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*Original Article*

# An alternative technique for treating unstable metacarpal and phalangeal fractures of the hand

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**Abstract:** This study aimed to describe a novel technique for unstable metacarpal and phalangeal fractures of the hand, fixed with a lateral minicondylar plate. A total of 32 metacarpal and phalangeal fractures of the hand, unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, and long oblique/spiral fractures in 25 patients were included in this retrospective study performed from 2008-2019. All fractures were managed by open reduction after fixation with a lateral minicondylar plate. The patients were followed up for an average of 20 weeks after surgery. No infections were recorded. Six weeks after operation, TAM averaged 185°. At the latest follow-up or time of plate removal, mean TAM values were improved to 249° for metacarpal fractures and 243° for proximal phalangeal fractures. Secondary surgery was not necessary, and no evidence of union, nonunion, or malunion was found in any of the patients. Lateral mini-condylar plate fixation is an alternative technique for most unstable metacarpal and phalangeal fractures, unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, and long oblique/spiral fractures with sharp and clean wounds.

**Keywords:** Hand bones, fracture healing, bone plates

## Introduction

Metacarpal and phalangeal fractures are classified based on the anatomical parts of the head, neck, shaft and base of the bones in the hands. Unstable metacarpal and phalangeal fractures, unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, and long oblique/spiral fractures are extremely common. A large number of studies assessing these fractures have been reported. Treatment outcomes after splint immobilization are mostly unsatisfactory, while open reduction and internal fixation result in satisfactory outcomes, with internal fixation of unstable metacarpal and phalangeal fractures using microlocking plates and screws [1-8]. The current concept concerning the management of these injuries is to restore a stable enough bony construct to allow early mobilization, delicate handling of tissues, preservation of gliding planes for tendons, prevention of infection, and early appropriate physiotherapy [2-4, 9-11].

The surfaces of metacarpophalangeal joints (MPJs) and proximal interphalangeal joints (PIPJs) are uneven. Joint or fracture malunion result in rotation or shortening that affects almost all the activities of the hands. Therefore, these fractures usually require open reduction, with the position fixed with a variety of available techniques. At present, the use of microlocking plates and screw fixation through the dorsal hand is accepted by most surgeons. However, these techniques are associated with elevated rate of long-term complications and negatively affect the function of the injured joint. For most surgeons, miniplate placement under the flexor tendons is inappropriate due to the possibility of adhesions and tendon damage. In that case, active range of motion (ROM) at the MPJ and PIPJ is lost with extensor lag when placing a miniplate beneath the extensor tendons. Furthermore, the treatment must be carefully planned and executed, and avoiding tendon damage is very challenging. More importantly, the fractures could be more comminuted than

**Table 1.** Fracture sites and configurations

| Site | | Configuration | Number of fractures (%) |
|---|---|---|---|
| Middle phalanx | Shaft | Oblique/spiral | 1 (3.12) |
| | Neck | Transverse | 1 (3.12) |
| | Base | Comminuted | 1 (3.12) |
| Proximal phalanx | Head | Transverse | 2 (6.25) |
| | With MPJ | Comminuted | 2 (6.25) |
| | Neck | Transverse | 1 (3.12) |
| | Shaft | Oblique/Spiral | 3 (9.37) |
| | Base | Comminuted | 2 (6.25) |
| Metacarpal | Head | Avulsion | 2 (6.25) |
| | with MPJ | Avulsion | 2 (6.25) |
| | Dislocation | Transverse | 2 (6.25) |
| | Neck | Transverse | 4 (12.53) |
| | Shaft | Oblique/Spiral | 6 (18.75) |
| | Base | Comminuted | 3 (9.37) |
| Total | | | 32 (100) |

MPJ, metacarpophalangeal joint.

anticipated. After full exposure of the fracture, the stability conferred by unaltered periosteum and other soft tissues subsides [10]. However, multiple patients still show serious degenerative alterations and might require arthroplasty [1-3].

The technique of fixing metacarpal and phalangeal fractures of the hand using a lateral minicondylar plate was investigated in this study. We found that most unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, and long oblique/spiral fractures can be managed using lateral minicondylar plates.

## Methods

*Patient data*

Between April 2008 and July 2019, 25 patients (15 males and 10 females; aged 37±15 years) with 32 unstable metacarpal and phalangeal fractures, unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, or long oblique/spiral fractures were included in the current study. A questionnaire was used in our study during face-to-face interviews. The ethics committee of the Fifth People's Hospital approved the study (NO: 2008071506). Written informed consent was received from all participants. The injuries were caused by falls, direct blows, and traffic accidents. The right hands were affected in 18 patients (**Table 1**). All fractures were treated using lateral minicondylar plates. Certain fracture patterns, such as displaced transverse, long spiral, short oblique and displaced articular condylar fractures involving above 25% articular surface, were considered to be inherently unstable and indicated surgical treatment was necessary if they met the aforementioned criteria for instability. Open fractures, or those of the thumb base, or patients who were unable to communicate due to dementia, or those refusing to participate were excluded. The current study included 19 metacarpal, 13 phalangeal and 4 intra-articular fractures. The mean time from injury to surgery was 7.6 days (range of 0-40 days). Descriptive analysis was used to determine the degree to which variables affected percent total active motion (%TAM) at the final followup.

*Operative technique*

Unstable metacarpal/phalangeal fractures of the hand were exposed through a direct approach applied to the radial (first, second, and third metacarpals) or ulnar (fourth and fifth metacarpals) borders. The extensor tendon was retracted to the back of the injured finger. Upon exposure, the fractures underwent precise anatomical reduction and were maintained with fine-pointed reduction forceps or small K-wires. This was followed by internal fixation with adequate miniature screws and/or plates. Interfragmentary lag screws were utilized for unstable spiral/long oblique- and displaced intra-articular fractures (2.7 or 2.0-mm and 2.0 or 1.5-mm screws for two metacarpal and phalangeal fractures, respectively). Contoured minicondylar plates were employed in unstable metacarpal or proximal phalangeal transverse/short oblique fractures. Meticulous attention was paid to dissection and internal fixation. Repair of the extensor mechanism used fine Prolene sutures in the proximal phalanx, applying the dorsal extensor splitting approach. A compression dressing was employed, with the limb raised after wound closure.

*Postoperative management*

A plaster splint was used for 48 h after the operation. The plaster splint was then removed, and active ROM exercises were initiated, with

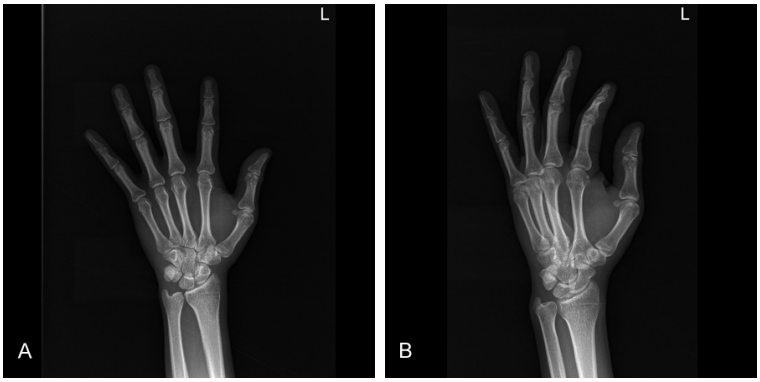


**Figure 1.** Normal X-rays of the left hand.

progressive increases according to pain tolerance under a doctor's supervision. Patient discharge occurred on the fifth postoperative day. Physiotherapy was performed in outpatient facilities after discharge. Clinical and radiological assessments were carried out every 6 weeks. TAM for all digits in the involved hand was measured (excluding the thumb) at 6 weeks postoperatively, and at the latest follow-up or the time of microlocking plate and screw removal. Serial radiographs were acquired for detecting potential loss of reduction and assessing bone healing.

*Functional evaluation*

At the final follow-up visit, TAM was assessed. The active flexion of MPJs, PIPJs, and distal IPJs minus the extension deficit in these joints was used for TAM assessment [5]. Complications such as fracture re-displacement, nonunion, and infection, as well as fracture healing time were recorded. TAM was the total active flexion range of MPJs, PIPJs, and IPJs. The following grading was adopted: good, TAM≥210°; fair, TAM = 210-180°; poor, TAM<180° [4, 6]. Thumb fractures were assessed based on a previous report [12, 13].

## Results

*Lateral mini-condylar plate fixation is an alternative technique for most unstable metacarpal and phalangeal fractures, unicondylar/bicondylar fractures of the head, intra-articular fractures of the base, and long oblique/spiral fractures with sharp and clean wounds*

The functional outcome after fracture treatment was assessed by determining TAM. Recovery was determined as percent-regained motion compared with a normal range of digital motion (260°). The outcome with 85%-100% of movement was classified as excellent, 70%-84% as good, 50%-69% as fair and <50% as poor.

Metacarpal fractures (*n* = 19) had good (*n* = 10, 53%) and fair (*n* = 6, 32%) TAM in 85% of cases, and 77% (good, *n* = 6 or 46%; fair, *n* = 4 or 31%) of phalangeal fractures (*n* = 10) achieved this TAM. A higher TAM was observed with single digit involvement (*n* = 18) compared with fractures involving more than one digits (*n* = 7). The final TAM was not related to the fracture configuration in the digit.

Overall end results of hand fractures in 25 patients managed by surgical stabilization were excellent in 14 (56%) cases, good in 6 (24%), fair in 3 (12%), and poor in 2 (8%). A total of four complications were observed in three of the 25 patients. Finger stiffness (12%) and deformity (4%) were the most commonly observed complications.

Usually, two radiographic views as posteroanterior and oblique views are recommended for the imaging assessment of hand trauma (**Figure 1**). In a case with IPJ (proximal phalangeal fractures), the preoperative postrero-anterior and oblique radiographs showed the distal fourth ring finger with dislocation of the proximal phalangeal fractures (**Figure 2**). The fracture has been fixed with the Lateral mini-condylar plate and the postoperative radiographs showed that the fracture had been healed properly after three months (**Figure 3A** and **3B**). The postoperative postrero-anterior (**Figure 4A**) and oblique (**Figure 4B**) radiograph showed good reductions of the fracture of the fourth metacarpal base fixed with the Lateral mini-condylar plate. After six months, the plate was removed and the postrero-anterior (**Figure 5A**) and oblique (**Figure 5B**) radiographs showed the good healing of the fourth metacarpal base.

## Discussion

A large number of studies have explored unstable metacarpal and phalangeal fractures.


**Figure 2.** A case of preoperative X-rays of the distal fourth ring finger with dislocation of the IPJ (proximal phalangeal fractures).

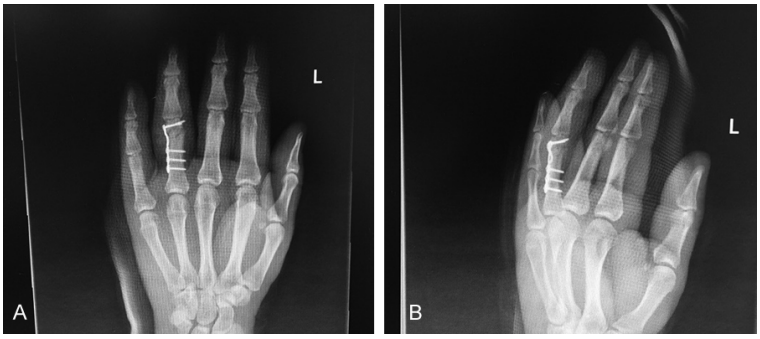


**Figure 3.** A case of postoperative X-rays of the distal fourth ring finger with dislocation of the IPJ (proximal phalangeal fractures).

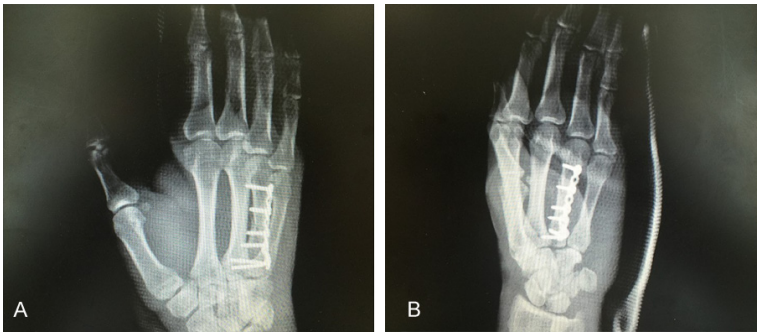


**Figure 4.** A case of postoperative X-rays of the fracture of the fourth metacarpal base.

Axial or reverse loading mechanisms of injury might cause head's unicondylar and bicondylar, base's intra-articular, and long oblique/spiral fractures. The primary objectives of current methods used for treating unstable metacarpal and phalangeal fractures are to restore anatomy, reduce soft tissue damage, and enable movement in the injured digit with fracture stability. Non-operative methods, such as open reduction and internal fixation using K-wires or plates and screws, have reached a consensus that they result in fixation with less rigidity and little rotational stability, usually leading to unsatisfactory results [2-4, 9, 10].

Microlocking plates and screws in unstable metacarpal and phalangeal fractures result in anatomical reduction and stabilization of fractures, which are thought sufficiently rigid to allow early adjacent joint mobilization, to avoid loss of reduction, prevent stiffness, and yield satisfactory functional outcomes [15-21]. However, these techniques show a high rate long-term complications and poor functional outcome. For most surgeons, miniplate placement under the flexor tendons is inappropriate due to the possibility of adhesions and tendon damage. In that case, active ROM at the MPJ and PIPJ is lost with extensor lag when placing a miniplate beneath the extensor tendons. Furthermore, because microlocking plates and screws are fixed through the dorsal hand approach, the treatment must be carefully planned and executed, and avoiding tendon damage is very challenging. More importantly, the fractures could be more comminuted than anticipated. After full exposure of the fracture, the stability conferred by unaltered periosteum and other soft tissues subsides [10]. However, multiple patients still show serious degenerative alterations and might require arthroplasty [1-3].

After review of the current literature, we designed an incision along the extensor tendon of the radial (first, second and third metacarpals) and ulnar (fifth and fourth metacarpals) borders. The extensor tendon was retracted to the back of the injured finger. Upon exposure, the fractures underwent precise anatomical reduction and were maintained with fine-pointed reduc-


**Figure 5.** A case of postoperative X-rays of the fracture of the fourth metacarpal base after removal of the internal fixator.

tion forceps or small K-wires. This was followed by internal fixation with adequate miniature screws and/or plates. Interfragmentary lag screws were utilized for unstable spiral/long oblique- and displaced intra-articular fractures [13, 14]. This enabled mobilization of the injured digit with fracture stability. It also prevented adhesions and tendon irritation. Most importantly, the integrity of the periosteum and other soft tissues was protected to the greatest extent.

In the present study, overall end results of hand fractures in 25 patients managed by surgical stabilization were excellent in 14 (56%) cases, good in 6 (24%), fair in 2 (12%), and poor in 2 (8%). A total of four complications were observed in three of the 25 patients. Finger stiffness (12%) and deformity (4%) were the most commonly observed complications. Secondary surgery was not necessary, and no evidence of union, nonunion or malunion was found in any of the patients.

## Conclusions

Lateral minicondylar plate and screw fixation constitutes an alternative technique for unstable metacarpal and phalangeal fractures of the hand. Most head's unicondylar/bicondylar fractures, base's intra-articular fractures, and long oblique/spiral fractures can be managed using this technique.

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## Disclosure of conflict of interest

None.

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