Ten-year Results Using a Dynamic Treatment for Proximal Phalangeal Fractures of the Hands

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Abstract

Fractures of the proximal phalanges of the hands can be treated by many methods. With surgical intervention, a loss in proximal interphalangeal joint movement is common. Using the stabilizing effect of the zancolli complex-metacarpophalangeal retention apparatus and an external device such as a thermoplastic metacarpophalangeal block splint, proximal phalangeal fractures can be stabilized in terms of axis, length, and rotation.

This study reports the authors’ 10-year results managing these fractures with dynamic treatment. All patients with closed fractures of the proximal phalanges admitted to Queen Mary Hospital, Hong Kong, China, between July 2000 and June 2010 were analyzed. Fractures with rotational deformities or displaced intra-articular configurations were excluded. A dynamic splint that kept the metacarpophalangeal joint maximally flexed while allowing free movement of the proximal and distal interphalangeal joints of the injured finger was applied for at least 4 weeks. Results were evaluated using the Belsky classification and grip strength assessment. The results of 97 patients (103 fractures) were analyzed. At a minimum 1-year follow-up, 75% of patients attained excellent or good results. Neither nonunion nor delayed fracture union was noted. The 25% of patients who attained poor results were older than those who attained excellent or good results (average age, 53.1 vs 35.1 years, respectively) and tended to comply poorly with the rehabilitation program. Using the stabilizing effect of the zancolli complex-metacarpophalangeal retention apparatus and a metacarpophalangeal block splint, bone healing and movement recovery can be achieved simultaneously.

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Although fractures of the proximal phalanges of the hand have been managed by hand surgeons for decades, a lack of consensus exists on the treatment of these fractures.1-3 This especially applies to a group of fractures that is not inherently stable in configuration (ie, oblique, spiral, and comminuted fractures) where immediate unrestricted mobilization cannot be allowed. Although static immobilization (splints and casts)4 and surgical intervention are alternate options for the management of these fractures,4-7 studies show that they both have weaknesses.8,9 Any type of prolonged immobilization could lead to adherence of the tendon to bone, causing stiffness of the fingers.10 Even if one allowed unlimited mobilization after surgical intervention, the secondary unavoidable injury to the soft tissue, caused by surgery itself, may lead to soft tissue adhesion.10

Numerous studies have revealed good results using dynamic treatment for the management of proximal phalangeal fractures, either alone or with surgical intervention.11-13 Using the zancolli complex-metacarpophalangeal (MCP) retention apparatus (Figure 1),14 together with a thermoplastic splint blocking the MCP joint in 90° flexion while freeing the movement of proximal and distal interphalangeal joints, proximal phalangeal fractures can be stabilized in terms of axis, length, and rotation. However, these studies involved a small number of patients and included proximal phalangeal fractures in variable locations, configurations, and soft tissue status, and it is difficult to conclude that the splint played a significant role in any specific type of proximal phalangeal fracture.

In general, the zancolli complex-MCP retention apparatus embraces the proximal part of the proximal phalanges and shifts distally with the MCP joint in a flexed position up to the proximal two-thirds of the proximal phalanges.14 Thus, the current authors hypothesized that dynamic treatment would be most beneficial to proximal phalangeal fractures involving the proximal shaft and base. The purpose of this study was to review the authors’ 10-year results using dynamic treatment for the management of basal proximal phalangeal fractures.

MATERIALS AND METHODS

All skeletally mature patients with acute (less than 1 week), nonpathological, closed basal proximal phalangeal fractures of the hands who were admitted to Queen Mary Hospital, Hong Kong, China, between July 2000 and June 2010 were reviewed (Figure 2).

Ninety-seven patients (103 proximal phalangeal fractures) underwent dynamic treatment. Sixty-nine patients were men and 28 were women. Average patient age was 41.2 years (range, 15-77 years). Thirty-four patients had fractures in their dominant hand. Five patients had more than 1 fracture, and 1 patient had 3 fractures in the same hand. Thirteen index fingers, 7 middle fingers, 24 ring fingers, and 59 little fingers were studied. Thus, 80% of patients had either their little fingers or ring fingers injured. Patients were followed up for a minimum of 1 year, when their rehabilitation reached plateau.

Closed reduction was performed under local digital block for all displaced fractures to improve bone alignment. Open reduction and internal fixation was performed for fractures with persistent rotational deformities or with persistent displaced intra-articular fragments (ie, more than 2 mm of displacement) after closed reduction; these patients were excluded from the study. Fractures with associated injuries, including tendon ruptures or collateral tears, were also excluded.

The remaining patients were given a dynamic thermoplastic splint to wear. The splint allowed free movement of the proximal and distal interphalangeal joints of the injured finger while keeping the MCP joint in a flexed position (Figure 3). The splint was initially molded in a position that kept the MCP joint maximally flexed. It was then adjusted during subsequent visits when swelling and pain subsided to keep the MCP joint at 90°. The splint was worn for at least 4 weeks. Over the entire rehabilitation period, each patient was managed by a team of dedicated physiotherapists and occupational therapists (R.K.Y.C.) in an outpatient setting. The institution’s supervised rehabilitation program was strictly followed to gain full range of motion (ROM) of the proximal interphalangeal joint and to prevent the development of an extension lag contracture.

Clinical results were evaluated by measuring power and pincer grip strength and using the Belsky classification15: excellent (no symptoms, pain-free union, no angular or rotational deformity, proximal interphalangeal joint ROM of more than 100°, total ROM of 215°); good (minimal angular or rotational deformity, proximal interphalangeal joint ROM of more than 80°, total ROM of more than 180°); or poor (presence of angular or rotational deformity, proximal interphalangeal joint ROM equal to or less than 80°, total ROM equal to or less than 180°). Radiographs were obtained regularly until fracture healing.

RESULTS

Based on the Belsky classification, 75% of the patients attained excellent (n = 30) or

Figure 1: Photographs of cadaveric dissection showing the zancolli complex-metacarpophalangeal retention apparatus (A) and its distal shifting up to the proximal two-thirds of the proximal phalanges (B). (Reprinted with permission from Vishy Mahadevan, MBBS, PhD, FRCS(Ed), FRCS, on behalf of the trustees of the Royal College of Surgeons of England.)
good (n=45) results (Figure 4). No conversion to surgical treatment was noted. Neither nonunion nor delayed union was noted. No complications occurred. Average power grip was 85%±12.8% and average pincer grip was 80%±17.7% compared with the uninjured side.

Sixty percent of patients had their injuries to their nondominant hand, but no significant difference existed in terms of functional outcomes. The recovery rate between men and women was not significantly different. Average rate of return to work was 13 weeks (range, 1-32 weeks), depending on the nature of the patient’s occupation.

The 25% of patients who attained poor results based on the Belsky classification were older than those who attained excellent or good results (average age, 53.1 vs 35.1 years, respectively), but the difference was not significant. They tended to have poor compliance with the rehabilitation program and often missed the outpatient therapy sessions. Nevertheless, no significant difference existed in terms of power grip (average, 80.9%), pincer grip (average, 81%), and rate of return to work (average, 12 weeks) compared with patients who attained excellent or good results.

**DISCUSSION**

Fractures of the proximal phalanges of the hand remain a difficult entity to manage.⁶,¹² Due to the close proximity of the soft tissue and bone, any injury to the bone will affect the surrounding soft tissue. It has been observed that after prolonged immobilization of a finger, a scar will form at the injury zone,¹⁶ leading to adherence of tendons, joint capsules, and ligaments to adjacent bone.¹⁰ As a result, stiffness of the finger is observed.

It is well known that permitting early mobilization of the hand after fixation is particularly beneficial to functional outcome because tendon gliding and joint mobility are crucial to a well-functioning hand.¹⁶ However, the time frame of early mobilization is not defined. For the group of fractures with inherently unstable configuration (ie, oblique, spiral, and comminuted fractures) but with no significant rotational deformity, many different treatments have been advocated.¹,²,¹⁶ Static mobilization was described by Sankar et al,³ who stated that a short period (ie, 3-5 weeks) of finger immobilization in proximal phalangeal fractures could lead to pain relief and patient satisfaction. This observation was supported by Strickland et al,²⁰ who noted that functional outcomes were unlikely to be affected until immobilization of the healing proximal

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Figure 2: Workflow of treatment. Abbreviations: CR, closed reduction; FU, follow-up; max, maximum; MCP, metacarpophalangeal; MCPJ, metacarpophalangeal joint; ORIF, open reduction and internal fixation.

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Figure 3: Photographs of a thermoplastic metacarpophalangeal extension block splint (A), the splint blocking the metacarpophalangeal joint from extension while allowing proximal and distal interphalangeal joint movement (B), and the splint allowing full flexion of the proximal and distal interphalangeal joints (C).
phalangeal fracture extended beyond 4 weeks. A decrease in function to 66% of normal total active ROM was observed only after a 4-week immobilization period. However, this scenario is not universally observed.

Many surgeons advocate surgical intervention with wires, screws, or plates to allow for early mobilization of fingers postoperatively. However, each of these methods has its drawbacks. It has been reported that any surgical intervention may act as a second “planned” insult to the injury zone, causing further adherence of tendinous phalangeal structures to the implants and bone. Using plate fixation for 64 phalangeal fractures with unstable or comminuted configurations, Kurzen et al reported a 52% complication rate, including total ROM less than 180°, complex regional pain syndrome, infection, delayed/nonunion, and implant failure. When phalangeal fractures were treated with plate fixation, Page and Stem reported a 64% complication rate, including extensor lag greater than 35°, active ROM less than 180°, flexion contracture greater than 35°, nonunion, plate prominence requiring further surgery for removal, deep infection, and tendon rupture. In another study, using smooth pin fixation for hand and wrist fractures led to an 18% complication rate, including infection, pin loosening, and nonunion. The best management of proximal phalangeal fractures is achieving stable, well-aligned fracture reduction without surgical intervention if possible and allowing immediate mobilization of the associated muscles, tendons, and joints to prevent finger stiffness. Use of the zancolli complex-MCP retention apparatus may be the solution for treating a specific group of proximal phalangeal fractures. In 1936, Jahss first described the use of a MCP block splint to treat proximal phalangeal fractures conservatively. Jahss observed that after closed reduction of a proximal phalangeal fracture, the fracture could be held in a reduced position if its MCP joint was being flexed.

The mechanism can be explained thus: with active finger flexion, compression forces are transmitted to the palmar cortex of the phalanx, and distraction occurs over the dorsal cortex. Simultaneously, with the MCP joint blocked in flexion, the zancolli complex-MCP retention apparatus at the midportion of the proximal phalanx will cover approximately two-thirds of the bone’s circumference, thus holding the fracture tightly wrapped, resulting in the creation of a dynamic tension band effect. The proximal phalangeal fracture can be kept in a reduced position with a dorsal plaster splint.

Many authors believe that the described dynamic treatment can be applied to a majority of closed, unstable proximal phalangeal fractures that occur in variable locations (eg, shaft, base, and neck). However, reviewing the anatomy of the proximal phalanges, the current authors believe that this dynamic treatment works best in basal proximal phalangeal fractures. A cadaveric study by Widgerow and Ladas revealed that maximum stability to proximal phalangeal fractures was in the proximal 6- to 9-mm range at the base of the proximal phalanx due to the contribution of the joint capsule, collateral ligaments, accessory collateral ligaments, interosseous muscles, and volar (palmar) plate. The dynamic constraint described by Zancolli implicated up to the proximal two-thirds of the proximal phalanx only. Thus, it is reasonable to postulate that this treatment works best for basal proximal phalangeal fractures.

The current study revealed good clinical outcomes after dynamic treatment of basal proximal phalangeal fractures. Irrespective of all fracture configurations and geometry, if a basal proximal phalangeal fracture can be temporarily reduced with no rotational deformity, this dynamic treatment will help stabilize the fracture. All fractures healed in the current study. Seventy-four percent of fractures attained excellent or good results with respect to pain, ROM (total ROM more than 180° and proximal interphalangeal joint ROM more than 80°), and deformity. Neither loss of reduction nor complications were noted.

Figure 4: Anteroposterior (A) and lateral (B) radiographs before splinting of a left index finger proximal phalangeal fracture in a young man who fell from a bicycle (A). Clinical photographs of the patient 2 months after treatment showing excellent results with extension (C) and flexion (D).
ble configurations, with 91% attaining an extension lag less than 35°. Unfortunately, the definition of unstable configurations was not clarified. Most of their fractures were at the midshaft, and the majority of patients (more than 60%) had short-term follow-up. Belsky et al studied 100 unstable proximal phalangeal fractures, of which only 33 were basal fractures. Although their cohort achieved 90% good or excellent results, all fractures had pin fixation prior to splint application, and 6% experienced pin-site complications. By comparison, no complications occurred in the current study. It is possible that the basal fractures in the Belsky et al study could be treated using the dynamic treatment without pin fixation. Ebinger et al reported excellent results in 48 proximal phalangeal fractures treated with or without surgery; however, only 11 basal proximal phalangeal fractures were included, which attained excellent outcomes with no surgery and physiotherapy. Although their results appeared to be better than those of the current study, their sample size was small, and average patient age in the current study was older.

The group of patients who attained poor results in the current study tended to be older and comply poorly with the rehabilitation program. This result was expected and is comparable with previous studies, which showed that the outcome of phalangeal fractures was adversely affected by factors such as old age, poor motivation, the presence of multiple fractures, significant comminution, and concurrent tendon injury or soft tissue loss at the fracture site.

**CONCLUSION**

Dynamic treatment is a useful tool for the basal proximal phalangeal fractures. Bone healing and movement recovery can be achieved simultaneously. However, to attain the best outcome, a compliant patient adhering to a well-designed rehabilitation program is necessary.

**REFERENCES**


