Orthopaedics & Traumatology: Surgery & Research 105 (2019) 429–433

Contents lists available at ScienceDirect

Orthopaedics & Traumatology: Surgery & Research

journal homepage: www.elsevier.com

Technical note

Mini hook plate fixation for thumb ulnar collateral ligament avulsion fracture: A technical report

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ARTICLE INFO

Article history:
Received 25 July 2018
Accepted 8 January 2019

Keywords:
Ulnar collateral ligament injury
Avulsion fracture
Internal fixation
Hook plate

ABSTRACT

Ulnar collateral ligament (UCL) injuries of the thumb sometimes occur with avulsion fracture. Avulsion fractures generally require open reduction and internal fixation to restore stability of the metacarpophalangeal (MP) joint of the thumb. Although several surgical techniques have been reported, UCL avulsion fractures are still challenging hand injuries to treat and to obtain stable fixation that allows early finger motion because of small size of fragment. This report describes two cases of thumb UCL avulsion fractures that were successfully treated with two-hole mini hook plates by adapting 1.5-mm variable angle locking hand plates. This method allowed for early postoperative rehabilitation and provided stability of the thumb MP joint and satisfactory clinical outcomes. Altogether, hook plate fixation could be an alternative technique for thumb UCL avulsion fracture.

1. Introduction

Ulnar collateral ligament (UCL) injuries of the thumb sometimes occur in cases of avulsion fracture of the proximal phalanx in approximately 20–30% of cases [1]. Undisplaced fractures without instability of the metacarpophalangeal (MP) joint can be managed conservatively by cast or splint immobilization, while displaced fractures generally require open reduction and internal fixation in order to restore stability of the MP joint of the thumb [1,2]. Although several operative methods, including pinning with Kirschner wires (K-wire), tension band wiring, mini screw fixation, and suture anchor fixation, have been reported, it is challenging to obtain stable fixation allowing early finger motion due to the small size of fragment [1–4]. Here, we present two cases of thumb UCL avulsion fractures that were successfully treated by the hook plate fixation technique and achieved rigid fixation of the small fragment and early rehabilitation.

2. Case presentation

2.1. Case 1

A 22-year-old man twisted his right thumb on a steering wheel during a motor accident and came to our hospital. Radiographs revealed a displaced UCL avulsion fracture of the thumb proximal phalanx; the size of the bone fragment was 3 × 4 mm rotating 30° (Fig. 1A and B). The displaced fragment was treated by open reduction and internal fixation via an ulnar lateral approach. The bone fragment with UCL was too small to achieve rigid fixation with K-wires or a mini screw. A two-hole mini hook plate was made by adapting a 1.5-mm locking plate (VA locking T-plate 1.5, Variable Angle Locking Hand System, DePuy Synthes), and bending it to fit along the ulnar side of the proximal phalanx (Fig. 2A and B). After reduction and temporary fixation of the fragment with a 0.7-mm K-wire, the bone fragment was lifted with a mini hook plate. Subsequently, a cortical screw was inserted to the proximal hole, which provided a buttress effect for the fragment; a locking screw was inserted to the distal hole to provide reliable fixation of the fracture (Fig. 2C and D). Despite the small size of the bone fragment, rigid fixation was achieved. The patient started early active motion of the operated thumb and wore a removable splint for 4 weeks. A total of 2 months after the surgery, bone union was achieved, and the patient returned to daily life without restriction. Six months after surgery, the patient had mild stiffness of the

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https://doi.org/10.1016/j.otsr.2019.01.008
1877-0568/

Fig. 1. A and B. Posteroanterior and lateral view radiographs of the right thumb of *Case 1*, showing displaced bone fragment of the proximal phalanx with the UCL attached.

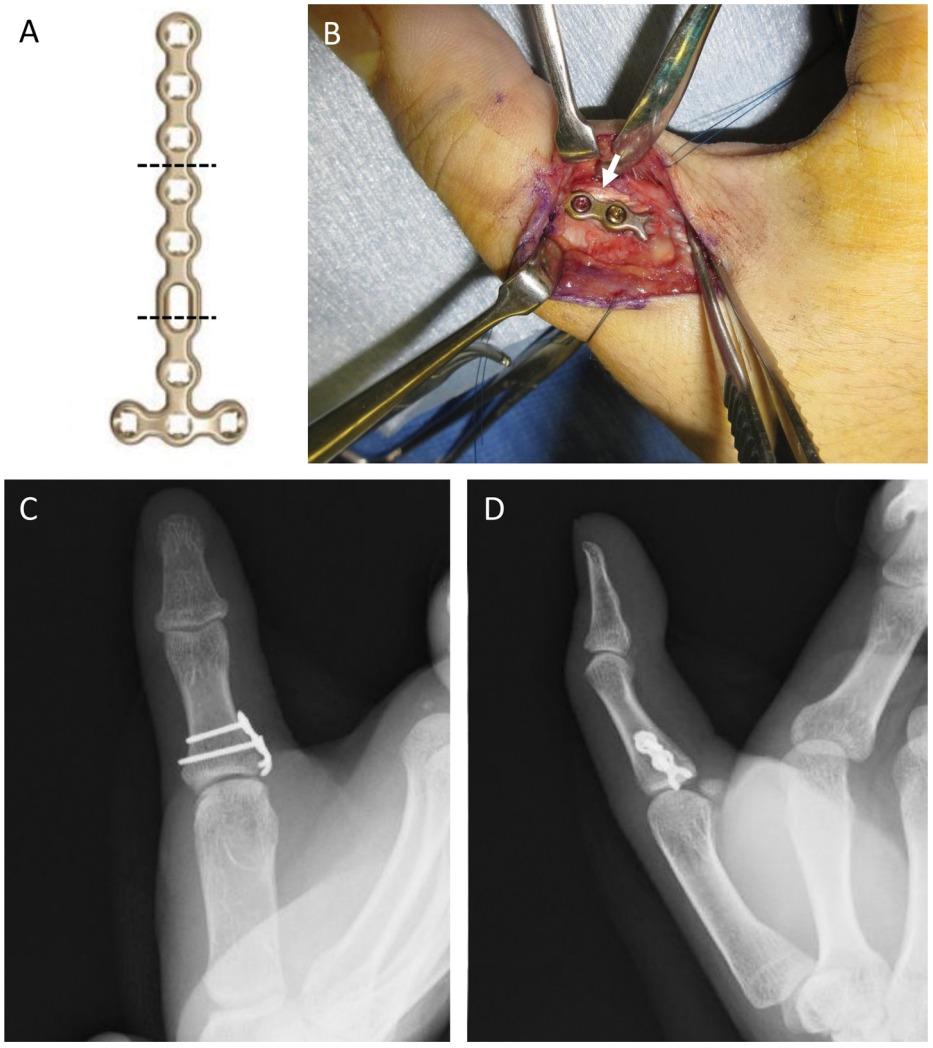

Fig. 2. A. A two-hole mini hook plate is made by adapting a 1.5-mm VA locking T-plate. Importantly, the plate should be cut at the oblong hole of the plate to make a hook large enough to lift the avulsion fragment. B. Intraoperative picture of *Case 1* after hook plate fixation. The arrow indicates the long fiber of the adductor pollicis tendon. C and D. Postoperative radiographs demonstrate anatomical reduction of the bone fragment.

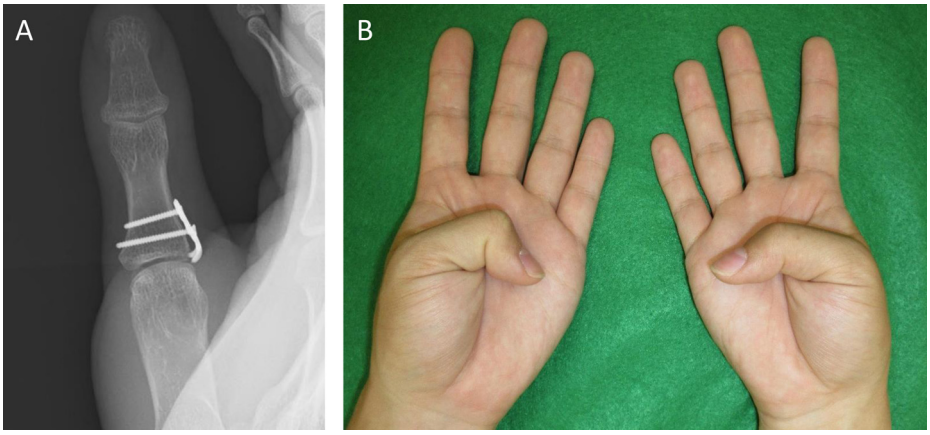

Fig. 3. A. A posteroanterior radiograph at 6 months after surgery, showing complete bone union with mild resorption of the bone fragment. B. The range of motion of the thumbs at 6 months after surgery.

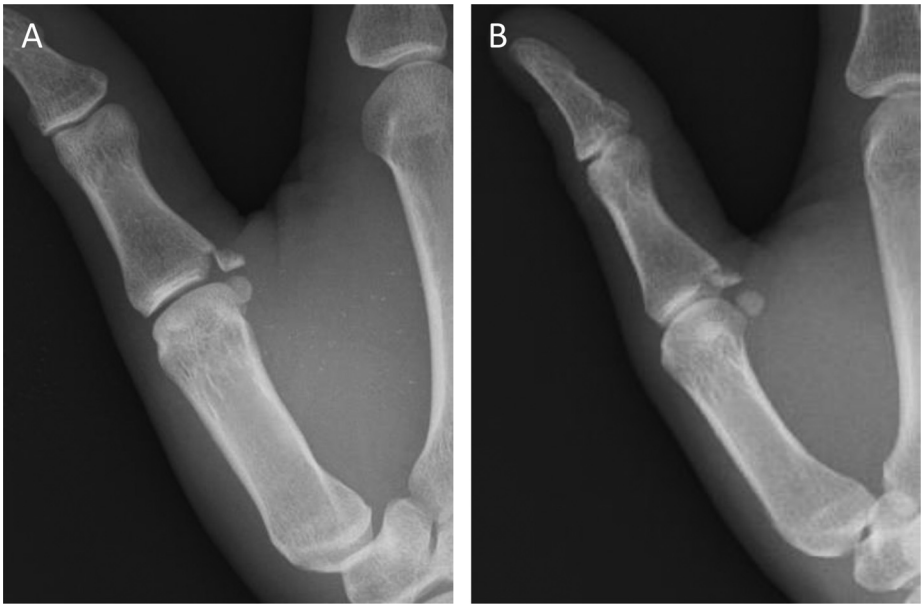

Fig. 4. A and B. Posteroanterior and lateral view radiographs of the right thumb of *Case 2*, showing severely displaced bone fragment of the proximal phalanx.

thumb interphalangeal (IP) joint; however, he did not have any pain or instability of the thumb, or prominence of the plate. The key pinch and grip strength of the affected hand were 5.5 kg and 27.7 kg, which were 86% and 88% of the contralateral side (6.4 kg and 31.5 kg), respectively. The range of motion (ROM) of the thumb MP and IP joints were extension 20° and flexion 64°, and extension 10° and flexion 56°, respectively (Fig. 3A). Although radiographs demonstrated complete fracture union, asymptomatic mild bone resorption under the hook was observed (Fig. 33B).

2.2. Case 2

A 24-year-old man hit his right thumb on a wall and sustained displaced UCL avulsion fracture of the thumb proximal phalanx; the size of the bone fragment was 3 × 4 mm rotating 90° (Fig. 4A and B). Through an ulnar lateral approach, the displaced fragment was reduced and fixed with a two-hole locking hook plate, which was made by adapting the same plate as in *Case 1* (Fig. 5A–D). Rigid fixation of the fragment with a hook plate was achieved; therefore, the patient started early active motion of the thumb and wore a removable splint for 4 weeks during work and at night. A total of 3 months after surgery, fracture union was complete. Seven months after surgery, the patient worked as before the injury without any pain, instability, or complaints of the prominence of the plate. The key pinch and grip strength of the affected hand were 9.7 kg and 41.0 kg, which were 99% and 100% of the contralateral side (9.8 kg and 41.0 kg), respectively. The ROM of the thumb MP and IP joints were extension 0° and flexion 60°, and extension 0° and flexion 65°, respectively (Fig. 6A). Radiography demonstrated asymptomatic slight bone resorption under the hook, as with the *Case 1* (Fig. 6B).

3. Discussion

UCL is an important stabilizer of the thumb MP joint during forceful grip and pinch; therefore, failed treatment of thumb UCL injuries leads to severe functional disturbances of the affected hand. Dinowitz et al. have reported that long-term cast immobilization even for 6 to 7 weeks for displaced thumb UCL avulsion fractures resulted in persistent thumb pain, especially during forceful pinch [1]. To restore stability and painless movement of the thumb, most studies recommend surgical treatment for this injury [1–3,5].

Although pinning with K-wires is a simple and common technique of managing thumb UCL avulsion fractures, it requires postoperative immobilization for several weeks and hardware

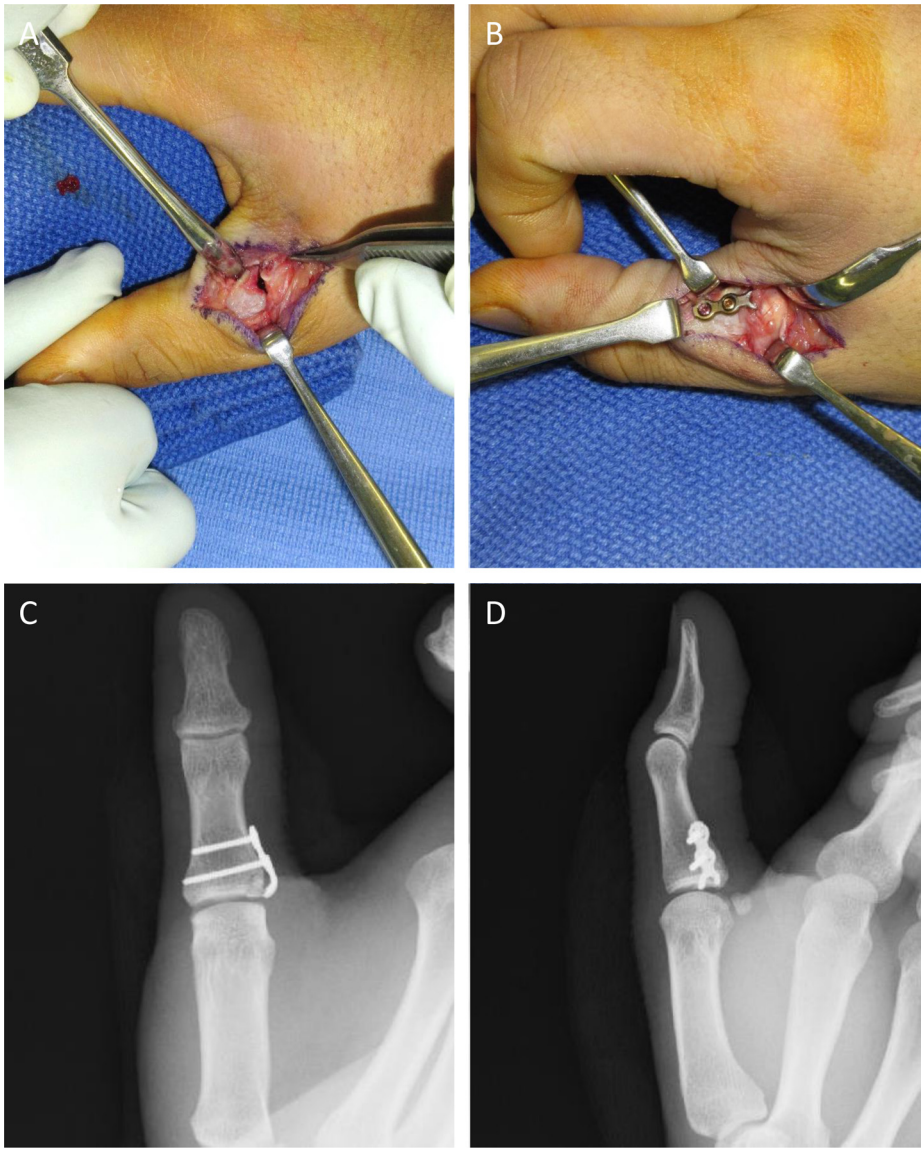

Fig. 5. A. Intraoperative image of *Case 2* before reduction. B. Intraoperative image of *Case 2* after hook plate fixation. C and D. Postoperative radiographs demonstrate anatomical reduction of the bone fragment.

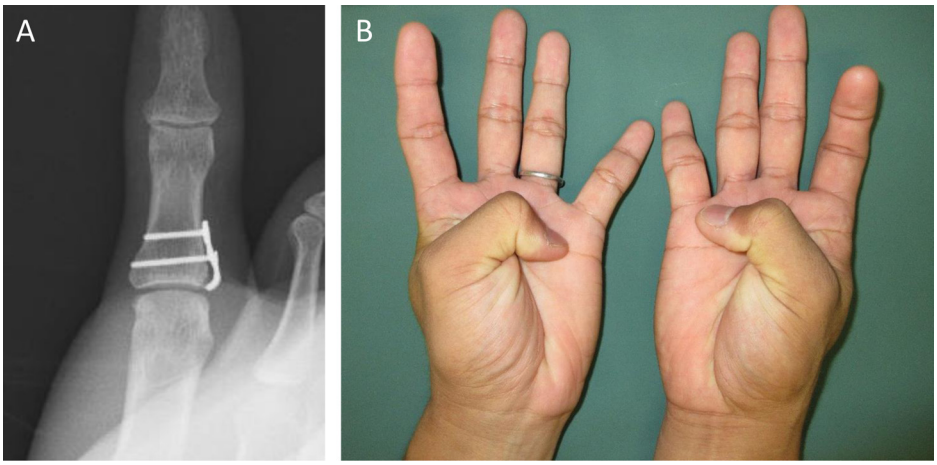

Fig. 6. A. A posteroanterior radiograph at 7 months after surgery, showing complete bone union with slight resorption of the fragment as with Case 1. B. The range of motion of the thumb at 7 months after surgery.

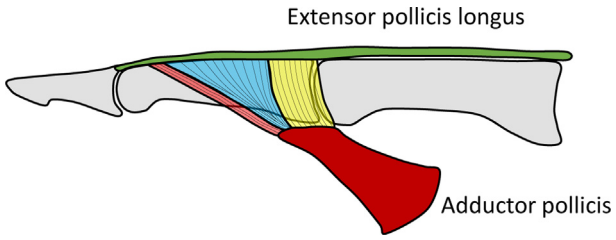

Fig. 7. A schema of the extensor aponeurosis of the thumb. Components indicated in yellow, blue, and red are transverse fibers, oblique fibers, and long fibers of adductor pollicis, respectively.

removal [1,3]. Conversely, a mini screw technique can provide more rigid fixation than K-wires. However, its application depends on the size of the fragment because the size of the screw should be less than one-half of the size of the fragment to prevent unexpected fragmentation [3]. Since Teoh's article reported using a hook plate for mallet fractures, several clinicians have demonstrated the usefulness of hook plate fixation for hand and finger fractures [5–9]. Hook plate provides both tension band and buttress effects for the avulsion fracture without direct screw insertion across small bone fragments; therefore, it demonstrates great power in cases when that bony fragment is small or thin [8]. Tabrizi and Afshar had first reported the usage of a 2.0-mm one-hole hook plate for thumb UCL avulsion fracture [5]. They obtained stability of the MP joint and satisfactory outcomes, although they did not allow the patient to start early motion of the operated thumb by cast and splint immobilization for a total of 8 weeks. We believe that one of the main benefits of the usage of the hook plate is acquisition of rigid fixation, which enables early rehabilitation. Indeed, in our cases, modified 1.5-mm two-hole hook plates (one cortical screw and one locking screw) provided rigid fixation, which enabled early postoperative rehabilitation and stability of the thumb MP joint with complete fracture healing. The optimal number of screw holes in hook plate fixation for hand and finger fractures remains under debate. Although some companies (e.g. KLS martin, Acumed, and Medartis) have ready-to-use one-hole hook plates and Kang et al. have reported that one-hole plate is usually sufficient for phalangeal avulsion fractures, we recommend 1.5-mm two-hole hook plates for the treatment of thumb UCL avulsion fractures [8].

Although there are strong advantages to this technique there are several drawbacks. First, the plate not fitting to the bone might cause hardware prominence, resulting in additional surgery for hardware removal. Making a well-fitting plate is important to avoid this complication. Secondly, despite good outcomes, slight restriction of the ROM of the IP joint remained in *Case 1*. Anatomical study of the dorsal aponeurosis of the thumb demonstrates that the adductor pollicis (AP) tendon is connected to the dorsal aponeurosis with its three components (transverse, oblique, and long fibers), especially long fibers attached in connection with the extensor tendon (Fig. 7) [10]. Retrospective investigation of intraoperative pictures of *Case 1* revealed that the distal portion of the plate interfered with a part of the long fibers of the AP tendon (Fig. 2B). This suggests that restriction of distal sliding of the AP tendon interrupted distal sliding of the extensor tendon, resulting in loss of the flexion of the thumb's IP joint. Therefore, we should avoid interference between the plate and AP tendon. Finally, detailed evaluation of the postoperative radiographs of both patients revealed some bone resorption of the fragment under the hook. We assume that bone resorption was caused by a continuous compression force onto the fragment from the hook plate. In order to minimize this phenomenon, surgeons should avoid exerting excessive compression onto the fragment by cortical screw insertion. Although this phenomenon was asymptomatic and did not influence clinical outcomes, further careful follow-up will be required.

Nevertheless, this report was limited by two cases of clinical report with short follow-up periods. More patients and longer follow-up would be necessary to reveal the usefulness of this method. However, we hope that our surgical report could help surgeons treating thumb UCL avulsion fractures, especially those with small or thin displaced fragment, which are difficult to treat by conventional methods.

4. Conclusion

We present two cases of thumb UCL avulsion fracture fixed with a two-hole mini hook plate by adapting a 1.5-mm variable angle locking hand plate. This method allowed early postoperative rehabilitation and provided stability of the thumb MP joint and excellent clinical outcomes. It could be an alternative treatment technique for thumb UCL avulsion fractures.

Ethical consideration

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

Informed consent was obtained from the patients.

Disclosure of interest

The authors declare that they have no competing interest.

Financing sources

We received no financing support.

Authors' contribution

Shingo Komura, Akihiro Hirakawa, Kyohei Ishizuka and Haruhiko Akiyama performed operation. Yasuharu Matsushita performed rehabilitation. Shingo Komura wrote the manuscript.

Acknowledgements

The authors report no benefits, grants, or assistance from any party.

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