PATTERN AND FUNCTIONAL OUTCOME OF HAND INJURIES AMONG PATIENTS TREATED AT MUHIMBILI ORTHOPAEDIC INSTITUTE (MOI)

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By

Boniphace Yohana Lukwinyo

A Dissertation Submitted in (partial) Fulfilment of the Requirement for the Degree of Master of Medicine (Orthopaedic and Traumatology) of

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled***; ''Pattern and Functional Outcome of Hand Injuries among Patients Treated at Muhimbili Orthopaedic Institute (MOI)''*** in (partial) fulfillment of the requirement for the degree of Master of Medicine (Orthopaedic and Traumatology) of Muhimbili University of Health and Allied Sciences.

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Dr. C.N Mcharo (MD, MMed, MSC, FCS (ECSA))

(Supervisor)

_____

Date

DECLARATION
AND
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I, **Boniphace Yohana Lukwinyo**, I declare that, this **dissertation** is my own original work and that it has not been presented and will not be presented to any other university for similar or any other degree award.

Signature…… **Date……**

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Special thanks to almighty God for the protection and good health he granted, both to me and all my family members throughout my study period

DEDICATION

This dissertation is dedicated to my beloved wife, Winniel S. Kinkoro, my daughters; Glory B. Lukwinyo and Grace B. Lukwinyo for their love, courage, support and commitments to make sure our family is running smoothly.

ABSTRACT

Hand and fingers are most often injured in work place (1)(2)(3). For acutely injured hand, the treatment goals are to alleviate pains, repair the injured structures, prevent complications, and restoring the normal function (3).Hand injuries can result in a considerable society burden including costs for the provision of acute health care services, as well as, reduced socio-economic productivity due to the injured person's limited capacity to perform daily functional activities throughout their recovery(2)

Hand injuries are common at MOI; 10-15 persons with hand injuries are attended at MOI emergency department every month(4)**.**

Objectives: To determine pattern and short term functional outcome of hand injuries among patients attended at MOI.

Methodology: A descriptive prospective hospital based study was conducted at MOI on adults aged 18years and above with hand injuries from June 2016-May 2017. Convenience sampling technique was used to get the sample size. 70 patients met the inclusion criteria and were recruited after consenting for the study. Data were collected with help of one research assistant and guided with a structured questionnaire and BMHQ. Goniometer and ruler were used to accomplish data collection process.

The outcome **was** assessed using objective and subjective criteria at 2^{nd}, 6^{th}, and 12^{th} week post treatment. The objective outcome was assessed using Belsky`s, Gingrass`s criteria for fingers and thumb injuries and Dargan`s criteria for tendon injuries. The subjective criteria was assessed using BMHQ. The data obtained were analyzed **using** SPSS version 20.

Results: A total of 70 patients with hand injuries were recruited with 66 being evaluated for outcome. The modal age group was 20-29 years. Males outnumbered females in a ratio of 6.8:1.Among the recruited patients, 54.3% had a primary education.45.7% depend on petty business to sustain their life. The right hand was affected more than the left hand. The right

hand was dominant hand in 87.1%.Road traffic crashes, machines and assaults were the leading causes of hand injuries.

72.9% were open injuries and 27.1% were closed injuries. The open injuries included lacerations 42.9%, traumatic amputation 12.9%, abrasions 8.6%, crush and degloving injury 8.6%.

Phalanges of the middle finger were the most fractured bones. Among the phalanges comminuted fracture pattern was the most common 38.9%.The transverse fracture pattern was common among the metacarpals.

Dislocation was most noted in the interphalangeal joints where proximal interphalangeal joint was dislocated in 38.5% and distal interphalangeal joint was dislocated 23.1%.Extensor tendons were injured in 58.3% while the flexor tendons were injured in 41.7%.Among the flexor tendons, flexor digitorum superficialis was the most injured tendon in 60%.

The functional outcome using objective criteria was good to excellent. The mean MHQ score was 79.7%

Conclusion: From this study it is observed that most hand injuries are due to road traffic crashes, machines and assaults. The fifth and second metacarpals are the most frequently injured. When joint dislocation occurs, the interphalangeal joints are the most likely to be affected. Flexor digitorum superficialis and Extensor digitorum communis are the leading tendons to be injured. Skeletal pain and deformity are the commonest complications of hand injuries however adhering to physiotherapy largely minimize the deformity. The functional outcome of hand injuries at MOI is good to excellent in terms of overall hand function, activities of daily living, pains, work performance, aesthetics and patient satisfaction with hand function. The mean MHQ score was 79.7% at three months

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LIST OF ABBREVIATION

AO	Arbeitsgemeinschaft für Osteosynthesefragen
BMHQ	Brief Michigan hand questionnaire
CMC	Carpalmetarcapal
DCP	Dynamic compression plate
DIPJ	Distal interphalangeal Joint
EMD	Emergency Medical Department
MCPJ	Metarcarpophallangeal joint
MHQ	Michigan hand questionnaire
MMed	Masters of Medicine
MOI	Muhimbili Orthopaedic Institute
MUHAS	Muhimbili University of Health and Allied Sciences
OPD	Out patient department
PAB	Palmar abduction
PIPJ	Proximal interphallangeal joint
ROM	Range of motion
SPSS	Statistical Program for Social Sciences
TAM	Total active movement
TBI	Traumatic brain injury
TF	Total flexion

CHAPTER ONE

1.0 INTRODUCTION

Hand and fingers are most often injured in work place (1)(2)(3). For acutely injured hand, the treatment goals are to alleviate pains, repair the injured structures, prevent complications, and restoring the normal function(3). Widening mechanism of technology in industrial and agricultural activities has increased incidence of injuries to the hand (1).Hand injuries can result in a considerable society burden including costs for the provision of acute health care services, as well as, reduced socio-economic productivity due to the injured person's limited capacity to perform daily functional activities throughout their recovery(2).

Epidemiology

The hand is the second most common part of the upper limb to sustain fractures, after the forearm(5).Data suggest that, the incidence of hand injuries is slightly higher in males with male to female ratios running from 1.8:1 to 5.4:1(5)(6). Hand fractures are commonly found in young individuals however, by the age of 65, hand fractures occur more often in women(6). Hand injuries constitute anywhere from 1.5% to 28% of all emergency department visits. Phalangeal and metacarpal fractures are the second and third most common hand and forearm fractures following radius fractures(5).

Classification

No any defined classification scheme which has been written regarding the hand injuries. Descriptions of fractures is based largely on the location within the bone (head, neck, shaft, base) and further modified by the direction of the fracture pattern (transverse, spiral, oblique, comminuted) and the measurable degree of displacement. Dislocations are described by the direction the distal segment travels (dorsal, volar, rotatory(6)

1.1 Background

(a) Hand Anatomy- A Brief Review

Skin

The skin of the palm of the hand is thick and hairless. It is bound down to the underlying deep fascia by numerous fibrous bands. The skin shows many flexure creases at the sites of skin movement, which are not necessarily placed at the site of joints(13).

The sensory nerve supply to the skin is derived from palmar cutaneous branch of the median nerve supplying the lateral part of the palm and palmar cutaneous branch of ulnar nerve supplying the medial part of the palm (13).

The skin over the base of the thenar eminence is supplied by the lateral cutaneous nerve of the forearm or the superficial branch of the radial nerve(13)

Bones

There are 27 bones within the hand, arranged into three distinct groups - carpals, metacarpals and phalanges.(13).The hand has a volar and dorsal surface, the radial border formed by the thumb and the ulnar border formed by the little finger(13). There are 8 irregularly shaped carpal bones arranged into two separate rows with the proximal row forming part of the wrist joint and the distal row articulating with the base of the metacarpal bones.(14)

The main body of the hand is formed by the five metacarpal bones, and is commonly referred to as the palm. The first one corresponds to the thumb and fifth corresponds to the little finger. Each metacarpal has a base that articulates with the distal row of carpal bones. The body or shaft of each metacarpal is curved and this gives the palm of the hand its characteristic cup shape. The shaft of each metacarpal widens at its distal end to form a neck and finally the metacarpal head. The dorsal surface of each metacarpal head is broad and flat, whilst the palmar surface has a central depression for the passage of the flexor tendons(14).

The heads of the metacarpals articulate with the proximal phalanx of each digit to form the metacarpal-phalangeal joints (MCPJ). These are condyloid joints that allow flexion and extension of the digits, as well as a very small degree of abduction and adduction when the digits are extended.(14)

The five digits of the hand begin at the MCPJ and are formed by the phalanges. There are 14 phalangeal bones in the digits of the hand. Like the metacarpal bones, each phalanx has a base, shaft, neck and head. The fingers are formed by three phalanges - proximal, middle and distal phalanx. These bones are arranged lengthways in relation to each other to give the long thin characteristic shape of the finger. There are two joints between the three phalanges in each finger, which are the proximal and distal interphalangeal joints (PIPJ, DIPJ). These joints are hinge joints that allow each finger to have two separate points of flexion and extension along its length. The joint capsule is reinforced on its volar aspect by the thickened ligament known as the volar plate that prevents hyperextension of the joint.(14)

The thumb is often considered a separate entity from the fingers and is formed from only two phalangeal bones referred to as proximal and distal. It therefore contains only one interphalangeal joint.(14)

Blood Supply of Hand

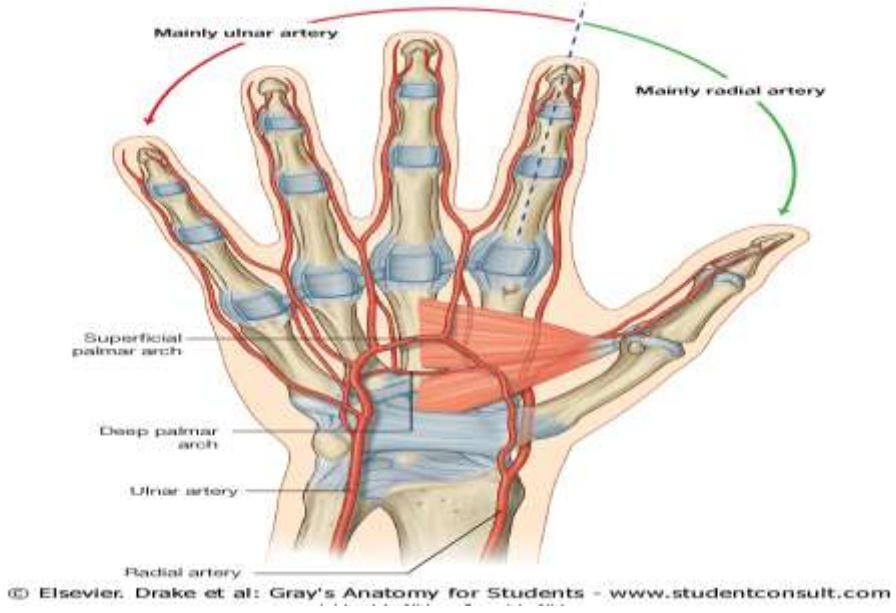


Figure 1: Arterial blood supply of the hand

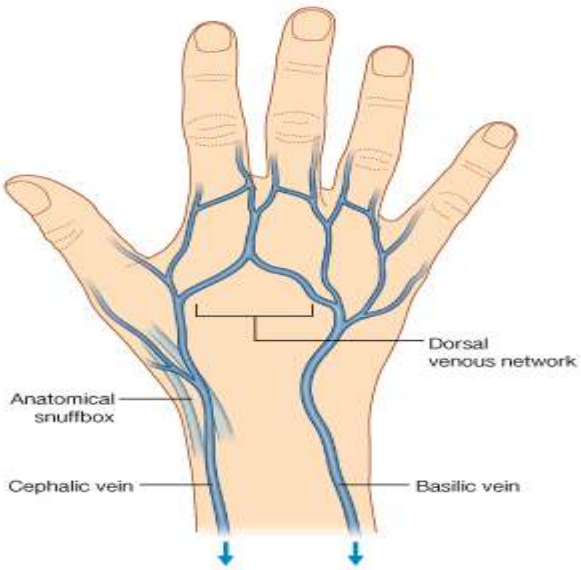


Figure 2: Venous blood supply of the hand

Nerve supply of hand

Ulnar nerve

The deep branch of the ulnar nerve, supplies the hypothenar, the interossei, adductor pollicis, and the two medial lumbricals. It also contributes small articular branches to the wrist joint(15).

The superficial branch of the ulnar nerve innervates the palmaris brevis muscle, skin on the palmar surface of the little finger and the medial half of the ring finger(15)

Median nerve

The recurrent branch of the median nerve innervates the three thenar muscle :- flexor pollic brevis abductor pollicis brevis and opponens polices(15).

The palmar digital nerves of the median nerve provides sensory innervations to skin on the thumb, index and middle fingers, and lateral side of the ring finger**.** I also suppy the lateral two lumbrical muscles(15).

Superficial branch of the radial nerve

The only part of the radial nerve that enters the hand. It innervates skin over the dorsolateral aspect of the palm and the dorsal aspects of the lateral three and one-half digits distally to approximately the terminal interphalangeal joints(15)

(b) Diagnosis

The signs of injury are; Pain, swelling, tenderness, ecchymosis, deformity, and/or skin abrasions. A careful examination of the flexor tendons, extensor tendons, and neurovascular function must be documented(30)

Posteroanterior, lateral, and oblique radiographic views are adequate to identify a fracture. Splints and dressings should be removed for imaging, unless there is gross instability or uncontrolled bleeding since they may obscure a subtle but clinically significant fracture line (6)(30)

If only one digit is injured, the images should be centered on the area of injury. Films of the hand obtained with overlap of the digits in one or more views can obscure important findings, and should not be accepted. Comparison films of the contralateral hand are occasionally helpful (6)(30)

Additional views, such as skyline and Brewerton views, which provide better visualization of the metacarpal heads are indicated sometimes. A skyline view is obtained by flexing the digits at the MCP and IP joints and directing the x-ray beam parallel to the dorsal surface of the proximal phalanx. The Brewerton view is more useful for visualizing the metacarpal head, and is obtained with the MCP joints flexed to 65°.For this view, the hand is placed with the dorsal aspect of the digits resting on the cassette, with the x-ray beam directed 15° from ulnar to radial.(6)(30)

Subtle thumb injuries may be missed if positioning is not appropriate because the thumb is rotated relative to the other digits . A Robert view, taken with the forearm fully pronated, the dorsum of the thumb on the cassette, and the x-ray beam angled 15° from distal to proximal, allows visualization of abnormalities of the thumb basal joints around the trapezium(6)

Computed tomography (CT) is indicated only in complex fractures or CMC fracture-dislocation if plain radiography does not offer adequate information(10)(6)

(C) Treatment Modalities

(C.1) General overview

Operative management of metacarpal and phalangeal fractures using K-wires, AO screws, plates and external fixation have definitively been shown to be advantageous over closed methods of treatment especially in displaced, unstable, comminuted, intra-articular, open and multiple fractures((19)(20)(24)(33). In general, joints should be mobilized reasonably early following fixation to prevent stiffness of the fingers. Postoperative physiotherapy of the hand is a must ((20)(34).

Most metacarpal and phalangeal fractures can be treated conservatively (33),(34)).Distal phalangeal tuft fractures should be treated conservatively with finger splint whereas distal

phalangeal diaphyseal fractures should be treated with K-wire fixation(22).

Mallet finger injury can be treated conservatively or surgically. Complications during conservative treatment are infrequent and benign, and in most cases are related to the skin. Irrespective of the operation technique used, the complications remain high. Stern and Kastrup reported a 53% incidence of complications after operation, and many of these patients still had problems at a mean follow up of 38 months(35)

(C.2) Specific treatment for injured region

(C.2.1)Non Thumb Metacarpals

Non-operative techniques involve buddy strapping the injured digit to a neighboring digit, or the application of splint including Plaster of Paris (POP) back slabs or cast. This is indicated for stable and minimally displaced factures(14)(10). The wrist is held at 20 degrees extension, the metacarpophalangeal joint in 60-70 degree flexion and interphalangeal joint in extension (14).

For undisplaced and impacted, minimal displaced avulsion fractures of metacarpal base fracture holding the wrist in a neutral position and the MCP joints in 70° flexion and allowing for movement in the PIPJ and DIPJ is recommended(36)

Metacarpal head fractures with no or minimal displacement, joint articular surface of <20% involvement, are treated conservatively either a radial or an ulnar gutter splint, which includes the noninjured, neighboring border digit and positions the wrist in 0° to 20° extension, MCP joints in full 90° flexion, and interphalangeal joints in extension for 3-4 weeks (14)(36).

Indications for surgery include; open fractures, intra-articular fractures, angulation of the fracture greater than 30 degrees, rotational deformity greater than 10 degrees, gross (>5mm) shortening of the metacarpal, irreducible or unstable fracture, multiple digit involvement ,transverse shaft fractures and failure to achieve successful closed reduction with residual malrotation and substantial shortening (14)(10).

Fixation is done using K- wire ,mini plates, AO screw, external fixation(14)(10)

(C.2.2)The First Metacarpal

Treated by longitudinal traction with abduction and extension of the thumb, then pronation of the digit to overcome Abductor pollicis brevis and longus followed by thumb spica application(14).

Displacement of greater than 1-3mm, failure to maintain reduction, comminuted fractures; warrants closed reduction and percutaneous pinning or ORIF using K wires, screws or plate((14),(36).Kirschner wire fixation of the first metacarpal to the second metacarpal, with a second wire fixing the first metacarpal to the trapezium, is the standard method used(36).

Postoperatively, patients are immobilized for 6 weeks in a short arm thumb spica cast. The interphalangeal joint is immobilized to reduce loading the CMC joint (14),(36).At 2 to 3 weeks after reduction, initiate controlled interphalangeal joint motion without resistance(36)

(C.2.3)Proximal and middle phalangeal fractures

Non-displaced extra-articular fractures are treated with buddy-taping OR splint for 3-4 weeks and early mobilization. As for spiral fractures or others with potential for instability treated as above, vigilant follow-up is a must to watch for any subsequent displacement (30)

Unstable shaft, neck fractures and intra articular fractures need surgical fixation using K wires, lag screws, mini plate. Plates are usually placed along the lateral border of the phalanx so as to avoid the extensor mechanism. The use of external fixators in phalangeal fractures is reserved for open fractures with severe soft tissue injury/loss.(14)

(C.2.4)Distal Phalanx Fractures

For a closed tuft fracture, decompress any associated subungual haematoma and apply protective splint for 2–3 weeks including the DIP joint, but leaving the PIP free. At 2–3 weeks begin passive DIP motion until pain resolves. Counsel the patient on decreased function caused by hyperaesthesia, cold intolerance, and numbness even after 6 months due to injury of the terminal sensory organ. (6)(30)

(6)Open tuft fractures should be thoroughly irrigated, soft tissue be repaired, antibiotic and anti tetanus treatment should be given. Although these fractures are best treated conservatively, it has been suggested that internal fixation can help prevent non-union (6)

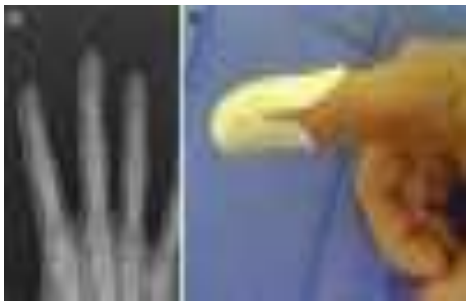


Figure 3:AP radiograph showing a distal tuft fracture (arrow) (b**) Typical clamshell splint used to protect a tuft fracture(6)**

Mallet deformity of the finger is caused by detachment of the extensor mechanism from the base of the distal phalanx either directly or in association with a fracture. Mallet injuries with and without a bony fragment are treated by dorsal or volar splinting of the DIP joint in extension for 6-8 wks, followed by 1 month of night splinting. The PIP should be left free to avoid resultant stiffness (6),(30)

Surgical treatment of mallet fractures is necessary if there is volar subluxation of the distal phalanx or in cases where the dorsal component is greater than one-third of the joint surface and for those cases were conservative management has failed (6),(30)

Figure 4: Mallet fractures

(a)Lateral radiograph of a mallet fracture (b) Dorsal splint used for mallet finger (soft tissue or bony mallet). Notice slight extension pre-bent into splint to assist in reduction of the avulsed fracture fragment(30)

(C.2.5) The Pollix Phalanges

Tuft fractures, simple undisplaced shaft fractures are managed by thermoplastic splint or a thumb spica for two to three weeks. The spica can be made by application of adhesive surgical tape in a criss-cross fashion (from proximal to distal) or with the use of plaster of Paris.(14)

Transverse, longitudinal and intra-articular fractures require operative treatment using K wire, lag screws, or cerclage wires (14)

(C.2.6) Carpal Bones

Scaphoid fracture is the most common carpal fracture, occurring predominantly in active men with a peak prevalence in the 2nd to 3rd decades. Triquetral fractures are the second most common carpal fractures with a prevalence of 18.3% .Trapezium fractures account for 3%–5% of all carpal fractures. The lunate is the fourth most fractured carpal bone. Most fractures of the lunate can be treated by cast immobilization for 4 weeks with MRI on follow up.Colles cast for non-displaced stable scaphoid fractures in low-demand patients, with the wrist in neutral deviation and neutral flexion extension for 8-12 weeks is the treatment of choice. Displaced fractures of the scaphoid, proximal pole and oblique fractures are treated by ORIF-Herbert bone screw (5)

(C.2.7) Flexor Tendon Injury

There are two flexor tendons to each finger and one for the thumb. The hand is divided into 5 zones Zone I starts at the end of the fingers and is distal to the flexor digitorum superficialis insertion. Zone II (no mans land) between the limits of the flexor tendon sheath and the insertion of the flexor digitorum superficialis. Zone III is from the distal edge of the transverse carpal ligament, with nerves, tendons and vessels being frequently involved due to the close proximity. Zone IV refers to the tendons within the carpal tunnel and zone V encompasses the forearm proximal to the carpal tunnel(11)

Suspect a flexor tendon injury if the patient is unable to actively flex the distal or proximal interphalangeal joint of a finger, the interphalangeal joint of the thumb (37)

To date there is no universally accepted gold standard for type of suture material or suture technique used to repair flexor tendon injuries with surgeons using their chosen method to repair such injuries. The most commonly incisions used are the bruner zig-zag and the bunnell incision .The former avoids vascular compromise and the latter avoids disturbing sensation to the volar aspect(11)

Non-absorbable synthetic sutures including monofilament nylon; monofilament polypropylene and braided polyester monofilament nylon are used in repair. Bioabsorbable sutures are not used as they have decreased tensile strength half-life and fear of increased tissue reaction and adhesion formation(11)

For injury to the flexor tendon of the thumb, use a thumb spica splint. For injury to the flexor tendon of the finger or wrist, immobilize the entire hand by applying a dorsal splint that covers the forearm, hand, and fingers with the wrist in 20 degrees of flexion and the metacarpal phalangeal joints flexed to 70 degrees with interphalangeal joints in extension(11)(37)

(C.2.8) Extensor Tendon Repair

REPAIR: Use a non absorbable suture such as 4-0 nylon. Can be repaired with a single figure-of-eight suture or by placing one or two simple sutures in the tendon ends to bring them together. Do not pull too tightly because you may rip the suture out of the tendon. A splint is required to protect the repair(37)

For extensor tendon of fingers and wrist apply volar slab from forearm to finger tips. The MCPJ should be 15-20 degrees of flexion, wrist kept in 20 degrees extension and the interphallangeal joint kept straight. For the thumb extensors apply a thumb spica(37).

The patient should wear the splint for 4–6 weeks. If the tendon is not repaired, the splint should be worn until the patient can be evaluated by a hand specialist(37).

(C.2.9) Open Injuries of the Hand

Open fracture is identified by a soft-tissue disruption that allows the fracture site to be exposed to the outside environment. Open fractures are usually severe and prone to serious complications, such as infection. The basic components of injury management are function restoration, bone union, and infection prevention(38)(6).

Management consists of irrigation, debridement and bone stabilization in the operating room. Irrigation should be performed with copious amounts of sterile saline, often combined with antibiotics, tetanus prophylaxis and debridement of nonviable tissue. Repeat I&D may be needed in severe open hand fractures (6)(38).

Current evidence indicates that infections that occur after management of open hand fractures are often caused by nosocomial organisms and not the initial contaminating organisms(38).

The risk of severe infection is lower with open fractures in the hand than in many other parts of the body, and the functional deficits produced by wide débridement may be significant(38)

Nerve repair, suturing of the lacerations, refashioning of traumatic amputations, and surgical amputations should be done when indicated. The indication for amputations/refashioning are traumatic amputations, crush injury, and posttraumatic gangrene(8)(10)

Table 1: Alogarithm for the treatment of open fractures of the hand

Algorithm for the treatment of open fractures of the hand

Gustillo–Anderson class	Description	Treatment recommendation	Antibiotics
Type 1	Clean laceration <1 cm No contamination, crush injury, or comminution	I&D plus immediate definitive fixation and closure	Cefazolin 48 h
Type 2	Clean laceration >1 cm No contamination, crush injury, or comminution	Controversial; - I&D with wound left open for second look in 24–72 h; clean wounds may be definitively treated or - I&D with immediate fixation for clean-appearing injuries and closure	Cefazolin 3–5 days
Type 3	Laceration >10 cm or soft tissue crush, periosteal stripping, comminution, blast, contamination or farm injury	- Aggressive I&D with preliminary fixation with K-wires and/or external fixator - Repeat I&D every 24–72 h until quantitative cultures have $<10^5$ bacterial count - Soft tissue or flap coverage within 1 week where possible	Cefazolin plus an aminoglycoside; add penicillin for soil contamination

Treatment algorithm as recommended by Gonzolez et al. 1999

1.2 Literature Review

(1) Gender, Age and Education

All age groups are the victims of hand injuries. The most commonly affected age group are those between 20-40 years of age followed by those between 11-20years. Males outnumber females in the ratio of approximately 3:1 because males are more exposed to trauma related activities which carry a high risk of causing hand injury(1)(16)(17)(18) (19)(20). It has also been reported that the right hand is more commonly injured than the left hand. This is likely due to the higher prevalence of right-handedness(1)(2)(18)(21). Studies shows that most of the hand injured people are unskilled. (1)(22).Most people who suffer from hand injuries have only some or completed primary education(16)

(2) Proportion

Hand injuries constitute 15-28% of cases referred to EMDs (18) (23)(24).Fractures of the metacarpal and phalanges constitute 10% of all fractures ((1)(21).In a total series of 1000 patients, the incidence of metacarpals, phalanges, and carpal bones accounted for 36%, 46%, and 18% of the fractures, respectively(21). Of the 4303 patients who sustained one or more fractures, hand fractures accounted for 19% of all fractures(17)

(3) Causes of Hand Injury

Studies show varying data on the percentage contributed by each mechanism. The most common mechanisms involved are machine related injuries followed by crush injuries due to motor traffic crush. Assaults, falls, sports, and accidental injuries which may be domestic or farm accident related such as a machete cut have been reported (1)(2)(16)(25).

The Mechanism of injury for carpal bones was found to be fall on outstretched hand (standing height) 54%,Road traffic crashes 18%,Direct trauma to hand 14%, Fall from height 12% and Unknown 2%(26). Work related injuries are largely due to machines(7).The mechanisms include:-sharp objects, compression, blunt trauma, burns through direct heat or chemicals and through blunt forces (5)

Most hand injuries are largely due to preventable causes including occupational hazards and violent assaults. Appropriate preventive strategies in the work place would therefore be helpful in reducing the incidence of hand injuries(1)(16)(25)

(4) Fracture Distribution and Pattern of Injuries

Digits are the most prevalent sites of injury followed by the metacarpals (1)(2)(16)(20)(23)(21)(27).The literature shows different findings on fracture distribution between the digits. Proximal phalanx are the most injured bones followed by middle and distal phalanx (23)(21).The distal phalanges are the most injured bones followed by proximal and middle phalanges (1)(2)(16)(23).Phalanges of the thumb and index finger are the most common fractured bones (1)(2)(27).

One case series found the second metacarpal to be the fractured in 33.3% patients and the fifth metacarpal in 19% (16). However(19)found that border metacarpals (first and fifth) are more commonly injured; Where the base of first metacarpal shaft is most injured while the neck of fifth metacarpal is the most injured. Diaphyseal fractures are common in non-border metacarpals.

In a study involving intra-articular fractures, the DIP joint was found to be the most injured joint followed by the PIP joint. The MCP joint was injured 19% of the time, and the remaining 5% involved the CMC joint(2)

The fracture patterns that are most commonly encountered in hand injuries are transverse fractures followed by oblique ,comminuted, spiral and intra-articular fractures (20)(21).However in another study by (2), the pattern of injuries in descending commonality were: comminuted, oblique, avulsion fractures, transverse and spiral fractures.

Regarding the carpal bones, the scaphoid, triquetrum and hamate are the most fractured bones consecutively((17)(21),(26).In a series of 162 carpal bones injury in Singapore ;the scaphoid was the most common single carpal fracture -99. This was followed by triquetrum -27, hamate-5, pisiform -4, lunate -2, capitate -1, and trapezium -1. No fracture of the trapezoid

was encountered. Ten patients had multiple carpal fractures, of which 4 were perilunate fracture dislocations (26)

Kaisha and Khainga had only 1(4.8%) patient with scaphoid fracture and 1(4.8%) with hamate fracture(16)

Hand injuries are often accompanied with tendon injuries. The flexor tendons are more commonly injured than extensor tendons (1)(16)(17).The most prevalent tendon injury is flexor digitorum superficialis followed by flexor digitorum profundus and extensor digitorum communis (16).However Narender et al and Seyed et al, reported extensor tendon injuries to be very common (61.3%) and are reported to be more common than flexor tendon injuries because of being located superficially on the dorsum of the hand(28)(29)

With regards to joint dislocations, interphalangeal joint dislocation is the most common joint injured while carpalmetarcapal joint dislocation is the least common.(1)(16)

The published literature has varying data about skin status after hand injuries. Hilal et al, reported that 70% of hand injuries were closed while 30% were open(1). Conversely, Kaisha and Khainga reported that 74.75% of the cases were open (42.4% lacerations and 32.3% contusions) while the rest had intact skin (16). Kaisha also found the prevalence of nerve injuries to be 2% which involved the median and ulnar nerves(16).

(5)Outcomes

Regardless of the implant used,the functional outcome is good/excellent in 85-90% of cases(19)(20)(24)(34). Metacarpal and closed fractures show a better functional outcome than phalange fractures (19)(24).In a study about functional outcome in metacarpal and phalangeal fractures, excluding the distal phalanx; The outcome was found to be 46% excellent, 39% good, and 15% fair to poor results, which is better than that of phalangeal fractures which had 75% good and 25% poor results(19)

Single digit involvement has better functional outcome (55%) than multiple digits involvement (29%) (24)

Closed fractures show a better functional outcome with excellent to good results in approximately 95% of cases whereas open fractures show excellent results in 27% and good results in around 45% of cases only(19)(24)

Open fractures takes longer time to unite because of more severe degree of bony and soft tissue injury with some degree of bony and soft tissue loss, longer period of immobilization. This also explains lower degree of functional outcome in open fractures

The long-term outcome in 61patients (62 fractures) treated operatively or conservatively for an acute fracture of the carpal scaphoid. A total of 30 fractures was randomized to conservative treatment using a cast and 32 to operative treatment using a Herbert bone screw. There were no differences between the groups in respect of function, radiological healing of the fracture, or carpal arthritis after follow-up at 12 years. Those managed by operation showed radiological signs of arthritis of the scaphotrapezial joint more often, but this finding did not correlate with subjective symptoms. Operative treatment of an acute fracture of the scaphoid allows early return of function and should be regarded as an alternative to conservative treatment in patients in whom immobilization in a cast for three months is not acceptable for reasons related to sports, social life or work (39)

In a study by Okafor et al about conservative management of mallet deformity of the finger**,** Twenty-eight of the 31 patients (90%) were satisfied with the result and 21 (68%) reported no impairment of their ability to carry out precision tasks irrespective of the type of mallet injury, the degree of Osteoarthritis, the presence of swan-neck deformity, and restriction of range of movement(35).

In a study about nail bed injuries by Elvin et al, where 299 nail bed injuries were studied over a 5 1/2-year period, 99% of the repaired nail beds were graded good to excellent. Poorer results occurred with crush or avulsion injuries, with injuries of both nail bed and nail fold, and with associated infection (40)

In a case report about fracture dislocation of MCPJ of the first thumb, where closed reduction, percutaneous fixation using a K-wire and thumb spica was done, Three months after injury, the patient had no pain or residual deformity of the thumb. The fracture had united and the CMC and MCP joints were stable .The patient had a full range of all thumb movements as compared with the other side and returned to all previous normal activities(41).

In another case report about DIP and PIP Joints of the Little Finger, treated by splinting; At six months the patient had achieved full range of flexion and extension of the proximal interphalangeal joint, full range of flexion of the distal interphalangeal joint, but extension of the distal interphalangeal joint was limited with a 15^0 of extension lag (42)

Also case report involving the dislocation of DIP and MCP joints of the middle finger, treated by volar and dorsal spilnt,At the final follow-up, the patient exhibited painless active range of motion of the MCP, PIP, and DIP joints of 0–90°,0–95°, and 0–85°, respectively. Grip strength at the 12-week follow-up was 48 kg in the injured hand and 56 kg in the contralateral dominant hand.. The patient had no feelings of instability at the affected joints and reported no loss of function (43)

Nerve injuries in the hand and upper extremity may cause long-lasting disabilities in terms of lost fine sensory and motor functions. Unlike adults, very young individuals regain a complete recovery of functional sensibility after nerve repair(44) (45)

In a study by Ioannis et al, about function evaluation after primary flexor tendon repair in zone 2; 20 out of 22(90%) had excellent to good range of motion. The rest 9.1% had tendon rupture and infection which resulted in interphalangeal flexion decrease as well as extension lag of both DIP and PIP joints(46)

The early mobilization of repaired extensor tendons, prevents formation of adhesions as compared to rigid immobilization. 73% patients showed excellent result, 19% patients showed good results and 8% patients showed poor results. The most common complication was adherent scar in 31% patients, and joint stiffness in 8% patients(28)

In various studies where outcome was assessed using Michigan Hand Outcomes Questionnaire; Xiao Fang et al found the average score to be 97.3 +- 3 . Using the Ishida and Ikuta scoring system, seven fingers were rated as having excellent outcomes and three fingers good outcomes(47). Kanthan Theivendran in his study, The mean MHQ score was 90(48). All patients were satisfied with the treatment and reported pain-free range of motion (47)(48) .Stanton J.S in his study about fractures of the tubular bones of the hand found the MHQ average score to be very poor. Only 20% (130/655) of patients returned their final MHQ questionnaires, even after repeated attempts to
obtain the information(49).

(6)Complications

Stiffness is the most commonly reported complication, with 76% of 66 patients studied reported to have total active motion less than 220°.Other complications include; nonunion, infection and tendon rupture each comprising 1.6 % of complications. Open fracture infection rates range between 2–11 % with operative treatment, whereas closed fractures have an infection rate close to 0.5% .Poor outcomes are directly correlated to the higher degrees of soft tissue injury and contamination. Osteomyelitis in the hand is rare but serious; 39% of patients with osteomyelitis went on to amputation(10).

Complications after tendon repair include adhesion formation, tendon rupture, stiffness of the joints, infection, pulley rupture and poor tendon gliding. Tendon rupture is the worst complication as it requires urgent secondary surgical intervention. Rupture can be due to overload of the tendons, edema, and misuse of the hand or bulky tendons. Adhesions require tenolysis which is usually performed 3-6 months after initial tendon surgery(11).

Most studies were able to achieve union in almost all cases(19)(20)(50). Additionally, no delayed union, nonunion or infection was reported by Alaa A.Dawood in his study(19) However, Ashwani Shoni et al reported 2 deep and 3 superficial Infections(50). Union times ranged from 6-16 weeks. In 71%, union is achieved at 8-10weeks post treatment(19). Stiffness and malunion are the most common complications noted(19)(24).

Stiffness occurred in 19% fractures and mal-union in 10% fractures(19).Out of 22 patients with complications, 10 had finger stiffness(24). These were noted in open and intraarticular fractures

Intaarticular fracture is also associated with stiffness due to intraarticular fibrosis. This requires intensive physiotherapy to improve the joint range of movement ((19)(24)

1.3 Problem Statement

The hand is an extremely important part of the upper limb used in daily activities. Malaligment of bones leads to finger deformity which interferes with hand function. Late attention to finger injuries leads to stiffness. Once it is injured, an individual can face many challenges from a socioeconomic and psychological standpoint

The incidence and prevalence varies worldwide. In USA, the hand injuries constitute 1.5-28% of all accidents and emergency department visits(7) .In Uganda, hand injuries constitute 4.7% of all trauma patients. Road traffic crashes, machines are the commonest causes(20).Males to females ratio varies between 1.8:1 to 5.4:1(5)(6).

Education related to road and work safety measures are mandatory to decrease the burden of hand injuries(12).

The magnitude and severity of hand injury in Tanzania has not been quantified. At MOI - EMD, approximately 10-15 hand injuries are managed every month, however little is known about socio-demographic characteristics, mechanisms of injury, pattern of injuries, and outcome after management of these patients.

1.4 Rationale of study

There is little which has been published about mechanism, pattern and functional outcome of hand injured patients in Tanzania

Understanding the causes and outcome will contribute to prevention strategies and assist in managing the long-term effects of the injuries. The study will also benefit local policy makers in formulating better workplace safety protocols to prevent injuries. Despite that, it may also form a basis for further research in hand traumatology. So, a study needs to be conducted at MOI to fill in this knowledge gap.

1.5 Research Questions

1. What are the socio-dermographic characteristics of hand injuries among patients attended at MOI?
2. What is the proportion of hand injuries among patients attended at MOI?
3. What are the mechanisms of hand injury among patients attended at MOI?
4. What is the pattern of hand injuries among patients attended at MOI?
5. What is the outcome of hand injuries among patients attended at MOI?

1.6 Objectives of the study

1.6.1 Broad Objective

To determine pattern and functional outcome of hand injuries among patients attended at Muhimbili Orthopaedic Institute between June 2016 and May 2017.

1.6.2 Specific Objectives

1. To determine socio-demographic characteristics of patients with hand injuries attended at MOI between June 2016 and May 2017.
2. To determine the proportion of hand injuries among patients with other injuries attended at MOI between June 2016 and May 2017.
3. To determine the mechanism of hand injuries among patients with hand injuries attended at MOI between June 2016 and May 2017.
4. To describe the pattern of hand injuries among patients with hand injuries attended at MOI between June 2016 and May 2017.
5. To determine the short term functional outcome of hand injuries among patients attended at MOI between June 2016 and May 2017.

CHAPTER TWO

2.0 METHODOLOGY

2.1 Study design

A descriptive prospective hospital based study was conducted between June 2016 and May 2017. A descriptive prospective study is the kind of the study where the healthy status of the community and the outcome and pattern of the diseases is described prospectively according to persons involved, their ages, occupation, sexes, education and causes according to routinely available data. No hypothesis is being tested.

2.2 Study area

The study was conducted at Muhimbili Orthopedic Institute (MOI) Dar-es-salaam, Tanzania, which is a specialized institute of Orthopedics, Traumatology and Neurosurgical care with a bed capacity of 350.It is the main referral center for patients with skeletal trauma serving both the city of Dar es Salaam and the country at large. The institute is also involved in carrying out researches in these fields with a view of improving management of patients.

2.3 Study period

The study period was one year from June 2016 - May 2017

2.4 Study population

Patients with hand injuries attended at MOI during the study period.

2.4.1 Inclusion Criteria

- Any patient aged 18years and above with hand injuries.
- Those who consented to participate in the study.

2.4.2 Exclusion Criteria

- Patients with Severe TBI.
- Mentally incapacitated patients
- Hemiplegic patients with ipsilateral hand injury

2.5 Sampling and sample size

A convenient non random sampling technique was used to select the appropriate patients based on inclusion criteria. Unlimited number of patients as per inclusion criteria was required for enrollment. The study enrolled a total number of 70 cases.

2.6 Data collection tools

Structured questionnaire, BMHQ, Belsky`s, Gingrass`s, and Dargan`s criteria were used during data collection .Goniometer, papers, rulers and pens were used to assist the process of data collection.

2.7 Pretesting of the tools

Pre- test was conducted at MOI to test the data collection tools (Structured questionnaire which was locally designed) if would provide the depth, range and quality of information required and the likely response rate. Necessary amendments of the tool were done to obtain the required information. The BMHQ, Belsky`s, Gingrass`s, and Dargan`s criteria are internationally designed and validated; Thus were not tested. The BMHQ was locally translated to Kiswahili version and captured the essence of the English version.

2.8 Recruitment and training of the Research Assistants

One research **assistant (Medical doctor)** with knowledge, ability and experience in research was recruited. One day training covered description of the objectives of the study; orientation to the tools for data collection, emphasizing on making sure that each participant was asked to consent before starting the interview.

2.9 Data collection technique

A structured questionnaires and radiographs were used for data collection. Datas were collected over a period of 5 months. Patients were evaluated on the day of admission and after surgery until they were discharged home, then were followed up at the clinic after two weeks, six weeks and three months post discharge

2.9.1 Socio-Demographic Characteristics

Data on admission included: age, sex, occupation, education level, hand involved, and time of injury, cause and sites of injury (digit or carpus). If the injury was work related, further details such as if the patient was working overtime, the lighting condition of the area where the injury occurred, and the work which was being performed during injury was also recorded.

2.9.2 Proportion

The proportion of hand injuries was determined by the formula

Number of NEW cases with hand injury during the study period X 100

Total number of patients with injuries

Also the proportion of phalangeal, metacarpal and carpal bones fractures in relation to total number of hand fractures was also calculated.

2.9.3 Pattern of Injury

Clinical and radiological examination on first arrival to MOI-EMD was used to assess the pattern of hand injury and was documented on the questionnaire.

2.9.4. Functional Outcomes

Objective and subjective criteria were used to assess the functional outcome after treatment as follows.

Objective Criteria

Functional outcome for finger injuries other than the thumb and the thumb were assessed by the following Belsky`s(51)(19) and Gingrrass`s(51) criterias respectively:

Belsky's criteria and graded as:-

- Excellent (pain-free, union/no deformity/total active motion (TAM) > 215°,
- Good (pain-free, union/ minimal deformity/ TAM > 180°)
- Poor (pain or non-union/ deformity affecting function or cosmesis/ TAM <180°.
- Total active motion (TAM) means cumulative active range of motion of one digit i.e. of metacarpo-phalangeal joint and two interphalangeal joints.
- Gingrass`s criteria and graded as follows:
- Excellent (palmar abduction (PAB) > 45°/ total flexion (TF) >100°)
- Good (PAB >30°/ TF >75°)
- Poor (PAB < 30°/ TF < 75°)

Dargan's criteria(28)

Was used to asses finger function after tendon injury, by measuring and summing the angles of flexion and extension lags of metacarpophalangeal joint, proximal interphalangeal joint and distal interphalangeal joint, and the distance between fingertips to palm. The function was graded as:

- EXCELLENT: no extension lag and fingertips go over palmar crease when fingers are flexed
- GOOD: Extension lag ≤ 15° and the fingertips could come up to palmar crease.
- FAIR: extension lag 16° to 45° and the distance between fingertips and palmar crease < 2 cm
- POOR: Extensions lag > 45°, and the distance between fingertips and palmar crease > 2 cm.

Pain was assessed by visual analogue scale.

- 0-no pain.
- 1-2-mild pain.
- 3-6-moderate pain.
- 7-10 severe pain

Subjective Criteria

The MHQ is a hand-specific outcomes instrument that measures outcomes of patients with conditions of, or injury to, the hand or wrist (36).

The MHQ contains six distinct scales; overall hand function, activities of daily living (ADLs), pain, work performance, aesthetics and patient satisfaction with hand function.

The Brief MHQ (bMHQ) contains 12 items with responses on a 1 through 5 Likert scale regarding several aspects of hand function was used to asses subjective functional outcome of hand injuries. It has 12 questions which were totaled and then normalized to yield a summary score on a scale of 0-100. Higher scores indicate better overall functioning and satisfaction.

The following items of brief MHQ were used to create the summary score:

1.Overall, how well did your hand(s) work during the past week?
2. How was the sensation (feeling) in your hand(s) during the past week?
3. How difficult was it for you to hold a frying pan during the last week?
4. How difficult was it for you to button a shirt or blouse during the past week?
5. Describe the pain in your hand(s)/wrist(s) in the past week?
6. I am satisfied with the look of my hand(s).
7. In the past week, how satisfied are you with the motion of your fingers?
8. In the past week, how satisfied are you with the motion of your wrist?

For these items, the responses were reversed in the following way:
1=5, 2=4, 4=2, 5=1

Scoring

Raw score range:
Minimum score (poorest functioning) = 1
Maximum score (ideal functioning) = 5

The 12 raw scores were then added to give a maximum score of 60 and a minimum score of 12.

To translate the raw score into a 0-100 range the score must be normalized. The raw score was averaged across the number of items (range 1-5). After averaging the items, the average score was then normalized to generate a score that is scaled from 0 (poorest function) to 100 (ideal function).

Normalization = 100 x (brief MHQ raw score – 1)/4

2.9.5 Treatment

Patients were treated by orthopaedic surgeons, residents and registrars. I observed the management provided and recorded on a questionnaire.

2.9.6. Follow up Visits

Each patient was evaluated in follow-up clinics at 2 weeks, 6 weeks, and 3 months. Serial radiographs were taken on each Visit to assess the reduction, displacement, and union quality of the fracture.

Patients with complications necessitating surgical intervention; orthopaedic surgeons and senior residents were consulted for appropriate management.

At 2 weeks

X-ray was done to assess the reduction and any displacement post reduction.

Emphasized on physiotherapy

Surgical wound assessment. Stitches were removed in already healed wounds. If there were signs of infections; Release of wound tension (remove part or all stitches/staples), Wound dressing, and oral or IV antibiotics administration was done.

Assessed for pain

Splint removal was done for tuft fractures

At 6 weeks

Control x ray was done to assess union quality of the fracture.

Implants, splints and thumb spica were removed

Continuation of physiotherapy; Active flexion and extension of fingers for tendon injury.

Assessment for the pain, infection and any deformity was done.

Assessment for the total active motion of the injured digit/s.

Assessment for palmar abduction and total flexion of the thumb

Assessment of extensor tendon injury outcome as per Dargan`s criteria

Assessment of functional outcome as per BMHQ

At 3 months

Control X-ray to asses callus formation

Continued with physiotherapy

Assessed for the pain, infection, and any deformity.

Assessed for the total active motion of the injured digit/s.

Assessed for palmar abduction and total flexion of the thumb

Assessed outcome of extensor tendon as per Dargan`s criteria.

Measured functional outcome as per bMHQ

2.10 Data Management and Analysis

Data were entered, cleaned and analyzed using statistical software (SPSS version 20). Categorical variables were summarized using frequency distributions while continuous variables were summarized using measure of central tendency and variability. The association between dependent variable and independent variables was assessed using chi-square or fishers exact test. The level of significance was set at 5%.

2.11 Ethical Consideration

Ethical clearance was obtained from the ethical clearance committee of MUHAS. The permission from MOI to carry out the study was also obtained. The aims of study were explained to the patients. The participants were allowed to ask questions about the study. During and after the study period, the patient's confidentiality was maintained. The obtained information are for research purposes only. The participants signed a consent form after they have agreed to participate. The participants were free to withdraw from study at any time during the study.

2.12 Dissemination of the results

The findings of this study were compiled into a dissertation and submitted in partial fulfillment for the award of Degree of Masters of Medicine in Orthopaedics and Traumatology of the Muhimbili University of Health and Sciences. One copy of the dissertation was submitted to the Department of Orthopaedics and Traumatology and one copy to the MUHAS library. The data of the study are also available for publication.

CHAPTER THREE

3.0 RESULTS

3.1 Socio-demographic characteristics

Table 2: Socio-demographic characteristics among patient with hand injuries (n=70)

Variables	Frequency (%)
Age in years	
<20	8 (11.4)
20- 29	27 (38.6)
30-39	14 (20)
40-49	14 (20)
50-5	5(7.1)
>60	2 (2.9)
Gender	
Males	61 (87.1)
Females	9 (12.9)
Education	
Primary education	38 (54.3)
Secondary education	15 (21.4)
Collage education	11 (15.7)
University education	6 (8.6)
Occupation	
Peasants	7 (10)
Petty business	32 (45.7)
Private sector employee	23 (32.8)
Government employee	8(11.4)
Hand dominance	
Right	61 (87.1)
Left	9 (12.9)
Hand injured	
Right	37 (52.9%)
Left	31 (44.3%)
Both	2 (2.9%)

Relevant data of 70 patients who sustained hand injuries attended MOI-EMD from June 2016 to May 2017 were analyzed. Majority 27 (38.6%) were between 21-29 years old followed by 30-39 years old and 40-49 years old; both 14 (20%).Males outnumbered females in the ratio of 6.8: 1.

Most of the injured patients had primary education 38 (54.3%).Only 6 (8.6%) had university education. 32 (45.7%) depends on petty business to sustain their life. While 16 (22.8%) of the hand injury victims were employed in private sector, 8 (11.4%) were government employees.

Right hand was involved in 52.9%, left hand in 44.3% and both hands were involved in 2.9%. Right hand was a dominant hand in 87.1% (Table 3).

Table 3: Characteristics in work related hand injuries (n=40)

Variable	Frequency (%)
Where injury occurred	
Work	40 (57.1)
Off work	22 (31.4)
Home	8 (11.4)
Extra working hours	
Yes	6 (15)
No	34 (85)
Light	
Adequate	30 (75)
Not adequate	10 (25)
Work during injury	
Operating a machine	28 (70)
Others(security officers at work place, recreational games, etc	12 (30)

Majority of the hand injuries were work related 40 (57.1%).Non work related injuries constituted 30 (42.9%).Most of the hand injuries occurred at 8am -5:59pm (47%),followed by 6:00pm-5:59pm (40%).12% of injuries occurred between 12:00am-7:59am

Of the injuries which were work related, 6 (15%) occurred at extra working hours while 34 (85%) injuries occurred during normal working hours.

30 (75%) reported to work in environments with adequate light despite sustaining hand injury while 10 (25%) of the work related injuries, had no adequate light.

Most of the patients who sustained hand injuries during working hours, reported to be operating a machine at the time of injury 28 (70%) while 12 (30%) were performing other activities such as cleaning the machines, participating in games, and human attacks to security officers (Table 4).

3.2 Proportion of hand injuries

70 cases with hand injuries were recruited during the study period. A total of 1679 patients with various types of other injuries, were noted during the study period. The proportion of hand injury among all patients with various injuries was 4.2%.

Among the 70 cases with various hand injuries; 38 involved phalangeal bones, 1 involved carpal bone, and 31 involved metacarpal bones whose proportion was 54.3%, 1.4%, and 44.3% respectively (Figure 5).

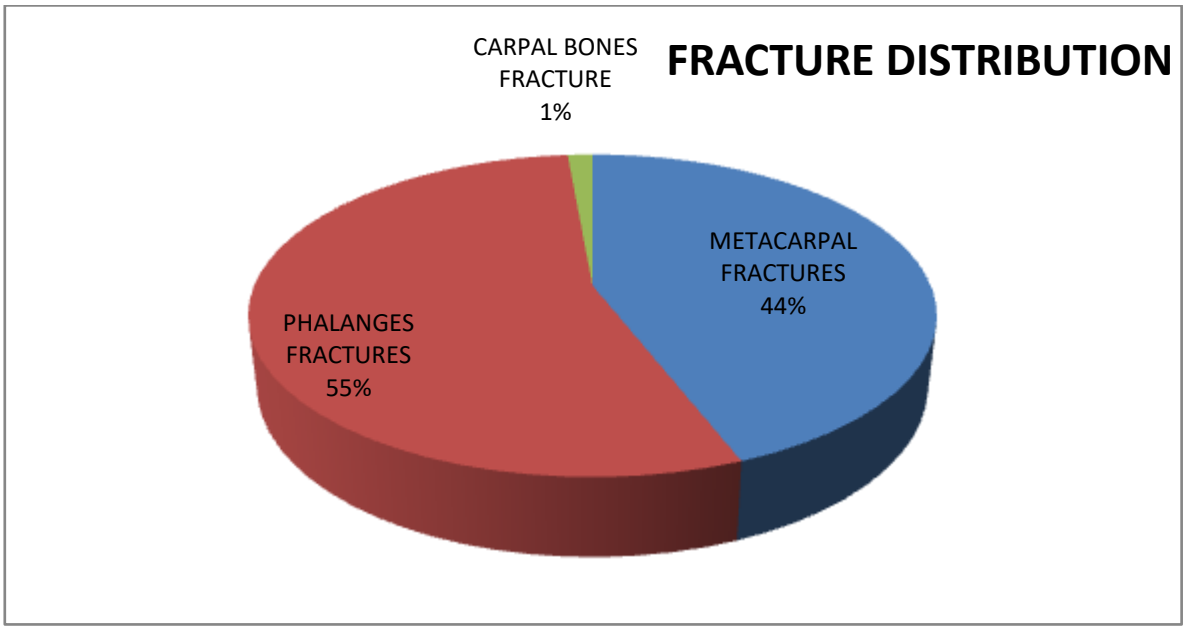


Figure 5: Fracture distribution among the hand bones

3.3 Mechanism of hand injuries

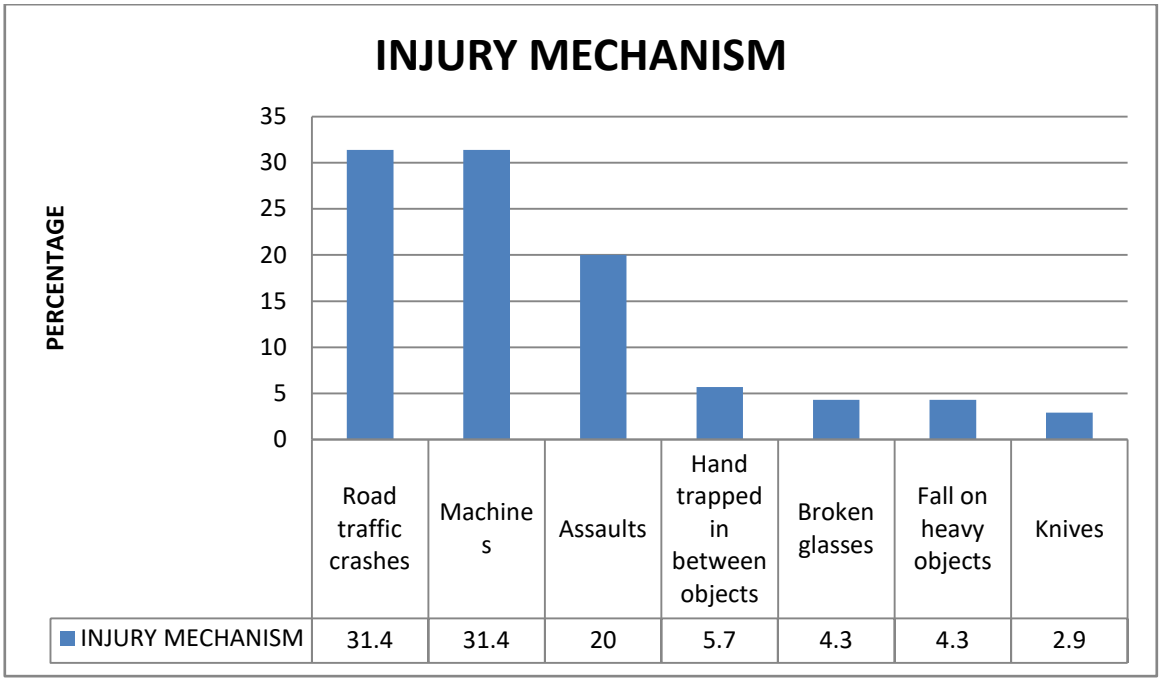


Figure 6: Mechanism of hand injuries

The most common mechanism of injury was road traffic crash and machines each contributing 22 (31.4%) followed by assaults 14 (20%).Hand trapped in between objects like doors and gates contributed 4 (5.7%).Broken glasses and heavy objects falling on hand, both contributed 3 (4.3%).Knives were the least contributors accounting for 2 (2.9%) of the injuries (Figure 6).

3.4 Pattern of hand injuries

Skin status

There were 51 (72.9%) open injuries and 19 (27.1%) closed injuries. Among the 51 (72.9%) open injuries, 30 (42.9%) were lacerations, 9 (12.9%) were traumatic amputations, 6 (8.6%) were abrasions and 3(8.6%) were crash and degloving injuries

Table 4: Fracture distribution and pattern among the phalangeal and metacarpal bones

Phalangeal bones fracture distribution						
Site	Proximal	Middle	Distal phalanx	Total(%)		
Thumb	7		2	9(15.5%)		
Index finger	8	2	2	12(20.7%		
Middle finger	5	4	4	13(22.4%		
Ring finger	6	3	5	14(24.1%		
Little finger	2	4	4	10(17.2%		
Total	28(48.3%)	13(22.4%)	17(29.3%)	58		
Metacarpal bones fracture distribution						
Metacarpal	1st	2nd	3rd	4th	5th	Total
Number(%)	4(7.1)	15(27	10(19.60)	11(19.6%)	16(28.9)	56(100)
Metacarpal bones fracture pattern						
Pattern	1st	2nd	3rd	4th	5th	Total(%
Oblique	1	6	2	3	3	15(25)
Comminuted	1	4	3	3	4	15(25)
Avulsion	1	-	1	-	-	2(3.3)
Transverse	1	4	8	7	8	28(46.7
Total						60
Phalangeal bones fracture pattern						
Pattern	Thumb	Index	Middle	Ring	Little	Total(%)
Oblique	4	3	2	-	1	10(18.5)
Comminuted	4	4	5	5	3	21(38.9)
Transverse	-	3	4	5	2	14(25.9)
Others	-	2	2	4	1	9(16.7)
Total						54

Phalanges of the ring and middle finger were the most common fractured bones (24.1% and 22.4%) respectively. However the proximal phalangeal bones 48.3% were the most common fractured bones followed by distal phalangeal bones in 29.3% and middle phalangeal bones in 22.4%.

Among the phalangeal bones, comminuted fracture pattern was the most common 21(38.9%) followed by transverse fracture pattern 14 (25.9%).

The fifth metacarpal is the most fractured bone 28.9% followed by third 26.8%.The first metacarpal bone was the least common fractured 7.1%

Among the metacarpal bones, the transverse fracture pattern 28 (46.7%) was the most encountered followed by oblique and comminuted pattern each contributing 15 (25%) (Table 5).

Joint dislocation and tendon injury

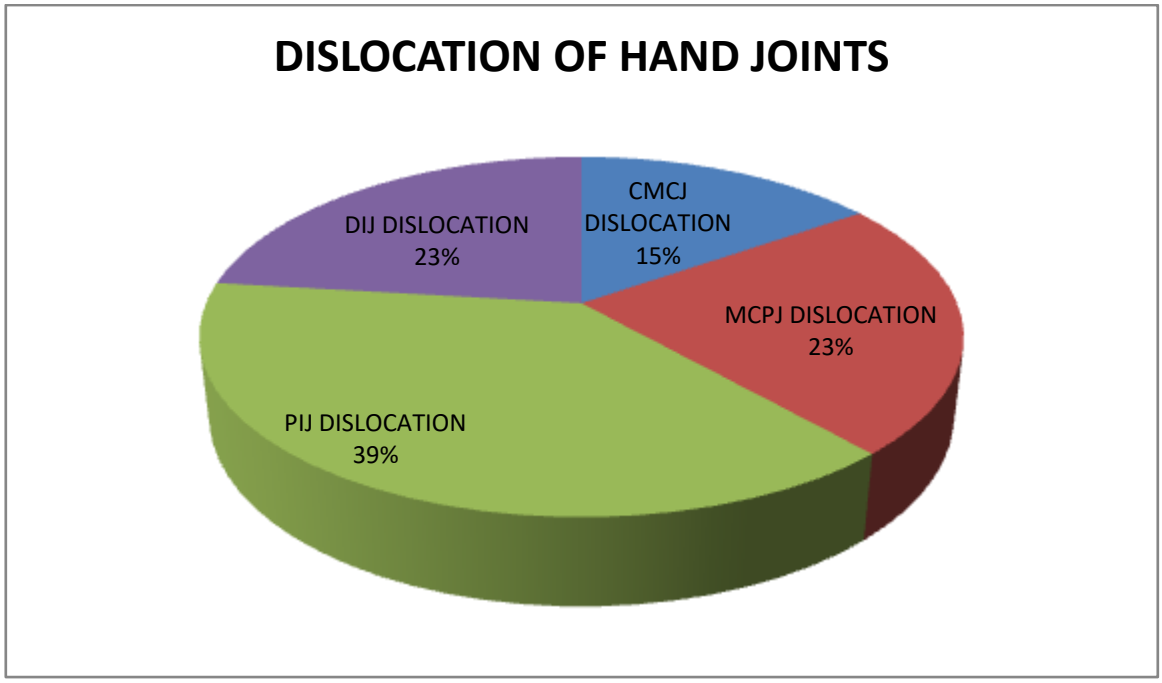


Figure 7.Trend of dislocation among the hand joints

Joint dislocation was seen in 13 patients. The interphallangeal joints were the most common involved joints {8(61.6%) (PIJ 5(38.5%) and DIJ (23.1%)}.MCPJ dislocation occurred in 3 (23.1).the intercarpal and cmcj were the least common joint involved 2 (15.3%)(figure 10).

Regarding the tendons injury; 12 tendons were injured. extensor tendons were injured in 7 (58.3%) whereas flexor tendons were injured in 5(41.7%).among the flexor tendons; FDS was the most injured tendon in 3(60%) followed by FDP -1(20%) and FPL-1(20%).

3.5 Outcome

The recruited patients were followed up for 3 months. 4 (5.7%) were not available for outcome assessment due to death and lost to follow up.

Among those who appeared for final assessment 51(72.9) reported to have no pain while 15(21.4) reported to have varying degree of pain. The pain ranged from mild to moderate; 13(18.6%) and 3(4.3%) respectively. There was none experienced severe pain during final assessment.

Stiffness was the most common noted complication throughout the study in 37(52.9%); however, improvement was noted in the subsequent follow up due to emphasis on physiotherapy. Paraesthesia was noted in 6(8.6%), Mal-union in 2(2.9%) cases .1(1.4%) had superficial surgical site infection at the last visit.

Objective functional outcome

Total functional outcome of second to fifth metacarpal and phalangeal bones injuries were assessed using Belsky`s criteria(51)(19). Of the 56 patients, excellent and good results was noted in 26(46.4%) and 21(37.5%) respectively.9 (16%) had poor outcome.

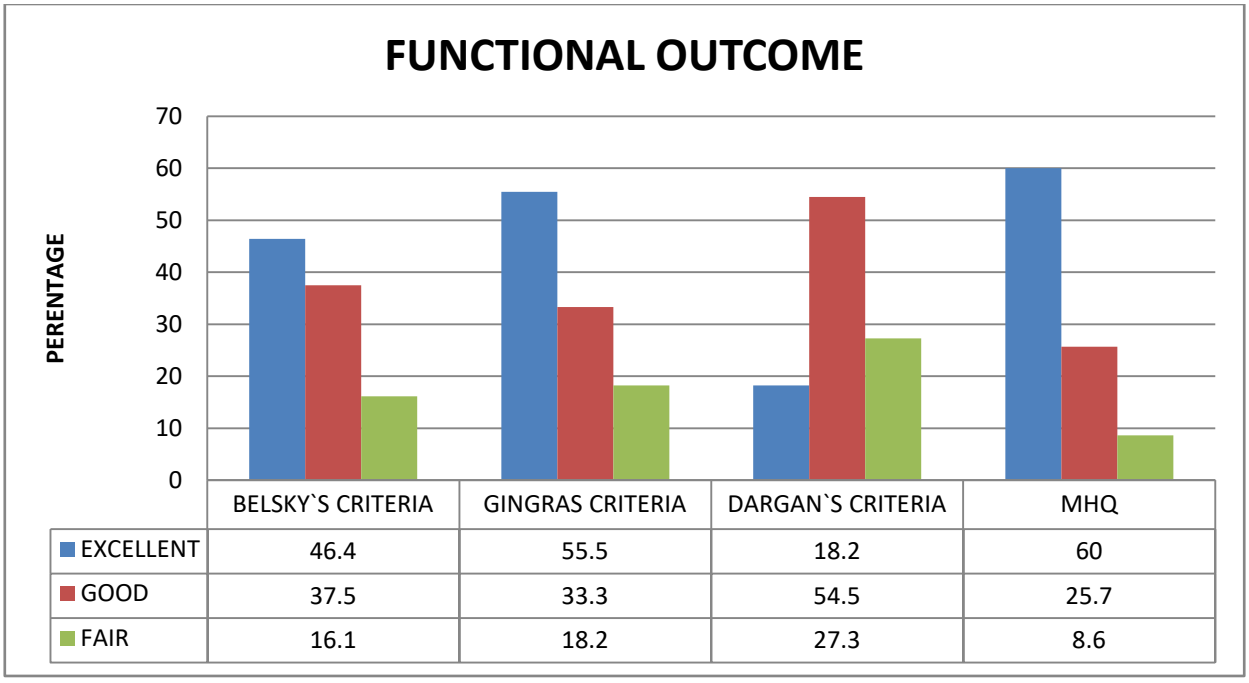
According to Gingrass criteria (51); Among thumb injuries, 5(55.5%) had excellent outcome, 3(33.3%) had good outcome and 1(11.1%) had poor outcome.

Regarding those who had tendon injury the general functional outcome was good to excellent in 6(54.5%) and 2(18.2%) respectively. 3(27.3%) had fair outcome (figure 11).Among the extensors, the outcome was good to excellent in 5(71.4%) and 2(28.6%) respectively.1(25%)

of the flexors had good outcome while 3(75%) had fair outcome. Dargan`s criteria was used to assess the functional outcome.

Subjective functional outcome

66 Patients were evaluated by MHQ with regard to their activities of daily living (ADLs), pain, work performance, aesthetics and patient satisfaction with hand function(40).42 (60%) had excellent MHQ score, 18(25.7%) scored good, fair 4(5.7%) and 2(2.9) had a very poor score.4 (5.7%) were not assessed for final MHQ score; These were lost to follow up and 1 died due to other causes not related to hand injury. The mean MHQ score was 79.7%.



	BELSKY`S CRITERIA	GINGRAS CRITERIA	DARGAN`S CRITERIA	MHQ
EXCELLENT	46.4	55.5	18.2	60
GOOD	37.5	33.3	54.5	25.7
FAIR	16.1	18.2	27.3	8.6

Figure 8: Functional outcome of hand injuries according to Belsky, Gingras, Dargan criterias and MHQ.

CHAPTER FOUR

4.0 DISCUSSION

4.1 Socio-demographic characteristics

(a) Age

All age groups were affected by hand injury. However, the mode age set was the 20-29 years group who consisted 38.6% of the patients. These findings compare well with other studies (16)(1)(17)(19) (18) (12).This group comprise most of the productive work force of any society. According to Kaisha(16) similar age group formed 45.5% of the injuries.

(b)Sex

Males sustained hand injuries more often than females, with a male to female ratio of 6.8:1.This is explained by the fact that men comprise the majority of the work force and are also involved in more violent confrontations leading to injury (refer table 2).This is similar to Gupta (24) in India who found male to female ratio of 6.8:1. Burridge in New Zealand found that men were eight times more prone to hand injury than females(52).The current study findings are also consistent with other studies ((53)(12)(1)(17)(16)(19)(54).

(C)Occupation and education

54.3% of the recruited patients had primary level education and majority 45.7% depended on petty business including motorcycling and tricycling to sustain their life.32.8% were private sector employee; doing manual works in industries, and operating various types of machines (refer table 2).This particular group with primary education level, depending on petty business and private sector employment are either exposed to occupational injuries through operating machines with a little or no knowledge on how to operate and maintain them or work in environments with no healthy/safety regulations and protective gear for machine operations. They are also exposed to road traffic crashes and assaults. This suggests the potential need for improving education level and awareness of risks associated with various injuries which includes the hand. The findings correlate well with other studies (16)(55)

(d)Hand involvement

The right hand (dominant hand in 87.1%) was involved in 52.9% of the injuries. It tends to be often used in warding off attacks, operating machines and provide support in falling. The finding is consistent with other studies (12)(1)(34).

The non dominant hand was involved in 44.3%.This is due to the fact that in road traffic crash, any of the two hands can be involved .The findings are different from those of Otene (53) who found the non dominant hand to be involved only in 4.9% and dominant hand in 89.2%.The difference is described by the fact that, in his series; Cuts and stab wounds were the major causes of hand injury where the dominant hand was used to ward off the attacks

(e)Work related hand injuries

57.1% sustained injury at the working station. Home injuries constituted 11% (refer table 3) .At homes careless handling of knives and machetes, may explain the incidence of hand injuries. The increase use of machines and industrialization rate in urban centre explain high incidence of hand injury during working hours. The finding is similar to other studies ((20)(16)(1)(56). In Uganda majority sustained hand injury at work and home place respectively (20). 52% of patients sustained injury during work hours and injuries that occurred at home constitute 20% of patients(1). In Hong Kong most of the hand injuries occurred at work, followed by home, and road traffic crashes(56).

The factors that influenced hand injuries at work were extra working hours (15%) and poor light (25%).70% of the work related injuries were associated by operating machines (Table 3).In India, the pattern of hand injuries was influenced by extra working hours (40%), poor light (18%), drinking alcohol (9%) and machinery defects (14%)(1)

Lack of protective equipment was the main risk factor occurring in 90.3% of the occupational hand injuries, Lack of safety training was present in 32.3% of the cases, followed by equipment failure in 19.4%(16).In the current study these factors were not assessed.

4.2 Proportion

The proportion of hand injury among all patients with various injuries was 4.2%.The findings are consistent with those of Makobore(20) at Mulago hospital in Uganda whose proportion was 4.7%.In Kenyatta National hospital the proportion was 5.6% (12).The Phalanges were injured in 54.3%, metacarpal 44.3% and carpal bones in 1.4%.The findings are explained by the fact that phalanges are most leading part of the hand. The findings closely relates with other studies (57)(21)(1)(24)(16).The phalanges, metacarpals and carpal bones were involved in 59.5%,28.9% and 11.6% respectively(57). The metacarpals, phalanges, and carpal bones account for 36%, 46%, and 18% of the fractures, respectively (21).The current study findings are slightly different from those of Wanjohi(12) who found the metacarpals to be frequently injured than phalanges in 50.9% and 49.1% respectively. This is due to the fact that in his study, assaults was the leading cause of injury where these bones provide a larger area of contact in an attempt to block an attack

4.3 Mechanism of Injury

The commonest cause of hand injury seen at MOI was road traffic crash and machines accidents; each 31.4%.The causes depend on the socio-economic state of the patients and development of the country (58). In The Netherlands and Denmark; Home and leisure accidents caused by objects and falls were the leading cause of injury to the hand (59).This is due to developed nature of the country where there is less industrial manual workers compared to Tanzania. In the current study assaults constituted 20%.This is explained by increase in crime rate, rapid urbanization and lack of official employment among youth in Dar-es-salaam. Pietrobon(60) observed assaults as the leading cause of hand injuries in South Africa .He attributed this to the period 1992 to 1994 when the country was in transition characterized by violence, social upheaval and uncertainty about the future

The current study findings nearly compares well with other studies (16)(1).Kaisha found that work related /machine injuries constituted 31%, assaults 30% and road traffic crash 8%.Such a difference in road traffic crash, when compared with the current study findings is attributed by the rapid increase of using motorcycles as means of fast transport in recent years in Dar-es-salaam and Tanzania at large.

The predominance of work-related and Road traffic injuries suggests that preventive measures focused at the work place and road safety may lead to reduction in the incidence of occupational and road related hand injuries.

4.4 Pattern of hand injuries

(a) Skin Status

There were more open fractures (72.9%), compared to closed fractures (27.1%). This is due to the fact that, the hand bones are relatively subcutaneous and any force that causes injury is likely to break the skin cover. Among the open injuries, 42.9% were lacerations and 12.9% traumatic amputations. This reflects the mechanism of injury where machines related and assaults Involving sharp objects are likely to cause lacerations/ traumatic amputations. The findings compares well with other studies(16) (12).74.75% were open injuries while 25.5% were closed injuries (16)

(b) Fracture Distribution

Among the metacarpals, the fifth and second were the most frequently injured 28.9% and 27% respectively. These metacarpals are on the open side of the hand, therefore exposed to violence of assaults and machine injuries. These figures compare well with those in Kenya (16)(12).There is variation across studies pertaining to fracture distribution among the digits. In the current study, the 4^{th} finger phalanges were most injured 24.1% followed by 3^{rd} finger 22.4% and 2^{nd} finger 20.7% (refer table 4). In India; the 1^{st} finger phalanges were most commonly involved (14%) followed by 2^{nd} and 5^{th} finger(1) . The 2^{nd} finger 21% and 3^{rd} finger 21% were most commonly involved followed by 4^{th} finger 18%, 1^{st} 11% and 5^{th} finger 11%(61).The 3^{rd} finger phalanges are the most common involved followed by 4^{th} , 2^{nd} ,

5^{th} and 1^{st} fingers phalanges(12). The 4^{th} and the 2^{nd} fingers were the most injured followed closely by the 3^{rd} finger (16)

Overall, the proximal phalanges (48.3%) were most injured followed by the distal phalanx 29.3% (Table 5).This has been observed because the proximal phalanges are relatively immobile at the metacarpo-phalangeaI joints, hence become more vulnerable to injury. The distal phalanx form the leading part of the hand hence increased vulnerability to injury especially in occupational related injuries. The findings are consistent with Wanjohi and Jehanzaib (12)(62),but not inconsistent with Kaisha and Duzgun who found that the distal phalanges were the most injured followed by the proximal phalanges(16)(22).

Such a difference in fracture distribution among the digits and phalanges is probably due to different predominant mechanisms of injury noted across studies(16)(12).While occupational injury and assaults were the predominant mechanisms of injury (16), In the current study; Road traffic crash followed by machines and assaults were the predominant mechanisms

(c) Fracture Pattern

Most of the metacarpal fractures occurred transversely in 46.7%, oblique 25% and comminution 25%. Most of the phalangeal fractures were comminuted 38.9% followed by transverse 25.9% and oblique 18.5%. Thus most of the forces applied had bending component resulting in transverse fracture, while oblique fracture had an added twisting force to the bending forces. Comminuted fractures had crushing component associated with heavy, blunt objects, or falls.

(d) Joint Dislocation

The inter-phalangeal joints were the most dislocated (61.6%) followed by MCPJ 23.1%.The pattern of dislocation is in parallel with injury distribution among the phalanges, metacarpals and carpals. The findings are well comparable with other studies (16)(1).

(e) Tendons Injury

Extensor tendons were injured more than flexor tendons 58.3% and 41.7% respectively. This was noted because extensor tendons are predisposed to laceration due to their superficial location on the dorsum of the hand and minimal amount of subcutaneous tissue between the tendons and the overlying skin. This anatomic feature also predisposes the extensor mechanism to more complex tendon injuries, including abrasion, crush, and avulsion of extensor tendons (28).The findings are consistent with other studies(63)(28)but different from those of Kaisha(16) and Hilal(1) who found the flexor tendons to be more injured than flexors.

Among the flexors, FDS was more injured than FDP; 60% and 20% respectively. Anatomically FDS is more superficial than FDP, hence more predisposed to injury. The findings are consistent with other studies (16)(1)

5.5 Outcome

(a) Objective functional outcome

The overall objective functional outcome of the second to fifth metacarpals and their corresponding digits, was excellent to good in 83.9% (excellent 46.4%,good 37.5%) which is similar to other studies(19)(24) whose results were excellent to good in 81%.However,the findings are different from Jehanzaib,Belsky, and Thakur (62)(64)(25).Phalanges have good to excellent results in 90% of cases using a barell and K-wire in a very comminuted, unstable and open fractures(62).Belsky (64) found excellent to good in 90% [excellent 61%, good 29%], and fair to poor in 10%.

Metacarpal fractures show a better functional outcome; Excellent to good in 11(85%)[46% excellent,39% good], as compared to phalangeal fractures in which no excellent but good results found in 6(75%) [(19)(34)(33)].In the current study, such a comparison was not assessed; Hence a need for another study to compare the functional outcome between metacarpals and phalanges both in open and closed fractures

The overall outcome of thumb injuries was excellent to good in 81.8% (refer figure 8).The findings are different from Jaswinder (51) who found the average outcome to be 89% in a group treated conservatively and 92% in a group treated surgically. The difference in outcome is described by a short period of follow up in the current study compared to Jaswinder (51) who assessed the final outcome after one year of follow up.

In the series of Narender et al(28), 91% (n=22) had excellent outcome after extensor tendon repair and rehabilitative therapy. Presence of associated injuries led to poor outcome(28). The final outcome was done after one year of follow up. Sylaidis(65), after six months of follow up, had excellent/good results in 92%.In the current study, the outcome was good to excellent in 71.4% and 28.6% respectively. The difference is attributed by short follow up period of three months prior to final assessment and presence of associated injuries in most of patients.

Among those who sustained flexor tendon injuries, the outcome ranged from fair to good in 75% and 25% respectively. No excellent results obtained in the current study. These study findings do not compare well with other studies(46)(66).Galanakis (46) found excellent results in 68%, good in 23% and fair in 9% while Chan(66) found excellent to good results in 81% and poor functional outcome in 19%.To optimize the outcome, only patients without associated injuries were recruited (66).

Failure of the current study to compare well with other studies is probably due to recruiting patients who have tendon injury with other associated injuries, poor compliance to rehabilitative protocol, inadequate understanding of the rehabilitative protocol due to low education level , analysis in a small sample size of patients having tendon injuries and short follow up period of twelve weeks.

Studies show a positive correlation between smoking/associated nerve injury and poor outcome of flexor tendons (67).In the current study, such a correlation was not assessed.

Thus a long term study assessing the functional outcome of flexor and extensor tendons separately while taking into consideration the above explained factors which might have contributed to poor outcome is recommended.

(b) Subjective functional outcome

Patient's perception about the injured hand was assessed using MHQ. The mean MHQ in the current study was 79.7%.The findings nearly compares with Deshmukh (68) whose mean MHQ 84% after 34 months of follow up of patients with fracture dislocation of PIJ of the hand using pins and rubber traction system .

The current findings do not compare with Xiao Fand and Thievandron (48)(47).They had mean MHQ score of 90% and 97% respectively.Had the current study made a long term follow up, probably would compare with Thievandron and Xiao Fang(48)(47)

5.6 Study Limitations

1. The follow up period was 12 weeks which is not adequate to full asses the functional outcome of hand injuries. Tendon injury may need up to 6 months for complete healing
2. The sample size is very small in some groups for statistical comparison.
3. Four patients were lost to follow up and therefore an opportunity to full asses for recovery and outcome was missed and hence reduced the sample size

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

1. The most common causes of hand injury in this study was road traffic crash, machines/work related and assaults which are largely preventable.
2. Hand injury involved the young age group with the modal group being 20-29 years group followed by 30-39 and 40-49 years group. Majority are male with primary level education. This is a group at risk of injury because it is the major working force; therefore are susceptible to road traffic crush, machine and violence.
3. The society is largely right handed with a very small group of left handed people. However hand dominance does not influence the likelihood of the hand being injured. RT hand 52.9% and left injured in 44.3%.
4. The fifth and second metacarpals were the most frequently injured .These are on the open side of the hand, therefore exposed to violence of assaults and machine injuries. The proximal phalanges were the most injured. When joint dislocation occurs, the interphalangeal joints are the most likely to be affected.
5. Flexor digitorum superficialis and Extensor digitorum communis were the leading tendons to be injured.
6. Among the work related injuries, majority were working at the environments with inadequate light and the rest were in extra working hours.
7. Skeletal pain and deformity are the commonest complications of hand injuries however adhering to physiotherapy largely minimize the deformity.
8. The functional outcome of hand injuries at MOI is good to excellent in terms of overall hand function, activities of daily living, pains, work performance, aesthetics and patient satisfaction with hand function. The mean MHQ score was 79.7% at three months.

5.2 Recommendations

1. A detailed industrial based study about hand injuries needs to be conducted to establish definitive associated risks of hand injury, preventive measures and laws to protect the workers both in small and large industries.

2. Recommendations on further hospital based study.
    - ✓ Establish long period prospective study on the management aspects of hand injuries including outcome of tendon injuries
    - ✓ Comparative study on outcome of open and closed hand injuries using various fixation methods
    - ✓ The cost/burden of hand injuries at MOI.

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APPENDICES

Appendix I: Questionnaire

English version questionnaire number……..

1. Name……
2. Registration number……
3. Address……
4. Phone number……
5. Sex.....
6. Age in years…….
7. Education (a) primary education (b)secondary education
   (c) collage education (d) university education
8. Occupation (a) peasant (b) business (c) skilled worker (d) government employee (e) student (f) housewife (g) others……..
9. Hand dominance …….
10. Hand injured (a)right (b)left (c)both
11. Time of injury (a)8am -6pm (b)6pm-midnight (c)midnight -8am
12. Place of injury (a) work (b) off work (c) home.

If the injury was work related continue with question number 13.if not work related go to question number 16

13. Working overtime? (a) yes (b) no
14. Lighting condition of the area (a)adequate (b) not adequate
15. Type of work during injury……

16. Site injured (a)Thumb (b)index finger (c)middle finger

(d)ring finger (e)little finger (g)palm (h)dorsum of hand (i)carpus

17. Mechanism of injury (a)machines (b)assaults, (c)Road traffic crush

(d) door knives (e)broken glasses (g) fall on heavy objects

(i) others……

18. Fracture distribution

Bones involved	
Metacarpals	
Phallanges	
Carpal	

19. Phallangeal fracture distribution

Site	Proximal	Middle	Distal
Thumb			
Index finger			
Middle finger			
Ring finger			
Little finger			

20. Metarcarpal fracture distribution

1^{ST} Metacarpal	2^{ND} Metacarpal	3^{RD} Metacarpal	4^{TH} Metacarpal	5^{TH} Metacarpal

21. Carpal bones fracture distribution

Hamate	Capitate	Trapezoid	Trapezium	Triquetrum	Pisiform	Lunate	Scaphoid

PATTERN OF INJURIES

22. A. Skin status (a)intact (b)not intact

22. B. If not intact

Abrassions	Lacerations	Crush injury	Degloving injury	Traumatic amputation

23. Anatomical fracture site and pattern

23. (A1) At metacarpal.

	Base	Shaft	Neck	Head
1ST				
2ND				
3RD				
4TH				
5TH				

23. (B).Fracture pattern

	Spiral	Oblique	Comminuted	Avulsion	Transverse
1ST					
2ND					
3RD					
4TH					
5TH					

23. (C) At phallanges

Proximal phallanx					Middle phallanx				Distal phallanx			
	Base	Shaft	Neck	Head	Base	Shaft	Neck	Haed	Base	Shaft	Neck	Head
1ST												
2ND												
3RD												
4TH												
5TH												

23. (D) Pattenrn at phallanges

Proximal phalanx		Middle phallanx	Distal phallanx
1ST			
2ND			
3RD			
4TH			
5TH			

24. Joint dislocations

Cmcj		Mcpj		Pij		Dij	
Yes	No	Yes	No	Yes	No	Yes	No

25. Injured carpal bone

Sacaphoid	Lunate	Triquetrum	Pisiform	Trapezium	Trapezoid	Hamate	Capitate

26. Tendon injury

Flexor tendon		Extensor tendon	
Yes	No	Yes	No
If yes, mention		If yes mention	

27. Type of treatment offered

OUTCOME OF TREATMENT

28. At 2 weeks.

Pain (a)yes (b)no if yes; (a) mild (b)moderate (c) severe pain

Intact fracture site (a)yes (b)no

Wound status if operated (a)clean (b)infected

If infected-dressing done yes/no

Antibiotics given yes/no

29. At 6 weeks

Pain (a)yes (b) no if yes; (a) mild (b)moderate (c) severe pain

Any deformity (a)yes (b)no

Wound inection (a)yes (b) no

If infected-dressing done yes/no

Antibiotics given yes/no

Total active movement of the involved digit(a)>215 (b)>180 (c)<180

Thumb (1)total flexion (a)>180 (b)>75 (c)<75

(2)palmar abduction (a)>45 (b)>30 (c)<30

30. At 3 months

Callus formation (a)yes (b)no

Pain (a)yes (b) no if yes; (a) mild (b)moderate (c) severe pain

Any deformity (a)yes (b)no

Wound inection (a)yes (b) no

If infected -dressing done yes/no

Antibiotics given yes/no

Total active movement of the involved digit(a)>215 (b)>180 (c)<180

Thumb (1)total flexion (a)>180 (b)>75 (c)<75

(2)palmar abduction (a)>45 (b)>30 (c)<30

Appendix II: Consent Form (English Version and Swahili Version)

I (full name) ---------- of P.O.BOX----------do agree to participate in the study and I am willing to undergo investigations as required by the investigator. I have been explained and I have understood the objective and benefits of the study. I am informed that I can agree/disagree to participate.

Signature of participant:----------

Date:----------

Swahili version

Mimi (jina kamili)----------, wa S.L.P---------- nakubali kushiriki katika utafiti huu na niko tayari kufanya vipimo vyote kama itakavyoagizwa na mtafiti. Nimeelezwa na nimeelewa madhumuni na umuhimu wa utafiti huu na ninafahamu kuwa niko huru kuamua kushiriki/kutokushiriki kwenye utafiti huu.

Saini ya mgonjwa ----------

Tarehe:----------