN WOUND-GUS AND2	8

20	Kallu	50	M	3347	R	RTA	4		EXC		6
21	Iranna	48	M	5881	L	RTA	6		EXC		6
22	Zameela	28	F	7598	L	RTA	7		EXC		8
23	Kamalabai	55	F	9321	L	Self fall	6		EXC	Distal ulna fracture	6
24	Gurubai	50	F	9884	R	RTA	5		EXC		6
25	Iraogoud	70	M	9258	R	RTA	8	PIN TRACT INFECTION	POOR		10
26	Usha	25	F	10067	L	RTA	6	RESTRICTED WRIST MOTION	FAIR	OPEN WOUND-GUS AND2	6
27	Balachandra	58	M	12388	L	Self fall	4		GOOD	Distal ulna fracture	6
28	Ramanagoud	30	M	16117	R	ASS	5		EXC		6
29	Anappa	48	M	16187	L	RTA	7	PIN TRACT INFECTION	POOR	OPEN WOUND-GUST ANDER 2	8
30	Lakshamann	50	M	20247	R	Self fall	3		EXC		6
31	Rukmabai	55	F	21507	L	RTA	7	PIN TRACT INFECTION	FAIR	OPEN WOUND-GUST AND 1	6
32	Ashok	40	M	21874	R	RTA	4		EXC		6
33	Kamlesh	38	M	22294	R	RTA	8		POOR		8
34	Savitha	38	F	22583	L	ASS	4		EXC	Distal ulna fracture	6
35	Ishwarappa	65	M	24676	L	RTA	5		FAIR	FEMUR #	6
36	Kavita	40	F	38799	B/L	RTA	8/6	WRIST STIFFNESS RESIDUAL PAIN	POOR		9
37	Shirlingawwa	60	F	38490	L	RTA	7		EXC		8
38	Santosh	18	M	38884	L	RTA	3		EXC		6
39	Shashank	18	M	20399	R	ASS	4		EXC		6
40	Dayanand	26	M	20124	R	RTA	5		EXC		6

41	Mallappa	56	M	21273	R	Self fall	6		EXC		6
42	Sangamesh	26	M	21715	R	RTA	7		EXC		8
43	Nigamma	65	F	22065	L	Self fall	6	PIN LOOSENING	GOOD		6
44	Gurukatari	19	M	22084	R	RTA	3		EXC		5
45	Rajesh	50	M	22935	L	RTA	6	RESIDUAL PAIN	GOOD		6
46	Shivananad	42	M	22532	L	Self fall	4		EXC		6
47	Shashank	18	M	23664	R	Self fall	3		EXC		5
48	Pooja	37	F	24082	R	RTA	5		EXC		7
49	Laxmibai	55	F	24541	L	Self fall	4		EXC		7
50	Maudakappa	24	M	24501	L	Self fall	4		EXC		6
51	Sulocha5na	35	F	39991	L	RTA	5		EXC		7
52	Basavraj	41	M	40863	R	RTA	6		EXC		6
53	Praveen	23	M	24855	L	RTA	7	RESIDUAL WRIST PAIN	GOOD	OPEN WOUND-GUST AND 1	8
54	Jalaja	34	M	24873	R	Self Fall	5		EXC		6
55	Siddaraya	62	M	24873	R	RTA	3	PIN TACT INFECTION	EXC		6
56	Mahadevi	52	F	26272	L	Self fall	4		EXC		6
57	Santosh	48	M	26168	L	Self fall	4		EXC		6
58	Shivaraj	44	M	27619	R	RTA	5	RESTRICTED FINGER MOVEMEN	GOOD		6
59	Ravi	19	M	28517	L	RTA	6		EXC		7
60	Rekha	45	F	28037	L	RTA	4		EXC		6
61	Ganesh	51	M	28876	R	RTA	7	PIN TRACT INFECTION	FAIR	OPEN WOUND-GUST AND 1	8
62	Laxman	66	M	27110	L	RTA	8	RESTRCITED WRIST MOTION	POOR		8
63	Asif	25	M	30934	R	Self fall	4		EXC		6
64	Sadhagira	59	M	31796	L	RTA	6		EXC		6

65	Vaishali	38	F	31804	L	Self fall	5	PIN TRACT INFECTION	GOOD	OPEN WOUND-GUST AND 1	6
66	Kavita	47	F	32261	L	RTA	6		EXC		6
67	Malappa	56	M	32254	R	Self fall	7		FAIR	OPEN WOUND-GUS AND 3	8
68	Sujata	62	F	32274	R	RTA	4		EXC		7
69	Farida	40	F	32858	R	RTA	6		EXC		8
70	Manohar	52	M	33134	R	Self fall	3		EXC		6
71	Ramesh	56	M	33808	R	RTA	4	PIN TRACT INFECTION	GOOD		6
72	Varun	18	M	34299	L	Self fall	4		FAIR	OPEN WOUND-GUS AND 3	6
73	Bhimu	43	M	35267	L	RTA	5		EXC		6
74	Kumar patil	36	M	33808	R	Self fall	4		EXC		6
75	Manoj	20	M	37997	R	RTA	8	RESIDUAL WRIST PAIN	FAIR	Ulna shaft fracture	9
76	Shirashankar	65	M	32305	R	RTA	5		EXC		6
77	Manjunath	28	M	29380	L	RTA	7	PIN TRACT INFECTION	POOR	OPEN WOUND-GUS AND 3	8
78	Ambakka	60	F	31943	R	RTA	6	PIN TRACT INFECTION	FAIR		8
79	Hazarathi	40	F	33385	L	RTA	4		EXC		6
80	Dundappa	45	M	34220	R	Self fall	3		EXC		6
81	Tukaram	20	M	41844	R	RTA	6	PIN TRACT INFECTION	GOOD	OPEN WOUND-GUST AND 1	6
82	Dongriba	50	F	7085	L	Self fall	3		EXC		6
83	Mallapa	50	M	7632	R	RTA	5		EXC		6
84	Basavraj	26	M	8799	R	RTA	7		EXC		8
85	Sharanu	19	M	10004	R	Self fall	3		EXC	Distal ulna fracture	7

86	Naveen	20	M	10416	L	Self fall	4		EXC		6
87	Shivalingamma	45	F	11366	R	RTA	5	DORSAL ANGULATION WRIST PAIN	FAIR	Ulna fracture	8
88	Amin saab	35	M	13534	L	RTA	5		EXC		6
89	Sharand	30	M	97278	R	ASS	8	RESTRCITED WRIST MOTION	POOR	Olecranon fracture	10
90	Shirappa	30	M	97285	R	RTA	6		EXC		6
91	Deepak	25	M	97285	L	RTA	4		EXC	OPEN WOUND-GUST AND 1	6
92	Bhagirati	19	F	15251	L	Self fall	3		EXC		6
93	Arun	30	M	17234	R	RTA	5		EXC		6
94	Sharda	53	F	18070	R	RTA	4		EXC		6
95	Akash	19	M	19234	L	RTA	8	SUDECK'S OSTEODYSTR OPHY	POOR	Ulna shaft fracture	8
96	Chandrakant	74	M	19701	L	Self fall	5		EXC		7
97	Sindalingawwa	43	F	39533	R	RTA	6		EXC		6
98	Roopa	47	F	42070	R	RTA	7	PIN TRACT INFECTION	FAIR	OPEN WOUND-GUS AND2	8
99	Sulochana	35	F	437065	L	RTA	8	RESTRCITED WRIST MOTION	GOOD		8
100	Basavraj	41	M	43678	R	RTA	5		EXC		8