STUDY OF CLINICAL OUTCOME IN METACARPAL FRACTURES FIXED WITH K WIRES

By

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In partial fulfillment of the requirements for the degree of

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IN

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Under the Guida

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Dr. NAGARJUNA REDDY.A

LIST OF ABBREVIATIONS

AO	–	Arbeitsgemeinschaft for osteosynthese fragen
AP	–	Anteroposterior
ASIF	–	Association for the study of internal fixation
BP	–	Blood pressure
CRIF	_	Closed reduction and internal fixation
I.V.	_	Intravenous
RLJH	–	R.L.Jalappa Hospital and Research Center
MCP	_	Metacarpo-phalengeal joint
ORIF	_	Open reduction and internal fixation
POP	_	Plaster of Paris
ROM	_	Range of motion
RTA	_	Road traffic accident
TAM	_	Total active movements

ABSTRACT

BACKGROUND:

. Fractures of the metacarpal bones of the hand are one of the most frequently encountered orthopaedic injuries constituting between 14-28% of all visits to the hospital following trauma by various means like assault, road traffic accidents, industrial accidents, agricultural accidents etc

Hand fractures can be complicated by deformity from no treatment, stiffness from over treatment and both deformity and stiffness from poor treatment. Fracture healing in the hand is not an isolated goal, rather the functional result is of paramount importance.

AIMS OF THE STUDY:

- To study the various mechanisms, pattern and effectiveness of K Wires in metacarpal fractures.
- To study the functional outcome of injuries after management by K Wires
- To study the complications associated with their management.

MATERIALS AND METHODS:

This study was a hospital based prospective study centered in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from Nov 2013 to May 2015 in which 50 patients with Metacarpal fractures treated with K wires

RESULTS:

The assessment of clinical outcome was made according to TAM functional scoring and grading system. End results showed excellent outcome in 33cases, Good outcome in 13 cases and 4 fair outcome.

CONCLUSION:

Displaced metacarpal fractures treated surgically by percutaneous K Wire gives excellent result in terms of union, recovery of daily activities and stiffness than those treated conservatively There will be less chances of infection and results than those treated conservatively There will be less chances of infection and early bone healing in case of CRIF With K Wire

However stiffness of hand joints especially proximal interphalangeal joints is a major concern and physiotherapy plays a major role to combat stiffness.

KEY WORDS:

Metacarpal fractures, K Wires, TAM Scoring system.

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INTRODUCTION

The Hand has been recognized as the symbol of man's power, outward reflection of his inner mind, the precise instrument of his perception, in fact the indispensable tool of his inheritance and independent livelihood.

Hand is a specialized structure interacting with the environment, is especially sensitive to functional impairment.

The prime functions of hand are feeling (sensibility) and motion. Hand performs the mechanical functions of hook, as in tilting a book from a shelf; grasp, as in picking it up; pinch, as in turning its pages. The loss or diminution of any of these functions is a serious blow

Hand fractures can be complicated by deformity from no treatment, stiffness from overtreatment, and both deformity and stiffness from poor treatment" Swanson.[1]

''Too often these fractures are treated as minor injuries and major disability results'' as stated by Lipscomb.[2]

Selection of the optimum treatment depends on a number of factors, including fracture location (intra-articular vs. extra-articular), fracture geometry(transverse, spiral or oblique, comminuted), deformity (angular, rotational, shortening), whether they are open or closed, whether they have associated osseous and soft tissue injuries, and fracture stability. Additional considerations include the patient's hand dominance,

age, occupation, and socioeconomic status; the presence of systemic illnesses; the surgeon's skill; and the patient's compliance.

Stable undisplaced fractures are treated conservatively with good results. Conservative method of treatment of unstable displaced fractures are associated with increase incidence of loss of reduction of fracture alignment, stiffness and loss of hand function so displaced unstable fractures as to be operated for better results.

Earlier metacarpal fractures were treated with ORIF with K Wire, although operative time was shorter, the incidences of loss of reduction, penetration to the metacarpalphalangeal joint were much higher.

intensifier CRIF with K wire percutaneously under image intensifier has given better results, faster healing, faster return of daily activities and faster rehabilitation.

Early and appropriate physiotherapy other than accurate reduction and fixation affect recovery of hand mobility and function.[3]

In the present study we are dealing with metacarpal fractures treated with CRIF with K wire percutaneously under image intensifier.

AIMS AND OBJECTIVES

- To study the mechanism, pattern and effectiveness of K wires in metacarpal fractures
- To study the functional outcome of injuries after management by K wires
- To study the complications associated with their management.

REVIEW OF LITERATURE

Hand injuries mainly metacarpal fractures are being treated, since times immemorial.

Bennett in 1882 described the fracture at the base of first metacarpal,which bears now his name.[4]

Conservative management was the main stay of treatment in earlier days, where an application of well moulded plaster after manipulative reduction and continuous traction, as described by Ehatt (1929), Roberts (1938), Watson Jones(1955), Bohler (1956).[5]

Lambotte (1913)[7] described first a method of open reduction and internal fixation of the fragments with a fine nail, in the treatment of Bennett's fracture.

Furlong (1957), Robins (1961) and Clarkson and Pelly (1962) advocated operative treatment for metacarpal fractures with K wire.

Bosworth (1937)[8] demonstrated transverse interosseous 'K' wire fixation in the treatment of head and neck fractures of the 5th metacarpal, Vomsaal (1955) extended this application to phalanges.

Jahss S.A (1938)[9]. Introduced a new method of reduction and immobilization for metacarpal fractures. In which the deforming forces are controlled by flexion of

the metacarpophalangeal joints. But later this was modified by many surgeons, as that method was itself carrying some inherent complications of immobilization.

In 1960's 809 patients (280 with fractures of the metacarpals and 529 with phalangeal fractures) were reviewed by Wright (1968).[10] He made a distinction between unstable injuries which must be immobilized and stable fractures in which early movement gave better results for long term.

Hunter and Cowen (1970) have shown that in fracture of fifth metacarpal neck considerable angulation is compatible with an early resumption of function. For many years they were treated by bandaging over a roller bandage with the finger flexed.

Hunter (1973)[11] has pointed out in fifth metacarpal fractures most should be treated fracture of head and neck with angulation more than 30° reduction should be attempted and angulation up to 70° is acceptable as long as there is no rotation deformity.

Hein Pieifler (1974)[12] author of small fragment set manual claimed that, "Rigid internal fixation enables us to achieve much better results than other procedures"

Wilhelm K and Kreusser T, (1990)[13] has found that surgical treatment is better than conservative treatment of splinting, immobilization and POP applications.

Lowka K. (1990)[14] of the various types of hand fractures, metacarpal fractures occur quite frequently, especially in younger people. In order to maintain hand function man's most important tool, the treatment of choice in recent years has shifted from predominantly conservative measures to more surgical procedures. From 1980to 1988, 33 patients with metacarpal fractures were treated: 66% received surgical and 34% conservative treatment. They reported that the results of hand

function, length of unemployment, patients subjective complaints and the peri and postoperative complications were less.

Mennen U (1990)[15] stated that internal fixation of metacarpal fractures has high complication rate, however ,some fractures do need internal stabilization. Use of clamp on plate , which is simple to use , has very low complication rate and allows immediate mobilization.

Ashkenaze D.M. and Ruby L.K. (1992)[16] stated that unstable fractures however required internal fixation.

years and found that fractures of fifth metacarpal was more common in the assault and fracture second metacarpal more common in fall on outstretched hand.

Thompson N S,Nolan PC, and Calderwood J.W. (2000)[20] describe a new technique for fixation of fractures of the middle three metacarpals by antegrade intramedullary fixation. They studied 20 displaced transverse midshaft fractures of the2nd, 3rd and 4th metacarpals treated by antegrade intramedullary Kirschner wiring and obtained satisfactory clinical and radiological outcomes.

Schaefer M, and Sibert HR. (2000)[21] has reviewed surgical and non-surgical treatment of metacarpal fractures in a total of 522 patients who underwent surgery received K-wires

Hopfner MS, Wild M, Windolf J, Linhart W (2006)[22] studied Thirty patients with displaced neck fractures of the fifth metacarpal who received operative treatment. Fifteen patients had antegrade intramedullary splinting and Fifteen patients

retrograde percutaneous pinning. Then they preferred antegrade intramedullary splinting as it avoids adhesions of the extensor hood and provides intramedullary stability this technique seems to be advantageous in comparison with traditional retrograde percutaneous crossed pinning.

Wong et al (2006)[23] in a series of 60 cases in Comparison between Percutaneous Intramedullary Fixation and Intramedullary K-Wires in Treating Closed Fractures of the Metacarpal concluded that intramedullary K-wires are safe methods of treating closed, displaced fractures of the metacarpal fractures, without significant complications.

Gupta R, Singh R, Siwach RC, Sangwan SS (2007)[3] In evaluating 41 fractures of digits in 31 patients managed surgically with ORIF with K-wires, plates and screws and CRIF with percutaneous K-wire, study concluded that surgical stabilization of metacarpal and phalangeal fractures of hand seems to give good functional outcome as compared to conservative treatment. Many factors, such as delicate handling of tissues, preservation of gliding planes for tendons, prevention of infection and early and appropriate physiotherapy other than accurate reduction an fixation affect recovery of good mobility.

Hyder Ali, Atif Rafique, Mabroor Bhatti, Shahab Ghani et al (2007)[24]4Evaluating 226 fractures of treated surgically opined percutaneous K wire fixation was the most common modality of treatment

Gupta R, Roop Singh, RC Siwach, SS Sangwan et al (2007)[3] described Surgical stabilization of metacarpal fractures of hand seems to give good functional outcome. Closed fractures and fractures with single digit involvement have shown a better grade of total active range of motion. Closed reduction and percutaneous Kirschner wire fixation was done where fracture could be reduced and maintained by closed means. 60% achieved excellent TAM.

Hin keung wong , Choyee lam ,Kam-yiu wong (2008)[25] in treating Metacarpal fractures showed the results of percutaneous K Wire fixation is comparable to open mini screw fixation and opined closed reduction and K Wire fixation is treatment of choice for most extra articular fractures, with excellent clinical outcome.

Somboon Wutphirlya angkul (2009)[26], in a study of 112 patients with 122 metacarpal Fractures Concluded that the the K Wire technique has similar effective results compared to the miniplate technique in the treatment of metacarpal and phalangeal fracture with a shorter operative time.

Kagan O, Syed Gillani, Allison W, Steven L. Steven M (2008)[27] in treating 52 closed, displaced, extra-articular metacarpal fractures found no significant differences in the clinical outcomes using either technique. Although operative time was shorter in intramedullary nail group than in the plate-screw group.

Ramsey Chamma, Peter Thomas, Ali Khalil et al (2010)[28] In treating 110 metacarpal fractures in 89 patients with single retrograde intramedullary K Wire fixation of unstable metacarpal shaft fractures concluded that transverse,angulated transverse,and short oblique fractures are suitable for this technique.

Facca, Ramdhian et al (2010)[29] in a continuous prospective study of 38 closed fifth metacarpal fractures between locking plate and percutaneous K Wire fixation opined that ,finally the result appeared to be linked to mobility,regardless of radiological aspect all in all locked plate with Immediate mobilization paradoxically gave poorer end of follow up mobility than did intramedullary K Wires. They concluded that K Wires remain the reference technique for displacement of fifth metacarpal neck fractures.

Onur Polat et al (2011)[30], in a prospective study of 40 patients concluded Extension block pinning is a successful and

Serdar, Bulent et al (2013)[31] in a study of 64 patients with diaphyseal fractures fixed with K Wires, two third of the patients achived good to excellent results .

McCarthy,Samora(2014)[32] , in a review of metacarpal shaft fractures concluded K Wire fixation is acceptable method of metacarpal shaft fracture.

Hassan Boussakri, Mohamad Elidrissi et al (2014)[33] in a report of 28 patients with fifth metacarpal neck fractures recommended that minimally invasive percutaneous k wire fixation gives good functional outcome and low morbidity.

Jiaming Xu and Changqing Zhang et al (2014)[34] in a metanalysis concluded ,K Wire fixation is simple to manipulate requires shorter surgery time and little damage to the fracture blood supply.

Gajanan Deshmukh , Steve Rocha et al(2014)[35], in a review of metacarpal fractures concluded operative intervention is the treatment of choice in early recovery and mobilization of metacarpal fractures.

Kangana sarathy,Kavin Amuthan et al (2015)[36] in a study of 25 boxers fractures treated with percutaneous K Wire fixation concluded that this technique is useful methods of treatment in metacarpal fractures.

Benjamin Curtis et al, (2015)[37] in a study of Biomechanical Comparison of Intramedullary Nail, Crossed K-Wires, and Plate-Screw, Constructs in 36 synthetic metacarpals opined Although plates are the most stable means of fixation of midshaft metacarpal fractures, if minimally invasive techniques are indicated, K Wires are the reference method of fixation .

Stephen et al (2015)[38] in a study [illegible] concluded stiffness of intramedullary wirre fixation for metacarpal shaft fractures using a single 1.6-mm-diameter wire was significantly greater than using three 0.8-mm-diameter wires.

SURGICAL ANATOMY

The anatomy of the hand is complex, intricate, and fascinating. Its integrity is absolutely essential for our everyday functional living. Our hands may be affected by many disorders, most commonly traumatic injury.

The hand skeleton is divisible into three elements of descending order of specialization.

- The thumb and its metacarpal as a wide range of motion at the carpometacarpal joint. Four extrinsic muscles and five intrinsic muscles are specifically influential on thumb positioning and activity.
- The index finger with independence of action within the range of motion [illegible] and ligamen[illegible] muscles allow such digital independence.
- The third, fourth and fifth fingers with their metacarpals. This unit functions as a stabilizing vise to grasp objects for manipulation by the thumb and index finger or in concert with the other hand units in powerful grasp

METACARPAL :

The metacarpal bones are is the intermediate part of the hand skeleton that is located between the fingers distally and the carpus which forms the connection to the forearm. It consists of five cylindrical bones which are numbered from the radial to the ulnar side (ossa metacarpalia I-V).

Common Characteristics of the Metacarpal Bones:

These are miniature long bones, with a distal head, shaft and expanded base. The rounded heads articulate with the proximal phalanges. Their articular surfaces are convex, although less so transversely, and extend further on the palmar surfaces, especially at their margins.

The knuckles are produced by the metacarpal heads. The metacarpal bases articulate with the distal carpal row and with each other, except the first and second. The shafts have longitudinally concave palmar surfaces, which form hollows for the palmar muscles. Their dorsal surfaces bear a distal triangular area, which is continued proximally as a round ridge. These flat areas are palpable proximal to the knuckles.

The medial four metacarpals are sometimes described as parallel, strictly speaking they diverge very slightly and radiate from the proximodistally. However the thumb metacarpal, relative to the others, is more [illegible] through 90°, so that its morphologically dorsal surface is lateral, its radial border palmar, its palmar surface medial, and its ulnar border dorsal. Hence the thumb flexes medially across the palm and can be rotated into opposition with each finger. Opposition depends on medial rotation and is the prime factor in manual dexterity: when an object is grasped, fingers and thumb encircle it from opposite sides, greatlyincreasing the power and skill of the grip.

INDIVIDUAL METACARPAL BONES

First metacarpal (os metacarpale I; metacarpal bone of the thumb):

The first metacarpal bone is shorter and stouter than the others, diverges to a greater degree from the carpus, and its volar surface is directed toward the palm.

The body is flattened and broad on its dorsal surface, and does not present the ridge which is found on the other metacarpal bones; its volar surface is concave from above downward. On its radial border is inserted the opponens pollicis muscle; its ulnar border gives origin to the lateral head of the first Interosseus dorsalis.

multiangular; it has no facets on its sides, but on its radial side is a tubercle for the [illegible] ligaments. The [illegible] is broader [illegible] other metacarpal bones, and is broader backward.On its volar surface are two articular eminences, of which the lateral is the larger, for the two sesamoid bones in the tendons of the flexor pollicis brevis muscle.

The second metacarpal bone (os metacarpale II) :

The second metacarpal has the longest shaft and largest base, of the four remaining bones. Its base is prolonged upward and medial ward, forming a prominent ridge. It presents four articular facets: three on the upper surface and one on the ulnar side

Of the facets on the upper surface the intermediate is the largest and is concave from side to side, convex from before backward ; the lateral is small, flat and oval; the medial, on the summit of the ridge, is long and narrow for articulation with the capitate.

The facet on the ulnar side articulates with the third metacarpal. The extensor carpi radialis longus muscle is inserted on the dorsal surface and the flexor carpi radialis muscle on the volar surface of the base.

FIG-1 LEFT FIRST METACARPAL SHOWING PALMAR AND LATERAL ASPECTS

FIG-2 AND 3 LEFT SECOND AND THIRD METACARPAL LATERAL AND MEDIAL ASPECTS

It is little smaller than the second. The dorsal aspect of its base presents on its radial side a pyramidal eminence, the styloid process, which extends upward behind the capitate; immediately distal to this is a rough surface for the attachment of theextensor carpi radialis brevis muscle.

The carpal articular facet is concave behind, flat in front, and articulates with the capitate. On the radial side is a smooth, concave facet for articulation with the second metacarpal, and on the ulnar side two small oval facets for the fourth metacarpal.

The fourth metacarpal bone (os metacarpale IV) :

It is shorter and smaller than the third. The base is small and quadrilateral; its superior surface presents two facets, a large one medially for articulation with the hamate, and a small one laterally for the capitate. On the radial side are two oval facets, for articulation with the third metacarpal; and on the ulnar side a single concave facet for the fifth metacarpal.

The fifth metacarpale bone (os metacarpale V, little finger) :

Presents on its base one facet on its superior surface, which is concavo-convex and articulates with the hamate, and one on its radial side, which articulates with the fourth metacarpal. On its ulnar side is a prominent tubercle for the insertion of the tendon of the extensor carpi ulnaris muscle.

The dorsal surface of the body is divided by an oblique ridge, which extends from near the ulnar side of the base to the radial side of the head. The lateral part of this surface serves for the attachment of the fourth Interosseus dorsalis; the medial part is smooth, triangular, and covered by the Extensor tendons of the little finger.

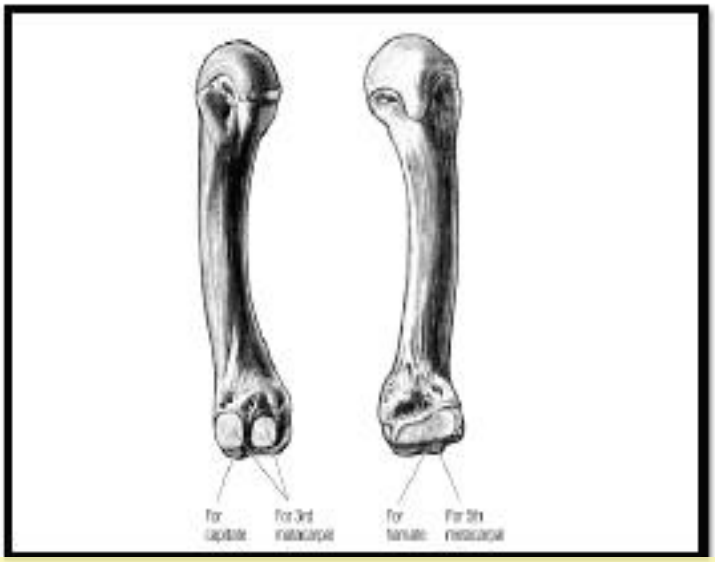


FIG-4 LEFT FOURTH METACARPAL SHOWING LATERAL AND MEDIAL ASPECTS

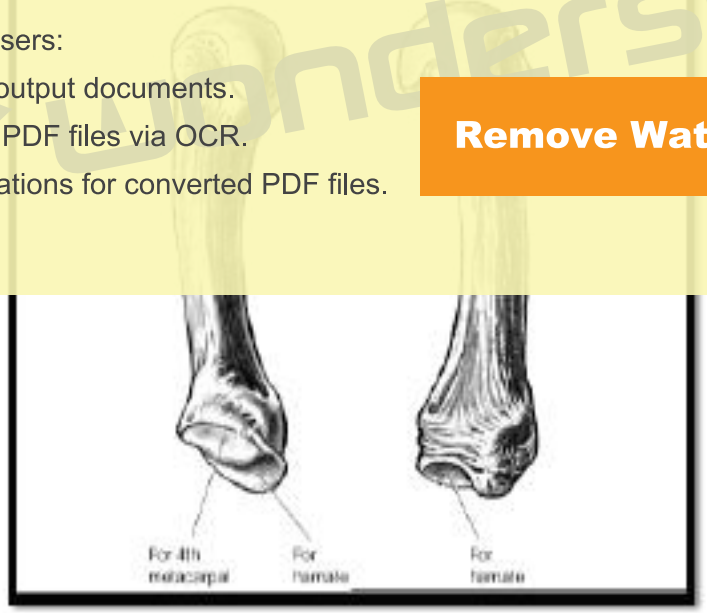


FIG-5 LEFT FIFTH METACARPAL SHOWING LATERAL AND MEDIAL ASPECTS

OSSIFICATION OF HAND SKELETON

Each metacarpal ossifies from a primary centre for the shaft and a secondary centre which is in the base of the first metacarpal and in the heads of the other four. Ossification begins in the mid shaft about the ninth week.

Centres for the second to fifth metacarpal heads appear in that order in the second year in females, and between 1½ to 2½ years in males. They unite with the shafts about the fifteenth or sixteenth year in females, eighteenth or nineteenth in males.

The first metacarpal base begins to ossify late in the second year in females, early in the third year in males, uniting before the fifteenth year in female and [illegible] males. Sometimes the styloid process of the third metacarpal is a separate ossicle.

The thumb metacarpal ossifies like a phalanx . Some authorities therefore consider that the thumb skeleton consists of three phalanges. Others believe that the distal phalanx represents fused middle and distal phalanges, a condition occasionally observed in the fifth toe. When the thumb has three phalanges, the metacarpal has a distal and a proximal epiphysis.

FIG 6 -OSSIFICATION OF HAND SKELETON

CARPOMETACARPAL JOINTS

CARPOMETACARPAL JOINT OF THE THUMB

Articulating surfaces : The carpometacarpal joint of the thumb is a sellar (saddle) joint between the first metacarpal base and trapezium. It enjoys wide mobility due to its extensive articular surfaces and their topology.

Ligaments : The first metacarpal and trapezium are connected by lateral, anterior and posterior ligaments and a fibrous capsule. The broad lateral ligament runs from the lateral surface of the trapezium to the radial side of the metacarpal base. The palmar and dorsal ligaments are oblique bands which connect the palmar and dorsal aspects of the metacarpal base from the palmar and dorsal surfaces of the trapezium respectively.

Synovial membrane : A synovial membrane lines the joint capsule.

Vascular supply : The carpometacarpal joint of the thumb receives its blood supplyfrom the radial artery and its first dorsal metacarpal branch.

Innervation : The carpometacarpal joint of the thumb is innervated by articular twigs from the posterior inter osseous nerve.

Joint movements : Except at initiation, flexion is accompanied by medial rotation; conversely, medial rotation involves flexion. Linkage of movements is due largely to the shape of the articular surfaces (which impose some conjunct rotation), and to the obliquity of the dorsal ligament (which, when taut, anchors the ulnar side of the metacarpal base while its radial side continues to move). Contraction of flexor pollicis brevis, assisted by opponens pollicis, thus produces medial rotation with flexion;

combined with abduction this brings the thumb pulp into contact with the pulps of the slightly flexed fingers, a movement termed opposition. (The flexed fingers have varying degrees of lateral metacarpo phalangeal rotation, which is minimal in the index, but maximal in minimus.) Conversely, full extension of the thumb metacarpal entails slight lateral rotation, attributable to the sellar form of the joint and to the action of the palmar ligament (which is similar to that of the dorsal ligament in flexion).

Muscles producing movements :

The muscles producing movements at the carpo metacarpal joint of the thumb are as Follows

Flexion

Abductor pollicis brevis and opponens pollicis, aided by flexor pollicis longus when the other joints of the thumb are flexed. Flexion entails medial rotation

Extension :

Abductor pollicis longus and extensors pollicis brevis and longus. In full extension extensor pollicis longus, owing to its oblique pull and the disposition of the palmar ligament, rotates the thumb laterally and draws it dorsally, i.e. slightly adducts it.

Abduction :

Abductors pollicis brevis and longus. When abduction is maximal the digit and metacarpal are not in line, and the thumb is abducted at both metacarpophalangeal and carpometacarpal joints.

Adduction :

Adductor pollicis alone.

Opposition :

Opponens pollicis and flexor brevis pollicis simultaneously flex and medially rotate the abducted thumb. Interpulpal pressure, or that generated by digital grasping, is increased by adductor pollicis and flexor pollicis longus.

Circumduction :

Extensors, abductors, flexors and adductors acting consecutively in this, or reverse, Order

SECOND TO FIFTH CARPOMETACARPAL JOINTS

The second to fifth carpometacarpal joints are synovial ellipsoid joints between the carpus and second to fifth metacarpals. Although widely classed as plane, they have curved articular surfaces which are often of complex sellar shape. The bones are united by articular capsules, and dorsal, palmar and inter osseous ligaments

INTERMETACARPAL JOINTS

Articulating surfaces :

The second to fifth metacarpal bases articulate reciprocally by small cartilage-covered facets connected by dorsal, palmar and interosseous ligaments

Fibrous capsule :

The intermetacarpal joints have fibrous capsules.

Ligaments :

The dorsal and palmar ligaments pass transversely from bone to bone. The

Synovial membranes:

The

Movements at the carpometacarpal and intermetacarpal joints :

Movements at the carpometacarpal and intermetacarpal articulations are limited to slight gliding, sufficient to permit some flexion-extension and adjunct rotation: ranges vary in different joints. They are partly accessory movements occurring when the palm is 'cupped', as in grasping an object.

The fifth metacarpal is most movable and the second and third are the least mobile.

Muscles producing movements :

Movements at carpometacarpal and intermetacarpal joints are effected by the flexors and extensors of the second to fifth digits.

METACARPOPHALANGEAL JOINTS

The metacarpo phalangeal joints are usually considered ellipsoid. However, the metacarpal heads are adapted to shallow concavities on the phalangeal bases: they are not regularly convex but partially divided on their palmar aspects and thus almost bicondylar

Fibrous capsule :

The metacarpophalangeal joints all have fibrous capsules

Ligaments :

Each metacarpophalangeal joint has a palmar and two collateral ligaments.

Palmar ligaments are fibrocartilaginous, and sited between, and connected to, the collateral ligaments. They are attached loosely to the metacarpals but firmly to the phalangeal bases. Their palmar aspects are blended with the deep transverse palmar ligaments and are grooved for the flexor tendons, whose fibrous sheaths connect with the sides of the grooves. Their deep surfaces increase articular areas for the metacarpal heads.

Deep transverse metacarpal ligaments :

The deep transverse metacarpal ligaments are three short, wide, flat bands which connect the palmar ligaments of the second to fifth metacarpophalangeal joints. They are related anteriorly to the lumbricals and digital vessels and nerves, and posteriorly

to the interossei. Bands from the digital slips of the central palmar aponeurosis join their palmar surfaces.

On both sides of the third and fourth metacarpophalangeal joints, but only the ulnar side of the second and radial side of the fifth, transverse bands of the dorsal digital expansions join the deep transverse metacarpal ligaments. The lumbricals and the phalangeal attachments of the dorsal interossei lie anterior to this band, and the remaining attachments of dorsal interossei and palmar interossei are posterior to it.

Collateral ligaments :

The collateral ligaments are strong, round cords which flank the joints. Each is attached to the posterior tubercle and adjacent pit on the side of its metacarpal head and each passes distoanteriorly to the side of the anterior aspect of its phalangeal base.

FIG 8 – PALMAR AND DEEP TRANSVERSE LIGAMENTS

Synovial membrane :

The metacarpophalangeal joints are lined by a synovial membrane

Vascular supply

The metacarpophalangeal joints receive their blood supply from the dorsal and palmar metacarpal arteries, the arteria princeps pollicis, and the arteria radialis indicis.

Innervation

The metacarpophalangeal joints are innervated by twigs from the palmar digital branches of the median nerve, the deep terminal branch of the ulnar nerve, and the posterior interosseous nerve.

Joint movements

Flexion is almost 90°, whereas extension is only a few degrees: both movements are limited mostly by antagonistic muscles. Flexion is often terminated by the resistance offered by a grasped object.

The metacarpophalangeal joint of the thumb has a flexion-extension range of 60°, which is almost entirely flexion. Other movements are adduction-abduction (maximal range 25°), which invariably accompanies the corresponding carpo metacarpal movements and increases their combined range, and slight conjunct rotation, but greater adjunct rotation, which accompanies flexion-extension. Of the second to fifth

metacarpophalangeal joints, the second is most mobile in adduction-abduction followed by the fifth, fourth, and third.

Muscles producing movements :

The muscles producing movements at the metacarpophalangeal joints are as follows

Flexion :

Flexors digitorum superficialis and profundus, assisted by the lumbricals and interossei and, in the minimus, flexor digiti minimi brevis. In the thumb, flexors pollicis longus and brevis and the first palmar interosseous. Slight lateral rotation accompanies digital flexion of digits 3-5. Flexion of the index finger may be accompanied by minimal lateral rotation or no rotation; a small amount of rotation is frequently observed.

Extensors

Extensor digitorum, assisted in the second and fifth digits by extensor indicis and extensor digiti minimi respectively. In the thumb, extensors pollicis longus and brevis.

Adduction :

In extended fingers, palmar interossei; the long flexors are predominant during flexion. In the thumb, limited metacarpophalangeal adduction is possible and may be attributable to adductor pollicis and the first palmar interosseous.

Abduction :

In extended fingers, dorsal interossei assisted by the long extensors (except in the middle finger), and abductor digiti minimi in the little finger. In the thumb, abductor pollicis brevis (which also contributes to opposition). When the fingers are flexed at

the IP joints, active abduction is impossible: if the long digital flexors are inactive, passive abduction is free.

Inability to abduct actively in this position may be due to shortening of the dorsal interossei and abductor digiti minimi by flexion. However the altered line of pull of the interossei relative to the axis of movement is probably the determining factor: in digital extension the axis of lateral movements is anteroposterior, whereas in flexion it is proximodistal, and the line of pull of the interossei is then nearly parallel to the axis.

muscles.

Abductor digiti minimi, flexor digiti minimi brevis and opponens digiti minimi all act on the little finger and are known collectively as hypothenar muscles.

Interossei and lumbricals act on the fingers.

Palmaris brevis is a superficial muscle which lies beneath the ulnar palmar skin.

FLEXOR POLLICIS BREVIS :

Attachments :

It has superficial and deep parts. The superficial head arises from the distal border of the flexor retinaculum and the distal part of the tubercle of the trapezium .It is attached, by a tendon containing a sesamoid bone, to the radial side of the base of the proximal phalanx of the thumb.

The deep part arises from the trapezoid and capitate bones and from the palmar ligaments of the distal row of carpal bones. It unites with the superficial head on the sesamoid bone and base of the first phalanx.

Innervation :

The superficial head of flexor pollicis brevis is usually innervated by the lateral [illegible] of the me[illegible] innervated by the deep branch of the ulnar nerve, C8 and T1

Action :

Flexor pollicis brevis flexes the metacarpophalangeal joint.

ABDUCTOR POLLICIS BREVIS

Attachments :

It arises mainly from flexor retinaculum: a few fibres spring from the tubercles of the scaphoid bone and trapezium, and from the tendon of abductor pollicis longus. Its medial fibres are attached by a thin, flat tendon to the radial side of the base of the

proximal phalanx of the thumb. Its lateral fibres join the dorsal digital expansion of the thumb.

Innervation :

Abductor pollicis brevis is innervated by the lateral terminal branch (motor branch) of the median nerve, C8 and T1.

Action :

Abductor pollicis brevis draws the thumb ventrally in a plane at right angles to the palm of the hand (abduction).

OPPONENS POLLICIS :

Attachments :

It arises from the tubercle of the trapezium and flexor retinaculum, and is attached to the whole length of the lateral border, and the adjoining lateral half of the palmar surface of the metacarpal bone of the thumb.

Innervation :

Opponens pollicis is innervated by the lateral terminal branch of the median nerve, C8 and T1

Action :

Opponens pollicis flexes the metacarpal bone of the thumb

ADDUCTOR POLLICIS :

Attachments :

Adductor pollicis arises by oblique and transverse heads). The oblique head is attached to the capitate bone, the bases of the second and third metacarpal bones, the palmar ligaments of the carpus and the sheath of the tendon of flexor carpi radialis. Most of the fibres converge into a tendon which unites with the tendon of the transverse head, and is attached to the ulnar side of the base of the proximal phalanx of the thumb

The transverse head is the deepest of the pollicial muscles. It is triangular, and arises from the distal two-thirds of the palmar surface of the third metacarpal. The fibres converge to be attached, with the oblique head and the first palmar interosseus, to the base of the proximal phalanx of the thumb.

Adductor pollicis is innervated by the deep branch of the ulnar nerve, C8 and T1.

Action :

Adductor pollicis approximates the thumb to the palm of the hand. It acts to greatest advantage when the abducted, rotated and flexed thumb is opposed to the fingers in gripping.

ABDUCTOR DIGITI MINIMI :

Attachments :

Abductor digiti minimi arises from the pisiform bone, the tendon of flexor carpi ulnaris and the pisohamate ligament .It divides into two slips. One is attached to the ulnar side of the base of the proximal phalanx of the little finger, and the other to the ulnar border of the dorsal digital expansion of extensor digiti minimi.

Innervation :

Abductor digiti minimi is innervated by the deep branch of the ulnar nerve, C8 and T1.

Action :

Abductor digiti minimi abducts the little finger away from the fourth.

FLEXOR DIGITI MINIMI BREVIS:

Attachments :

Flexor digiti minimi brevis arises from the convex surface of the hook of the hamate and the palmar surface of the flexor retinaculum. It inserts into the ulnar side of the base of the proximal phalanx of the little finger with abductor digiti minimi.

Innervation :

Flexor digiti minimi brevis is innervated by the deep branch of the ulnar nerve, C8 and T1.

Action :

Flexor digiti minimi brevis produces flexion of the little finger at its etacarpophalangeal joint, together with some lateral rotation.

OPPONENS DIGITI MINIMI :

Attachments :

It arises from the convexity of the hook of the hamate, and the contiguous portion of flexor retinaculum. It inserts along the whole length of the ulnar margin of the fifth metacarpal bone, and the adjacent palmar surface.

Innervation :

Action :

Opponens digiti minimi flexes the fifth metacarpal bone, These actions, together with flexion and some lateral rotation at the metacarpophalangeal and interphalangeal joints, bring the digit into opposition with the thumb.

PALMARIS BREVIS :

Attachments :

Palmaris brevis is a thin, quadrilateral muscle, lying beneath the skin of the ulnar side of the palm . It arises from the flexor retinaculum and the medial border of the central

part of the palmar aponeurosis, and is attached to the dermis on the ulnar border of the hand.

Innervation :

Palmaris brevis is innervated by the superficial branch of the ulnar nerve, C8 and T1.

Action :

Palmaris brevis wrinkles the skin on the ulnar side of the palm of the hand and deepens the hollow of the palm by accentuating the hypothenar eminence. In this way it may contribute to the security of the palmar grip.

Palmar Interossei :

Attachments :

Palmar interossei are smaller than dorsal interossei and lie on the palmar surfaces of the metacarpal bones rather than between them.

With the exception of the first, each of the four arises from the entire length of the metacarpal bone of one finger, and passes to the appropriate (adductor) side of the dorsal digital expansion.

The middle finger has no palmar interosseus. The remaining digits have palmar interossei on their aspects which face the middle finger.

First palmar interosseus often very rudimentary because the thumb has its own powerful adductor

Innervation :

All the interossei are innervated by the deep branch of the ulnar nerve, C8 and T1.

Action :

Palmar interossei adduct the fingers to an imaginary longitudinal axis through the centre of the middle finger

Dorsal interossei consist of four bipennate muscles, each arising from the adjacent sides of two metacarpal bones, but more extensively from the metacarpal bone of the finger into which the muscle passes

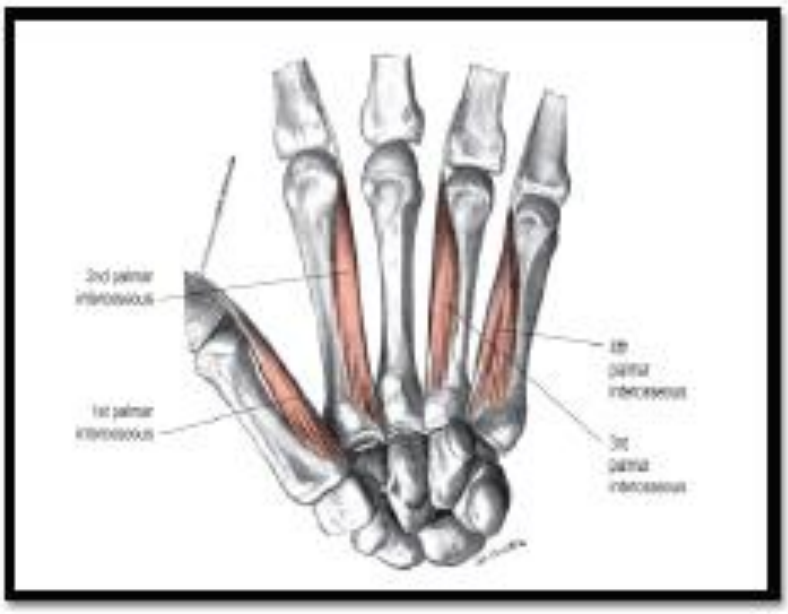


FIG- 10 PALMAR INTEROSSEUS ATTACHMENTS

FIG- 11 DORSAL INTEROSSEUS ATTACHMENTS

They insert on the bases of the proximal phalanges and separately into the dorsal digital expansions.

Innervation :

All the interossei are innervated by the deep branch of the ulnar nerve, C8 and T1.

Action :

Dorsal interossei abduct the fingers from an imaginary longitudinal axis through the centre of the middle finger.

Innervation :

The first and second lumbricals are innervated by the median nerve, C8 and T1, and the third and fourth lumbricals by the deep terminal branch of the ulnar nerve, C8 and T1.

Action :

Lumbricals arise from flexor tendons and insert into the extensor apparatus. Since both attachments are mobile, they have the potential for producing movement at either. The action on the extensor apparatus is easier to understand and consists of extension of both interphalangeal joints in a coordinated manner and at the metacarpophalangeal joint through flexion via a rocking

SPECIAL FUNCTIONS OF THE HAND

POSITION OF REST

The hand has a well-recognized position of rest, with the wrist in extension and the digits in some degree of flexion. The precise position of the thumb in the position of rest appears to be rather variable. Typically it is considered as the midpoint between maximal palmar abduction and maximal retro position. In this position the carpo metacarpal joint lies within 20° of radial abduction and 30° of palmar abduction, and from clinical observations it seems that the metacarpo phalangeal joint lies within c.40° of flexion and the inter phalangeal joint between extension and 10° of flexion.

From different positions of the arc of circumduction, numerous different types of pinch are possible. In clinical practice a

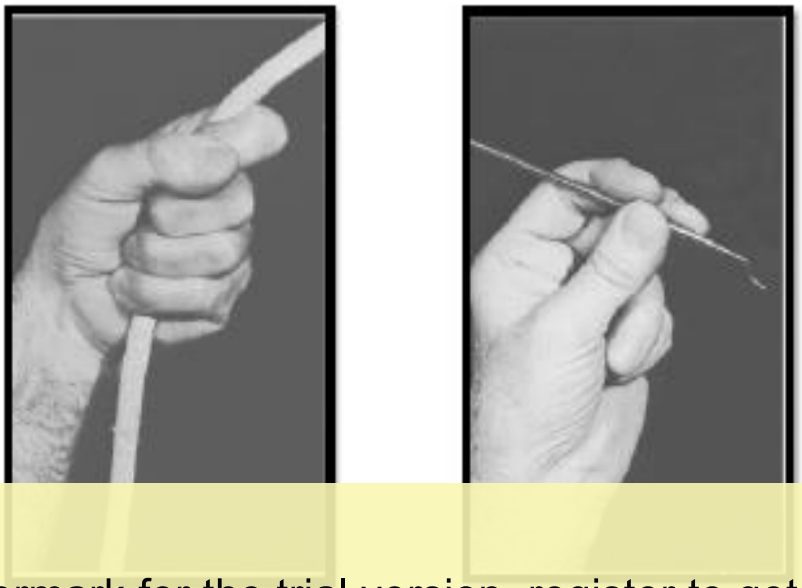
Many varieties of functional posture that may be adopted by the human hand;

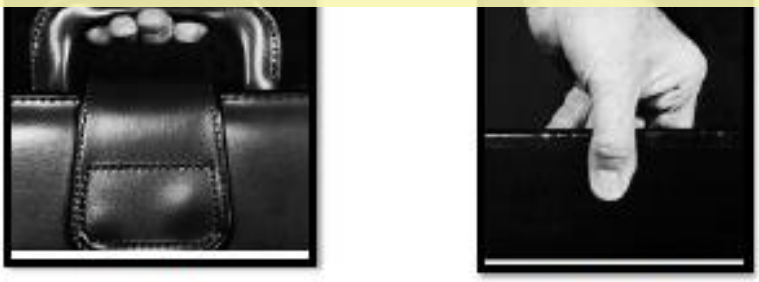
Power grip : In the power grip, the fingers are flexed around an object, with counter pressure from the thumb. Any skill in wielding the object derives from the limb, including the wrist; relative movements of the thumb and fingers are not involved.

Precision grip : which varies considerably with the task, stabilizes the object between the tips of one or more fingers and the thumb. The gross position of the object may be adjusted by movements at the wrist, elbow, or even shoulder, but the most skilled manipulations are carried out by the digits themselves, e.g. in advancing a thread through the eye of a needle.

Hook grip : The hook grip is used to suspend or to pull open objects. The fingers are flexed around the object; the thumb may or may not be involved. It is a grip for the transmission of forces, not for skillful manipulation.

Lateral pinch grip : Powerful opposition of the thumb to the radial side of the index finger produces a lateral pinch grip, e.g. to hold a door key; here the object is larger than a key, and all the fingers are involved





Hook grip Lateral pinch

FIG -12 VARIOUS HAND GRIPS

FUNCTIONAL POSITION OF THE HAND

The metacarpal fractures of the hand is best managed by immobilizing it in the functional position.

The position of function is assumed by the hand when all muscles are in relaxed balance.

Functional position of the hand is that position, in which the hand has the most function and is least susceptible to develop joint stiffness and contractures.

The injured hand usually tend to stiffen in a position of non-function i.e. flexion of the wrist, abduction of the metacarpo-phalangeal joints and extension of the proximal interphalangeal joints and adduction of the thumb. This is mainly due to the greater strength of the collateral ligaments as compared to the flexors. Stiffness is aided by oedema, fibrosis, stiffness.

The chief targets are the metacarpo-phalangeal joints. Following trauma, synovial fluid increases in the joint. Metacarpo-phalangeal joints go into a position just short of full extension. As, flexor tone is greater than extensor tone, the proximal and distal inter phalangeal go into flexion.

Flexor power of the wrist being stronger, the wrist goes into flexion.

Inter phalangeal joints :

Collateral ligaments originates, in the centre of axis of rotation in a concentric arc. Central fibres are taut in all positions while the volar become taut in extension and dorsal fibres in flexion.

The volar plates are attached firmly to the ligamentous structures proximally, which is why, when the joints are flexed; they undergo shortening and prevent extension later.

Thus the ideal position of immobilization of inter phalangeal joints is full extension.

Metacarpo phalangeal joints :

Collateral ligaments arise dorsal to the axis of rotation of the metacarpal head and are taut in flexion and relaxed in extension. The volar plates of metacarpophalangeal joints do not have firm proximal ligamentous attachments and in flexion do not fold. Hence the volar plates take a longer time to contract. Hence ideal position of immobilization, of metacarpo-phalangeal joints is flexion. In flexion metacarpo-phalangeal joints are stable and lateral movements such as extension abduction and adduction movement do take place.

FIG – 13 FUNCTIONAL POSITION OF HAND

FIG -14 ASSESSMENT OF MALROTATION

THUMB

Main aim is prevention of adduction contracture, hence the thumb is kept in a position of abduction.

WRIST

In dorsiflexion of the wrist neither the flexors nor the extensors are inhibited hence dorsiflexion is the ideal position of immobilization.

Thus in functional position wrist is in 10°dorsiflexion, metacarpo-phalangeal joints in 90° of flexion and inter phalagneal joints in full extension and thumb in full abduction and in line with the axis of the radius.

Normally, all fingers point toward region of scaphoid when fist is made. Malrotation at fracture causes affected finger to deviate.

Observing the plane of the fingernails at the time of reduction or fixation helps to determine rotation; passively flexing all fingers fully at the metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints at one time also helps to verify the appropriate fracture rotation after fracture reduction or internal fixation.[22]

TYPES OF FRACTURE AND METHODS OF TREATMENT OF METACARPAL FRACTURES(SECOND TO FIFTH METACARPAL BONES)

CLASSIFICATION :

Currently, treatment of metacarpal fracture is based on its anatomic location, whether it is stable or unstable, and the degree of comminution.

Fractures of the metacarpal may be classified according their anatomic location :

1. Metacarpal Head
2. Metacarpal neck
3. Metacarpal shaft, and
4. Base of the metacarpal

Classification based on direction of fracture plane :

1. Transverse

2. Spiral

3. Oblique

4. Comminuted

Metacarpal Head Fractures :

Fractures of the metacarpal head are rare and are usually intra-articular

These fractures are usually the result of axial loading or direct trauma (crush or clenched-fist injury).

The injury involved the index metacarpal most frequently, presumably because it is a border digit and its metacarpal base is fixed to the carpus

Comminuted fractures occurred most commonly. Half the patients with comminuted fractures had loss of more than 45 degrees of flexion at the MCP joint. Articular defects may remodel with time; and unlike weight-bearing joints, an incongruous MCP joint may function satisfactorily with painless motion.

Treatment of these fractures must be individualized.Displaced ligament avulsion fractures and osteochondral fragments can be satisfactorily treated by ORIF.

Non-comminuted fractures with more than 25% of the articular surface involved or at least 1 mm of articular step-off

Two part coronal, sagittal, and oblique intra-articular fractures are best managed by ORIF with Kirschner pins or interfragmentary screws.

The most common complication of intra-articular metacarpal head fractures is stiffness. This may result from extensor tendon adhesions, collateral ligament or dorsal capsular contracture, or articular incongruity

Metacarpal Neck Fractures

Metacarpal neck fractures are common and usually involve the ring and small metacarpals.

"Boxer's fracture" is really a misnomer. Fractures of the fifth metacarpal neck are rarely seen in professional boxers; they are far more common in brawlers and in people who hit solid objects such as walls.

These fractures invariably occur when a clenched MCP joint strikes a solid object and angulates with its apex dorsal. Apex dorsal angulation occurs because

(1) The impact occurs on the dorsum of the metacarpal head and causes comminution of the volar metacarpal neck; and

(2) The intrinsic muscles that cross the MCP joint lie volar to its axis of rotation and maintain a flexed metacarpal head posture

Controversy exists regarding the optimum treatment of [illegible] varies from nonoperative treatment to a variety of techniques for internal fixation.

Nonoperative treatment, however, may [illegible] the ring and small finger carpometacarpal (CMC) joints have 20 to 30 degrees of mobility in the sagittal plane, whereas the index and middle CMC joints have less mobility. Therefore, angulation can be better compensated for in the ring and small fingers.

Because of the lack of compensatory CMC motion, there is almost universal agreement that residual angulation over 10 to 15 degrees in fractures of the index and middle metacarpal necks should not be accepted

METHODS OF TREATMENT

Closed reduction and immobilization with plaster :

90-90 method (Jahas)[39]: This method takes advantage of the anatomic fact that the collateral ligaments of the MP joint are tight when the joint is flexed to 90°. With the tight collateral ligaments holding the loose metacarpal head the PIP joint is flexed and the bone of the proximal phalanx is used to push the metacarpal head back into position. Because of the inherent instability of this fracture, Jahss maintained the reduction in plaster with the finger flexed 90° at the MP joint and 90° at the PIP joint, the 90-90 position.

Closed reduction and percutaneous pin fixation :

Metacarpal should be transfixed to the adjacent intact metacarpal(s) with smooth ‘ K' wires introduced transversely proximal and distal to the fracture site.

Only intra medullary pin fixation or a combination of intra medullary and transverse pins can also use. The pins are generally left in place for 3-4 weeks, during which time the patient may be allowed to use the hand. The major advantage is that early motion can be started without external splinting.

External fixation :

With anderson, AO and mini Haffman devices. External fixation techniques are rarely necessary in fractures of the metacarpal neck.

Open reduction and internal fixation :

In acute metacarpal neck fracture ORIF is rarely indicated and is reserved for those unusual instances in which the head has been displaced entirely from the shaft of the metacarpal.

FRACTURES OF THE METACARPAL SHAFT

Fractures of the metacarpal shaft are of four types :

- Transverse
- Spiral
- Oblique
- Comminuted.

Transverse fractures are usually produced by axial loading through the metacarpal head or by a direct blow. The fracture angulates with the apex dorsal because the interosseous muscles are the deforming force.

Oblique and spiral fractures are usually the result of torsional forces and can cause rotational malalignment. Five degrees of malrotation in a metacarpal fracture can cause 1.5 cm of digital overlap.

Comminuted fractures are usually produced by direct impact, are often associated with soft tissue injury, and may produce shortening

Indication for operative procedures includes presence of multiple fractures(especially spiral or oblique), fractures of the index or small finger , open fractures,especially those with bone loss or concomitant soft tissue injury, and fractures in polytrauma victims who cannot cooperate or tolerate cast immobilization.

METHODS OF TREATMENT:

Closed Reduction and Plaster Immobilization :

Closed reduction with plaster immobilization works well for the majority of metacarpal shaft fractures, and overtreatment is to be avoided. Many metacarpal fractures are inherently stable and may be treated with minimal or no immobilization.

Clam-digger cast for a metacarpal shaft fracture. [22]

The wrist is extended 30 degrees, the MCP joints are flexed 80 to 90 degrees, and the IP joints are extended. Active range of motion is encouraged, and supplemental buddy-taping can help control rotation.

Prolonged immobilization limits joint contractures and mal

Closed Reduction and Percutaneous Pinning

The procedure is greatly facilitated by the use of image intensification. Using an awl, a cortical window is made at the ulnar base of the fifth metacarpal or 1 cm distal to the CMC joints of the other metacarpals. Three or four pre-bent (approximately 300) 0.9-mm pins are inserted and preferably buried proximally within the medullary canal.

Open Reduction

Definite indications for open reduction include:

- Open fractures : particularly those with associated bone loss, soft tissue injury, or additional regional fractures
- Multiple fractures : in such cases the stabilizing effect of the adjacent metacarpals is lost.
- Unstable fractures : especially those that cannot be satisfactorily held by closed or percutaneous techniques. Fractures of the border metacarpals tend to be more unstable and more difficult to control than fractures of the central metacarpal because of the lack of support from soft tissue on both sides.
- Malalignment : Rotational malalignment is seen in spiral and oblique fractures. When correction of a rotational deformity by closed techniques or percutaneous pinning is unsatisfactory, open reduction is often indicated.

Techniques of Open Reduction

- Kirschner Pins
- Intramedullary Fixation
- Interfragmentary Compression Screws
- Plate Fixation
- External Fixation

Metacarpal Base Fractures

Isolated intra-articular fractures of the base of the [illegible] are because of the lack of [illegible] in these joints. Hence, there is no consensus regarding optimal treatment. The

Avulsion fractures from the dorsal base of the index and/or middle metacarpals have been successfully managed both operatively and non-operatively.Justification for surgical reattachment includes restoration of the integrity of the extensor carpi radialis longus or brevis as a functional wrist extensor, reconstitution of the articular surface of the CMC joint, and elimination of a potentially irritating fragment of dorsal bone.

Intraarticular Fracture of the Base of the Fifth Metacarpal

Bora and Didizian called attention to a potentially disabling intraarticular fracture at the base of the fifth metacarpal .If the injury is not reduced properly, a malunion may result in weakness of grip and a painful joint. The joint consists of the base of the fifth metacarpal articulating with the hamate and the adjoining fourth metacarpal.

The extensor carpi ulnaris tendon attaches proximally to the fifth metacarpal dorsal base. The joint permits approximately 30 degrees of normal flexion and extension and the rotation necessary in grasp and in palmar cupping.

then protected by a cast.

FRACTURES OF THE THUMB METACARPAL

Metacarpal Head Fractures

Metacarpal head fractures are unusual because the longitudinally directed force that produces them is usually dissipated at the proximal metaphysis or trapeziometacarpal joint. Displaced intra-articular fractures require anatomic reduction. Fixation can be obtained by fluoroscopically assisted percutaneous Kirschner pin placement or by open reduction

Shaft Fractures

Fractures of the thumb metacarpal occur in three locations: shaft and base fractures of the tra

Shaft fractures are uncommon because of the lack of firm fixation of the proximal portion of the bone and because stress applied to the thumb is usually well tolerated by the strong cortical shaft and is dissipated by the soft cancellous bone at its base

Extra-articular fractures through the base are common and are usually transverse or mildly oblique. They generally occur at the proximal metaphysealdiaphyseal junction and are referred to as epibasal. The fracture is angulated with its apex dorsal such that the distal fragment is adducted and flexed

Closed reduction of an extra-articular metacarpal base fracture is usually easy to accomplish by longitudinal traction, downward pressure on the apex of the fracture,

mild pronation of the distal fragment, and thumb extension. The reduction is usually stable and can be maintained in a thumb spica cast that excludes the distal phalanx.

In fractures angulated greater than 30 degrees, closed reduction and percutaneous pinning (CRIF) is preferred. Open reduction for transverse and oblique basilar thumb metacarpal fractures is rarely necessary.

Fractures of the Base of the Thumb Metacarpal: Bennett's Fracture

In 1882, Bennett, an Irish surgeon, described an intraarticular fracture through the base of the first metacarpal in which the shaft is laterally dislocated by the unopposed pull of the adducted pollicis longus. Reduction by traction is easy, but difficult to maintain

The technique of closed pinning described by Wagner is preferred, but should reduction be unsatisfactory, open reduction is indicated’

- Wagner technique of closed pinning
- Wagner technique of open pinning

Rolando Fracture (Comminuted First Metacarpal Base) :

In 1910, Rolando described a Y-shaped fracture involving the base of the thumb metacarpal that usually does not result in diaphyseal displacement as in a Bennett fracture.

It is found that in most Rolando-type fractures the joint surface fragments can be reasonably well fixed with the use of small wires placed directly under the subchondral bone and supplemented with a larger transarticular and occasionally transmetacarpal pinning

Because of the likelihood of posttraumatic arthritis after these fractures or after intra-articular treated fractures, a wrist reduction is important. Most fractures can be reduced by traction and held by open or closed pinning. Some authors recommend [illegible] with a [illegible] T plate if the articular fragments are of good bone size.

MATERIALS AND METHODS

This present study consists of 50 patients with fracture of metacarpal admitted in Orthopaedics Department in R L Jalappa Medical College and research center,Tamaka,Kolar between from December 2013 to may 2015 and operated with CRIF percutaneous K wire fixation.

INCLUSION CRITERIA :

- Patients in the age group of 16 years and above
- Multiple fractures.

EXCLUSION CRITERIA

- Open fractures.
- Fractures associated with Tendon injuries.
- Fractures with associated Neurovascular injuries.
- Fractures with intra articular extension

All patients were admitted and a careful history was elicited from the patient and / or attendants to reveal the mechanism of the injury and the severity of the trauma, site of the incident, circumstances about which the injury occurred, premorbid medical history and pre-injury functional status.

The patients were then assessed clinically to evaluate their general condition and the local injury.comprehensive examination, not only of the injured limb, but also of all the limbs, to avoid missing the other associated injuries, if any, was done.

The involved extremity was examined for swelling, deformity, local bony tenderness abnormal mobility, crepitus, discoloration, rotational malalignment , skin integrity, neurological and vascular compromise.

Radiographic evaluation included antero posterior and oblique radiographs of affected hand. then immobilization of the hand was done with POP cockup slab.

The patient was then taken up for surgery after investigations and as soon as the patient was medically fit for surgery.

a) Hemoglobin percentage, bleeding time, clotting time.

b) Random blood sugar, blood urea, serum creatinine.

c) Blood grouping and cross matching.

d) Urine for macroscopy, sugar, albumin and microscopy.

e) Other investigations depending on patients premorbid conditions.

Patient is reffered to Physician for fitness to undergo surgery. Preoperatively the affected hand and forearm, axilla was prepared. Consent of the patient or relative was

taken prior to the surgery. A dose of tetanus toxoid and antibitoic were given preoperatively . Most of the patients were operated within 3-5 days of admission.

Out of total 50cases, Metacarpal fractures were treated with CRIF percutaneous K Wire fixation.

INSTRUMENTS AND IMPLANTS

- Drill bit – 2.0mm.
- K wires : 0.8mm to 1.5mm diameter.
- Power or hand drill.
- K wire bender.
- General instruments: Reduction clamps, Mallet,etc.

Hand and distal half of forearm was scrubbed with savlon solution. Pneumatic or esmach's rubber tourniquet was used in all patients after esanguination of blood. Operative site painted with betadine solution. Affected limb was placed over side arm rest. Sterile drapping done.

Fig.16 : POWER DRILL WITH K WIRE

TECHNIQUE OF CRIF WITH KIRSCHNER WIRES:

Metacarpal fractures are reduced by closed methods under C arm and are internally fixed by k-wires.

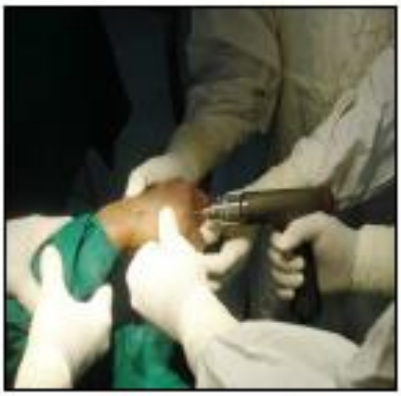
Technique for Retrograde insertion of K Wire[29] :

Reduction was achieved by dorsal pressure over the fracture site and a dorsal push on the metacarpal head on the flexed digit .

Then K-wire was extracted proximally until its distal end was out of head of the metacarpal, Metacarpophalengeal joint is put through full range of motion , confirming the withdrawal of k-wire, then k-wire is cut at the distal end and it is bent to prevent proximal migration .

Proper rotational alignment was determined in relationship to the other fingers by flexing the other fingers to see that it points to the scaphoid tubercle.

PARTS PAINTED AND DRAPED



K-WIRE INSERTED PERCUTANEOUSLY

POST OPERATIVE IMMOBILISATION

Fig 17 : CRIF With K Wire Fixation

Technique for Antegrade insertion of K Wire :

Mohammed, Farook et al.[40] described a single K-wire is pre-bent in a lazy S fashion with a mild bend at approximately 5 millimeters and a longer smooth curve bent in the opposite direction.

Depending on the metacarpal dimensions, either a 1.6 or a 2.0 millimeter mm K Wire is used. Under image intensifier, an initial entry point is made at the base of the involved metacarpal using a 2.5 mm drill wire by hand.

A T-piece mounted K-wire is then inserted blunt end first in an antegrade manner into the medullary canal after fracture reduction. The advancing end of the [illegible] wire is then passed across the fracture site. Final position of the reduction is checked [illegible]

POST OPERATIVE MANAGEMENT

- IV fluids.
- I.V Antibiotics consisting of third generation cephalosporins and amikacin were given.
- Analgesics (Inj. Diclofenac I M) were given
- Half hourly T. P.R.
- Limb was elevated for 24-48 hours.
- Distal neurovascular examination was done.
- Active movements of fingers were advised as early as possible

The wound was inspected on 2nd post operative day. Sutures were removed on 12th day depending on the condition of the wound. Superficial infection were seen in two cases and treated with antibiotics and dressing.

Mean while postoperative check X-ray was taken and POP cast applied in functional position of hand and immoblisied with sling.

The patient was discharged after suture removal with instructions to do active movements of fingers and to wear the sling continuously .

FOLLOW UP

At 4 weeks, the POP cast was removed, clinical examination was done regarding tenderness at fracture site and movements of the affected metacarpo phalangeal joints and inter phalangeal joints. X-rays were taken and signs of callus formation,union was looked at the fracture line.

All the patients showed clinical union and radiologically callus formation by 6 weeks.

In Patients treated with K Wire , at the end of 4 weeks K Wire was removed under local anaesthesia in out patient department if needed.

Regular clinical and radiological follow up was done at an interval 8 weeks and [illegible] malunion, rotation.

By 12 weeks, complete consolidation of fracture site was seen radiologically in all cases and [illegible] follow up.

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. 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	19	38.0
	31 to 40 years	19	38.0
	> 40 years	12	24.0
	Total	50	100.0

In the study 38 patients of them were below 40 yrs age group and 12patients were > 40 years.

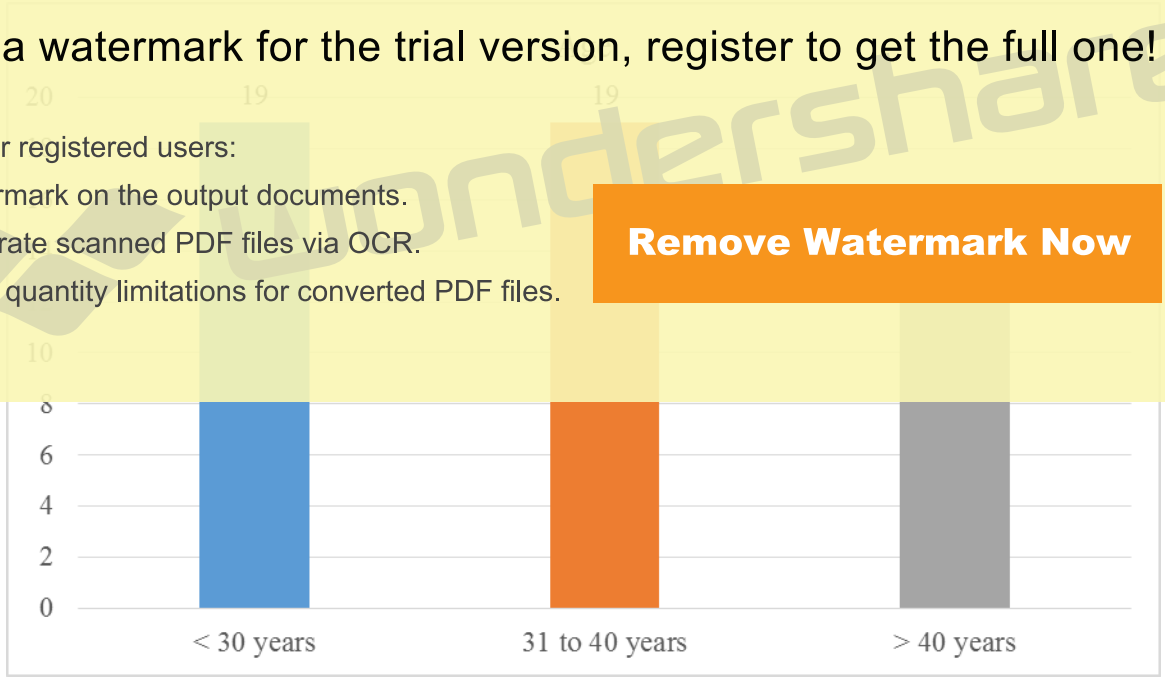


Figure 18: Bar diagram showing Age distribution of subjects

Table 2: Gender distribution of subjects

		Frequency	Percent
Gender	Female	5	10.0%
	Male	45	90.0%

Out of 50 cases 45 were males and 5 were females.

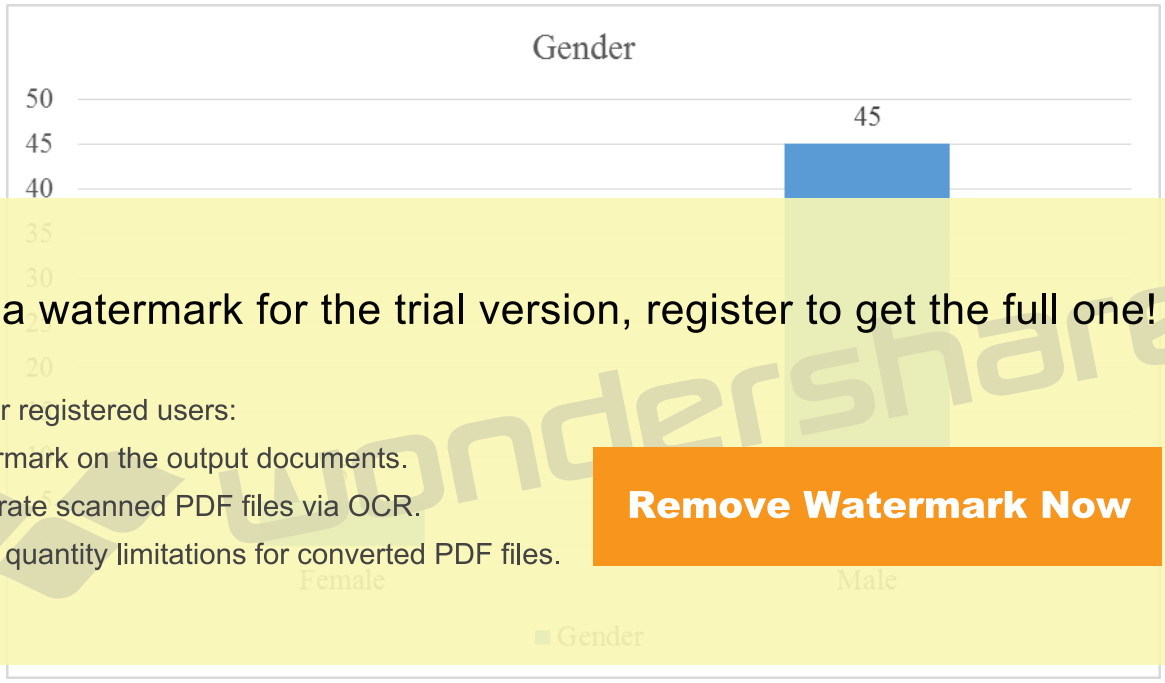


Figure 19: Bar diagram showing Gender distribution of subjects

Table 3: Side of Fracture in subjects

		Frequency	Percent
Side	Left	21	42.0
	Right	29	58.0
	Total	50	100.0

Out of 50 cases 29 had Right side fracture and 21 had left side fracture.

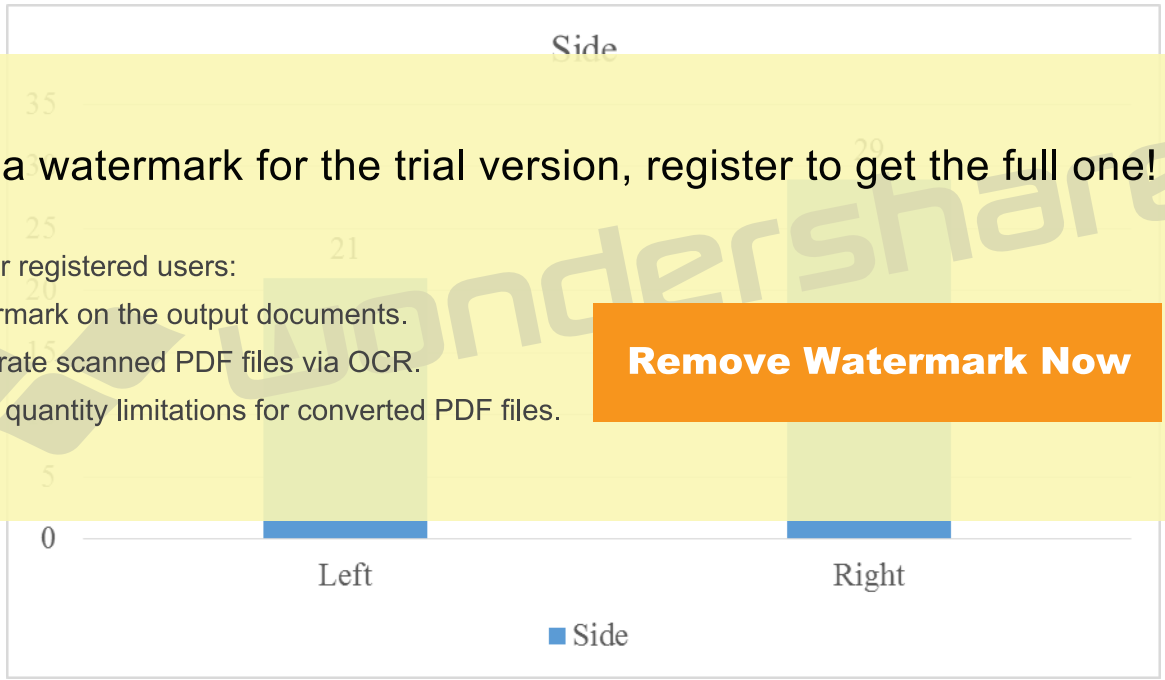


Figure 20: Bar diagram showing Side of Fracture in subjects

Table 4: Metacarpals Fractures in the study

		Frequency	Percent
Metacarpal	I	7	14.0
	I II III IV	2	4.0
	I IV	1	2.0
	II	9	18.0
	II III IV	1	2.0
	II III	3	6.0
	II III IV V	1	2.0
	II III V	1	2.0
	III	1	2.0
	III IV	2	4.0
	III IV V	1	2.0
	IV	4	8.0
	V	12	24.0
		50	100.0

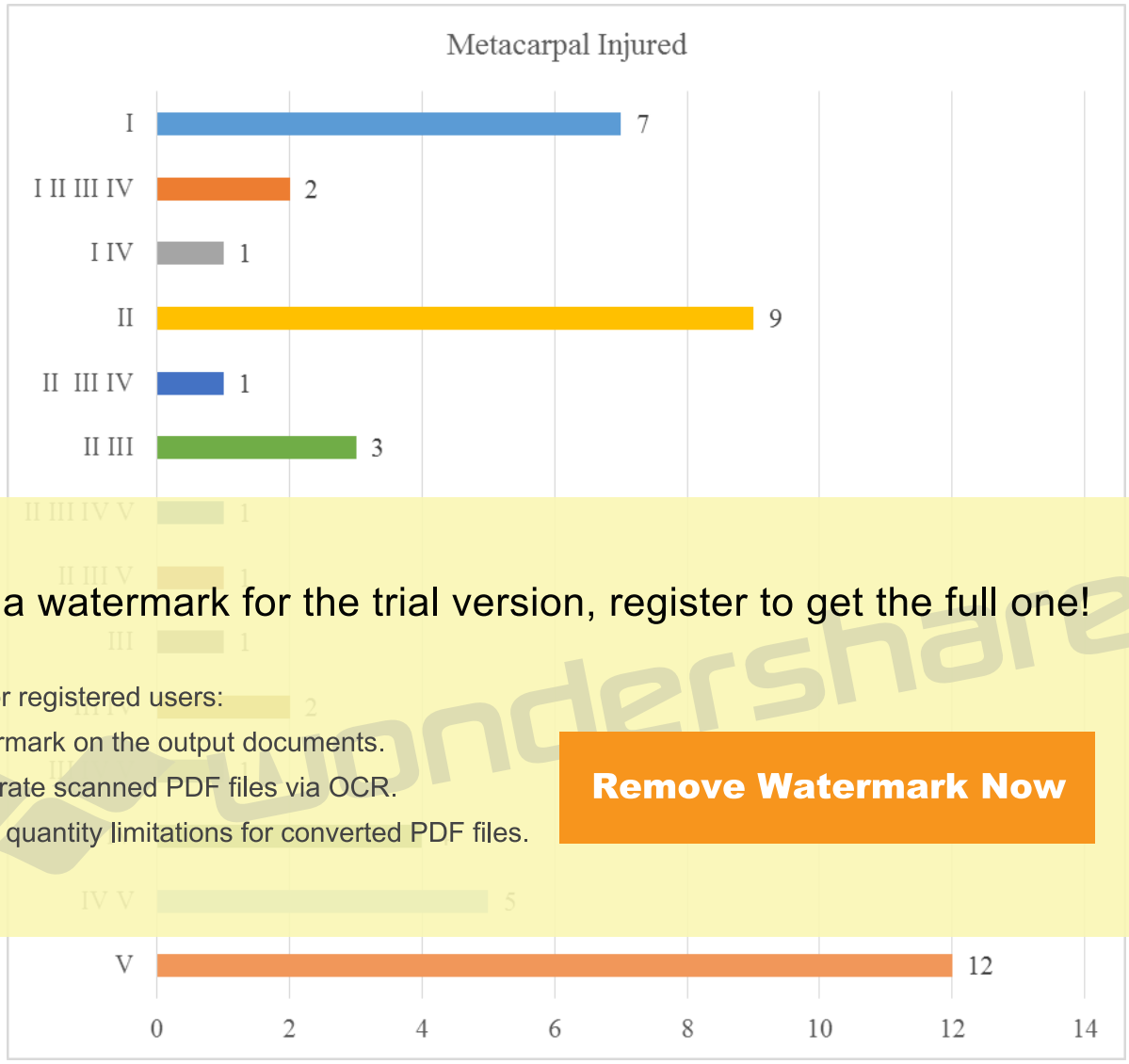


Figure 21: Bar diagram showing Metacarpal Fractured

Table 5: No of Metacarpals Fractured in the study

		Frequency	No of Metacarpal fractured	Percent
No of Metacarpal involved	1	33	33	66.0
	2	11	22	22.0
	3	3	9	6.0
	4	3	12	6.0
	Total	50	76	100.0

In the study 33 cases had one metacarpal fracture, 11cases had 2 metacarpal fracture and 3 cases had 3 and 4 metacarpal fractures respectively.

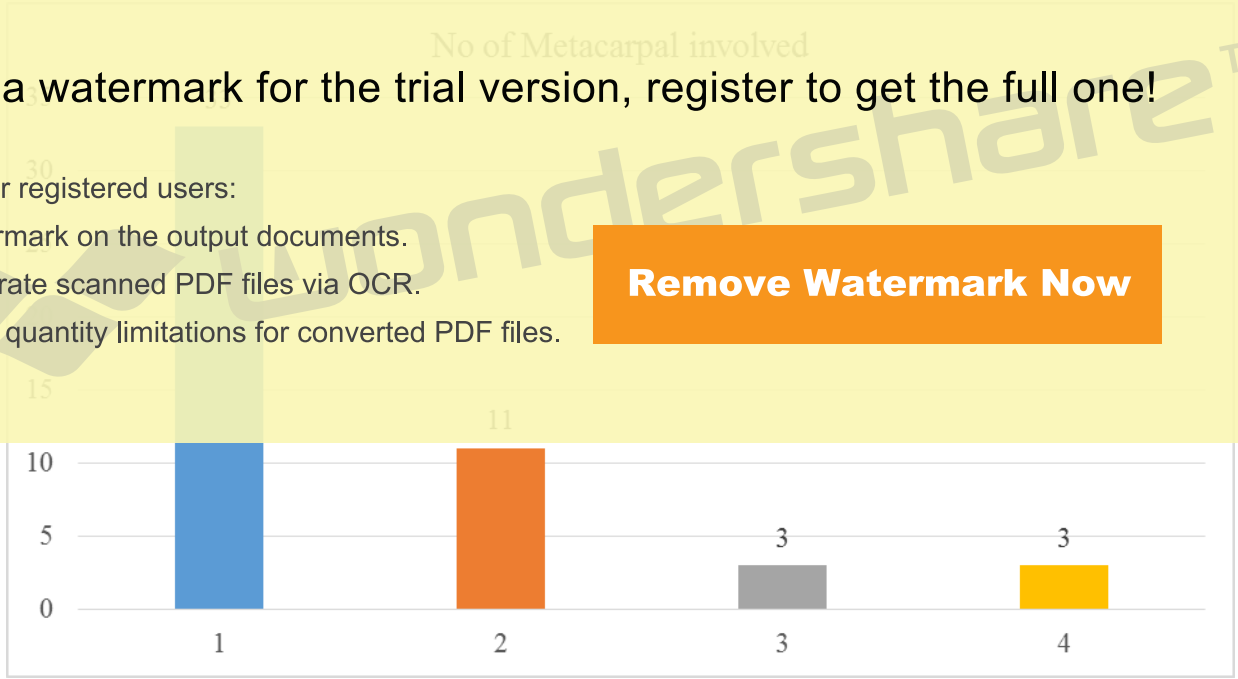


Figure 22: Bar diagram showing No of Metacarpals Fractured in the study

Table 6: Part of Bone Fractured in the study

		Frequency	Percent
	Neck Shaft	34	24
	Neck	12	68
	Shaft & Neck	4	8
	Total	50	100.0

In the study 34 of them had shaft fracture, 12 cases had neck fracture, 4 cases had shaft fracture in combination with neck.

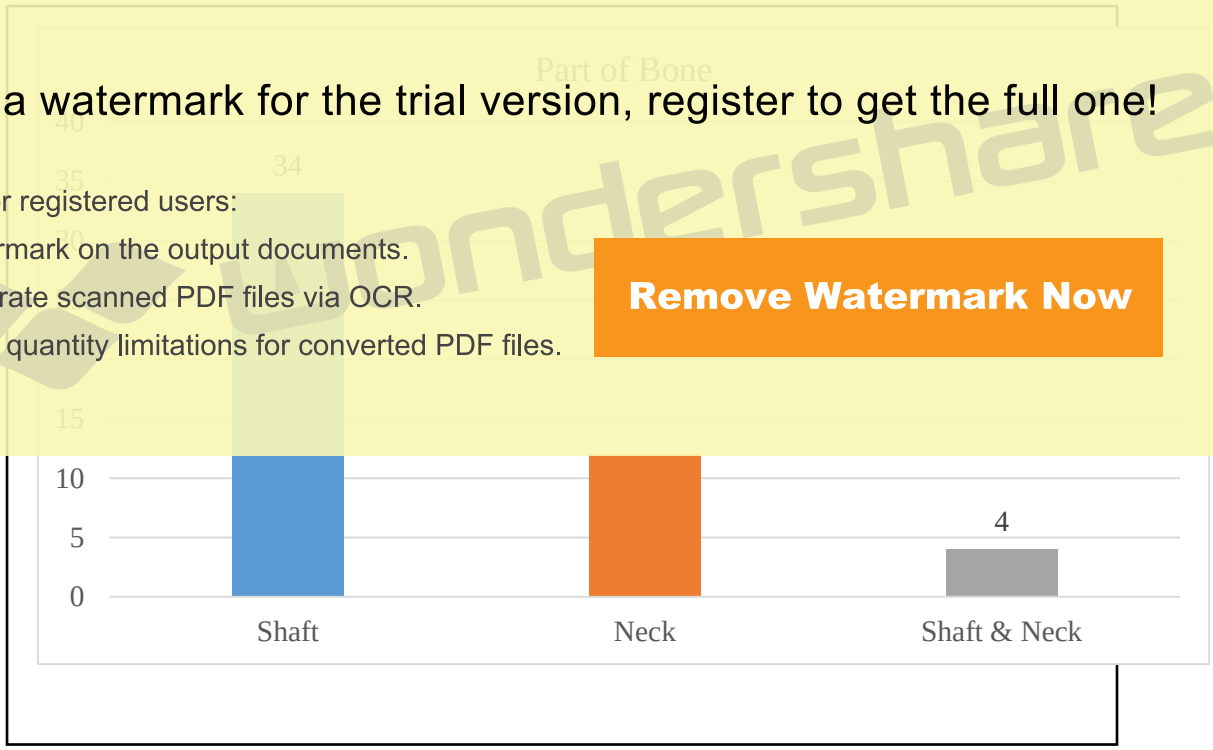


Figure 23: Bar diagram showing Part of Bone Fractured in the study

Table 7: Mechanism of Injury in the study

		Frequency	Percent
Mechanism of Injury	RTA	30	60.0
	Assault	9	18.0
	Fall	5	10.0
	Industrial	4	8.0
	Others	2	4.0
	Total	50	100.0

In the study 30 cases has sustained # in RTA, 9 cases by assault, 5 cases by fall, 4 cases by industrial injuries and 2 by other modes.

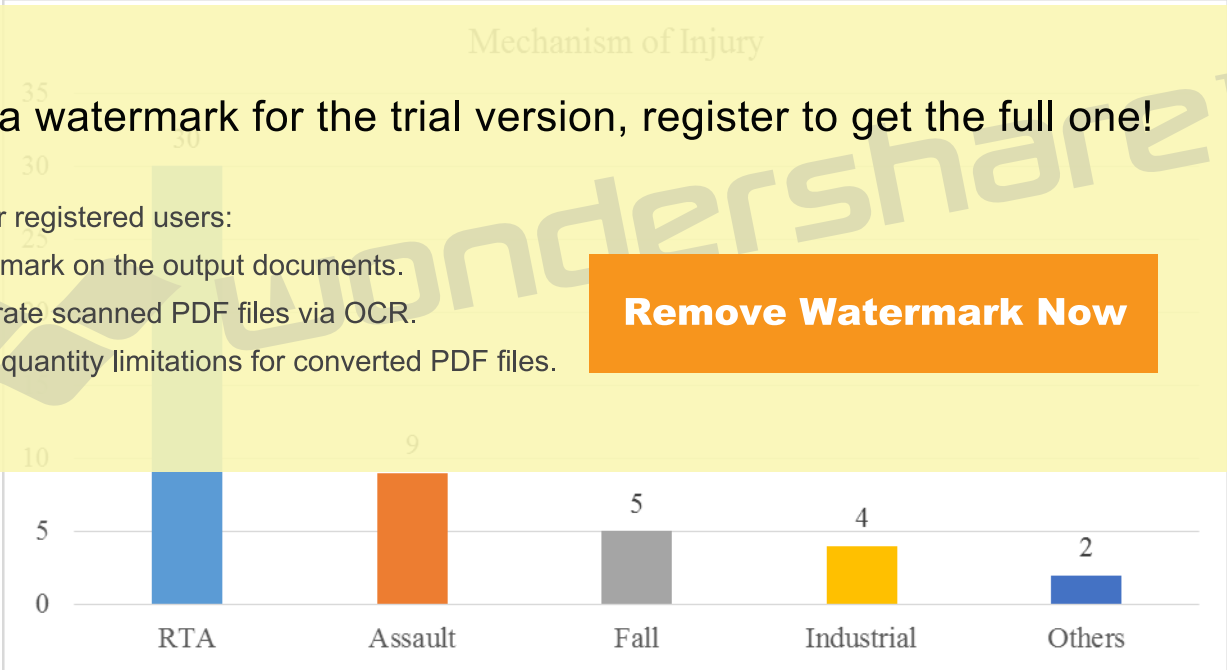


Figure 24: Bar diagram showing Mechanism of Injury in the study

Table 8: Type of Fracture in the study

		Frequency	Percent
Type of Fracture	Transverse	23	46.0
	Short Oblique	20	40.0
	Transverse & Short Oblique	4	8.0
	Long Oblique	1	2.0
	Spiral	1	2.0
	Comminuted	1	2.0
	Total	50	100.0

In this study 23 cases had transverse #, 20 cases had short oblique, 4 cases had Transverse & Short Oblique # and 1case had long oblique #, spiral # & comminuted respectively.

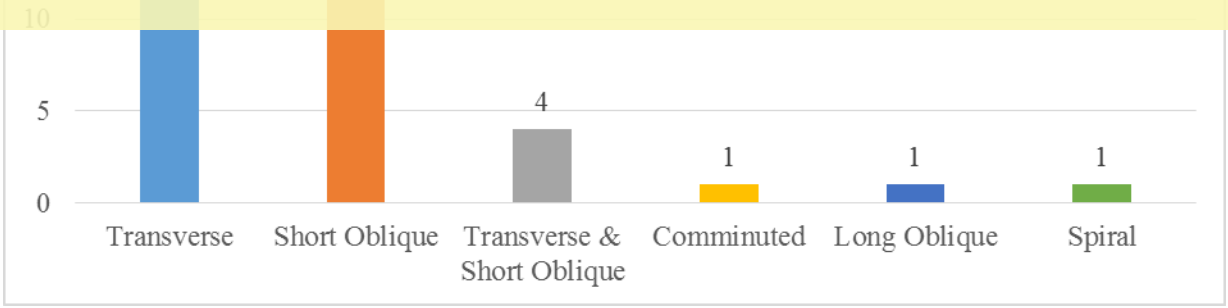


Figure 25: Bar diagram showing Type of Fracture in the study

Table 9: Associated Injuries in the study

		Frequency	Percent
Associated Injuries	Nil	42	84.0
	Both Bone Forearm	2	4.0
	Distal Femur	1	2.0
	Head Injury	1	2.0
	Bimalleolar	1	2.0
	Patella	1	2.0
	Phalyngeal Fracture	1	2.0
	Post Disc of Hip	1	2.0
	Total	50	100.0

In this study 2 cases had Both bone forearm associated injuries and 1 case had Bimalleolar, distal femur, head injury, patella, Phalyngeal fracture & post disc of hip.

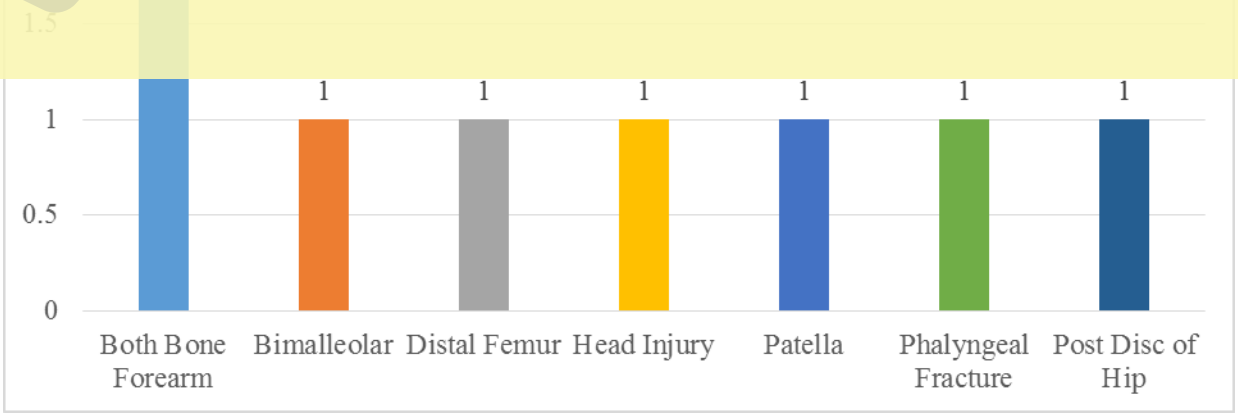


Figure 26: Bar diagram showing Associated Injuries in the study

Table 10: Type of Anaesthesia given in subjects

		Frequency	Percent
Type of Anaesthesia	Wrist Block	41	82.0
	GA	5	10.0
	Axillary Block	4	8.0
	Total	50	100.0

In the present study 41 of them received Wrist block anaesthesia, 5 were operated under GA and 4 by axillary block.

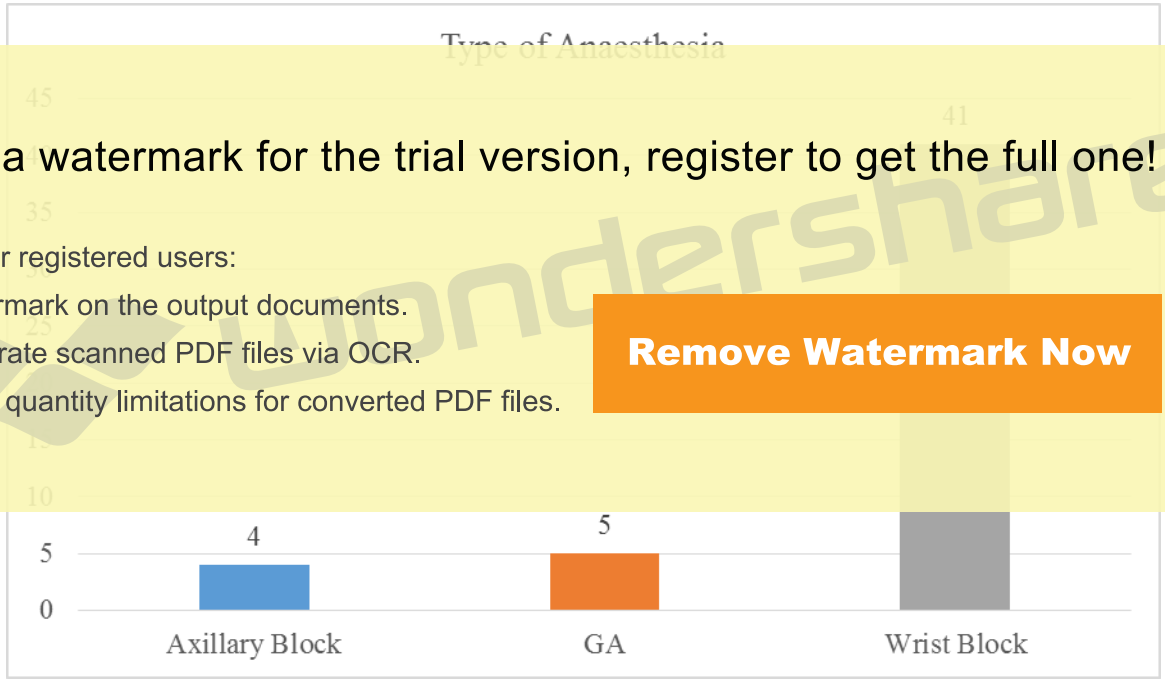


Figure 27: Bar diagram showing Type of Anaesthesia given in subjects

Table 11: Method of wiring done in study

		Frequency	Percent
Method of Wire	Retrograde	40	80
	Antegrade	10	20
	Total	50	100.0

In this study 40 had retrograde wiring, 10 cases had antegrade wiring.

Figure 28: Bar diagram showing Method of wiring done in study

Table 12: Functional Outcome scores in the study

	Functional Outcome (TAM)
Mean	219
Median	220
SD	28.51
Range	130
Minimum	140
Maximum	270

In this study Mean TAM score was 219 ± 28.51.

Table 13: Final results in the study

		Frequency	Percent
Results	Excellent	33	66.0
	Good	13	26.0
	Fair	4	8.0
	Total	50	100.0

In the present study 33 cases had excellent results, 13 had good results and 4 cases had fair results.

Figure 29: Bar diagram showing Final results in the subjects

Table 14: Complications in subjects

		Frequency	Percent
Complications	Nil	35	70.0
	Pain	9	18.0
	Stiffness & Pin tract infection	2	4.0
	Stiffness	2	4.0
	Rotation	1	2.0
	Pain & Rotation	1	2.0
	Total	50	100.0

9 cases had pain, 2 cases had stiffness and stiffness with pin tract infection and 1 case had pain & rotation and rotation respectively as complications.

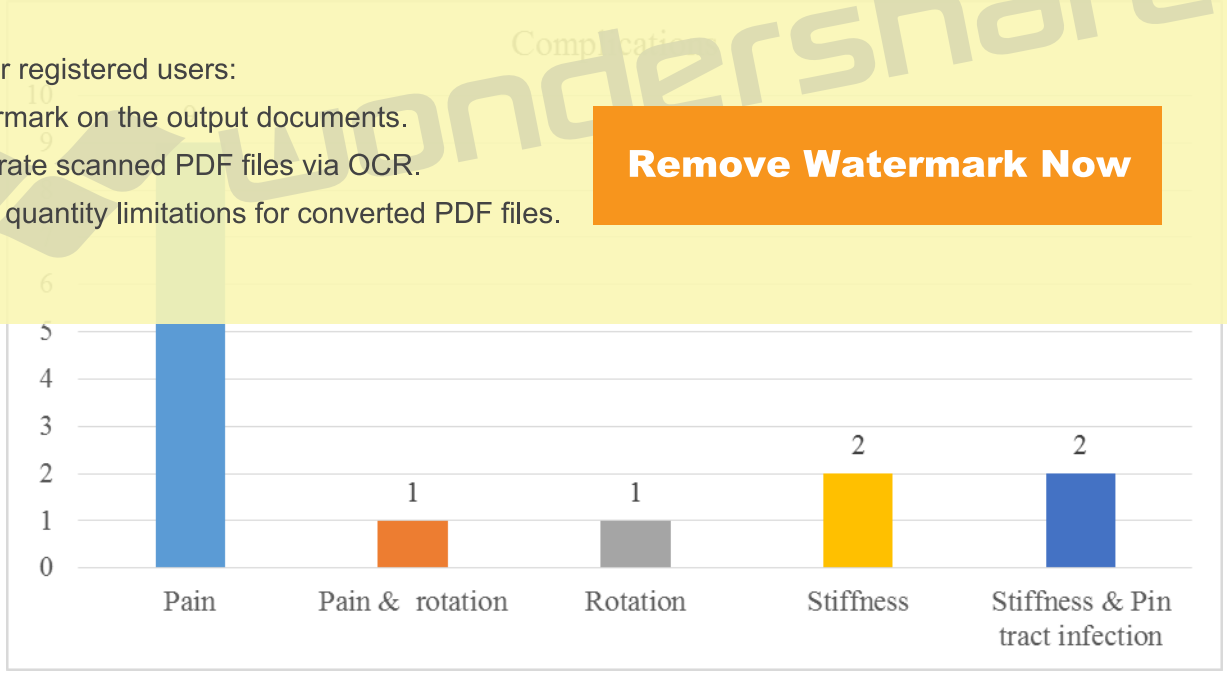


Figure 30: Bar diagram showing Complications in subjects

Table 15: Duration of Union in Weeks in subjects

		Frequency	Percent
Duration Of Union (wks)	8	8	16.0
	10	15	30.0
	12	26	52.0
	14	1	2.0
	Total	50	100.0

In this study 26 cases achieved union in 12 weeks, 15 cases in 10 weeks, 8 cases in 8 weeks and 1 case in 14 weeks.

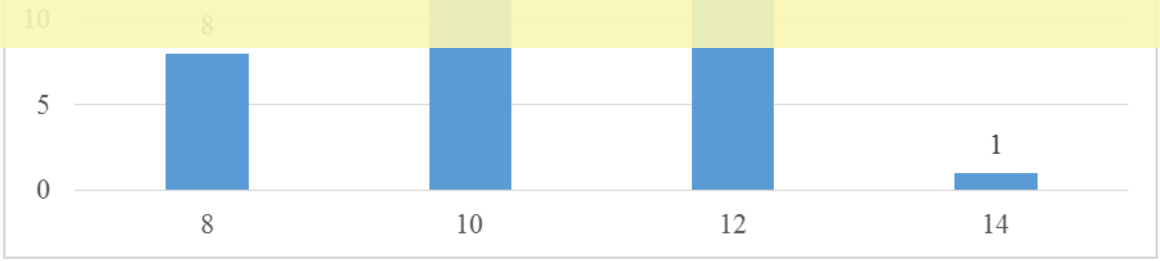


Figure 31: Bar diagram showing duration of union

GRADING OF RESULTS

Results of the operated metacarpal fractures were graded accordingly.

EXCELLENT : Grade I

- Pain free union.
- No symptoms or signs.
- No angular or rotator deformity.
- Range of movements at interphalangeal joints 75° - 100°
- Total active movement (TAM) greater than 250°. (TAM refers to the sum of flexion at the metacarpophalangeal joint, proximal interphalangeal joint and distal interphalangeal joint minus the extension deficit at the same joints).

GOOD : Grade II

- Occasional pain at the fracture.
- Mild oedema
- Clinically united.
- Range of movements at interphalangeal joints atleast 60°
- Minimal rotatory or angular deformity,

- TAM > 180°.

FAIR : Grade III

- Painful movements
- ROM at IP joints <50°
- Deformity
- TAM > 120°
- Pain at fracture site.

DISCUSSION

Fractures of the metacarpal bones of the hand are one of the most frequently encountered orthopaedic injuries constituting between 14-28% of all visits to the hospital following trauma by various means like fall , assault, road traffic accidents, industrial accidents, agricultural accidents etc[3]

Too often these metacarpal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent crippling of fine movements.

Fracture healing in the hand is not an isolated goal; rather the functional result is of paramount importance.

Metacarpal diaphysis is vascularized by longitudinally oriented vessels [illegible] metaphysis. Major disturbance to the blood supply is therefore likely after fracture at shaft level especially if fracture is displaced.

In this clinical study of surgical treatment of 50 cases of metacarpal fractures ,the analysis of the results were made in terms of age of patients, sex distribution, laterality of fracture, mode of violence, analysis of the types of fracture, scoring system, functional outcome and complications.

Patients studied in this series were between the age of 21-90 yrs with maximum incidence being involving the productive age group < 40 yrs which Constitutes 76%, with mean age 36.1 yrs. in comparison to study by Somboon Wutphiriya angkul

(2009)[26] mean age was 26.8 yrs , Facca,Ramadhian et al(2010)[29]with 32.1 and Hassan Boussakri, Mohamad Elidrissi et al (2014)[33] with mean age of 33.9 yrs.

Study	Mean age
Present study	36.1
Somboon Wutphiriya angkul(2009)	26.8
Facca,Ramadhian et al(2010)	32.1
Hassan Boussakri, Mohamad Elidrissi et al (2014)	33.9

In this series majority of the patients were males 90% as compared to study by Somboon Wutphiriya angkul (2009)[26] with 77.2%, Duzgun,Ozkurt et al(2013)[40] with 93% and Hassan Boussakri, Mohamad Elidrissi et al (2014)[33] with 89.2%

Present study	90
Somboon Wutphiriya angkul (2009)	77.2
Duzgun,Ozkurt et al(2013)	93
Hassan Boussakri, Mohamad Elidrissi et al (2014)	89.2

In this series, there is a right hand predominance in 58% as compared to study by Somboon Wutphiriya angkul (2009)[26] with 70.3% and Hassan Boussakri, Mohamad Elidrissi et al (2014)[33] with 89.2%

Study	% of right hand predominance
Present study	58
Somboon Wutphiriya angkul(2009)	70.3
Hassan Boussakri, Mohamad Elidrissi et al (2014)	89.2

In this series all metacarpal fractures were closed injury and compound fractures were not included in this study.

In this series, mode of injury in majority of cases were RTA in 60%, fall in 10%, industrial injury in 8%, assault in 18% and others as 4% as compared to study by Gupta et al.[3] with 60% as trauma and Hassan Boussakri, Mohamad Elidrissi et al (2014)[33] with trauma as 72% and fall in 28%.

Study	% of RTA
Present study	
[illegible]	
Hassan Boussakri, Mohamad Elidrissi et al (2014)	72

Fifth metacarpal was most commonly involved in this series with 24%, followed by second with 18%,

Single metacarpal was involved in 66% of cases,Two metacarpals were involved in 22%,three metacarpals in 6%,four metacarpals in 6%.

In this study metacarpal Shaft fractures was involved in 68%,24% Neck, Shaft and neck in 8% as compared to Gupta et al.[3] with 65% of shaft,12 % in metacarpal neck

and Duzgun,Ozkurt et al(2013)[40] With shaft involvement in 57%,head and neck in 26%

Study	% of shaft involved
Present study	68
Gupta et al (2007)	65
Duzgun,Ozkurt et al(2013)	57

Transverse fractures were the most commonly observed pattern in this study, constituting 46%, short oblique in 40%, transverse and short oblique in 8%,long oblique, comminuted and spiral in 2% each respectively as compared to Gupta et al[3] with transverse fractures in 53%.

Study	% of transverse fractures
Present study	46
Gupta et al (2007)	53

In this study retrograde mode of stabilization was done in 80%,antegrade mode in 20%.

In this present study 82% cases had union between 10 to 12 weeks as compared to Somboon Wutphiriya angkul(2009).[26] witn 92% of cases having union by 12 weeks and Duzgun,Ozkurt et al(2013)[40] With union of 8 weeks in 88%.

Study	% of union by 12 weeks
Present study	82
Somboon Wutphiriya angkul(2009)	92
Duzgun,Ozkurt et al(2013)	88

In our study mean TAM score was 219 compared to Gupta et al(2007)[3].mean TAM score 230 and in Somboon Wutphiriya angkul(2009).[26]as 246.

Study	Mean TAM score
Present study	219
Gupta et al (2007)	230
Somboon Wutphiriya angkul(2009)	246

4%,rotation in 4% compared to Gupta et al.[3] with stiffness in 15%,pin tract infection in 2.2%,rotation in 6.6%, Somboon Wutphiriya angkul.[28] stiffness in 5.1%,pintract infection in 6.8%,rotation in 3.1% and Jiaming Xu et al(2014)[34] with pin tract infections in 6.5%.

Study	% of Pin tract infection
Present study	4
Gupta et al (2007)	2.2
Somboon Wutphiriya angkul(2009)	6.8
and Jiaming Xu et al(2014)	6.5

In our study 66% had excellent results, 26% had good results, 8% had fair results in view of complications such as pintract infection,stiffness and rotation as compared to Gupta et al.[3] with 46.8% as excellent,46.8% as good and 6.24% fair results, Page and Stern[41] (excellent 62%,. Good 14%, fair 13%), Duncan et al.[42] (excellent 40 %,. Good 24 %, fair 7%), Drenth and Klasen.[43] (excellent 35 %,. Good 34 %,fair 10 %).

Study	% of results
Present study	66
Gupta et al (2007)	46.8
Page and Stern	62
Duncan et al	40
Drenth and Klasen	35

Among the many surgical methods closed reduction and percutaneous K Wire [illegible] osteosynthesis of metacarpal bones stands out [illegible] and the fact it puts least strain on sliding tissue however stiffness of MCP joints was often observed.

Despite early active motion, stiffness was most frequent complication. Probable causes of stiffness includes Initial fracture severity, Patient cooperation for physiotherapy

Closed reduction with percutaneous intramedullary CRIF K Wire under Image intensifier produce good functional result in long term .With low rate of Complication CRIF with K Wire under image intensifier can be recommended for stabilization of metacarpal fracture and implant removal at outpatient department is the further advantag

CONCLUSION

This study was a hospital based prospective study centered in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from Nov 2013 to May 2015 in which 50 patients with Metacarpal fractures treated with Percutaneous K Wires

At the end of our study, following conclusions could be drawn

- Metacarpal fractures are increasing with the increase in Road traffic accidents.
- These fracture need optimum treatment as most of them involved the [illegible] (keys)
- [illegible] CRIF with K wires gives stable fixation following which early mobilization of joints of hand can be done early, there by preventing stiffness.
- Fractures treated with CRIF with K Wire show faster union, faster recovery of daily activities and lesser stiffness than treated conservatively.
- Multiple metacarpal fractures treated surgically gives better results than those treated conservatively.
- There will be less chances of infection and early bone union in case of CRIF with K Wire fixation.

Thus we conclude that Metacarpal fractures treated by K wires gives better results than those treated conservatively in terms of union, recovery of daily activities and stiffness especially in cases of displaced and multiple metacarpal fractures.

However stiffness of hand joints especially metacarpophalangeal joint is of major concern and physiotherapy plays a major role to combat stiffness.

SUMMARY

This study was a hospital based prospective study centered in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from Nov 2013 to May 2015 in which 50 patients with Metacarpal fractures treated with Percutaneous K Wires

- Age of the patients ranged from 21 yrs to 90 yrs with maximum incidence being involving the productive age group < 40 yrs 76 %.
- In this series Right hand 58% was predominantly involved compared to the left hand.
- In this series all metacarpal fractures were closed injury and compound fractures were not included in this study.
- In this series, mode of injury in majority of cases is RTA constituting 60%.
- Fifth metacarpal were most commonly involved in this series constituting 24% .
- In this study shaft was involved in majority of cases constituting 68% of cases.
- Transverse fractures were the most commonly observed pattern in this Study constituting 46%.

- In this study retrograde K Wire technique used in 80%.
- In this study patients developed pain in 18%,stiffness in 4% ,pin tract infection in 4% of cases
- In this study 66% had excellent result ,26% with good results and remaining 8% had fair result.
- No purely implant related complications were noted (viz. K Wire loosening ,K Wire migration).
- We suggest that Metacarpal fractures treated by K Wires gives better results in those treated conservatively in terms of union, recovery of daily activities especially in case of displaced and multiple metacarpal

With low rate of complication CRIF with Percutaneous K Wire fixation under image intensifier can be used for stabilization of metacarpal fracture, intraoperative image intensifier radiation is the only drawback and implant removal at outpatient department is a further advantage.

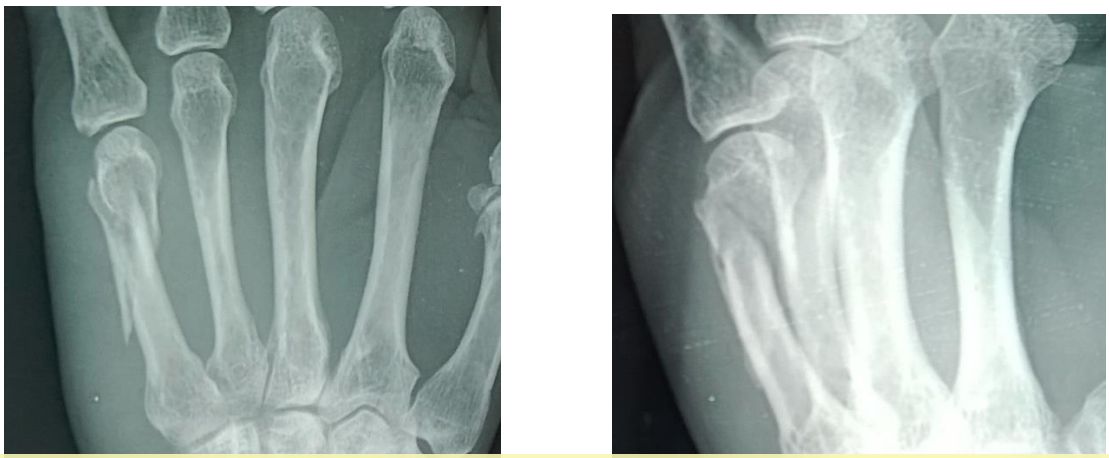
Radiological and Clinical Photographs

Case 1

Immediate PostOp AP/Oblique Views

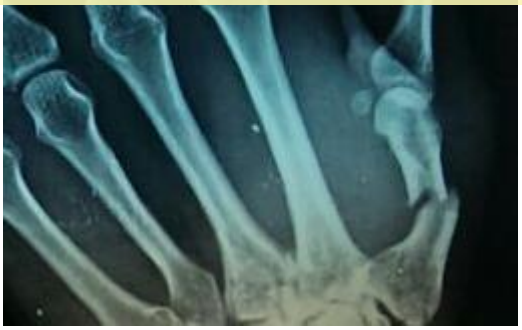
Fig 32 : Followup Range of Moments

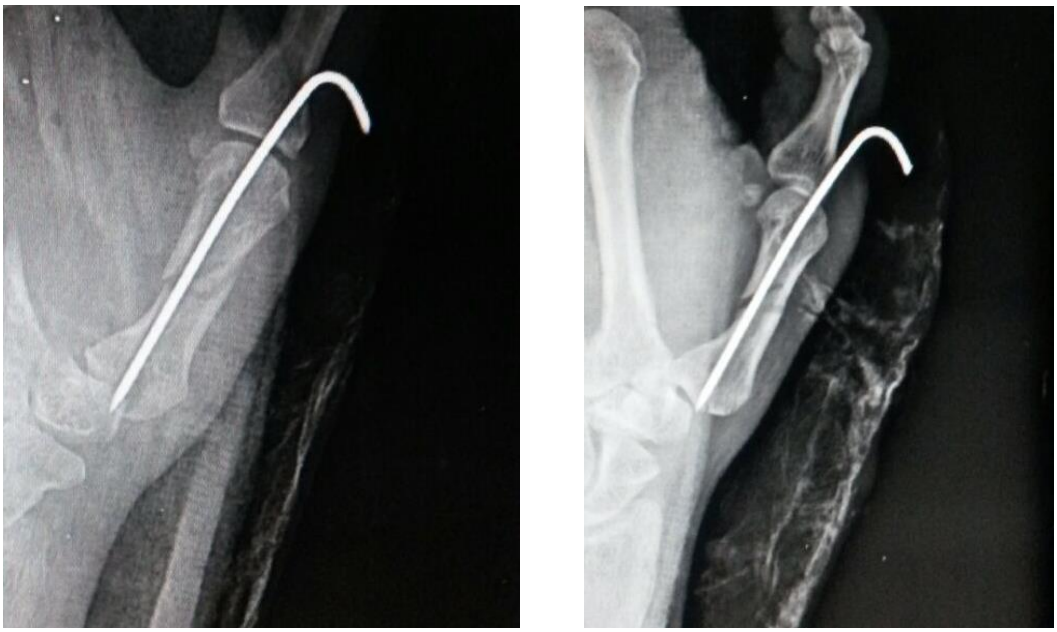
Case 2



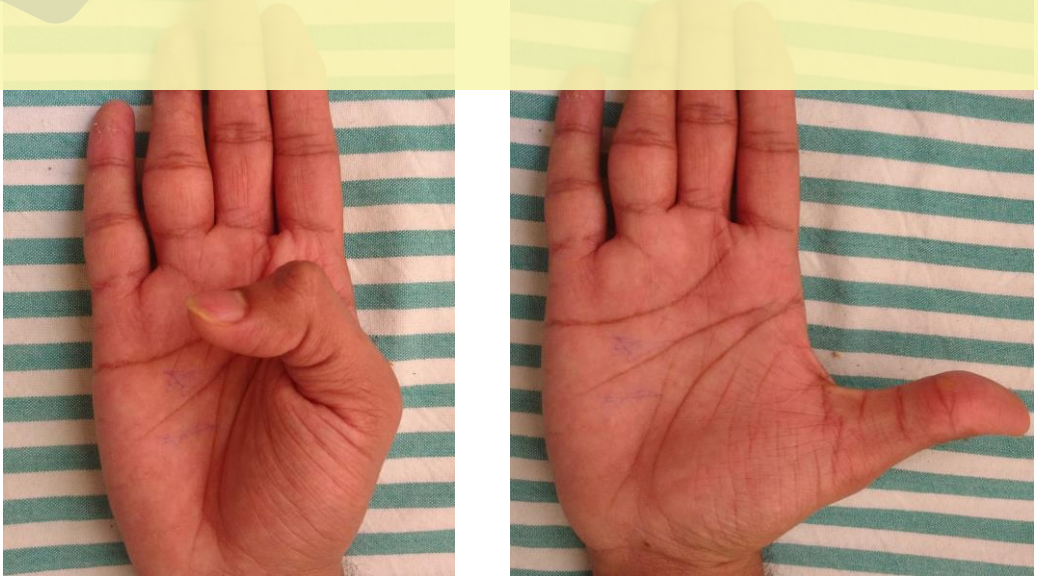
Immediate PostOp AP/Oblique Views

Fig 34 : 10 Weeks Postop and Followup





Preop and Immediate Postop AP/Oblique Views



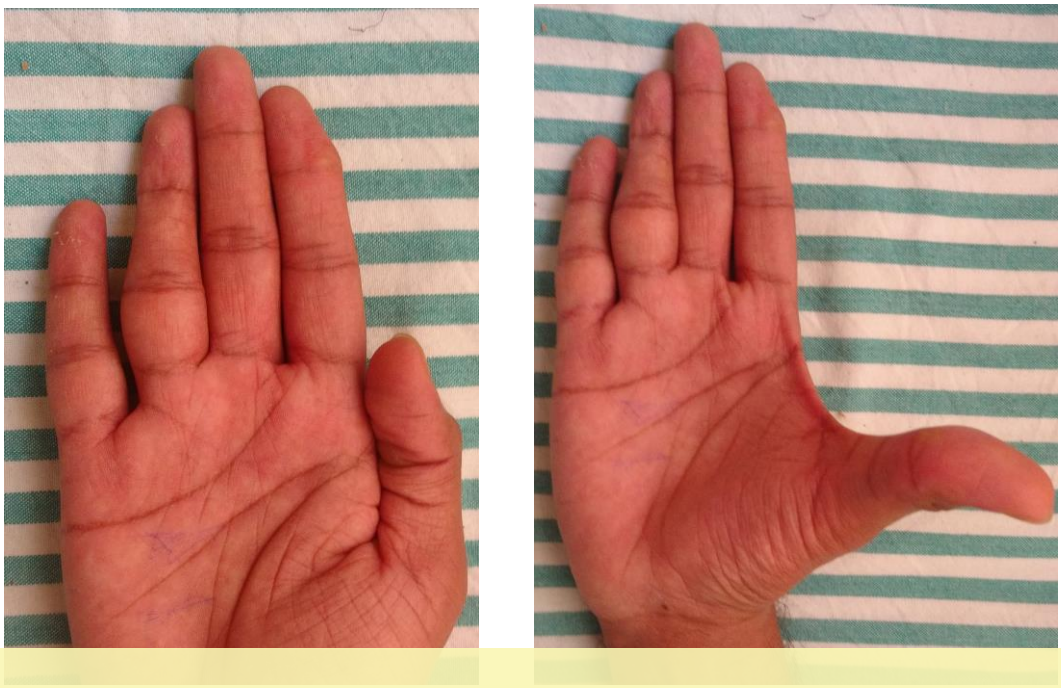
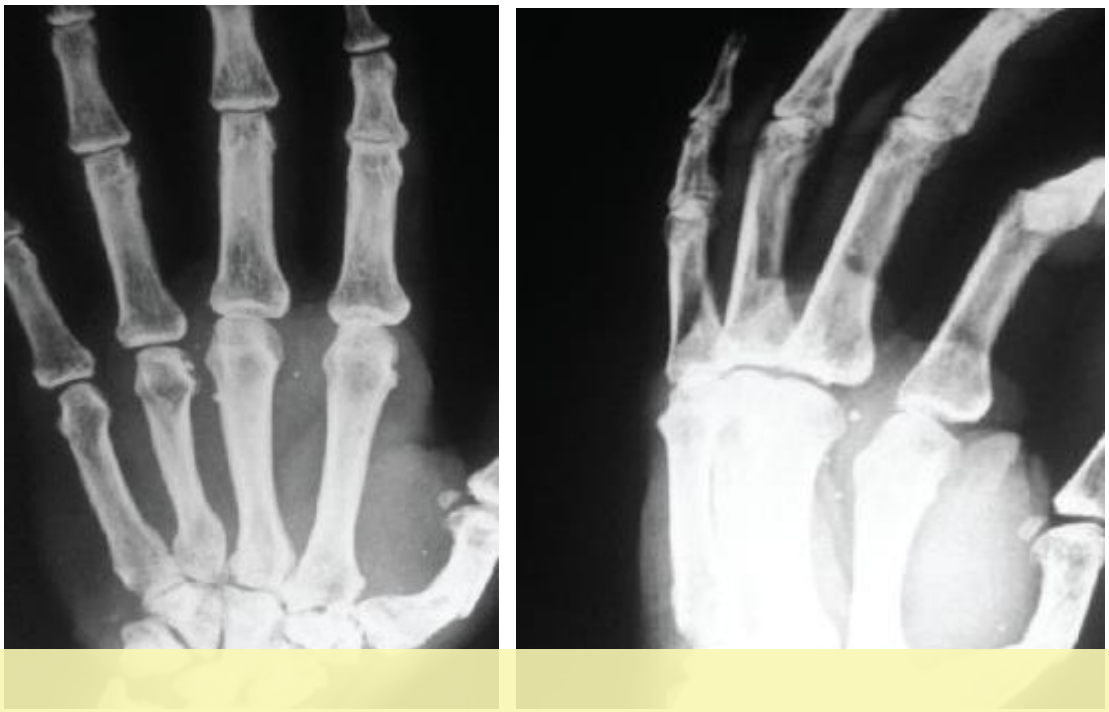


Fig 35 : 8 Weeks Postop and Followup

Case 4

Postoperative AP/Oblique Views



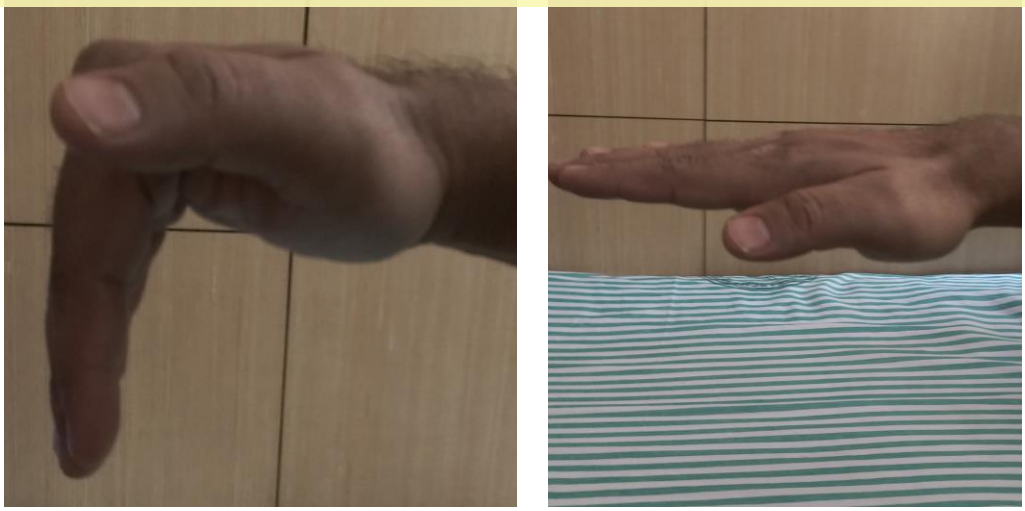


Fig 36: 10 Weeks Followup and Range of Movements

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ANNEXURE I

PROFORMA

STUDY OF CLINICAL OUTCOME IN METACARPAL FRACTURES FIXED WITH K WIRES

Introduction

Name : Age :

Sex : Male/ Female Occupation :

Address : I.P. No. :

Date of Injury : Date of Admission :

Date of surgery : Date of Discharge :

Allergy :

Mode of Injury (tick appropriate one)

Road traffic accident :

Domestic Injury :

Industrial Injury :

Miscellaneous (specify) :

Mechanism Of Injury :

Duration from injury to surgery …….. days

Mode of treatment till reference - (tick appropriate one)

Nil :

Splint :

Slab :

Local Examination

Inspection

Side of injury : Right / Left

Overlying skin :

Attitude of the limb :

Deformity :

Swelling :

Dorsal :

Palmar :

Palpation

Temperature :

Tenderness :

Abnormal mobility :

Bony irregularity :

Systemic Examination

RR	Temperature
CVS	RS
CNS	PA

Clinical Diagnosis :

Associated Injuries:

Investigations

Hb% : Blood urea :

Random blood sugar: Serum Creatine :

Blood Group : Complete Blood picture :

Radiology :

Site of Fracture :

No.Metacarpals Involved:

Type of fracture – Transverse / oblique /spiral / segmental / communited

Management

Method of immobiliation / Splintage :

Duration :

Surgical Management

Date of surgery :

Anaesthesia :

Method Of K-Wire Passage :

Antegrade Retrograde

Time duration of surgery :

External immobilization :

Post operative management :

Position of limb :

Compression bandage :

External immobilization :

Antibiotics :

Follow up

Second Review(4 Weeks) :

Third Review(2 Months) :

Fourth Review(4 Months) :

Result: Excellent / good / fair

SIGNATURE OF THE GUIDE:

Dr. Manohar.P.V

Professor

Dept of Orthopaedics

ANNEXURE II

CONSENT FORM FOR ANAESTHESIA/OPERATION

I_____ Hosp No_____ in my full senses hereby give my complete consent for _____ or any other procedure deemed fitwhich is a diagnostic/therapeutic/procedure/biopsy//transfusion/operation to beperformed on me/my/son/daughter/ward_____age_____under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me in my own language to my satisfaction. For academic and scientificpurpose, the operation/ procedure may be television or photographed, or used for statistical measurements.

Date :

Signature/Thumb

Impression Of the Patient

Name :

Designation:

Guardian

Relationship

Full Address

KEY TO MASTER CHART

IP No.	-	IN PATIENT NUMBER
MC	-	METACARPAL
M	-	MALE
F	-	FEMALE
#	-	FRACTURE
PP	-	PROXIMAL PHALANX
R	-	RIGHT
L	-	LEFT
RTA	-	ROAD TRAFFIC ACCIDENT
CRIF	-	CLOSED REDUCTION INTERNAL
SL No.	-	SERIAL
GA	-	GENERAL ANAESTHESIA
&	-	AND
TAM	-	TOTAL ACTIVE MOTION

ANNEXURE III

SL.No	NAME	HOSP NO	AGE/SEX	SIDE	MC INVOLVED	PART OF BONE	MECH OF INJURY	TYPE OF FRACTURE	ASSOCIATED INJURIES	TYPE OF ANAESTHESIA	METHOD OF WIRE	K WIRES REMOVAL	COMPLICATIONS	DURATION OF UNION	FUNCTIONAL OUTCOME	RESULTS
1	MALLIKARJUNAPPA	387964	65/M	LEFT	IV	NECK	RTA	SPIRAL	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	8 WEEKS	TAM = 250	EXCELLENT
2	MAH PASHA	389619	25/M	LEFT	I	SHAFT	INDUSTRIAL	TRANSVERSE	-	WRISTBLOCK	RETROGRADE	4 WEEKS	-	10 WEEKS	TAM = 250	EXCELLENT
3	MANJUNATHA K.N	392066	27/M	RIGHT	III IV V	SHAFT	RTA	TRANSVERSE	-	AXILLARY BLOCK	RETROGRADE	3 WEEKS	STIFFNESS & PIN TRACT INFECTION	12 WEEKS	TAM = 160	FAIR
4	NARASIMHA	393430	16/M	RIGHT	II	SHAFT	RTA	TRANSVERSE	HEAD INJURY	GA	RETROGRADE	4 WEEKS	-	10WEEKS	TAM = 260	EXCELLENT
5	SAJJAD	400538	25/M	LEFT	I	NECK	INDUSTRIAL	TRANSVERSE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	10 WEEKS	TAM = 240	EXCELLENT
6	BAABU	25682	35/M	RIGHT	II	SHAFT	ASSAULT	TRANSVERSE	-	WRISTBLOCK	ANTEGRADE	4 WEEKS	-	10 WEEKS	TAM = 250	EXCELLENT
7	CHANDRA SINGH	401201	60/M	LEFT	II III IV V	SHAFT & NECK	RTA	TRANSVERSE	POST DISC OF HIP	GA	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 140	FAIR
8	NARAYANSWAMY	482812	45/M	LEFT	IV V	SHAFT	Others	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	PAIN	10 WEEKS	TAM = 200	GOOD
9	RAVI	22082	20/M	RIGHT	II	NECK	ASSAULT	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	8 WEEKS	TAM = 230	EXCELLENT
10	SUNDARAJAN	38295	42/M	LEFT	III IV	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	PAIN	8 WEEKS	TAM = 210	GOOD
11	NANJAPPA	56782	79/M	LEFT	V	NECK	RTA	TRANSVERSE	BIMALLEOLAR #	GA	RETROGRADE	4 WEEKS	ROTATION	12 WEEKS	TAM = 240	EXCELLENT
12	MANJUNATH	68731	40/M	LEFT	V	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	8 WEEKS	TAM = 270	EXCELLENT
13	GIRISH	98452	32/M	RIGHT	I II III IV	SHAFT	INDUSTRIAL	TRANSVERSE	-	AXILLARY BLOCK	RETROGRADE	4 WEEEKS	STIFFNESS	12WEEKS	TAM = 150	FAIR
14	VISHWANATH REDDY	286282	38/M	RIGHT	II	SHAFT	RTA	TRANSVERSE	PATELLA #	GA	RETROGRADE	4 WEEKS	PAIN	10 WEEKS	TAM = 220	EXCELLENT
15	AYYACHARI	90252	33/M	RIGHT	V	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	8 WEEKS	TAM = 240	EXCELLENT
16	PRAKASH	78733	35/M	RIGHT	II	SHAFT	ASSAULT	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	PAIN	12 WEEKS	TAM = 210	GOOD
17	MUTHAHAR	24695	20/M	LEFT	IV V	SHAFT	RTA	SHORTOBLIQUE	DISTAL FEMUR #	GA	RETROGRADE	4 WEEKS	PAIN	8 WEEKS	TAM = 190	GOOD
18	VARADA REDDY	24480	90/M	RIGHT	V	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	8 WEEKS	TAM = 250	EXCELLENT
19	RATHNAMMA	65487	50/F	RIGHT	II III	NECK	ASSAULT	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	PAIN & ROTATION	10 WEEKS	TAM = 210	GOOD
20	SURESH	82041	24/M	LEFT	IV	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETRROGRADE	4 WEEKS	-	10 WEEKS	TAM = 240	EXCELLENT
21	SUDHAKAR	22476	28/M	RIGHT	V	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	ANTEGRADE	4 WEEEKS	-	12 WEEKS	TAM = 260	EXCELLENT
22	KRISHNAMACHARY	12382	37/M	RIGHT	II	NECK	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	10 WEEKS	TAM = 250	EXCELLENT
23	VENKATESHAPPA	68015	40/M	RIGHT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 220	EXCELLENT
24	GOVINDAPPA	86592	38/M	RIGHT	III	SHAFT	FALL	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 230	EXCELLENT
25	GANESH	46066	24/M	LEFT	II III IV	SHAFT	RTA	LONG OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	8 WEEKS	TAM = 210	GOOD
26	KONAPPA	47285	33/M	RIGHT	IV V	NECK & SHAFT	RTA	SHORT OBLIQUE	PHALYNGEAL FRACTURE	WRIST BLOCK	RETROGRADE	4 WEEKS	PAIN	10 WEEKS	TAM = 190	GOOD
27	RANJITH	165186	28/M	RIGHT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 240	EXCELLENT
28	SRINIVAS	169531	22/M	RIGHT	V	SHAFT	RTA	COMMINUTED	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	10 WEEKS	TAM = 230	EXCELLENT
29	CHANG	166701	21/M	RIGHT	II	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 220	EXCELLENT
30	VASANTH KUMAR	57452	24/M	LEFT	IV V	SHAFT	INDUSTRIAL	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 210	GOOD
31	JAGADISH	65476	28/M	RIGHT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 200	GOOD
32	SUBRAMANI	49185	23/M	RIGHT	II IV	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 210	GOOD
33	SARVANAN	98702	21/M	RIGHT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 230	EXCELLENT
34	LAKHSMI DEWI	47680	35/F	LEFT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	10 WEEKS	TAM = 220	EXCELLENT
35	RAMI REDDY	16752	42/M	RIGHT	II	NECK	ASSAULT	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	12 WEEKS	TAM = 240	EXCELLENT
36	MUNIVENKATAPPA	76842	48/M	RIGHT	II	NECK	FALL	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	PAIN	12 WEEKS	TAM = 210	GOOD
37	RAMESH	36752	45/M	RIGHT	V	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	ANTEGRADE	4 WEEEKS	-	12 WEEKS	TAM = 230	EXCELLENT
38	RAJABAABU	90252	33/M	RIGHT	V	NECK	ASSAULT	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	12 WEEKS	TAM = 240	EXCELLENT
39	THAYAMMA	96531	42/M	RIGHT	IV	SHAFT	FALL	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 200	GOOD
40	RAGHURAM	93452	54/M	LEFT	I	NECK	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	14 WEEKS	TAM = 230	EXCELLENT
41	PRAKASH	42045	38/M	RIGHT	II	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 240	EXCELLENT
42	MUNIRAJU	95522	37/M	LEFT	II III V	SHAFT	RTA	SHORTOBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	STIFFNESS	12 WEEKS	TAM = 200	GOOD
43	MANOJI RAO	40045	35/M	RIGHT	II	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	12 WEEKS	TAM = 230	EXCELLENT
44	LAKSMIDEVAMMA	96252	37/F	LEFT	I	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	10 WEEKS	TAM = 250	EXCELLENT
45	HARNATH REDDY	165877	40/M	RIGHT	II	SHAFT & NECK	RTA	SHORT OBLIQUE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	12 WEEKS	TAM = 230	EXCELLENT
46	PAVITHRA	54896	38/F	RIGHT	II	NECK	ASSAULT	TRANSVERSE	-	WRIST BLOCK	ANTEGRADE	4 WEEKS	-	12 WEEKS	TAM = 220	EXCELLENT
47	RATHNAMMA	67286	26/F	RIGHT	I	SHAFT	OTHERS	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 240	EXCELLENT
48	GANESH	98462	21/M	LEFT	V	SHAFT	RTA	SHORT OBLIQUE	-	WRIST BLOCK	RETROGRADE	4 WEEKS	-	12 WEEKS	TAM = 220	EXCELLENT
49	RAJANNA	89374	24/M	LEFT	I II III IV	SHAFT & NECK	RTA	TRANSVERSE & SHORT OBLIQUE	BOTH BONE FOREARM#	AXILLARY BLOCK	RETROGRADE	3 WEEKS	STIFFNESS & PIN TRACT INFECTION	14 WEEKS	TAM = 170	FAIR
50	SATYANAND PRAKASH	53752	28/M	LEFT	II III	SHAFT	RTA	TRANSVERSE	-	WRIST BLOCK	RETROGRADE	4 WEEEKS	-	12 WEEKS	TAM = 240	EXCELLENT