CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Phalangeal Fracture Fixation

Overview

- Screw fixation is suggested to achieve patient satisfaction and optimal functional recovery for closed, isolated proximal phalanx fractures of the long fingers [1].
- Surgical corrections of phalangeal malunion have evolved to safe and rewarding procedures [2].
- A retrospective study evaluated the clinical results and complications of 72 patients with metacarpal and phalangeal fractures treated with low-profile plates [3].
- Less than one half of distal phalangeal fractures will have united by the time of evaluation [4, 5].
- Results for proximal phalangeal fractures treated with tension band wiring were universally satisfactory [6].
- Less good outcomes occurred for some middle phalangeal fractures treated with tension band wiring due to loss of extension of the proximal and interphalangeal distal joints [6].
- Age-related differences in demographics, morphology, treatment, and outcome were investigated in 701 fractures of the metacarpals or phalanges, including fracture-dislocations, in 655 patients [7].
- Proximal phalangeal fractures and comminuted fractures had the worst outcomes in a prospective study of 245 open digital fractures [8].
- Associated significant soft tissue injuries had a particularly deleterious effect on the outcome of open digital fractures [8].
- Intra-articular fractures of the proximal and middle phalanx can cause great patient morbidity if managed poorly [9].
- Dorsal plating with unicortical angular stable screws is suitable for proximal phalangeal fractures [10].
- Commonly used plates and screws for fracture fixation of the hand may not be suitable in size for groups of people with smaller hand sizes, in particular some Asians and women [11].
- Open surgical reduction of phalangeal neck fractures leads to phalangeal head osteonecrosis and poor functional results [14].
- Better results emerge from the use of A.O. screws than of Kirschner wires for closed fractures of the proximal phalanges and metacarpals [16, 17].
- Flexible intramedullary rodding of specific proximal phalangeal fractures provides excellent results with a low complication rate [18].

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- Union was achieved in all cases of mallet fractures treated with a hook plate in a consecutive series of nine fractures [20].
- Intraosseous suture fixation is recommended if the need arises for fixation of sagittally split distal phalanges [24].
- Preliminary evidence favors the use of extensor sparing approaches when fixing proximal phalanxes, though this result requires validation with randomised controlled trials [25].
- Excellent stability in the longitudinal and rotational planes is obtained with intramedullary Herbert screws for phalangeal nonunion [27].
- Intramedullary fixation of unstable hand fractures has advantages over techniques using plates or Kirshner wires [31].

Anatomy & Pathophysiology

BONY ANATOMY

- The skeleton of the hand consists of 27 bones, of which 19 are long bones [47].
- The hand skeleton is divided into five rays, each comprising a polyarticulated chain of metacarpals and phalanges [47].
- The thumb ray is composed of a metacarpal and two phalanges, making it the shortest ray [47].
- The four finger rays are each composed of a metacarpal and three phalanges [47].
- The proximal and middle phalanges of the middle and ring fingers are longer than those of the index finger [47].
- The epiphyseal plates of the phalanges are located at the proximal ends [47].
- The epiphyseal plate of the first metacarpal is located at its distal end, similar to phalanges [47].

SOFT TISSUE ANATOMY

- The extrinsic extensor muscles run through six fibroosseous retinacular compartments at the wrist level [46].
- The principal bony insertion of the extrinsic digital extensors is on the dorsal proximal aspect of the middle phalanx [46].
- Metacarpophalangeal joint extension is provided by extrinsic extensor force transmitted through the sagittal bands [46].
- Distal interphalangeal joint extension is achieved through conjoined lateral bands composed of tendinous slips from extrinsic and intrinsic tendons [46].
- The flexor digitorum profundus inserts on the proximal volar aspect of the distal phalanx [46].
- The flexor digitorum superficialis inserts via radial and ulnar slips into the proximal metaphysis of the middle phalanx [71].

- The fibroosseous tunnel of the digital flexor sheath extends distally to the proximal aspect of the distal phalanx [71].
- The A2 and A4 annular pulleys are situated over the middle portion of the proximal and middle phalanges, respectively [71].
- The A2 and A4 pulleys are the most essential in maintaining the mechanical advantage of the flexor tendons [71].
- The dorsal interossei are abductors and lie to the radial side of the index and middle fingers and the ulnar side of the middle and ring fingers [64].
- The volar interossei are adductors and lie to the ulnar side of the index finger and the radial side of the ring and little fingers [64].
- The superficial head of each dorsal interosseous muscle inserts onto the lateral tubercle of the base of the proximal phalanx [64].
- The deep head of each dorsal interosseous muscle forms a lateral band that inserts onto the lateral tubercles at the base of the middle phalanx [64].
- The volar interossei do not insert onto the proximal phalanx but form lateral bands that insert onto the base of the middle phalanx [64].
- The dorsal skin of the hand is thin, has loose connections with deeper planes, and allows free gliding over the motor system [73].
- Flexion of the fingers produces a significant lengthening of the dorsal skin, with an average increase of 3 cm in the middle finger from extension to full flexion [73].
- The palmar skin of the digits is subdivided into phalangeal units separated by digital flexion folds [63].
- The digital neurovascular structures are surrounded by a diffuse network of thin transverse oblique fibers known as Cleland ligament (dorsal) and Grayson ligament (palmar) [74].

PATHOPHYSIOLOGY

- Fractures of the proximal phalangeal shaft typically exhibit an apex palmar angulation with the fracture gap wider volarly and compressed dorsally [22].
- The intrinsic muscles flex the proximal fragment of a proximal phalangeal shaft fracture, while the distal fragment is extended by the attachment of the central slip to the dorsal lip of the middle phalanx [22].
- The axis of rotation for proximal phalangeal fractures lies on the fibro-osseous border of the flexor tendon sheath [22].
- The moment arm from the rotational axis of a proximal phalangeal fracture site to the extensor tendon is greater than that to the flexor tendon [22].
- Fracture hematoma permeates the zone of injury and incites a proliferative fibroblastic response of surrounding collagenous structures [22].
- Scar tissue from a proximal phalangeal fracture tends to involve all structures within the zone of injury, producing adherence between bone and adjacent tendons, joint capsule, and ligaments [22].

- Adhesions formed between the extensor mechanism and a proximal phalangeal fracture may result in loss of extensor glide [22].
- Persistent skeletal deformity from a proximal phalangeal fracture may contribute to PIP joint extensor lag [22].
- The incidence of nonunion of the phalanges is low, with Barton noting a 0.7% incidence in 148 fractures of the phalangeal shaft [33].
- Borgeskov found a 0.2% incidence of nonunion among 485 phalangeal and metacarpal fractures [33].
- Most phalangeal and metacarpal fractures show clinical signs of union in 3 to 6 weeks [33].
- Nonunion of a phalangeal fracture cannot be diagnosed for at least 1 year after injury according to Smith and Rider [33].
- Less than one half of distal phalangeal fractures will have united by the time nonunion is typically assessed [4, 5].
- In the proximal phalanx, the immediate vicinity of the flexor tendon to the volar cortex gives low tolerance to a protruding screw [44].
- The epiphysis of the distal phalanx may fail to revascularize enough to prevent structural collapse, while resorption of the ulnar condyle of the middle phalanx can contribute to angular deformity [59].

Classification

PHALANGEAL NECK FRACTURES

- Al-Qattan's classification of phalangeal neck fractures defines Type I as an undisplaced fracture [12].
- Al-Qattan's classification of phalangeal neck fractures defines Type II as a displaced fracture where the distal fragment maintains some bone-to-bone contact with the proximal fragment [12].
- Al-Qattan's classification of phalangeal neck fractures defines Type III as a displaced fracture with loss of bone-to-bone contact between the proximal and distal fragments at the fracture site [12].
- In Al-Qattan's classification, Type III phalangeal neck fractures may result from the original injury or from 90 to 180° rotation of the head following fruitless attempts at closed manipulation with rapid longitudinal traction [12].
- In a series of 11 adult phalangeal neck fractures, seven occurred at the neck of the proximal phalanx of the thumb and four at the neck of the middle phalanx of the fingers [12].
- No fractures at the neck of the proximal phalanx of the fingers were observed in a series of 11 adult phalangeal neck fractures [12].
- In a series of 11 adult phalangeal neck fractures, the distal fragment was dorsally displaced in all Type II fractures [12].
- In a series of 11 adult phalangeal neck fractures, the loss of bone-to-bone contact in the single Type III fracture was due to 180° rotation of the distal fragment [12].

MALLET FRACTURES

- The Wehbe and Schneider classification defines Type 1 mallet fractures as having no subluxation of the fractured fragment [34].
- The Wehbe and Schneider classification defines Type 2 mallet fractures as having subluxation of the fractured fragment [34].
- The Wehbe and Schneider classification defines Type 3 mallet fractures as affecting the whole distal phalanx [34].
- The Wehbe and Schneider classification defines Subtype A as a fragment size of less than one-third of the distal articular surface [34].
- The Wehbe and Schneider classification defines Subtype B as a fragment size between one-third and two-thirds of the distal articular surface [34].
- The Wehbe and Schneider classification defines Subtype C as a fragment size greater than two-thirds of the distal articular surface [34].

NONUNION

- The Weber and Čech classification has been found useful in the analysis of phalangeal and metacarpal nonunions [33].

Clinical Presentation

EPIDEMIOLOGY AND DEMOGRAPHICS

- Proximal phalangeal fractures accounted for 61% of phalangeal fractures and 7% of all hand fractures in a series of 100,851 emergency department attendances [32].
- In a prospective study of 245 open digital fractures, proximal phalangeal fractures and comminuted fractures had the worst outcomes [8].
- Age-related differences in demographics, morphology, treatment, and outcome were investigated in 701 fractures of the metacarpals or phalanges in 655 patients [7].
- In a cohort of 48 patients with proximal phalangeal fractures, the mean age was 35 years (SD 11), with 75% being male [21].
- In a series of 11 phalangeal neck fractures, the mean age was 40 years (range 25–55), with seven men and four women [12].

INJURY MECHANISMS AND PATTERNS

- In a series of 11 phalangeal neck fractures, the mechanism of injury was a fall in three patients and a heavy object hitting the digit in eight patients [12].
- In a cohort of 48 patients with proximal phalangeal fractures, 52% involved the little finger, 40% were intra-articular, and 46% were in the dominant hand [21].

- In a series of 11 phalangeal neck fractures, seven occurred at the neck of the proximal phalanx of the thumb and four at the neck of the middle phalanx of the fingers [12].
- In a series of 11 phalangeal neck fractures, no fractures were seen at the neck of the proximal phalanx of the fingers [12].
- In a series of 11 phalangeal neck fractures, the distal fragment was dorsally displaced in all Type II fractures [12].
- In a series of 11 phalangeal neck fractures, loss of bone-to-bone contact in the single Type III fracture was due to 180° rotation of the distal fragment [12].
- In a series of 11 phalangeal neck fractures, none of the digits showed vascular compromise [12].
- In a series of 11 phalangeal neck fractures, one patient also had a tuft fracture of the distal phalanx in the injured digit [12].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, the average age was 26.5 years (range, 14–36 years) [78].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, the dominant hand was involved in 7 patients and the nondominant hand in 3 patients [78].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, the small finger was involved in 3 patients, the index finger in 6, and the middle finger in 2 [78].

CLINICAL ASSESSMENT AND CLASSIFICATION

- Al-Qattan's classification defines Type I phalangeal neck fractures as undisplaced fractures [12].
- Al-Qattan's classification defines Type II phalangeal neck fractures as displaced fractures where the distal fragment maintains some bone-to-bone contact with the proximal fragment [12].
- Al-Qattan's classification defines Type III phalangeal neck fractures as displaced fractures with loss of bone-to-bone contact between the proximal and distal fragments [12].
- Al-Qattan's classification notes that Type III loss of bone-to-bone contact may be due to the original injury or 90 to 180° rotation of the head following fruitless attempts at closed manipulation with rapid longitudinal traction [12].
- Accurate clinical examination is essential, in particular checking for rotation of the finger [43].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, radiographically all avulsion fractures involved the articular surface and were displaced and/or rotated [78].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, the avulsion fractures involved between 20% and 40% of the proximal phalanx articular surface [78].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, ulnar and radial collateral ligament instability was assessed with the metacarpophalangeal joint at 0° extension and at 90° flexion [78].
- In a series of 10 patients with avulsion fractures of the proximal phalanx, the collateral ligament was deemed incompetent if a firm end point was lacking or when a greater than 30° increase in angulation was present compared with the uninjured contralateral digit [78].

- In a series of 11 phalangeal neck fractures, the degree of displacement of the distal fragment was graded as Type I in 1 patient, Type II in nine patients, and Type III in one patient [12].

PATHOPHYSIOLOGY AND COMPLICATIONS

- Two major causes of PIP joint extensor lag are soft tissue adhesions and persistent skeletal deformity [22].
- Fracture hematoma permeates the zone of injury and incites a proliferative fibroblastic response of the multiple surrounding collagenous structures that is proportionate to injury severity [22].
- Scar tissue tends to involve all of the structures within the zone of injury, described as "one wound–one scar" [22].
- The resulting scar tends to produce adherence between the bone and the adjacent tendons, joint capsule, and ligaments, especially when the tendons remain dormant during fracture healing [22].
- Adhesions formed between the extensor mechanism and the fracture may result in loss of extensor glide [22].
- Simple fractures caused by low-energy injuries occasionally may be complicated by some measure of permanent stiffness as a result of this process [22].
- When adjacent flexor or extensor tendon injury accompanies a proximal phalangeal fracture, the difficulty of treatment and achieving a favorable outcome may be compounded substantially [22].
- Surgical treatment requires a second "planned injury," superimposing further soft tissue injury and increasing the risk of soft tissue adhesions [22].
- The intrinsic muscles flex the proximal fragment, whereas the distal fragment is extended by the attachment of the central slip to the dorsal lip of the middle phalanx [22].
- The axis of rotation of proximal phalangeal fractures lies on the fibro-osseous border of the flexor tendon sheath [22].
- The moment arm from the rotational axis of the fracture site to the extensor tendon is greater than that bet [22].
- Less than one half of distal phalangeal fractures will have united by then [4, 5].
- The incidence of nonunion of the metacarpals and phalanges is low [33].
- Barton noted a 0.7% incidence of nonunion in 148 fractures of the phalangeal shaft [33].
- Borgeskov found a 0.2% incidence among 485 phalangeal and metacarpal nonunions [33].
- Open fractures may require a longer healing time [33].
- Smith and Rider noted radiographic signs of bone healing 5 months after the phalanges had fractured, while clinical union occurred in 5 weeks [33].
- Approximately 50% of the fractures in the series by Smith and Rider were chip or avulsion fractures [33].
- Smith and Rider concluded that nonunion could not be diagnosed for at least 1 year after injury [33].
- Others have also recommended a minimum 12 months after injury before classifying a phalangeal fracture as a nonunion [33].

- Müller and Allgöwer and Segmüller have demonstrated successful union of 'reactive' types of nonunions by applying fixation appliances without disturbing the nonunion site or providing additional bone grafts [33].
- In the series by the authors of [33], ununited fractures were operated on as soon as 4 months after injury to obtain union because additional immobilization causes serious joint stiffness [33].
- The classification of Weber and Čech has proved useful in the analysis of the phalangeal and metacarpal nonunions in the series by the authors of [33] [33].
- Similar radiographic and clinical manifestations to those present in larger bones were found in the nonunions and delayed unions of these smaller tubular bones [33].
- Radionuclide scanning is helpful in determining the biologic reactivity of nonunion [33].
- For a well-aligned stable nonunion, the surgeon should avoid disrupting the fibrous junction and thereby risk destabilizing the bone before applying the inte [33].
- Pain in the post-operative week predicts pain and hand use twelve weeks after proximal phalangeal fracture fixation [21].

Investigations

- Accurate clinical examination is essential for phalangeal fractures, particularly to check for rotation of the finger [43].
- A careful physical examination is essential to direct care and future testing if indicated [45].
- Diagnostic tests such as imaging and serum laboratory studies are useful in determining pathology but can be expensive, time consuming, and often nonspecific [45].
- Surgical exploration is recommended for locked metacarpophalangeal joints due to chronic fracture fragment incarceration because it is difficult to ascertain the definitive cause of locking preoperatively using radiographic examination [93].

Treatment

OPERATIVE TECHNIQUES: SCREW AND PLATE FIXATION

- Stable internal fixation using 1.5 mm and 2mm screws has a definite place in the treatment of oblique fractures of the condyles, shafts, and base of the proximal and middle phalanges [19].
- Open reduction and internal fixation using two 1.5-mm interfragmentary screws oriented in a dorsal to volar direction resulted in anatomic restoration of the articular surfaces and satisfactory functional results for triplane fractures of the head of the proximal phalanx [92].
- The use of a Herbert screw is recommended for the reduction and stabilization of unstable fractures of the distal phalanx [90].
- In the proximal phalanx, the immediate vicinity of the flexor tendon to the volar corticalis gives low tolerance to a protruding screw [44].

- There is preliminary evidence favouring the use of extensor sparing approaches when fixing proximal phalanxes, a result that requires validation with randomised controlled trials [25].
- An adipofascial flap is an ideal surgical alternative to bone fixation alone when treating multifragment fractures of the proximal phalanges [53].

OPERATIVE TECHNIQUES: INTRAMEDULLARY AND WIRE FIXATION

- The procedure of intramedullary fixation of unstable hand fractures has advantages over techniques using plates or Kirshner wires [31].
- Excellent stability in the longitudinal and rotational planes is obtained with intramedullary Herbert screws, providing a substantial advantage over other techniques for nonunions at the mid-third of the phalanges [27].
- The ECMES (embrochage centromédullaire élastique stable) appears perfectly suitable for bone fixation of the diaphysis of bones of the hand and certain metaphyseal and epiphyseal fractures [58].
- Tension band wiring results for proximal phalangeal fractures were universally satisfactory, though less good outcomes occurred for some middle phalangeal fractures due to loss of extension of the proximal and interphalangeal distal joints [6].
- Percutaneous fixation of hand fractures using locked K-wires has been reported to result in a shorter time in recovery of function compared to free K-wires pinning in association with postoperative immobilization [29].

OPERATIVE TECHNIQUES: EXTERNAL FIXATION AND DYNAMIC TRACTION

- A novel wire external fixation technique is particularly useful in comminuted pilon-type fractures of the base of the proximal phalanx, especially with associated open wounds [36].
- Bony union was achieved in all patients treated with a dynamic external fixation device for fractures of the base of the middle phalanx, with no late collapses of the fractures despite relatively short periods of fixation [37].
- Intra-articular fractures of the proximal and middle phalanx can cause great patient morbidity if managed poorly, for which an alternative technique for external fixation is described [9].

OPERATIVE TECHNIQUES: MALLET FRACTURES

- Union was achieved in all cases in a consecutive series of nine mallet fractures treated with a hook plate [20].
- The “umbrella handle” technique for percutaneous fixation of mallet fractures is intended for use in Types 1 and 2, subtypes B and C, specifically for cases with a dorsal bony fragment of size between one-third and two-third of the articular surface of the distal phalanx [34].
- A new technique for open reduction of the mallet finger has been introduced [26].

OPERATIVE TECHNIQUES: MALUNION AND NONUNION CORRECTION

- Correction of rotational deformity via rotational step-cut osteotomy was rated satisfactory in all patients, with a trend for increased range of motion of the metacarpalphalangeal (MP) and proximal interphalangeal (PIP) joints [39].
- Good results obtained with a strong and precise grip of the fingers favour a metacarpal rotational osteotomy against a more delicate and difficult rotational osteotomy of the malunited phalanx for correcting overlapping of fingers due to malunion [30].
- Late and nonoperative treatment of intra-articular impaction fractures of the phalanges is uniformly less successful at restoring motion, although surgery improved results over nonoperative treatment and hand therapy alone in a small group of late patients [15].
- The Ikuta's phalangeal compression-distraction-fixation device facilitated bone lengthening, defect filling with bone graft, and stable fixation for phalangeal reconstruction [42].

NON-OPERATIVE MANAGEMENT AND REHABILITATION

- Closed displaced shaft fractures of the proximal phalanx frequently can be successfully treated without a surgical assault [28].
- Less than one half of distal phalangeal fractures will have united by the time of assessment referenced in the study [4, 5].
- Proximal phalangeal fractures and comminuted fractures did worst in a prospective study of open digital fractures, and associated significant soft tissue injuries had a particularly deleterious effect on the outcome [8].
- All five children with proximal phalangeal neck fractures with 180° rotational deformity achieved a full functional recovery of the finger with clinical and radiological union at 4 weeks [13].
- All patients undergoing percutaneous reduction of incipient malunion of phalangeal neck fractures in children had restoration of full passive PIP flexion during surgery equivalent to the same digit on the contralateral hand [41].
- There are two major causes of PIP joint extensor lag following proximal phalangeal fractures: soft tissue adhesions and persistent skeletal deformity [22].
- Surgical treatment of proximal phalangeal fractures requires a second "planned injury," superimposing further soft tissue injury and increasing the risk of soft tissue adhesions [22].
- Some stable closed metacarpal and phalangeal fractures could be allowed immediate active motion safely [23].
- Early mobilization of stable hand fractures is defined as beginning after the initial apprehension and pain disappear, usually towards the third day [23].
- There is no justification for immobilizing less stable hand fractures longer than 3 weeks [23].
- Functional outcomes are not likely to be affected until immobilization of the healing proximal phalanx fracture extends beyond 4 weeks [23].

Complications

- Proximal phalangeal fractures and comminuted fractures had the worst outcomes, and associated significant soft tissue injuries had a particularly deleterious effect on the outcome [8].
- The incidence of nonunion of the metacarpals and phalanges is low, with Barton noting a 0.7% incidence in 148 fractures of the phalangeal shaft [33].
- Open fractures may require a longer healing time than closed fractures [33].
- Nonunion of phalangeal fractures could not be diagnosed for at least 1 year after injury according to Smith and Rider [33].
- Others have recommended a minimum 12 months after injury before classifying a phalangeal fracture as a nonunion [33].
- Additional immobilization causes serious joint stiffness, which was observed in the series where ununited fractures were operated on as soon as 4 months after injury [33].
- The epiphysis did not revascularise enough to prevent structural collapse, but resorption of the ulnar condyle of the middle phalanx contributed to the angular deformity [59].
- Loss of extension of the proximal and interphalangeal distal joints occurred for some middle phalangeal fractures treated with tension band wiring [6].

Recovery

FUNCTIONAL OUTCOMES AND COMPLICATIONS

- Surgical corrections of phalangeal malunion have evolved into safe and rewarding procedures [2].
- Proximal phalangeal fractures and comminuted fractures had the worst outcomes in a study of open digital fractures [8].
- All five children with proximal phalangeal neck fractures with 180° rotational deformity achieved full functional recovery of the finger [13].
- Clinical and radiological union was achieved at 4 weeks in all five children with proximal phalangeal neck fractures with 180° rotational deformity [13].
- Late and nonoperative treatment of intra-articular impaction fractures of the phalanges is uniformly less successful at restoring motion [15].
- Surgery improved results over nonoperative treatment and hand therapy alone for late-presenting intra-articular impaction fractures of the phalanges [15].
- Bony union was achieved in all patients with fractures of the base of the middle phalanx treated by a dynamic external fixation device [37].
- There were no late collapses of fractures in patients treated with a dynamic external fixation device for base of the middle phalanx fractures [37].
- The bony union rate for hand fractures fixed with bicortical screws was 100% (37 of 37) [57].

- The complication rate for hand fractures fixed with bicortical screws was 6% (2 of 37) [57].
- The treatment failure rate for hand fractures fixed with bicortical screws was 0 (0 of 37) [57].
- All patients treated with nail hooks and elastic bands external dynamic traction for fractures of the proximal interphalangeal joint were able to return to their preinjury level of functioning [87].

REHABILITATION AND MOBILIZATION

- Two major causes of PIP joint extensor lag following proximal phalangeal fractures are soft tissue adhesions and persistent skeletal deformity [22].
- Fracture hematoma permeates the zone of injury and incites a proliferative fibroblastic response proportionate to injury severity [22].
- Scar tissue tends to involve all structures within the zone of injury, described as "one wound–one scar" [22].
- Simple fractures caused by low-energy injuries may be complicated by permanent stiffness due to soft tissue scarring [22].
- The difficulty of treatment and achieving a favorable outcome is compounded substantially when adjacent flexor or extensor tendon injury accompanies a proximal phalangeal fracture [22].
- The stability of the fracture largely dictates the type of immobilization required [23].
- Functional outcomes were not likely to be affected until immobilization of the healing proximal phalanx fracture extended beyond 4 weeks [23].
- The special issue on hand fracture management addresses ensuring that soft tissue stresses do not jeopardize fracture stability and that methods to achieve stability do not cause undue harm to soft tissues [55].
- Fracture bracing for proximal phalanx fractures results in patients having greater range of motion once the fracture is healed [80].
- Fracture bracing for proximal phalanx fractures reduces the length of later rehabilitation [80].

SPECIFIC RECOVERY METRICS AND PREDICTORS

- Of the 66 participants in the original trial, 48 patients who completed measurements at both Week 1 and Week 12 were included in the study on pain prediction [21].
- The mean age of the group in the pain prediction study was 35 years (SD 11) [21].
- 75% of the participants in the pain prediction study were male [21].
- 52% of the proximal phalangeal fractures in the pain prediction study were little fingers [21].
- 40% of the proximal phalangeal fractures in the pain prediction study were intra-articular to either the metacarpophalangeal or proximal interphalangeal joints [21].
- 46% of the proximal phalangeal fractures in the pain prediction study were in the dominant hand [21].
- Percutaneous fixation of hand fractures using locked K-wires resulted in a shorter time in recovery of function compared to free K-wires pinning with postoperative immobilization [29].

- Remodelling of a displaced phalangeal neck fracture can result in the return to a normal range of motion [35].
- Remodelling of a displaced phalangeal neck fracture can obviate the need for surgical correction that may be required in the treatment of phalangeal neck malunion [35].

Key Evidence

- [L4] The authors suggest using screw fixation to achieve patient satisfaction and optimal functional recovery of closed, isolated proximal phalanx fractures of the long fingers. [1] (10.1016/j.hansur.2016.08.009)
- [L4] Surgical corrections of phalangeal malunion have evolved to safe and rewarding procedures. [2] (10.1097/00130911-199809000-00003)
- [L4] The study retrospectively evaluated the clinical results and complications of 72 patients with metacarpal and phalangeal fractures treated with low-profile plates. [3] (10.1177/1558944716660555df)
- [L3] Less than one half of distal phalangeal fractures will have united by then. [4] (10.1016/0266-7681_88_90111-8)
- [L3] Less than one half of distal phalangeal fractures will have united by then. [5] (10.1016/0266-7681(88)90111-8)
- [L4] The results for proximal phalangeal fractures were universally satisfactory, though less good outcomes occurred for some of the middle phalangeal fractures due to loss of extension of the proximal and interphalangeal distal joints. [6] (10.1016/j.jhsb.2003.10.013)
- [L3] Age related differences in demographics, morphology, treatment and outcome were investigated in 701 fractures of the metacarpals or phalanges, including fracture-dislocations, in 655 patients. [7] (10.1016/j.jhse.2007.06.017)
- [L3] Proximal phalangeal fractures and comminuted fractures did worst and associated significant soft tissue injuries had a particularly deleterious effect on the outcome. [8] (10.1016/0266-7681(91)90162-h)
- [L4] Intra-articular fractures of the proximal and middle phalanx can cause great patient morbidity if managed poorly. [9] (10.1097/bth.0000000000000102)
- [L4] Dorsal plating with unicortical angular stable screws is suitable for proximal phalangeal fractures. [10] (10.1177/1558944716660555db)
- [L5] The commonly used plates and screws for fracture fixation of the hand may not be suitable in size for groups of people with smaller hand sizes, in particular some Asians and women. [11] (10.1016/s0363-5023(98)80102-0)
- [L4] [12] (10.1016/j.jhsb.2006.06.005)
- [L4] All five children achieved a full functional recovery of the finger with clinical and radiological union at 4 weeks. [13] (10.1016/s0266-7681(05)80093-2)
- [L4] The study demonstrates that open surgical reduction of phalangeal neck fractures leads to phalangeal head osteonecrosis and poor functional results. [14] (10.1016/j.main.2003.09.010)

- [L4] Late and nonoperative treatment of these injuries is uniformly less successful at restoring motion, although it appears from our small group of late patients that surgery improved results over nonoperative treatment and hand therapy alone. [15] (10.1016/s0363-5023(05)80035-8)
- [L4] Better results emerge from the use of A.O. screws than of Kirschner wires for closed fractures of the proximal phalanges and metacarpals. [16] (10.1016/0266-7681_86_90027-6)
- [L4] Better results emerge from the use of A.O. screws than of Kirschner wires for closed fractures of the proximal phalanges and metacarpals. [17] (10.1016/0266-7681(86)90027-6)
- [L4] Flexible intramedullary rodding of specific proximal phalangeal fractures provides excellent results with a low complication rate. [18] (10.1016/s0363-5023(05)80436-8)
- [L4] We conclude that stable internal fixation using 1.5 mm and 2mm screws has a definite place in treatment of oblique fractures of the condyles, shafts and base of the proximal and middle phalanges. [19] (10.1016/0266-7681(87)90049-0)
- [L4] In a consecutive series of nine fractures, union was achieved in all cases. [20] (10.1016/j.jhsb.2006.09.007)
- [L3] [21] (10.1142/s2424835519500607)
- [Paper] [22] (10.1016/s0894-1130(03)80008-x)
- [L5] [23] (10.1016/s0894-1130(03)80011-x)
- [L5] The authors recommend the use of this technique if the need arises for fixation of sagittally split distal phalanges. [24] (10.1177/1753193415613983)
- [L1] This study demonstrates that there is preliminary evidence favouring the use of extensor sparing approaches when fixing proximal phalanxes – however, this result requires validation with randomised controlled trials. [25] (10.1142/s2424835520500514)
- [L4] A new technique for open reduction of the mallet finger is introduced. [26] (10.1097/00130911-199809000-00009)
- [L4] Excellent stability in the longitudinal and rotational planes is obtained with this technique, which provides a substantial advantage over other techniques for nonunions at the mid-third of the phalanges. [27] (10.1097/00130911-199703000-00008)
- [L5] Closed displaced shaft fractures of the proximal phalanx frequently can be successfully treated without a surgical assault. [28] (10.1016/s0363-5023(85)80089-7)
- [L4] We have reported a shorter time in recovery of function in comparison with our previous experience with free K-wires pinning in association with postoperative immobilization of the hand. [29] (10.1097/bth.0b013e31828afc48)
- [L4] The good results obtained, with a strong and precise grip of the fingers, favour such an operation against a more delicate and difficult rotational osteotomy of the malunited phalanx. [30] (10.1016/s0266-7681_85_80070-x)
- [L4] The procedure of intramedullary fixation of unstable hand fractures has advantages over techniques using plates or Kirshner wires. [31] (10.1016/s0363-5023(81)80134-7)
- [L4] [32] (10.1016/0266-7681(92)90123-j)

- [L4] [33] (10.1016/s0363-5023(85)80066-6)
- [L4] [34] (10.1016/j.jhsb.2006.04.014)
- [L5] This remodelling can result in the return to a normal range of motion and obviate the need for surgical correction that may be required in the treatment of phalangeal neck malunion. [35] (10.1016/0266-7681(94)90122-8)
- [L5] The novel method is particularly useful in comminuted pilon-type fractures of the base of the proximal phalanx, especially with associated open wounds. [36] (10.1097/bth.0b013e31820a02aa)
- [L4] Bony union was achieved in all patients and despite the relatively short periods of fixation there were no late collapses of the fractures. [37] (10.1016/s0266-7681(05)80190-1)
- [L4] Correction of rotational deformity was rated satisfactory in all patients, with a trend for increased range of motion of the metacarpalphalangeal (MP) and proximal interphalangeal (PIP) joints. [39] (10.1016/0363-5023(91)90031-6)
- [L4] All patients had restoration of full passive PIP flexion during surgery equivalent to the same digit on the contralateral hand. [41] (10.1016/j.jhsa.2004.03.007)
- [L4] In the reported cases, the device facilitated bone lengthening, defect filling with bone graft, and stable fixation for phalangeal reconstruction. [42] (10.1016/s0363-5023(88)80087-x)
- [L5] Accurate clinical examination is essential, in particular checking for rotation of the finger. [43] (10.1016/s0266-7681(98)80103-4)
- [L4] In the proximal phalanx, the immediate vicinity of the flexor tendon to the volar corticalis gives low tolerance to a protruding screw. [44] (10.1016/s0363-5023(03)80400-8)
- [L5] The ease of harvesting and performing the adipofascial flap (AFF) makes this flap an ideal surgical alternative to bone fixation alone when treating multifragment fractures of the proximal phalanges. [53] (10.1016/j.main.2014.12.005)
- [L5] The special issue on hand fracture management addresses both sides of the equation necessary for successful fracture rehabilitation, ensuring that soft tissue stresses do not jeopardize fracture stability and that methods to achieve stability do not cause undue harm to soft tissues. [55] (10.1016/s0894-1130(03)80002-9)
- [L4] Our bony union rate of 100% (37 of 37) compared favorably with historic controls of 92%; our 6% complication rate (2 of 37) compared favorably with historic ranges of 10%; and our treatment failure rate of 0 (0 of 37) compared favorably with historic controls of 8%. [57] (10.1016/j.jhsa.2004.07.016)
- [L4] The ECMES appears perfectly suitable for bone fixation of the diaphysis of bones of the hand and certain metaphyseal and epiphyseal fractures. [58] (10.1016/s1297-3203(02)00106-3)
- [L5] The epiphysis did not revascularise enough to prevent structural collapse, but resorption of the ulnar condyle of the middle phalanx contributed to the angular deformity. [59] (10.1016/0266-7681_90_90069-g)
- [L4] [78] (10.1053/jhsu.2001.24149)

- [L5] We have found this treatment approach to be successful in that patients have greater range of motion once the fracture is healed, therefore reducing the length of later rehabilitation. [80] (10.1016/s0894-1130(96)80050-0)
- [L4] All patients were able to return to their preinjury level of functioning. [87] (10.1097/bth.0b013e31825bd4da)
- [L5] We recommend the use of the Herbert screw for the reduction and stabilization of unstable fractures of the distal phalanx. [90] (10.1016/s0363-5023(88)80024-8)
- [L4] Open reduction and internal fixation using two 1.5-mm interfragmentary screws oriented in a dorsal to volar direction resulted in anatomic restoration of the articular surfaces and satisfactory functional results. [92] (10.1053/jhsu.1999.1263)
- [L5] Surgical exploration is recommended in such cases because it is difficult to ascertain the definitive cause of locking preoperatively using radiographic examination. [93] (10.1142/s2424835518720396)

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