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Assessment of hand fractures mainly metacarpal and phalangeal fractures treated by internal fixation

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Abstract
Recent studies have shown good functional results with surgical treatment of metacarpal and phalangeal fractures using various modalities of internal fixation compared to the conservative treatment. This study involves evaluating functional outcome of metacarpal and phalangeal fractures treated by various modalities of internal fixation. The present study was planned with the objective to assess the functional outcome of metacarpal and phalangeal fractures treated by various modalities of internal fixation.
The study was planned in the Department of Orthopaedics in Nalanda Medical College and Hospital, Patna from Jun 2018 to Dec 2018. Total 15 patients diagnosed with displaced midshaft metacarpal and phalangeal fractures were included in the present study. The approval of the institutional ethical committee was taken prior to conduct of the study. All the patients were informed consents. The aim and objective of the present study were conveyed to them.
Detailed clinical and radiological assessment of fracture and careful preoperative planning, meticulous dissection and precision in surgical technique and choosing the correct implant are critical in achieving good results and minimising the complication.

Keywords: metacarpal and phalangeal fractures, internal fixation, hand injury

Introduction
The hand is a very complex organ with multiple joints, different types of ligament, tendons and nerves. Hand disease injuries are common in society and can result from excessive use, degenerative disorders or trauma. Trauma to the finger or the hand is quite common in society. In some particular cases, the entire finger may be subject to amputation. The majority of traumatic injuries are work-related. Today, skilled hand surgeons can sometimes reattach the finger or thumb using microsurgery. Sometimes, traumatic injuries may result in loss of skin, and plastic surgeons may place skin and muscle grafts [1].
A hand fracture is a break in one of the bones in the hand. This includes the small bones of the fingers (phalanges) and the long bones within the palm (metacarpals). A broken hand can be caused by a fall, crush injury, twisting injury, or through direct contact in sports. In most cases, a hand fracture will heal well with nonsurgical treatment. Depending on the type and location of the fracture, this may include wearing a cast, splint or buddy straps for a period of time. For more serious fractures or for fractures that do not line up properly, however, surgery may be required to realign the broken pieces of bone.
Phalanges: These are the small bones that form the thumb and fingers. There are two phalanges in the thumb and three in each of the fingers. And Metacarpals: These are the five bones that are located in the palm of the hand [2].

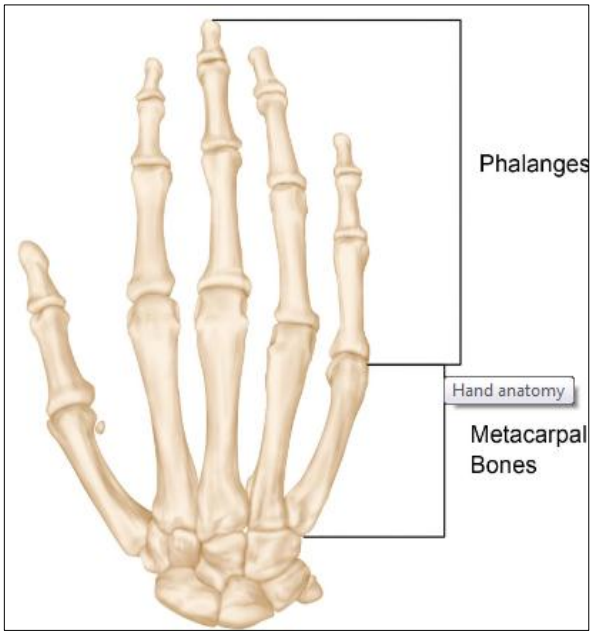

Fig 1: The bones of the hand. A fracture can occur in the middle of a bone or at the end, near the joint

The most common hand fracture is a fracture of the fifth metacarpal—the bone in the hand that supports the little finger. This is commonly called a “boxer’s fracture” and

Involves the "neck" of the bone, next to the knuckle joint. A boxer's fracture is caused most often by punching or striking a hard object when your hand is closed in a fist.

Fractures of the fingers occur when the finger or hands hit a solid object. Fractures are most common at the base of the little finger (boxer's fracture). Nerve injuries occur as a result of trauma, compression or over-stretching. Nerves send impulses to the brain about sensation and also play an important role in finger movement. When nerves are injured, one can lose ability to move fingers, lose sensation and develop a contracture. Any nerve injury of the hand can be disabling and results in loss of hand function. Thus it is vital to seek medical help as soon as possible after any hand injury [3]. Sprains result from forcing a joint to perform against its normal range of motion. Finger sprains occur when the ligaments which are attached to the bone are overstretched and this results in pain, swelling, and difficulty for moving the finger. Common examples of a sprain are jammed or twisted fingers. These injuries are common among ball players but can also occur in laborers and handy men. When finger sprains are not treated on time, prolonged disability can result [4]. Finger injuries are usually diagnosed with x-ray and can get to be considerably painful. The majority of finger injuries can be dealt with conservative care and splints. However, if the bone presents an abnormal angularity or if it is displaced, one may need surgery and pins to hold the bones in place. Non-operative treatment is generally the choice of treatment for fractures of the distal phalanx because of the small size. Conservative treatment with splints is used for non-displaced fractures immobilizing the proximal and distal interphalangeal joints (but not the metacarpophalangeal). After that tape can be used if there is still some pain. For proximal fractures, the splint needs to be longer and immobilize the metacarpophalangeal joint and the wrist. It can be used for non-displaced fractures and for displaced fractures after orthopedic reduction and testing of stability.

Surgical treatment of displaced proximal phalanx fracture after reduction is common because of instability and rotation trouble. It involves Kirchner wires by percutaneous pinning or open reduction, or very small screws and plates. Comminuted fractures are difficult to treat and need wires in traction. Open fractures need urgent evaluation and treatment with tetanus prophylaxis and antibiotic therapy [5]. Too often these metacarpal and phalangeal fractures are neglected or treated as minor injuries and results in major disability and deformity with permanent disability and handicap. Hand fractures can be complicated by deformity from no treatment, stiffness from over treatment and both deformity and stiffness from poor treatment. Fracture healing in the hand is not an isolated goal; rather the functional result is of paramount importance. Recent studies have shown good functional results with surgical treatment of metacarpal and phalangeal fractures using various modalities of internal fixation compared to the conservative treatment. This study involves evaluating functional outcome of metacarpal and phalangeal fractures treated by various modalities of internal fixation. The present study was planned with the objective to assess the functional outcome of metacarpal and phalangeal fractures treated by various modalities of internal fixation.

Methodology

The study was planned in the Department of Orthopaedics in Nalanda Medical College and Hospital, Patna from Jun 2018 to Dec 2018. Total 15 patients diagnosed with displaced mid shaft metacarpal and phalangeal fractures were included in the present study. The approval of the institutional ethical committee was taken prior to conduct of the study. All the patients were informed consents. The aim and objective of the present study were conveyed to them.

A dorsal longitudinal incision was made, and the fracture was exposed with adequate soft tissue dissection. Excessive soft tissue dissection and periosteal sleeving were avoided. A low profile 2.0 mm mini plate was applied with fixation of at least four cortices, two oneach side of the fracture.

In oblique or spiral type of fractures, those fractures suitable for inter fragmentary screw fixation were initially fixed with inter fragmentary screws, and then, by plate fixation. The plates and screws were covered with periosteum and soft tissues, and wound is closed in layers.

Short-arm splint was applied in functional position until the edema and pain subsided, and the extremity was elevated for the first 24–48 h. Depending on the general condition of the patient, type of fracture and fixation method, active finger, and Meta carpo phalangeal joint motion were initiated on the 2nd postoperative day. Based on these same factors, the patients were allowed to use their hands in daily activities after the 4th postoperative week, and in activities requiring force, till there is complete radiological fracture union. Regular clinical and radiological follow-up was done at an interval 4, 8, 12, and 24 weeks.

Inclusion Criteria: 1. Age more than 18 to 70 years. 2. Physical fitness for surgery. 3. Sex: Both male and female. 4. All cases of fractures of metacarpals and phalanges of hand.

Exclusion Criteria: 1. Age less than 18 years. 2. Patient not willing or medically unfit for surgery. 3. Undisplaced hairline fractures.

Results & Discussion:

The data from the 15 cases of the displaced midshaft metacarpal and phalangeal fractures were collected and presented as below. Most of the metacarpal and phalangeal fractures are stable before or after closed reduction are managed successfully by conservative method of protective splinting followed by early mobilization. Only a small percentage of metacarpal and phalangeal fractures are unstable and in these patients the functional results following conservative treatment are unsatisfactory. These are the cases indicated for various modalities of internal fixation which are usually less than 5% of hand fractures. James *et al* [11] reported that conservative method used in treatment of unstable fractures had loss of function in 77% of fingers.

Metacarpal fractures can be fixed with external fixator. Report by Shehadi *et al* [15] showed full return of total range of motions in up to 100% of metacarpal fractures treated with external fixator. This mode of fixation is useful in compound metacarpal fractures with bone loss. But the routine use of external fixator is discouraged as there is loosening of construct following pin tract infection leading to loss of fixation and there is difficulty in constructing and applying the fixator. Intramedullary fixation with prebent K-wires were used for transverse and short oblique fractures. They provide comparable functional outcome with plate and screw fixation. But there is incidence of loss of reduction, penetration of Meta carpo phalangeal joint by hardware, thus necessitating a second surgery for hardware removal.

Table 1: Fracture Pattern

Type of Fracture Pattern	No. of Cases
Oblique	6
Transverse	4
Spiral	3
Comminuted	2
Total	15

Among these three patients with stiffness, one patient had signs of tenosynovitis, and hence, the hardware was removed with a second operation once the fracture had healed after 3 months postindex surgery. Results were graded as follows in table 2.

Table 2: Clinical Outcome

Clinical Outcome	Parameters	No. of Cases
Excellent	• Pain-free union • No symptoms or signs • No angular or rotational deformity • Range of movements (ROM) at interphalangeal joints 75°–100° • Total active movement (TAM) >250°s	11
Good	• Occasional pain at the fracture • Mild edema • Clinically united • Range of movements at interphalangeal joints at least 60° • Minimal rotatory or angular deformity • TAM >180°.	3
Fair	• Painful movements • ROM at IP joints <50° • Deformity • TAM <120° • Pain at fracture site.	1
Total		15

Earlier metacarpal fractures were treated with ORIF with k-wire although operative time was shorter, the incidences of loss of reduction and penetration to the metacarpal-phalangeal joint were much higher. Gupta *et al* [6]. concluded that surgical stabilization of metacarpal and phalangeal fractures of hand seems to give good functional outcome as compared to conservative treatment.

Tekkis *et al* [7]. Found that patients treated with ORIF using a 4-holed mini fragment plates and screws gave better long-term results. Prokuski and Eglseder [8] have reviewed that ORIF of the 2nd, 3rd, 4th, and 5th metacarpal achieved better reduction and fixation by miniplates and screws. Main outcome of grip strength and wrist and finger range of motion are above 280°.

The technique of plate fixation in the hand is well documented, but there are many drawbacks. Stern and Wieser [9] stated that main disadvantage of plate was their size and wide exposure necessary for plate fixation and this may involve extensive periosteal stripping. Plate is usually placed under the extensor apparatus and can interfere with tendon gliding. Fusetti *et al* [10]. have reviewed complications of plate fixation for metacarpal fractures. In a follow-up of 129 consecutive patients with 157 metacarpal fractures treated by open reduction and internal fixation, fusetti concluded that despite technical advances in implant material, design, and instrumentation, plate fixation of metacarpal fractures remains fraught with complications and satisfactory results.

A majority of hand fractures are stable either before or after closed reduction and can be successfully treated by non-operative methods, which include protective splintage and early mobilization. On the other hand, results of closed treatment in the remaining small percentage of unstable hand fractures are usually unsatisfactory. James [11] reported loss of function in 77% of fingers with unstable phalangeal fractures treated by closed means. On the other hand, open reduction and internal fixation with K-wires produces a less rigid fixation with little rotational stability, leaving much to be desired. The problems are compounded by the protruding ends of the K-wires. Interosseous wiring when combined with K-wire provides more rigid stabilization; however, this technique is applicable to transverse diaphyseal fracture patterns only. Osteosynthesis using AO miniature plates and screws in this small group of unstable metacarpal and phalangeal fractures produces anatomical reduction of fractures with stabilization that is rigid enough to allow early mobilization of adjacent joints without allowing loss of reduction, thereby preventing stiffness and hence good functional results. Many studies in the literature have demonstrated biomechanical superiority of AO mini-plates and screws over other modes of internal fixation in hand fractures. A biomechanical study by Fyfe and Mason [12] to evaluate the rigidity of various modes of internal fixation showed that AO mini-plates and screws and IO wiring produced much stronger stabilization than K-wires. A similar study by Black [13-14] concluded that dorsal plating with or without lag screws provided significantly more stability than K-wires/IO wiring.

Conclusion

Fractures involving the metacarpal and phalangeal shafts occur in multiple patterns (transverse, oblique, spiral, and comminuted). The presenting deformity is influenced by the

forces across the fracture site. Treatment options range from immobilization and early motion for stable injuries to surgical intervention with fracture fixation for unstable fractures. Fracture pattern, soft-tissue injury, and surgeon preference guide the surgical approach and implant selection. Percutaneous Kirschner-wire insertion and internal fixation with inter fragmentary screws or a plate are most commonly utilized. Detailed clinical and radiological assessment of fracture and careful preoperative planning, meticulous dissection and precision in surgical technique and choosing the correct implant are critical in achieving good results and minimising the complication.

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