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THE USE OF NAIL TRACTION SPLINT IN THE MANAGEMENT OF PROXIMAL PHALANGEAL FRACTURES OF THE HAND

DISSERTATION SUBMITTED FOR

MS DEGREE (BRANCH II - ORTHOPAEDIC SURGERY)

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MADURAI.

CERTIFICATE

This is to certify that the dissertation entitled **"THE USE OF NAIL TRACTION SPLINT IN THE MANAGEMENT OF PROXIMAL PHALANGEAL FRACTURES OF THE HAND"** is a bonafide record of work done by **Dr. PL.VIJAYA KUMAR** in the Department of Orthopaedics, Government Rajaji Hospital, Madurai Medical College, Madurai, under the direct guidance of me.

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DECLARATION

I **Dr. PL. Vijaya Kumar,** solemnly declare that the dissertation entitled **"THE USE OF NAIL TRACTION SPLINT IN THE MANAGEMENT OF PROXIMAL PHALANGEAL FRACTURES OF THE HAND"** has been prepared by me under the able guidance and supervision of my guide **Prof. M. Chidambaram, M.S.Ortho., D. Ortho.,** Prof & HOD, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, in partial fulfillment of the regulation for the award of M.S. (ORTHOPAEDICS) degree examination of The Tamilnadu Dr. M.G.R. Medical University, Chennai to be held in March 2008.

This work has not formed the basis for the award of any other degree or diploma to me previously from any other university.

Place: Madurai

Date:

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CONTENTS

INTRODUCTION

Fractures involving the tubular bones of the hand are the most common of all skeletal injuries. It accounts for approximately one third of fractures involving the hand. Outer rays of hand especially thumb and little fingers are most commonly involved. Unfortunately these are often neglected or regarded as trivial injuries.Hand fractures can be complicated by deformity from no treatment, stiffness from overtreatment and both from poor treatment. Preventing angular or rotational deformity , articular stiffness , and tendon adhesions challenges the even the most experienced surgeon.As **Charnley** recognized : **The reputation of a surgeon may stand as much in jeopardy from this injury [phalangeal fracture] as from any fracture of the femur.**

The incidence of the metacarpal and the phalangeal fractures peaks between 10 and 40 years. Most fractures are functionally stable either before or after the closed reduction and will do well with the protective splintage and early mobilisation.

Selection of optimum treatment depends on a number of factors including the fracture location (intrarticular versus extraarticular), fracture geometry (transverse, spiral or oblique, comminuted), deformity (angular,rotational,shortening), open or closed, associated osseous or soft tissue injuries, and the fracture stability.

Additional considerations include the patient's age, occupation, and the socioeconomic status, the presence of systemic illness, surgeon's skill and the patient's compliance.

Comminuted fractures are inherently unstable and are more frequently compounded by injuries to tendons, nerves, and vascular structures than are simple fractures. Ultimate digital stiffness correlates with severity of initial injury to bone and soft tissues. Comminuted fractures tend to lead to a higher risk for stiffness than simple fractures. This is especially true of articular fractures as compared with extra-articular fractures. The injured finger's proximal interphalangeal joint is especially vulnerable.

Open reduction and internal fixation, even when essential, may significantly increase the risk of joint stiffness. Closed manipulation and careful splinting sometimes provide reasonable positioning and reduction than surgical procedures. **Comminuted fractures of the proximal phalanx have been most successfully managed with static or dynamic traction.**

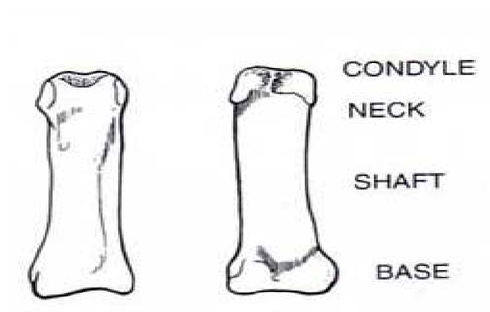
This principle may be extended to the treatment of other comminuted joint fractures in the hand, whether closed or open. Comminuted diaphyseal hand fractures may be treated with static traction, mini-external fixators, kirschner wires, or miniplates. Static traction, mini-external fixators, and kirschner wires are less invasive, but premature loosening or removal may lead to fracture setting or collapse. Miniplates have the advantage of permanency, maintaining fracture support throughout healing and allowing earlier and more intensive rehabilitation, but have the disadvantage of requiring operative dissection. No clear solution to this dilemma exists. Surgeons must use their best judgment based on individual fracture considerations.

ANATOMY OF PROXIMAL PHALANX

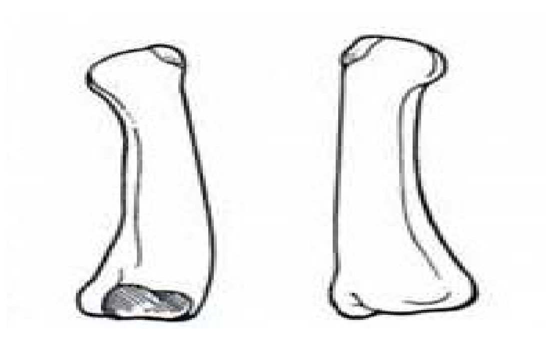
PROXIMAL PHALANX:

Because the proximal phalanx lies between the middle phalanx and metacarpal, connecting with them via the PIP and metacarpophalangeal (MP) joints respectively, its head consits of two condyles , whereas its base presents only an articular facet . Detailed anatomic features are as follows.

Right Proximal Phalanx



Dorsal view **Palmar view**



Radial Side **Ulnar Side**

General Features of the Proximal Phalanx			
	Anatomic Features	**Description**	**Related Structures**
Head	Two condyles and an intercondylar space .	Head is pulley shaped with two condyles between which shallow and smooth intercondylar space. Articular surface on the palmar aspect of the condyles is more extended than on the dorsal aspects.	Corresponding to the articular facets and median crest of the base of the middle phalanx.
	Circular depression .	Located on the lateral aspect of the condyles.	For proximal insertion of the collateral ligament of the proximal interphalangeal joint.
Shaft	Palmar concavity .	More concave than that of the middle phalanx. Its bottom is flat and surmounted by a lateal ridge.	Passage for the flexor tendons.
	Lateral ridge .	Slightly rough; it ends distally at the junction of the distal and middle thirds of the phalanx. Proximally, it continues onto a lateral tubercle.	For attachment of the fibrous tendon sheath.
	Dorsal convexity .	Round and smooth.	Overlaid by the extensor apparatus.
Base	Dorsal ridge .	Somewhat smoother; there is no tubercle at its midpoint, as on the base of the middle phalanx; instead it has a slight rough area.	For attachment of the capsule of the MP joint. The rough area may sometimes be an inconstant insertion of the extensor tendon.
	Palmar depression .	At the middle part of the palmar ridge of capsule of the MP joint, between the lateral tubercles.	For passage of the flexor tendon.
	Lateral tubercles .	On the lateral ends of the palmar ridge.	For attachment of the collateral ligament.
	Articular facet for MP joint .	Single, oval, and concave, on the proximal aspect of the base.	Articulates with the head of the metacarpal to form the MP joint.

APPLIED ANATOMY

Fracture of PPX may well be one of the most difficult of all orthopaedic injuries. The prime reason is the local anatomy

The PPX closely invested by a sheet like extensor mechanism with a complex array of decussating collagen fibres.

Contrary to other regions of the body, the hand at least as regards the fingers lacks any muscle-endowments to surround the bones, and it also lacks a reasonably thick subcutaneous layer of fatty tissue. Muscles cover the forearm : the hand, however, has only a tendon-system, which clings to the skeleton like a glove (VERDAN), and whose gliding ability is endangered by an operative exposure.

The extensibility of the skin of the hand is limited by the small cross-section of the finger and the lack of bulky muscles, which, wherever present, command a certain amount of extensible spare of skin. There is little room to acccommodate any oedematous swelling in the epifascial or subfascial space. Any traumatic oedema uses up the physiological reserve of skin. Tension of an additional postoperative oedema can become dangerous.

The mere fact that the fragments and indeed the bones are of such a small size cells for high surgical skills as well as for appropriate instruments and metallic implants. Surgical disturbances of the fine balance between these fibres can permanently alter the long term function of the digit.

Infection quickly and irreversibly destroy the bradytrophic tendons and the physical properties of their gliding structure. Infections in muscle-covered parts of the extremities are much less subject to these sequelae of infection.

The osseous healing of the hand-skeleton needs little time. The necessary immobilization by plaster-cast is of short duration and thus the danger of any considerable impariment of the periarticular tissues from long-standing immobilization is correspondingly unimportant. For this reason, the majority of all fractures of the hand-skeleton lend themselves to well-conducted conservative treatment.

Collateral lig of the IP joint take origin from the head of the phalanx at the centre of joint rotation, unlike the dorsally eccentric origin of MP collateral lig.

One must understand the phalanx to be highly elliptical (tunnel shaped) in cross section rather than cylindrical with a thicker dorsal cortex in PPX

BIOMECHANICS

At the proximal phalangeal level, both intrinsic and extrinsic tendon forces deform the fracture. They result in a predictable apex volar deformity for transverse fractures. These forces can infact be used with benefit during rehabilitation. If the MP joints are maximally flexed(as in the Burkhalter splint design), the intrinsic muscle forces acting through the extensor mechanism overlying PPx create a tension band that helps to maintain fracture reduction.

Active PIP joint motion will heighten this effect and forms the basis for non operative fracture management. When a spiral frature pattern at either level is recognized, careful evaluation of rotation must be performed as the degreee of deformity is often underappreciated. Spiral and oblique fractures also have a more complex patterns of deformity that are not so easily controlled through the joint positioning described above.

PROBLEMS IN PPX FRACTURE

Joint Stiffness

According to the findings of PEACOCK any prolonged immobilization brings in its train a considerable increase in the production of collagen in joint capsule and ligaments. This collagen production is further increased by posttraumatic oedema. The change in physical properties of the ligamentous elements about the joint is the main cause for this stiffness. The collateral ligaments of a joint are not elastic; they behave like fascia. Thus there is not stretching and shortening of these structures, instead they glide laterally on flexion over the condyles without changing their length.

The following points have therefore to be noted in guarding aganist stiffness of the fingers.

- The area over which the lateral ligaments glide over the lateral aspects of the condyles is considerable, and any diminution of the capacity to glide, even without contracture of the ligaments, interferes with the free mobility of the joint.
- The volar capsule, as a proximal continution of the fibro-cartilaginous volar plate, glides on itself with the formation of folds. Folding and unfolding depend on the nature of the surface of these structures. Incipient stickness is soon followed by fibrous adhesions of the folded capsule and so by flexion-contracture.

Tendons

Furthermore, free mobility depends on the unimpaired ability of the flexor and extensor tendons to glide. The close relationship of tendon and bone in the fingers is the cause of mechanical damage to tendons and other tissues involved in gliding. When function is interrupted for just only a few weeks, any accompanying haematoma is bound to lead to considerable peritendinous adhesions.

Muscle forces

Even if the rules governing closed fracture treatment in general fully apply in hte case of phalangeal fractures, the problems are different as far as immobilisation is concerned. MOBERG mentions the considerable muscle pull which acts upon them. The tendency to redisplacement is therefore great and it is difficult to retain any reduction achieved. These difficulties explain why, in fractures of the fingers, a comparatively high invalidity is not at all rare.

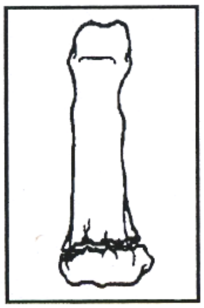
CLASSIFICATION OF PPX FRACTURE

1. OTA Classification

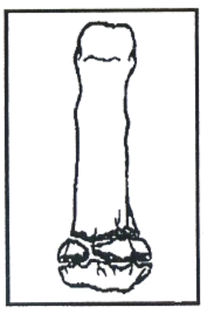
Subgroups and Qualifications:

Phalanx, proximal extra-articular (26-A1)

1. Simple (26-A1.1)

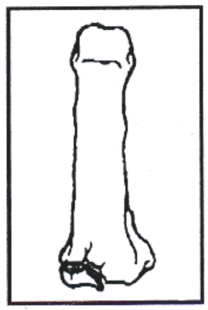


2. Multifragmentary (26-A1.2)

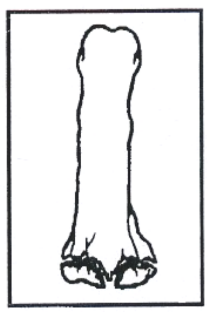


Phalanx, proximal partial articular (26-B1)

1. Unicondylar (26-B1.1)

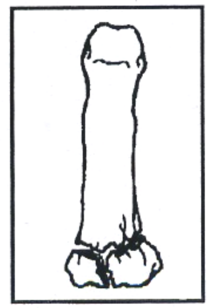


2. Bicondylar (26-B1.2)

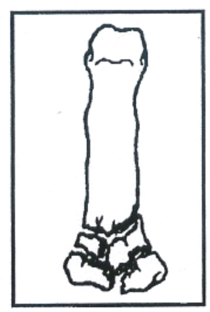


Phalanx, proximal complete articular (26-C1)

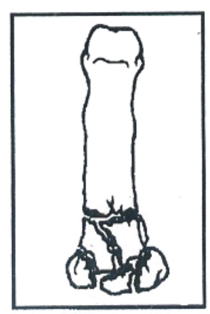
1. Simple articular/metaphyseal simple (26-C1.1)



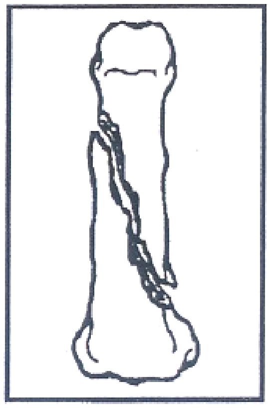
2. Simple articular/metaphyseal multifragmentary (26-C1.2)



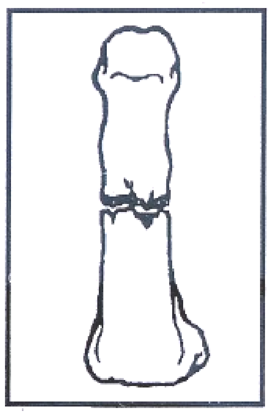
3. Multifragmentary articular and metaphysis (26-C1.3)



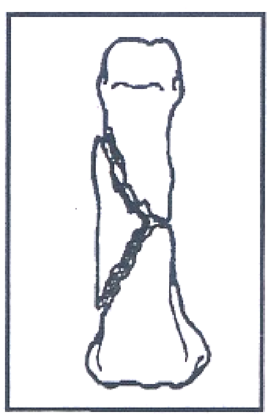
1. Spiral oblique (26-A2.1)



2. Transverse (26-A2.2)

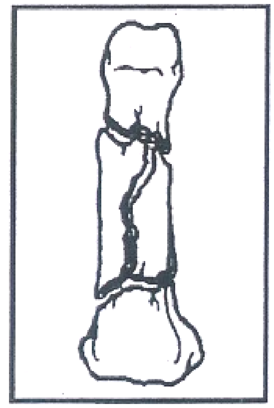


3. Simple wedge (26-A2.3)



A2

4. Multifragmentary (26-A2.4

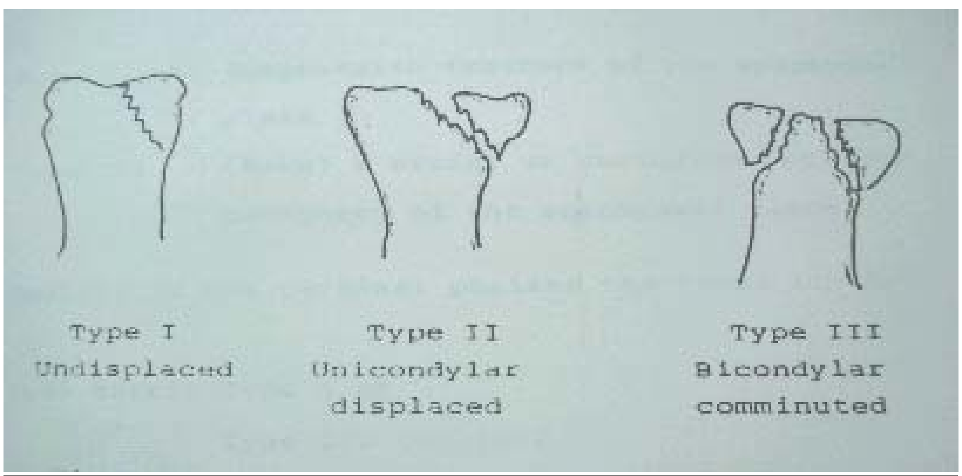


A2

2. Functional fracture classification

LOCATION	PATTERN	SKELETON	SOFT TISSUE	REACTION TO MOTION
Base	Tarnsverse	Simple	Closed	Stable
Shaft	Oblique	Impacted	Open	Unstable
Neck	Spiral	Comminuted		
Condyle (head)	Avulsion			
Epiphysis				

3. P S London' S Classification of Condylar Fractures



Phalangeal fractures that are stable and nondisplaced can be effectively managed by buddy taping or splint immobilisation. However, for successful outcome of many fractures a sophisticated approach is necessary. Each fracture type has its own characteristics and can be influenced by multiple factors. Improper treatment often leads to stiffness and deformity.

Fracture factors (intraarticular versus extraarticular) have a major influence on the ultimate result. The intraarticular fractures have a generally poorer prognosis than extraarticular fractures.The stability and alignment are more important than articular congruency in determining the outcome. Likewise, comminuted fractures, those associated with bone loss, and unstable fractures with significant deformity are also prone to residual disability regardless of the method of treatment. There is a direct correlation between the severity of the soft-tissue injury and the final range of motion at follow-up.

In addition, the fractures located in flexor tendon Zone II has the worst prognosis. The final range of motion after proximal phalangeal fractures depends not only on bony union but also on restoration of flexor and extensor excursion, which may be limited, especially when there is an open fracture with soft-tissue compromise. It is concluded that flexor tendon injuries have a more serious effect on recovery of digital mobility than do extensor tendon injuries. Prolonged immobilisation clearly has a detrimental influence. It is safe to immobilise the digit for 3 or fewer weeks. If the immobilisation following a phalangeal fracture is less than 4 weeks, final active motion was 80 percent of normal. However, if immobilisation exceeded 4 weeks, total active motion declined to 66 percent of normal.

Finally the successful outcome depends on the selection of the appropriate treatment .The therapeutic armamentorium is vast and ranges from buddy straping and short term splinting to the complex methods of internal fixation. **Appropriate selection should be tailored to the individual patient and the fracture.**

Articular Fractures of the Phalanges

Condylar Fractures:

Type I consists of stable fractures without displacement, Type II includes unicondylar, unstable fractures, and Type III fractures are bicondylar or comminuted. Oblique x-rays are mandatory to properly visualize the fracture and adequately assess displacement.

The two most popular techniques of fixation are (1) Kirschner pins and (2) a lag screw.

Bicondylar fractures and comminuted intraarticular fractures can be very difficult to fix. Various modaities of treatment have been tried eg minicondylar plate, dynamic traction, external fixation and primary joint arthrodesis as the last resort.

Nondisplaced unicondylar fractures are potentially unstable. Immobilisation in a splint is risky and displacement should be anticipated. If this method of treatement is selected, careful x-ray follow-up is mandatory to avoid a malunion with articular incongruity. Displaced unicondylar fractures are best managed operatively. Postoperatively, early active motion is initiated and the IP joint is splinted in extension to avoid extensor lag. Kirschner wires are removed at 3 to 4 weeks. Screws do not require removal unless they are symptomatic.

Although open reduction-internal fixation is the standard option for the management of condylar fractures, the results of closed reduction and percutaneous pin fixation are also satisfactory.. The reduction is verified with the image intensifier.

Bicondylar fractures of the proximal phalangeal head are nearly always displaced and often comminuted. Anatomic restoration of articular congruency usually cannot be accomplished by closed manipulation. Open reduction as for unicondylar fractures is advised . First, the two condyles are reduced and fixed to each other with either a screw or

Kirschner pins. Next, the head fragment is secured to the shaft in a similar fashion.

In such circumstances, skeletal traction through the middle phalanx for 3 ½ to 4 weeks is preferred. The traction is secured to a forearm-based splint to immobilise the proximal phalanx but allow active flexion of the PIP joint. Fracture consolidation can be anticipated, and some articular remodeling will occur. Restoration of full motion is unlikely. Primary arthrodesis is unpredictable and may result in excessive shortening.

Other Fractures of the Head of the Phalanx:

Extensive comminution of the phalangeal head may preclude satisfactory open reduction**.** These fractures are frequently associated with significant damage to the soft-tissue sleeve and are best treated nonoperatively. **Treatment consists of manual molding and traction to restore general alignment, immobilization for 10 to 14 days, and early protected motion.**

Dorsal, Volar, or Lateral Base Fractures and Physeal Fractures:

Avulsion fractures of the the dorsal base of the middle phalanx represent detachment of the insertion of the central tendon and usually the result of an anterior PIP joint dislocation . If the avulsed fragment is displaced more than 2mm , accurate reduction is necessary to prevent extensor lag and subsequent boutenniere deformity.

Fractures of the lateral volar base of the proximal or middle phalanx usually represent the collatral ligament avulsion injuries.Minimally displaced lateral corner fractures that do not compromise joint stability or result in an incongruous articular surface can be treated by splinting for 10 to 14 days , followed by the protected motion.Significantly displaced corner fractures may compromise joint stability. The recommended treatment is open reduction and fixation with the K-wire or tension band wire.

Epiphyseal fractures involving the proximal phalanx are opened through a dorsal tendon-splitting incision. Similar fractures involving the base of the middle phalanx can be approached laterally by incising the interval between the transverse retinacular ligament and the dorsal apparatus.The T fractures of the base of the proximal phalanx often requires open reduction and the internal fixation .

Comminuted intraarticular fractures of the base of the middle phalanx (Pilon Fratures) can be treated in three fashions: Splintage, traction through the middle phalanx and open reduction & internal fixation.

Nonarticular Fractures of the Phalanges

Neck Fractures:

Neck fractures (subcapital) of the phalanges are uncommon in adults and can usually be managed either in closed fashion by reduction and splinting or by percutaneous crossed kirschner pins.

Shaft fractures:

Phalangeal fractures can be transverse, oblique or spiral and comminuted. Spiral and oblique fractures are more common in the proximal phalanx, whereas tranverse fractures tend to be more common in the middle phalanx. Proximal phalangeal fractures angulate volarly, the proximal fragment being flexed by the strong interosseous muscles. The deformity in middle phalangeal fractures depend on the relationship of the fracture to the superficialis insertion.

The flexion of the proximal fragment by the intact tendon in fractures distal to the superficialis insertion produced volar angulation.

Fractures proximal to its insertion resulted in flexion of the distal fragment and dorsal angulation of the fracture.. Middle two-fourth fractures could angulate in either direction, and distal one-fourth fractures were always angulated volarly because of the superficialis pull on the proximal fragment. In some cases, the type of deformity in displaced middle phalangeal fractures is related to the force and direction of trauma rather than the superficialis pull.

MANAGEMENT

VARIOUS METHODS

1. Closed Reduction with a Cast or Splint:

Earlier manual reduction over a roller bandage with or without the addition of a dorsal splint have been tried. Jahss reduced a proximal phalanx fracture by taping the MCP and PIP joints in full flexion. For fractures of the middle phalanx, the PIP and DIP joints were taped in flexion and left the MCP joint free to move. Later the reduction of fractured proximal phalanx and immobilisation of all the fingers in a flexed position in a plaster mitten was done.

The plaster over the proximal and middle phalanges and proximal portion of the nail was removed to allow intermittent motion of the uninvolved fingers at 10 days and movement of the injured finger at 3 weeks. **MCP flexion was advised to avoid the contracture of the collateral ligaments that occurs with MCP extension.**

The PIP joints are held in nearly full extension to prevent the collateral ligament and volar plate contracture that occurs in flexion. Another advocated treatment of proximal phalangeal shaft fractures is by closed reduction and immobilisation in a short arm cast with the wrist held in 30 to 40 degrees of extension. **A dorsal plaster extension block is added to hold the MP joints flexed 90 degrees and the IP joints fully extended.** 75 percent of phalangeal fractures did not require reduction and could be treated with strapping to the adjacent finger from the start.

If the immobilisation is prolonged over 3 weeks, 60 percent of the patients had significant loss of hand function. It is also observed that the return of function between 75 and 80 percent of normal in fractured digits mobilised within the first 4 weeks after fracture. However, when the mobilisation is initiated after 4 weeks, only 66 percent return of function resulted.

James' position, 70 degrees of MP flexion and nearly full IP extension, is also useful and should be used whenever possible in treating phalangeal fractures. A forearm-based splint with the wrist extended facilitates maintenance of this position.

Malrotation is detected clinically and not radiologically. Patinet should be asked to fully flex the phalanges and the long axis of fingers should point to the scaphoid tubercle (or) the distal radius with fingers parallal to each other. A rotational deformity is associated with spiral, oblique, comminuted fracture.

2. Traction:

Traction can be exerted through the nail plate, the skin or the skeleton. It has the advantage of being minimally invasive and simple; however, traction may be difficult to maintain and is cumbersome. There are excellent results in angulated proximal phalangeal fractures treated by traction for 2 ½ to 3 weeks, followed by active range of motion with buddy taping. There were no complications, malunions, or nonunions.

Traction can either be applied thro' nail or through a hook glued on the nail with the MP joint flexed 70 to 90 degrees and the PIP joint in full extension. Complications are relating to the method of application, joint stiffness, difficulty in controlling fracture alignment, and counterpressure problems. **Traction has a definitive role in the management of comminuted phalangeal fractures which are not amenable to other treatment options.**

3. External Fixation:

External fixation is indicated for open fractures, especially those with concomitant soft-tissue injury such as gunshot wounds, highly comminuted diaphyseal fractures, severely comminuted articular fractures, and fractures with significant loss of bone stock. Advantage include ease of insertion, minimal dissection, preservation of bony length, and it provides access for additional soft-tissue care.

4. Percutaneous Pining:

Percutaneous Kirschner pin fixation has the advantage of stabilising the fracture and allowing early motion while minimising injury to the soft-tissue sleeve. This technique is particularly useful in shaft fractures that are transverse, spiral or oblique in orientation.

FACTORS DETERMINING MANAGEMENT

As with any fracture, many factors enter into the decision for fracture management. Four categories must be considered.(modified strickland et.al)

1 . stability
2. open versus closed
3. associated injuries
4. fracture geometry

1. Stability;

Phalangeal fracture stability is judged both clinically and radiographically. Fractures that rotate, angulate, or shorten are potentially unstable.Rotation is difficult to judge radiographically and is best assessed clinically by having patients actively simultaneously flex their fingers while the examiner looks for digital overlap (scissoring). Angulatory malalignment is radiographically apparent in either the coronal or sagittal plane. Clinical angulation in the coronal plane results in digital overlap on flexion.

Angulation (apex volar) in the sagittal plane of the proximal phalanx produces compensatory hyperextension at the MCP joint and an extensor lag at the PIP joint (pseudoclawing). Shortening, typically seen in comminuted fractures, is easily assessed both radiographically and clinically.

2. Open versus closed:

Open phalangeal shaft fractures usually result from direct high-energy trauma and tend to be unstable.

3. Associated injuries:

Fractures with injuries to adjacent structures such as nerves, vessels, the soft-tissue sleeve, or tendons are usually open and generally require internal stabilisation. Concomitant fractures either in the same ray or in the hand also necessitate operative fixation because it is difficult to maintain satisfactory alignment of multiple fractures by closed means.

4. Fracture geometry:

Three basic fracture patterns occur: transverse, oblique , spiral, and comminuted. Transverse fractures tend to produce angulatory deformities in both the lateral and frontal views. Oblique fractures produce rotatory deformities, but they may also angulate or shorten. Comminuted fractures nearly always shorten and may also malortate or angulate.

<u>Nondisplaced and Stable</u>:

Management is nonoperative. If there is discomfort or soft-tissue swelling, the digit is immobilised in the "safe" position). **MCP joint flexed 70 degrees and IP joints extended) for a week with a dorsal splint (padded aluminum) extending one joint proximal and distal to the fractures.** If there is minimal pain, immediate motion with buddy splinting can be initated. Follow-up x-rays should be obtained at weekly intervals to make sure that alignment remains satisfactory.

Displaced: Stable after Closed Reduction:

Displaced fractures that are malaligned can often be manipulated into alignment and stabilised. Transverse fractures of the proximal and middle phalanx are especially amenable to closed reduction. First, flex the MP joint maximally to stablize the proximal fragment, and then flex the distal fragment to correct the volar angulation.

Particular attention should be paid to rotation by comparing the plane of the nails. The reduction can be maintained with a short arm cast (wrist in neutral or slightly extended), with a dorsal plaster extension block holding the MCP joints flexed 70 to 90 degrees and the IP joints extended.

The extension block splint should include the adjacent digits with buddy taping to help control fracture alignment. Active flexion of the digit should begin within a few days to minimize stiffness and tendon adhesion. Supervised hand therapy with customised splinting and a carefully monitored rehabilitation programs are often required to optimise the final outcome.

The splint is maintained for approximately 3 weeks, and following removal, buddy taping is continued for an additional 2 weeks.

Spiral and oblique fractures tend to displace and shorten after reduction and casting and often require internal fixation. These fractures require careful scrutiny if treated with splinting alone. **X-rays can be especially deceptive and difficult to interpret.** In addition, once the digit has been immobilised, rotatory malalignment is almost impossible to assess.

The position for immoblisiation of spiral fractures is similar to that for transverse fractures. However, initiation of early motion will often result in loss of reduction. Therefore, immobilisation for approximately 3 to 3 ½ weeks is preferred , followed by mobilisation in an extension block cast or buddy taping for approximately 2 weeks. Repeated attempts at closed treatment are not warranted. If loss of reduction occurs, operative fixation should be done. .

<u>Displaced : Unstable After Closed Reduction</u>:

***Spiral and oblique Fracture*:**

Closed pinning works particularly well for spiral and oblique fractures treated within 3 to 4 days of injury. Fluoroscopy greatly facilitates fracture reduction and pin placement.

After pin insertion, rotational alignment should be checked by asking the patient to actively flex and extend the digits. If malalignment persists (either clinically or radiographically), either remove the pins and make another effort at closed reduction or proceed to open reduction. It is unwise to make more than two or three attempts at closed pinning, otherwise it may result in swollen, “pincushion” finger.

***Transverse Fractures*:**

Percutaneous cross-pinning of unstable transverse fractures is difficult even with an image intensifier. The goal is to insert two pins in crossed fashion and avoid the MCP and PIP joints. Closed percutaneous cross-pinning of these fractures is frustrating.An easier percutaneous technique is to insert the pin through the flexed MP joint into the medullary canal of the proximal phalanx .

This penetrates the metacarpal head to either radial or ulnar side and should be driven into the subchondral region of proximal phalanx head. Although this technique does not provide rotational stability and requires 3 weeks of immobilisation, this is simple and effective and preferred technique for percutaneous fixation. At the time of pin removal, range-of-motion exercises are initiated.

Some unstable phalangeal shaft fractures require open reduction to facilitate management of concomitant injuries because closed reduction and percutaneous pinning are unsatisfactory.

Displaced: Unstable and Comminuted:

These fractures are difficult to manage and usually open and are often associated with soft-tissue injury. Instability patterns include angulation, malrotation, and shortening. Fracture stabilisation is necessary to restore length and alignment and to facilitate management of concomitant soft-tissue injuries. In nearly all cases, operative intervention is necessary.

Application of mini-external fixation device is preferred treatment. It provides stablisation, allows access to open wounds, and does not risk devitalisation of small fracture fragments, which may have a tenuous blood supply. Supplemental Kirschner pins and intraosseous or cerclage wires may increase stability. If there is an osseous void, bone grafting can be considered, assuming that there is adequate soft-tissue coverage. The fixator is left in place for 4 weeks, during which time active mobilisation of uninvolved joints is encouraged. After the fixator is removed, an aggressive physiothreapy is initiated. Secondary surgery, including tenolysis and capsulotomy, is frequently necessary but should be delayed until there is solid bony union and the soft-tissue sleeve is mature and pliable.

Plates and screws are a popular alternative to external fixation. However, several caveats must be kept in mind: additional soft-tissue mobilisation is usually necessary, there is no margin for error (plate malposition may lead to malreduction), the plate may interfere with tendon excursion, and soft-tissue coverage (without a flap) may not be possible. For these reasons, plate fixation is the second choice of stabilisation for comminuted phalangeal shaft fractures.

<u>Base Fractures of the Proximal Phalanx</u>:

In the lateral view these fractures angulate, apex palmar, and often the amount of angulation is difficult to assess because of the adjacent overlying digits. Malunion was associated with immobilisation of the digit in insufficient flexion at the MCP joint and resulted in loss of reduction or acceptance of oblique x-rays for the evaluation of angulation.

Up to 30 degrees of volar angulation is acceptable in younger children, but uncorrected angulation of 25 degrees or more in adults or older children caused loss of motion and necessitated corrective osteotomy. Occasionally, reduction may be impossible because of interosseous tendon interposition. Clinically, a malunion is seen as "pseudoclawing ," which is clinically manifested by hyperextension at the fracture and MCP joint and an extensor lag at the PIP joint. This fracture is reduced by flexing the MCP joint maximally to stabilise the proximal fragment and relax the intrinsic muscles and then correcting the volar angulation by flexing the distal fragment.

Immobilisation with the MCP joint flexed at 70 degrees and the PIP joint extended for 3 to 4 weeks is recommended. Closed reduction with pinning is an excellent technique to maintain reduction. A Kirschner pin is drilled through the flexed MP joint into the proximal fragment to stabilize it. After the distal fragment is reduced onto the proximal fragment, the Kirschner pin is drilled across the fracture into the distal fragment.

Epiphyseal fractures of the base of the proximal phalanx are most common in the small finger. The injury is produced when the finger is grabbed and twisted. Reduction is usually easily accomplished by flexing the MCP joint maximally to stabilize the proximal fragment while the deformity is corrected. Following reduction (MCP joint flexed 70 degrees and the IP joints extended), an ulnar gutter splint incorporating the adjacent digit is applied for 2 ½ to 3 weeks. Only buddy taping can be used to maintain stability after reduction. Occasionally, open reduction is necessary.

Traction Splinting:

Comminuted fractures with small bone bits either intra articular or extra articular, are not amenable to miniplate or K-wire fixation. In those cases traction splint provides adequate distraction to keep the fragments in acceptable alignment.

HEALING TIME:

Many authors have commented on the lack of correlation between x-rays and clinical signs of union of phalangeal fractures. The average time for complete bony healing was approximately 5 months for the phalangeal (toes and hands) fractures and the clinical healing time when the patient could return to work was about one fourth of this. The average time for clinical union was 5 to 7 weeks for the middle portion of the proximal phalanx and up to 10 to14 weeks for transverse fractures of the exceedingly hard cortical portion of the middle phalanx.

COMPLICATIONS

1. Malunion – most common

   malrotation ,volar angulation , lateral angulation shortenning

2. Non union
3. Stiffness of MCP & PIP joints
4. Extensor & flexor tendon adhessions & rupture
5. Infection

AIM OF STUDY

The main objectives of this clinical study are

1. To discuss the role of traction splint in the management of proximal phalangeal fractures which are not amenable to the other forms of treatment.

2. To evaluate the results of the cases of proximal phalangeal fractures managed by the traction splint.

3. To review the age and sex incidence, mode and the type of injury in cases of proximal phalangeal fractures.

4. To study the commonly involved hand and fingers, type of the fractures, anatomical site of the fracture and the treatment options.

5. To discuss the postoperative management and final outcome.

REVIEW OF LITERATURE

1. The use of traction splint in the management of phalangeal fractures of the hand

Medhat E. Habib, Ammar S. Saleh and C. Thomas, European Journal of Plastic Surgery, Department of Plastic Surgery, Khoula Hospital, Muscat, Oman, Volume 28,Number 8/April 2006

The use of skin traction splintage is established in the treatment of phalangeal fractures of the fingers. Fifty patients with 53 different types of closed displaced proximal and middle phalangeal fractures were included in a 4-year study period. Satisfactory radiological reduction was obtained by 48 traction splints applied (90.56%) while five cases required operative intervention (9.44%). Out of the 48 traction splints used, full range of movement was obtained in 45 fingers (93.75%). This technique is recommended, as it is a simple, quick, inexpensive, and noninvasive procedure with excellent results.

2. Old principles revisited--traction splinting for closed proximal phalangeal fractures.

Collins AL, Timlin M, Thornes B, O'Sullivan T.Department Of Orthopaedic Surgery, Waterford Regional Hospital, Waterford, Ireland. Injury Volume 33,Issue 3 ,Page235-237 April 2002

Proximal phalangeal fractures are commonly caused by a blunt injury to the dorsum of the hand. This typically results in a closed transverse fracture with volar angulation, which is an inherently unstable fracture pattern. K-wiring and internal fixation have the disadvantage of damage to the soft tissue envelope, risk of infection and wire loosening. 15 patients treated with an alternative method of skin traction and splintage has been described. Fractures were reduced under X-ray and reduction was maintained using a combination of a malleable metal splint and tape to provide skin traction. Fourteen patients had an excellent objective and subjective outcome. The advantage of this technique is preservation of the soft tissue envelope and it should be considered an alternative to other treatment options as it is simple, quick, inexpensive and non-invasive.

3. The pins and rubbers traction system for treatment of comminuted intraarticular fractures and fracture-dislocations in the hand

Suzuki Y,Matsunaga T,Sato S,Yokoi T Department of Orthopaedic Surgery, Gifu Prefectural Gifu Hospital, Japan J Hand Surg [Br]. 1994 Feb;19(1):98-107.

A skeletal traction system for comminuted intraarticular fractures and fracture-dislocations in the hand. The system consists of two or three Kirschner wires and rubber bands, and is easy to assemble. It is compact and comfortable , and effective, and it allows early motion of the affected digits. At the time of follow-up, the average range of the affected PIP joint motion was about 80 degrees. The final active motion of the injured DIP joint ranged from 0 to 40 degrees in flexion and that of the affected thumb (trapezial fracture) was not limited. The average follow-up period was 13.1 months.

4. Pins and Rubbers Traction System.

de Soras X, de Mourgues P, Guinard D, Moutet F. Hand Surgery and Burns Unit, CHU de Grenoble, France J Hand Surg [Br]. 1997 Dec;22(6):730-5

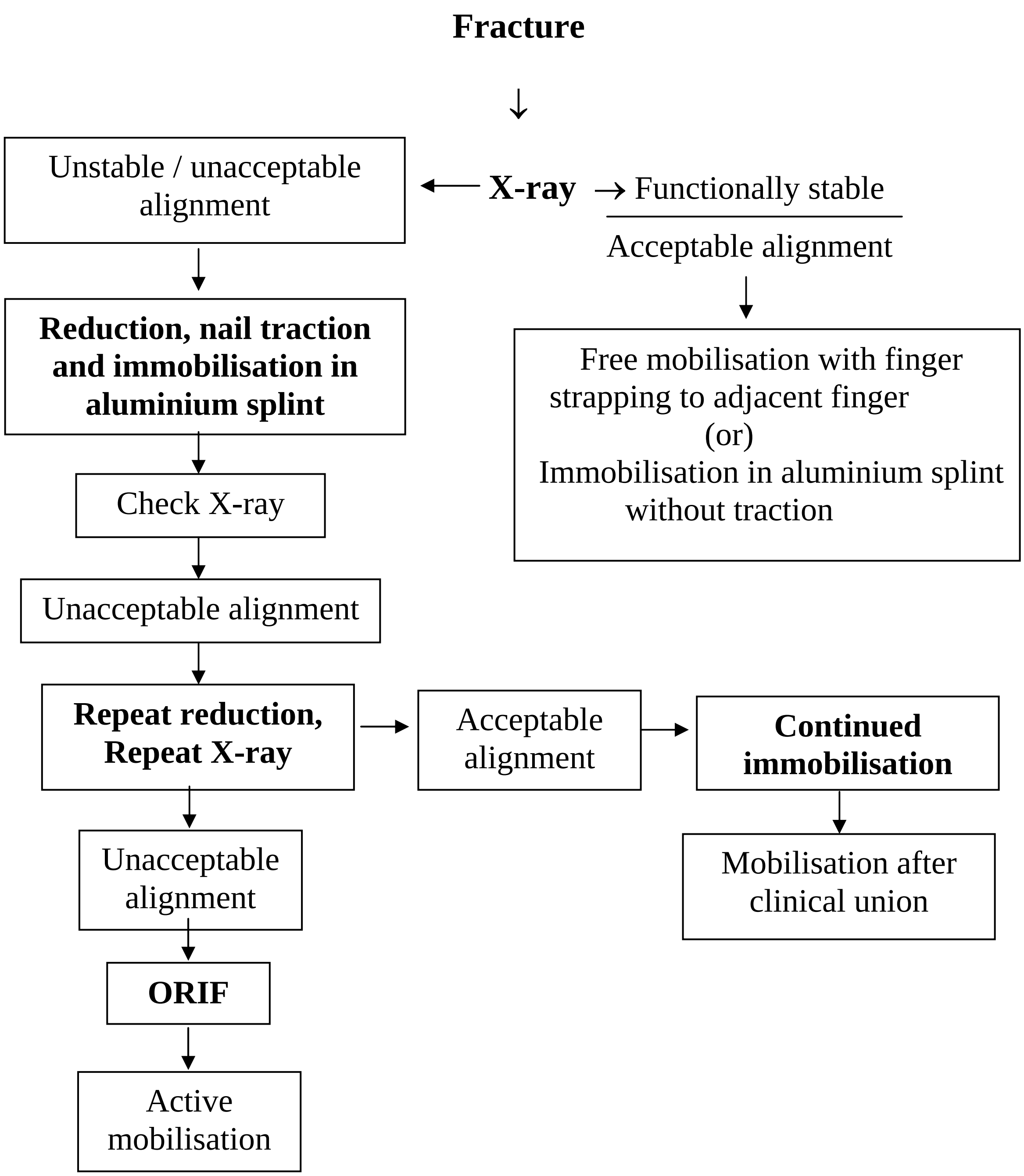
The Pins and Rubbers Traction System (PRTS) is a mobile frame created with wires to support elastic traction, which produces a ligamentotaxis effect in the same direction and of the same intensity whatever the position of the joint. This technique has been used in 11 cases of complex PIP joint fractures with eight excellent results. The advantages are simplicity, adaptability, the possibility of immediate mobilisation, reasonable cost and relatively small bulk.

5. Pilon fractures of the proximal interphalangeal joint.

Stern PJ, Roman RJ, Kiefhaber TR, McDonough JJ. Department of Orthopaedic Surgery, University of Cincinnati College of Medicine, Ohio **J Hand Surg [Am]. 1991 Sep;16(5):844-50.**

A pilon fracture is an uncommon intraarticular fracture of the proximal interphalangeal (PIP) joint resulting in comminution, central depression, and splay, sagittally and coronally, of the articular surface of the base of the middle phalanx. This study reviews three treatment methods and results in 20 patients. Injury was produced by an axial load and occurred primarily to the ulnar digits. Clinical and radiographic follow-up averaged 25 months. Treatment was divided into three categories: splint (four patients), skeletal traction through the middle phalanx (seven patients), and open reduction with Kirschner pins (nine patients). Anatomic restoration of PIP articular contour was not achieved, regardless of technique. No patient regained full mobility at either interphalangeal joint. Treatment by immobilisation is undesirable. Open reduction should be approached cautiously and may result in significant complications. Skeletal traction is safe and gives results that are radiographically and clinically comparable to those achieved with open reduction.

OUR MANAGEMENT PROTOCAL



MATERIALS AND METHODS

Materials:-

This study consists of evaluation of all consecutive proximal phalangeal fractures managed in our department from July 2005 to October 2007. This study included 32 patients of proximal phalangeal fractures which are suitable for nail traction system were treated with nail traction splint. The average age of the study group was 27.6 years. The material used for the traction was a long malleable aluminium splint, POP, 3-0 Prolene suture & bandage materials.

Methodology:-

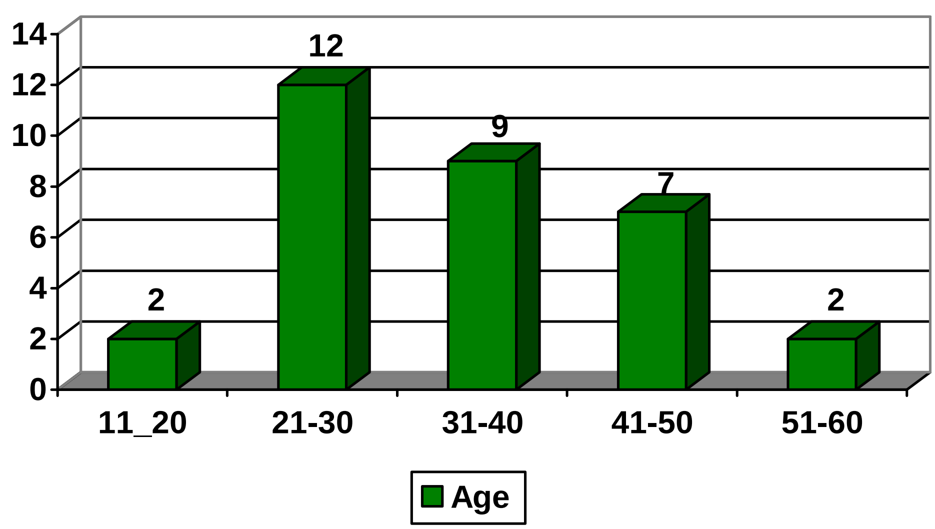
The factors taken in to account for analysis in this study were

1. Age and Sex of the patient
2. Mode of Injury
3. Type of the wound
4. Anatomical site of the Fracture with presence of intraarticular extension
5. Type of the fracture
6. The involved Hand and fingers

AGE DISTRIBUTION

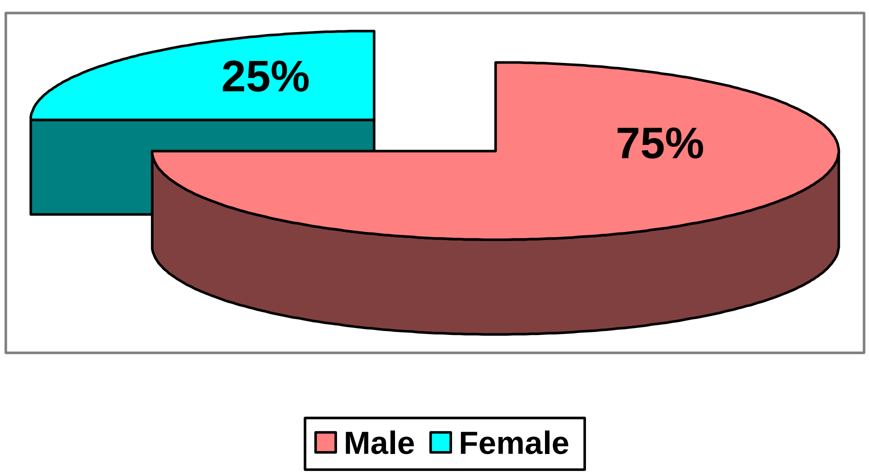
In the thirty two patients included in our study, the mean age was 27.6 years with a range of 10-60 years.

S.NO.	AGE RANGE	TREATED BY TS
1	11-20	2
2	21-30	12
3	31-40	9
4	41-50	7
5	51-60	2



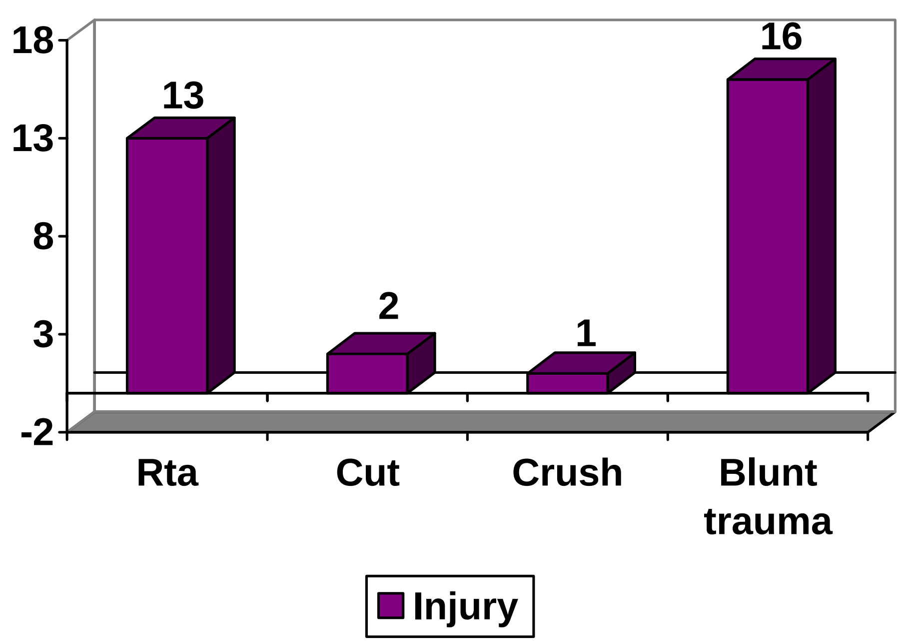
SEX DISTRIBUTION

S.NO.	SEX	TREATED BY TS
1	MALE	24
2	FEMALE	8



MODE OF INJURY

S.NO.	MODE OF INJURY	TREATED BY TS
1	Road traffic accident (Blunt &Crush injury)	13
2	Cut injury (Assault & Accidental)	2
3	Machinary injury (Crush)	1
4	Blunt trauma (Iron / Wooden Rod)	16



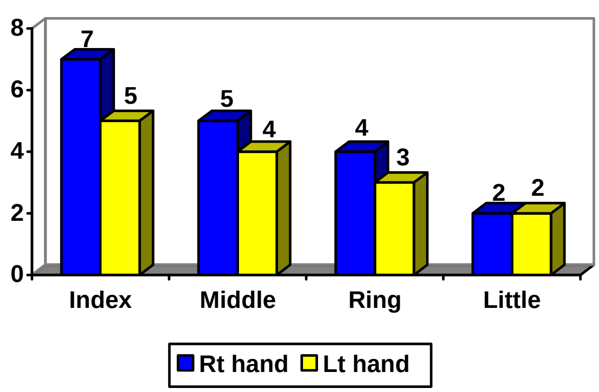
HAND & FINGERS INVOLVEMENT IN PPX #

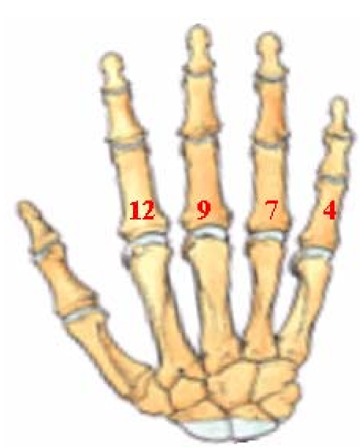
(A) RIGHT HAND-18

S.NO.	FINGER INVOLVED	TREATED BY TS
1	Index	7
2	Middle	5
3	Ring	4
4	Little	2

(B) LEFT HAND- 14

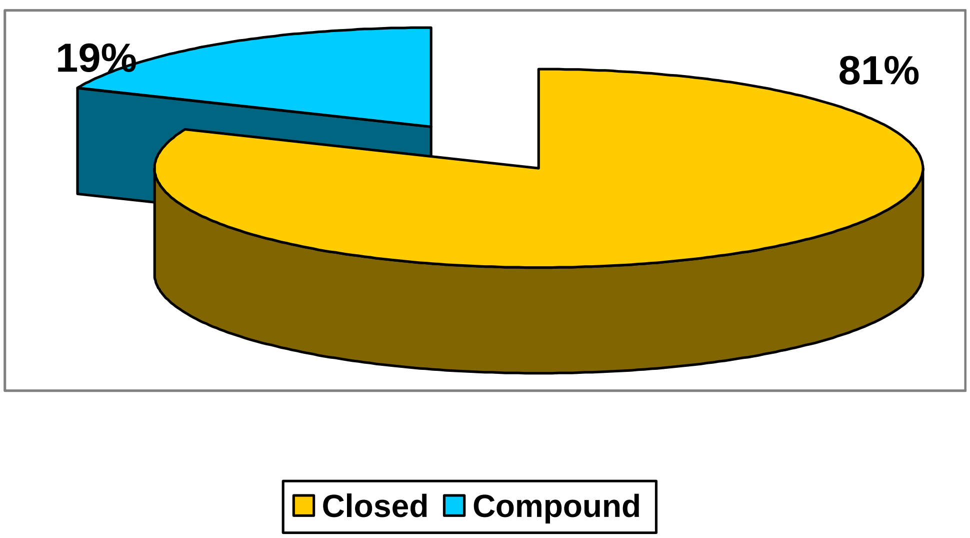
S.NO.	FINGER INVOLVED	TREATED BY TS
1	Index	5
2	Middle	4
3	Ring	3
4	Little	2





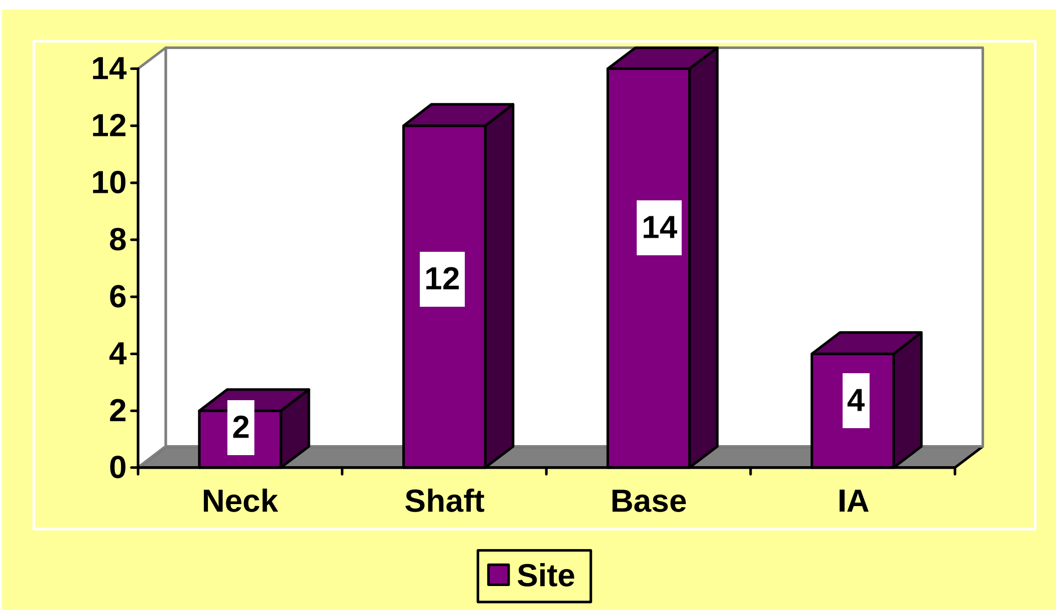
TYPE OF WOUND

S.NO.	TYPE OF WOUND	TREATED BY TS
1	Closed	26
2	Compound	6



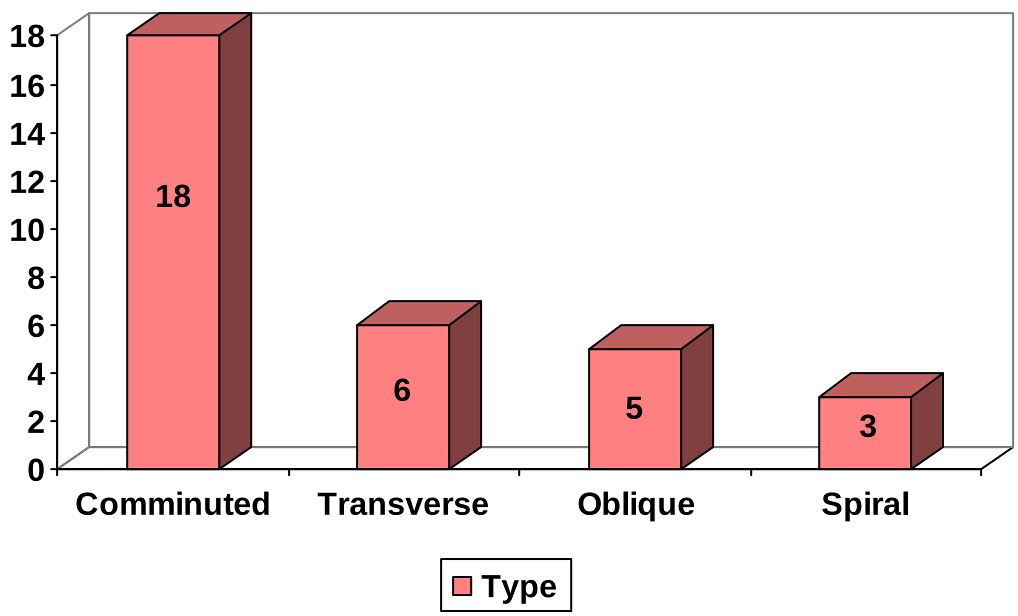
SITE OF FRACTURE

S.NO.	SITE OF FRACTURE	TREATED BY TS
1	Neck	2
2	Shaft	12
3	Base	14
4	Intrarticular components	4



TYPE OF FRACTURE

S.NO.	TYPE OF FRACTURE	TREATED BY TS
1	Comminuted	18
2	Transverse	6
3	Oblique	5
4	Spiral	3



PROCEDURE & POSTOPERATIVE PROTOCOL

Under digatal block, with aseptic precautions, after the wound closure, if any, horizontal mattress suture was taken with No. 3-0 prolene in the nail. Then a long aluminium splint was incorporated into a volar BE slab extending upto the head of the metacarpal with wrist dorsiflexed to 30°. The aluminium splint, which extends upto about 10 cm beyond the fingertip, is flexed to 60° at the MCP joint. Traction was then applied and closed reduction done by moulding. After satisfactory reduction the prolene suture was then tied around the aluminium splint over a bend on the splint. It was ensured that the finger was placed parallel to the aluminium splint with the flexion at the MCP joint to about 60° and IP joints in complete extension.

Post operative check x-rays were taken in the AP & oblique views and traction adjusted accordingly.

Follow up:-

All patients were periodically reviewed on a weekly basis or if having any symptoms. It was ensured that the proper traction was maintained throughout and traction adjusted if any loosening of the prolene suture was noted.

The mean duration of traction splint application was 15 days (range 14–16 days). The splint was removed when there was no tenderness at fracture site clinically. The mean duration of the physiotherapy required after removal of the traction splint was 3 weeks (range 5–35 days). The mean follow-up period was 3 months (range 2-5months). The outcome was assessed both functionally and radiologically as per the steel’s criteria.

COMPLICATIONS

The complications taken into account were,

1. Vascular compromise: Diagnosed by severe pain and blanched finger tips. Treated by reducing the tension.
2. Subungual haematoma
3. Infection.
4. Chronic persistent swelling.
5. Chronic pain.
6. Joint stiffness of MCP and IP joints.
7. Nonunion
8. Malunion
9. Pressure necrosis due to splint

VASCULAR COMPROMISE	**1**
SUBUNGUAL HAEMATOMA	**1**
CHRONIC SWELLING & PAIN	**1**
INFECTION OF FINGER TIP	**1**
STIFFNESS OF PIP JOINTS	**2**
NONUNION	**1**
MALUNION	**1**
PRESSURE NECROSIS	**1**

One patient with open fracture had vascular compromise diagnosed by severe pain & blanching of the finger tips and was treated by reducing the tension. One patient had chronic persistent swelling of the finger and one patient had infection of finger tip. The above cases were treated with antibiotics NSAIDS & hand elevation. Two patients had severe stiffness of the PIP joint. There was one case of malunion & non union.

ANALYSIS OF OUTCOME

The outcome was assessed both functionally and radiologically as per the steel’s criteria.

Steel’s criteria for assessing outcome

1. Pain
2. Deformity
3. Movement
4. Function

1. Pain

Severity	Score
No pain	100
Cold aches (Whether related)	80
Mild Pain	60
Moderate pain	40
Severe pain (require analgesic)	20

2. Deformity

Deformity	Score
No rotation deformity	100
< 15° angulation / rotation	70
> 15° of deformity	0

3. Movement

S. No.	Result	MCP ROM	PIP ROM	Score
1.	Excellent	Full	Full	100
2.	Good	70° to 90°	90° to 110°	80
3.	Moderate	30° to 70°	30° to 90°	60
4.	Poor	0° to 30°	0° to 30°	0

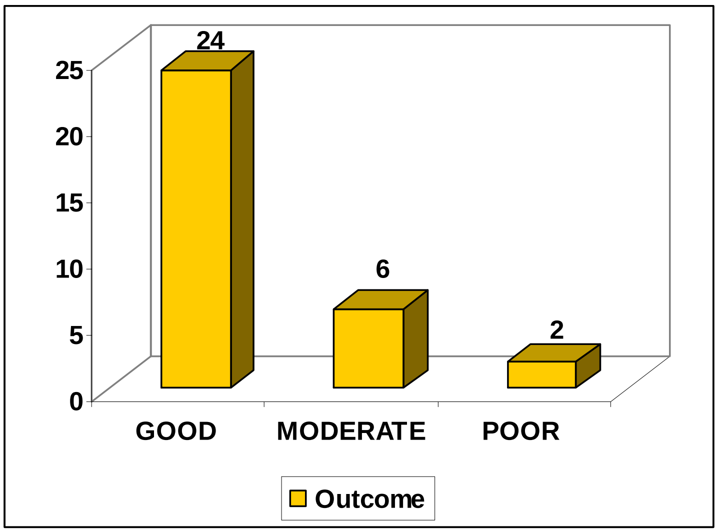
4. Function: percentage of normal opposite hand

Score			**Overall Results**		
Pain	-	100	Excellent	-	400
Deformity	-	100	Good	-	300-399
Movement	-	100	Moderate	-	300-349
Function	-	100	Poor	-	< 300
Total	-	**400**			

All these details were recorded for each patient and the master chart was made and the results were analysed.

TABLE 10 OUTCOME

TOTAL NO. OF PATIENTS	GOOD RESULT	MODERATE RESULT	POOR RESULT
32	24	6	2



The mean time for clinical union was 21 days (14 to 28 days). The mean time for radiological union was 42 days (28 to 56 days). 24 patients had good functional outcome (75%), Six patients had moderate outcome (18.75%) and only two patients (6.25%) had poor outcome. The mean ROM of the involved PIP joints was above 70° in most of the cases. No fixed flexion deformities were observed. All patients returned to their pre injury work status and were satisfied with their overall result.

DISCUSSION

It was observed that proximal phalangeal fractures were mostly seen in the age group of 20 to 40 years particularly in males and traction splint was commonly used in the third decade, since it requires patient's compliance and regular follow up. Though proximal phalangeal fractures were commonly associated with compound injuries, traction splint could be employed mostly in closed injuries or in compound wounds in which primary skin closure was possible as the traction splint is contraindicated in patients with large wounds and in cases of doubtful vascularity.

Among the various causes of the proximal phalangeal fractures, blunt trauma was the leading cause followed by RTA. As expected the right hand was found to be commonly injured with more number of cases with index finger involvement.

In the proximal phalangeal fractures, base fractures are commonly observed followed by the shaft fractures.

Comminution was seen in most of the base fractures with intra articular component in half of the cases. These cases were more suited and indicated for the treatment using the traction splint in preference to other treatment options.

Minor complications were encountered with eight patients treated by the traction splint for the proximal phalangeal fractures. One patient had vascular compromise diagnosed by severe pain & blanching of the finger tips and were treated by reducing the tension. One patient had chronic persistent swelling and pain of the finger. One patient had pressure necrosis and one patient had finger tip infection, one patient had subungual haematoma. The above cases were treated symptomatically with antibiotics, NSAIDS and hand elevation. Two patients with irregular follow up had severe stiffness of the PIP joint and advised physiotherapy. There was one case of malunion and non-union.

Outcome was found to be good with the traction splint in more than 75% of the cases both clinically and radiologically, good plus moderate results were seen (93.75%). Patients developed good range of movements following the traction splinting and physiotherapy. Six patients were found to have moderate result and were advised to continue the physiotherapy. Two patients were lost for follow up four weeks after the treatment and on review found to have severe stiffness with the poor outcome.

Good outcome

S.No	Study Group	Percentage
1	Medhat E. Habb et al	90.56%
2.	Suzuki Y. et al	94%
3.	Our study	93.75%

CONCLUSION

Traction splint with long aluminium splint immobilisation, in our study has proved most simple and least invasive procedure not requiring sophisticated bone instruments or manipulation. It is cheap in terms of raw materials, which include: aluminum splint, which can be easily procured cheaply, POP, prolene suture & bandage materials. When compared to other treatment options, it is a technically easier procedure, found to be safe, efficient and effective in the management of proximal phalangeal fractures particularly associated with the comminution and the intraarticular component where other options are too difficult or not possible.

Post operative results are good in more than 75% of patients (good plus moderate 93.75%); poor results (6.25%) are rarely seen. Number of complications needing secondary procedures is much less when compared with other methods of management.

Good results were observed in most of the patients with very good radiological and functional outcome without significant complications provided good followup could be ensured.In cases with poor follow up the result can turn out to be poor as we observed in two of our cases.

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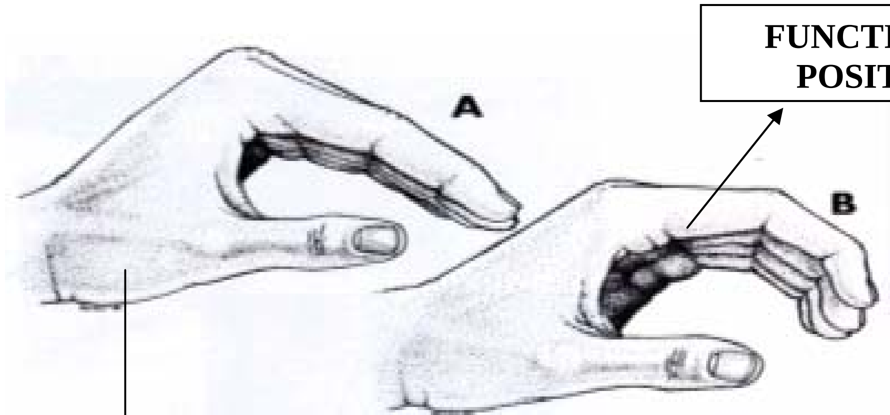
POSITION OF HAND

FUNCTIONAL POSITION



POSITION OF IMMOBILISATION

Safe intrinsic plus position of JAMES – 30^{0} of wrist extension, 70° of MCP flexion & full extension of IP JT

HAND ALLIGNMENT

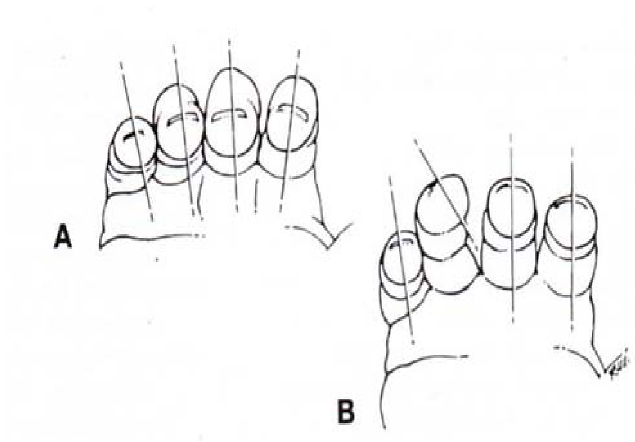
1. RELATION TO SCAPHOID

Normal **Malrotation**

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

2. RELATION TO POSITION OF FINGER NAIL

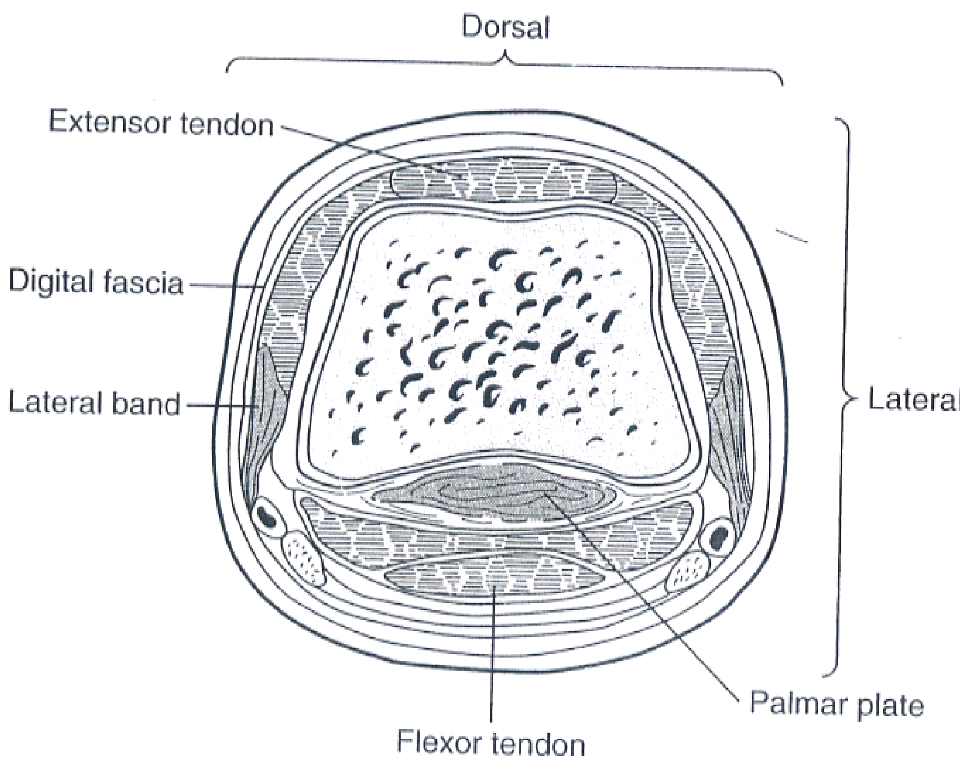
Plane of finger nails helps in detecting malrotation of fractures compared to opposite hand.



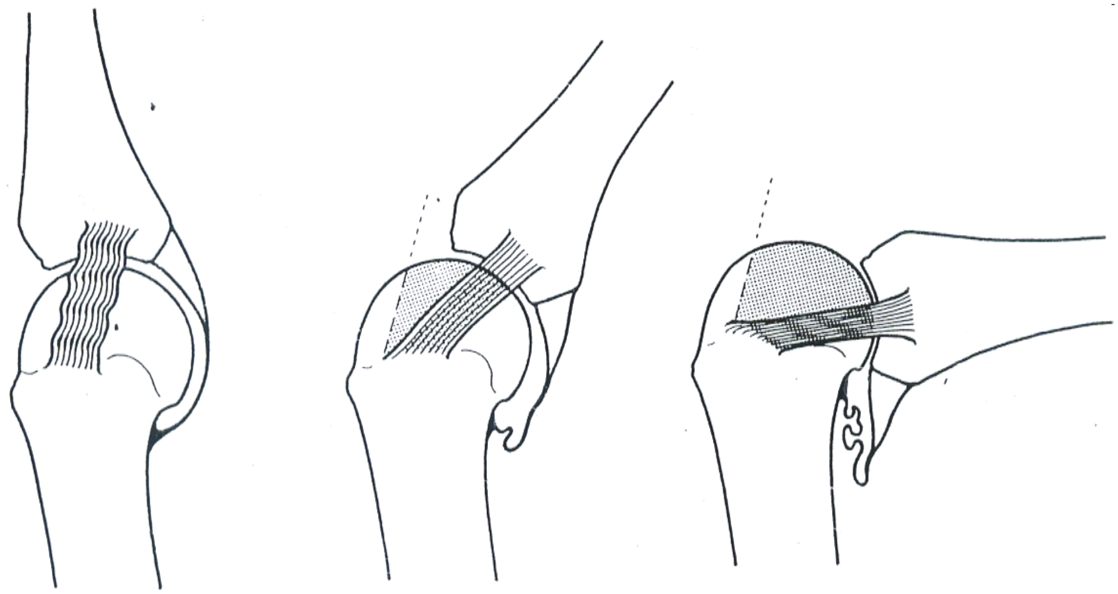
A – normal allignment of finger nail

B – allignment of finger nails with malrotation of ring finger

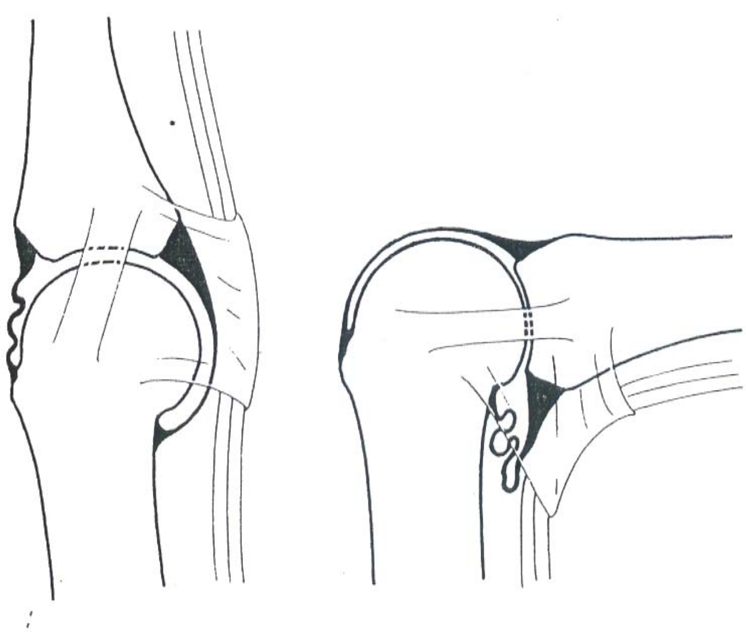
CROSS SECTION OF A FINGER AT PPx LEVEL



JOINT STIFFNESS – LATERAL LIGAMENT



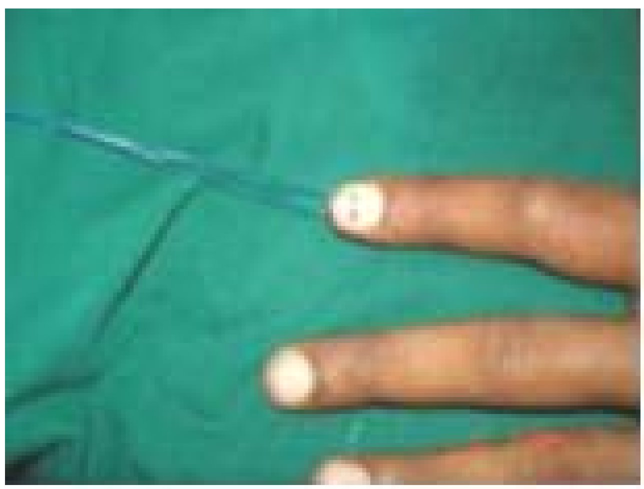
JOINT STIFFNESS –
CARTILAGINOUS PORTION OF THE PALMAR CAPSULE



INSTRUMENTS

PROCEDURES





COMPLICATIONS

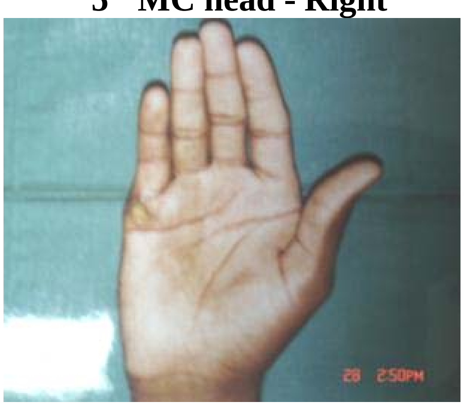
1. MALUNION OF F_5 - Left

Mal Rotation

Volar angulation

2. Chronic Swelling and Pain of F_3 - Left

3. Pressure necrosis over 5th MC head - Right



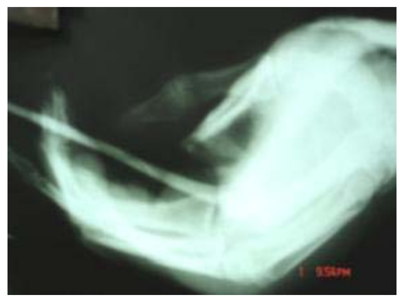
4.Infection of finger tip F_4 Left - finger looks shiny

CLINICAL ILLUSTRATION

CASE I - 27 y/M Intraarticular # Base of PPx F4 RT

PRE OP

IMMEDIATE POST OP



6 MONTHS POST OP

Bone union at fracture site

FULL FUNCTIONAL RECOVERY

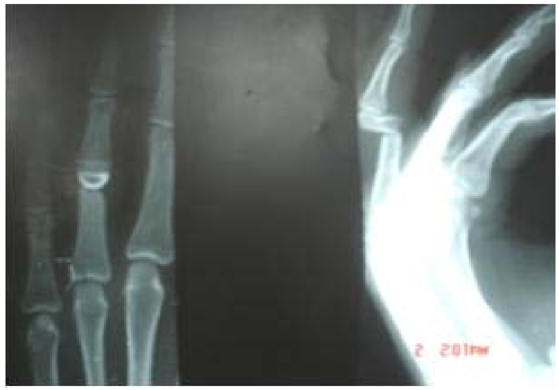
Full Extension

Full Flexion, no rotation

CASE II

27 y/M Transverse # Neck of F4 RT

PREOP



4 MONTHS POST OP

Fracture united

FULL FUNCTIONAL RECOVERY

FULL EXTENSION

FULL FLEXION, NO ROTATION

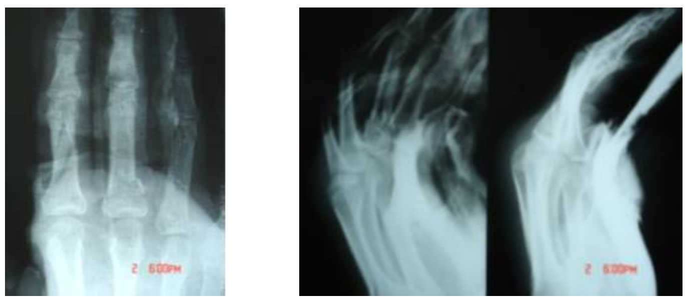
CASE III

30/M Compound Communited # Base of F3 & Spiral # Shaft of F2 RT

Compound # F3

Pre op

Immediate Post Op



7 Months Post Op

Fractures united well

Full Functional Recovery

Full Extension

Full Flexion, No Rotation

CASE IV
35 y/ M Transverse # Shaft of PPx F3 Lt

Pre Op

Volar Angulation

Immediate Post Op

16 months Post Op

 # site united

Full functional recovery
– full flexion and no rotation

CASE V
24y/F RT F2 Transverse # PPX – shaft

Pre Op

Volar angulation

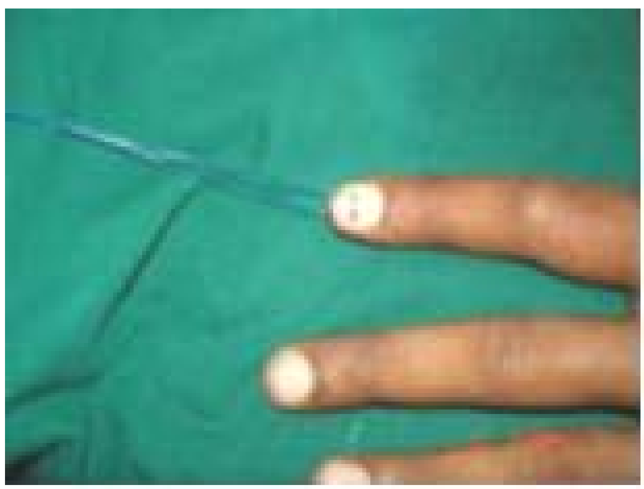
Immediate Post Op

12 months post op

Bony union at fracture site

INSTRUMENTS

PROCEDURES


COMPLICATIONS

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Volar angulation

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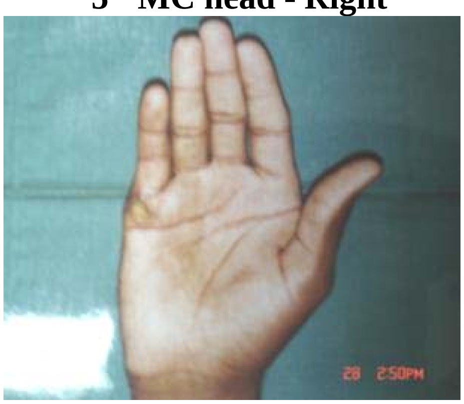
3. Pressure necrosis over 5th MC head - Right



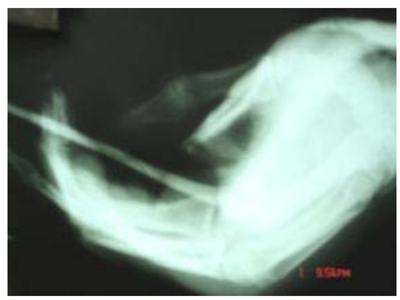
4.Infection of finger tip F_4 Left - finger looks shiny

CLINICAL ILLUSTRATION

CASE I - 27 y/M Intraarticular # Base of PPx F4 RT

PRE OP

IMMEDIATE POST OP



6 MONTHS POST OP

Bone union at fracture site

FULL FUNCTIONAL RECOVERY

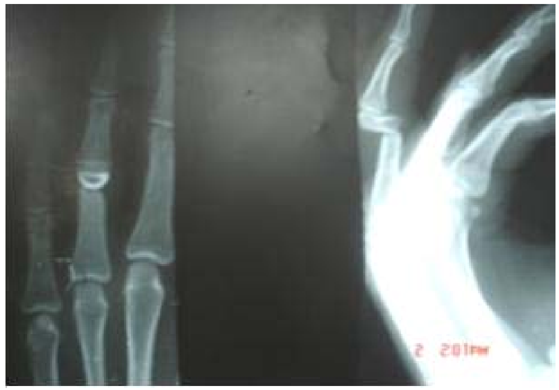
Full Extension

Full Flexion, no rotation

CASE II

27 y/M Transverse # Neck of F4 RT

PREOP



4 MONTHS POST OP

Fracture united

FULL FUNCTIONAL RECOVERY

FULL EXTENSION

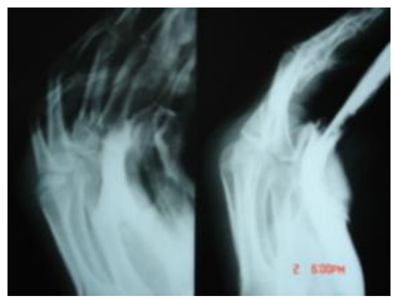
FULL FLEXION, NO ROTATION

CASE III

30/M Compound Communited # Base of F3 & Spiral # Shaft of F2 RT

Compound # F3 | **Pre op**

Immediate Post Op



7 Months Post Op

Fractures united well

Full Functional Recovery

Full Extension

Full Flexion, No Rotation

CASE IV
35 y/ M Transverse # Shaft of PPx F3 Lt

Pre Op

Volar Angulation

Immediate Post Op

16 months Post Op

 # site united

Full functional recovery

– **full flexion and no rotation**

CASE V
24y/F RT F2 Transverse # PPX – shaft

Pre Op

Volar angulation

Immediate Post Op

12 months post op

Bony union at fracture site

MASTER CHART

SI.NO	AGE/SEX	HISTORY	FINDINGS	TYPE	SITE	FINGER	COMPLICATION	OUTCOME
1	16/M	RTA	COMPOUND	COMMINUTED	SHAFT	R- F2	SUBUNGUAL HAEMATOMA	GOOD
2	20/F	BLUNT TRAUMA	CLOSED	TRANSVERSE	INTRAARTICULAR	R- F3		GOOD
3	28/M	BLUNT TRAUMA	CLOSED	SPIRAL	SHAFT	L- F2		GOOD
4	26/M	RTA	CLOSED	COMMINUTED	BASE	R- F2		GOOD
5	27/M	RTA	CLOSED	TRANSVERSE	NECK	R- F4		GOOD
6	21/M	CUT INJURY	COMPOUND	OBLIQUE	BASE	L- F3		MODERATE
7	30/M	CRUSH INJURY	COMPOUND	COMMINUTED	SHAFT	L- F4		GOOD
8	25/M	RTA	CLOSED	OBLIQUE	SHAFT	R- F2		GOOD
9	26/M	BLUNT TRAUMA	CLOSED	COMMINUTED	INTRAARTICULAR	L- F5	INFECTION OF FINGER TIP	GOOD
10	27/M	RTA	CLOSED	COMMINUTED	INTRAARTICULAR	R- F3		GOOD
11	23/F	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	R- F4		GOOD
12	24/F	CUT INJURY	COMPOUND	COMMINUTED	NECK	L- F2		MODERATE
13	28/F	RTA	CLOSED	SPIRAL	SHAFT	R- F2		GOOD
14	30/F	RTA	COMPOUND	COMMINUTED	SHAFT	R- F3		MODERATE
15	32/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	L- F3	SWELLING AND PAIN	MODERATE

16	36/M	RTA	CLOSED	COMMINUTED	BASE	L- F4		GOOD
17	24/F	RTA	CLOSED	TRANSVERSE	SHAFT	R- F2		GOOD
18	38/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	L- F3		GOOD
19	40/M	RTA	CLOSED	SPIRAL	SHAFT	R- F5	NONUNION	POOR
20	39/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	L- F2		MODERATE
21	30/M	BLUNT TRAUMA	COMPOUND	OBLIQUE, IA	SHAFT, BASE	R- F2,F3		GOOD
22	31/F	BLUNT TRAUMA	CLOSED	OBLIQUE	BASE	L- F2		GOOD
23	37/F	RTA	CLOSED	COMMINUTED	SHAFT	R- F4	STIFFNESS,	MODERATE
24	46/M	BLUNT TRAUMA	CLOSED	TRANSVERSE	BASE	R- F2		GOOD
25	43/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	L- F2		GOOD
26	35/M	RTA	CLOSED	TRANSVERSE	SHAFT	L- F3		GOOD
27	49/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	R- F5	PRESSURE NECROSIS	GOOD
28	41/M	RTA	CLOSED	OBLIQUE	SHAFT	L- F5	MALUNION,STIFFNESS	POOR
29	46/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	R- F3		GOOD
30	27/M	BLUNT TRAUMA	CLOSED	COMMINUTED	INTRAARTICULAR-BASE	R- F4		GOOD
31	53/M	BLUNT TRAUMA	CLOSED	COMMINUTED	BASE	L- F4	VASCULAR COMPRAMISE	GOOD
32	60/M	BLUNT TRAUMA	CLOSED	TRANSVERSE	BASE	R- F3		GOOD