MUSCULOSKELETAL SURGERY (2019) 103:77–82
https://doi.org/10.1007/s12306-018-0571-7

ORIGINAL ARTICLE

Use of dorsal buttress plate fixation for ulnar carpometacarpal joint fracture dislocations for early mobilization: outcomes of 11 cases

S. C. Tay[1,2] · M. Q. H. Leow[2] · E. S. Tan[1]

Received: 4 October 2017 / Accepted: 6 October 2018 / Published online: 22 October 2018

Abstract

Aim This study reviews the surgical outcomes of using dorsal buttress plate for open reduction and internal fixation of ulnar (5th, or 4th and 5th) CMCJ fracture subluxation or dislocations.

Methods A retrospective review of 11 patients at our center who underwent operative fixation with dorsal buttress plating technique was performed. The surgery was performed between February 2012 and March 2017. Outcome measurements include radiographic evaluation of time to union, grip strength, and range of motion of the wrist.

Results Of 11 patients in our case series, eight had injuries involving both 4th and 5th CMCJs, while three had isolated involvement of 5th CMCJ. Mean time to union on radiographs was 48 days (IQR 17.0; range 30–88). The median palmar flexion and dorsiflexion of the wrist were 56° (IQR 11.3; range 50°–80°) and 65° (IQR 10.0; range 60°–80°) respectively. Patients regained a median of 79% of grip strength (IQR: 36.0, range 43–100). All fingers achieved full range of motion, and no patient had scissoring of the fingers. Two patients had temporary mild numbness over the dorsoulnar aspect of the hand in the region of the 4th webspace. Five patients underwent removal of implants due to plate breakage ($n=2$), or mild pain or pain with cold ($n=3$). All patients were well after plate removal, and all the patients with pain had resolution of pain after implant removal.

Conclusion The dorsal buttress plate is a viable option for fixation of ulnar CMCJ fracture dislocations to allow early mobilization.

Keywords Dorsal buttress plating · Carpometacarpal joints · Fracture subluxation or dislocation · 4th CMCJ · 5th CMCJ

Introduction

A variety of methods have been described for operative fixation of ulnar carpometacarpal joint (CMCJ) fracture dislocations. The most common method is fixation with intramedullary implants such as Kirschner wires (K-wires) or Steinman pins [1–4]. If K-wires are used, they can be placed through the CMCJ [5–10]. K-wires can also be placed transversely through more than one metacarpal [11]. Arthroscopic-assisted methods have also been described [12].

Screw fixation of hamate fracture and temporary plates fixation across 4th and 5th CMCJs for comminuted fractures have been described [13]. As the ulnar CMCJs are fixed with this surgical method, ulnar CMCJs cannot be mobilized until implant removal is performed at an average of 3.6 months.

In spite of previous techniques, we proposed a new surgical technique for ulnar CMCJ fracture dislocations using dorsal buttress (DB) plating [14]. The most unique feature of this construct is that it crosses but does not fix the ulnar CMCJs. This allows the ulnar CMCJ to mobilize during the early postoperative period, and implant removal is not routinely required. We reviewed our experience and outcomes in the operative treatment of ulnar CMCJ fracture dislocations using this technique in a series of 11 patients.

✉ S. C. Tay
tay.shian.chao@singhealth.com.sg

[1] Department of Hand Surgery, Singapore General Hospital, The Academia, 20 College Road, Singapore 169856, Singapore

[2] Biomechanics Laboratory, Singapore General Hospital, Singapore, Singapore

Methods

Ethical approval was obtained from the institutional review board. A retrospective review of all patients who underwent operative fixation for ulnar CMCJ injuries using DB plate fixation from November 2008 to March 2017 were performed. Patients who presented more than 3 weeks from injury were excluded as it is more difficult to reduce the fracture due to callus starting to consolidate. Eleven patients were included in the study. Charts and radiographs were reviewed, and relevant data such as age, gender, hand dominance, time to union, range of motion, and grip strength were recorded. The median and interquartile range (IQR) were reported.

Classification of 4th and 5th CMCJ injuries

We classified the ulnar CMCJ injuries into 4 types (Table 1). This classification can be applied to patients with isolated 5th CMCJ injury or combined 4th and 5th CMCJ injuries.

Principles of the dorsal buttress (DB) plate

The action of the DB plate is based on the pathomechanics of ulnar CMCJ injuries. The metacarpal base has a tendency to displace dorsally and proximally when there is an axial load. The plate is aligned parallel and dorsal to the metacarpal and acts as a buttress or "pillar" to resist this movement.

The plate is fixed proximally to the hamate without any distal fixation. The distal end of the plate overlies the proximal portion of the metacarpal but is not fixed to it. This allows the CMCJ to maintain its physiological range of motion of 15–30 degrees of flexion, while controlling CMCJ dorsal subluxation/dislocation [15].

Surgical technique and post-surgical management

A longitudinal incision over the hand dorsum centered over the 4th and 5th CMCJs is used. The dorsal cutaneous branch of the ulnar nerve is identified and carefully protected from damage. Extensor tendons are retracted if required. The entire dorsal cortex of the hamate and the base of the 4th and 5th metacarpals are exposed subperiosteally. After debridement of callus and reduction in fragments, DB plate fixation is performed using a 1.5-mm plate system.

Straight plates, T plates, Y plates (Figs. 1 and 2) or ladder plates (Figs. 3 and 4) can be used. In general, at least two screws per plate per joint are required to ensure sufficient proximal hold in the hamate. The screws should remain unicortical in the hamate to prevent inadvertent damage to volar structures in the wrist. Distally, there should be adequate plate length to buttress the base of the metacarpals (usually two screw holes). More than two screw holes distally are not recommended to avoid prominence of the plate during flexion of the CMCJs. Fixation should be checked intraoperatively using an image intensifier. The dorsal cortex of the involved metacarpal base should also be flushed with the dorsal cortex of the hamate. Postoperatively, all patients were given an ulnar gutter splint. Intermittent active range of motion is commenced within the 1st week.

Fig. 1 Preoperative radiographs of a patient with a Type 3 ulnar CMCJ injury (4th and 5th CMCJ with large hamate fracture)

Table 1 Classification of ulnar CMCJ fracture dislocations

Type	Description
1	5th CMCJ dislocation or fracture subluxation-dislocation
2A	5th CMCJ dislocation or fracture subluxation–dislocation with 4th metacarpal fracture (non-articular)
2B	4th and 5th CMCJ dislocation or fracture subluxation–dislocation
3	Significant fracture of the hamate (larger than 3 × 3 mm) with 5th CMCJ dislocation or fracture subluxation–dislocation, with or without involving the 4th CMCJ

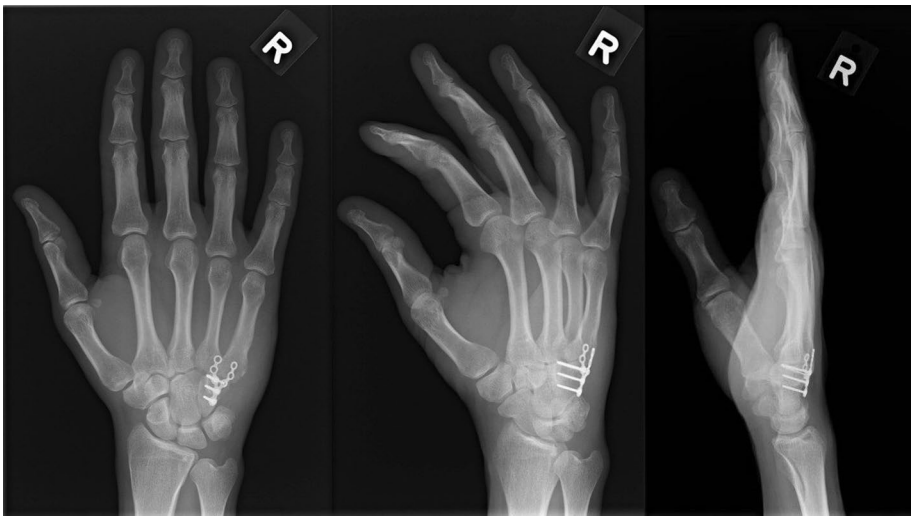

Fig. 2 Postoperative radiographs at 5 months showing excellent reduction and union with dorsal buttress plate fixation using a Y plate

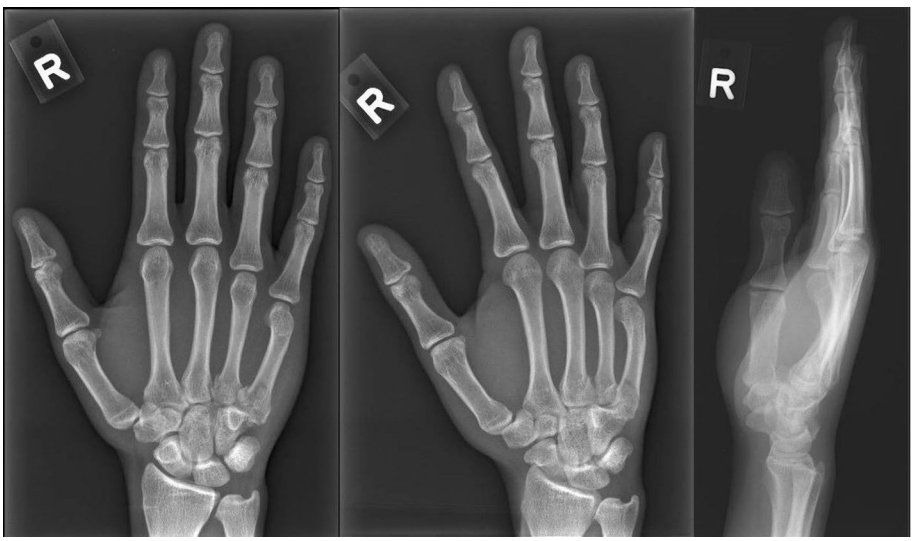

Fig. 3 Preoperative radiograph of a patient with Type 2B ulnar CMCJ injury (4th and 5th CMCJ fracture dislocation)

Results

Patient demographics

All patients were male and right-hand dominant. Their ages ranged from 21 to 47 years (median 31.0; IQR 10.0).

Injury patterns and operative fixation

The most common mechanism of injury was a fall ($n = 9$), one from a door slamming shut onto the hand, and one from punching a door. The median duration between the date of injury and operative fixation was 13.0 days (IQR 6.0 days; range 7–18 days). Nine patients had injury on the right dominant hand. Of the 11 patients in our case series, eight had injuries involving both 4th and 5th metacarpal rays, while three had isolated involvement of the 5th CMCJ. All patients sustained dorsal subluxation or dislocation of the metacarpals; none had volar displacement. There were three patients with type 1, three patients with type 2A, three patients with type 2B, and two patients with type 3. Types 1 and 3 injuries usually only require a single plate which can be a straight plate or a ladder plate. Type 2A will require two separate plates, whereas Type 2B injuries can be fixed with two plates or a single ladder plate if it is broad enough to bridge over both the 4th and 5th CMCJs. Table 2 documents the injury patterns, method of operative fixation and surgery complications.

Outcomes

The median follow-up duration was 34 weeks (IQR 42; range 4–109). All patients in our study achieved fracture union without displacement of fracture or subluxation on

Fig. 4 Postoperative radiographs at 4.5 months showing excellent reduction and union with dorsal buttress plate fixation using a single ladder plate. As the plate is buttressing over both the 4th and 5th CMCJ, 4 proximal screws were used. Some contouring of the distal end of the plate can also be done to mold the plate to the bone. In some locking plate systems, this can be done in situ

radiographs. The median time to fracture union was 48 days (IQR 17.0; range 30–88). The median palmar flexion and dorsiflexion of the wrist were 56° (IQR 11.3; range 50°–80°) and 65° (IQR 10.0; range 60°–80°), respectively. The median grip strength of the injured hand was 32 kg (IQR 10.0; range 18–40 kg) and 42 kg (IQR 4.0; range 36–54 kg) on the uninjured hand. Patients regained a median of 79% of grip strength (IQR: 36.0, range 43–100). All fingers achieved full range of motion, and no patient had scissoring of the fingers.

Two patients had temporary mild numbness over the dorsoulnar aspect of the hand in the region of the 4th webspace. Five patients underwent removal of implants. Two was due to plate breakage. One patient had plate breakage detected on radiograph 10 months post-surgery but was otherwise asymptomatic. The other patient had plate breakage detected on radiographs 8 months post-surgery. Both plates that broke were ladder plates. The other three patients had mild pain or pain with cold, and underwent plate removal. After plate removal, all patients had resolution of symptoms.

Discussion

Ulnar (5th, or 4th and 5th) carpometacarpal joint (CMCJ) fracture dislocations are relatively uncommon injury [12]. The most common mechanism of injury is a clenched fist striking a firm surface during forced flexion of the wrist with extension of the arm [11, 12, 16]. However, in our case series, 9 out of 11 of the patients reported the injury during a fall.

All patients in our study had 5th CMCJ subluxation or dislocations. 5th CMCJ injuries are more common due to the relative instability from the increased mobility and lack of supporting structures on the ulnar side [15, 16]. Eight patients had accompanying 4th metacarpal or 4th CMCJ injury, but none had isolated 4th CMCJ injury. Isolated 4th CMCJ injury is rare [16]. The 4th CMCJ is less susceptible to dislocation due to its supporting ligaments, contiguous articulation with the base of the 3rd and 5th metacarpals, and the absence of muscular insertions that would exert a deforming force in the event of a fracture. All our patients also sustained dorsal dislocations [17]. Volar dislocations are rare because the hook of hamate acts as a buttress [18].

We proposed a descriptive classification for 4th and 5th CMCJ injuries as current classifications could not be applied to all our patients. Using Cain et al.'s [11] classification, (Type 1A: subluxation or dislocation of the 5th metacarpal base with disruption of dorsal CMC ligament without any hamate fracture; type 1B, a dorsal hamate fracture; type 2, dorsal hamate comminution; type 3, coronal splitting of the hamate) only five of our patients could be included. Kim and Shin [19] classification could only be applied to eight patients in our study. The classification we proposed (Table 1) is more comprehensive and is able to categorize all the cases encountered in our study, as it included isolated 5th, as well as combined 4th and 5th injuries. The rationale for the classification is that Type 1 injuries only involve one ray–the 5th CMCJ in this case. Type 2 injuries involve both 4th and 5th rays but in 2A, the 4th metacarpal injury is non-articular. Type 3 injuries refer to injuries involving a significant fracture of the hamate bone resulting in subluxation or dislocation of 5th CMCJ, with or without the 4th CMCJ.

Straight plates, T plate, Y plates, or ladder plates can be used depending on the injury pattern. Type 1 injuries only require a single plate. Typically we use a reversed T or Y plate to achieve at least two unicortical screw fixations into the hamate proximally. Reversed T or Y plates have the advantage of reducing the length of subperiosteal exposure needed over the hamate compared to a straight plate. Type 3 injuries are characterized by hamate fracture dislocations involving the 4th and 5th CMCJs. As such, a single plate can be used. This can be a ladder plate or a Y plate with the two limbs of the Y lying over the base of the 4th and 5th metacarpals. In type 2B injury patterns, a double plate construction is usual. However, a single ladder plate, if placed appropriately, can be used to bridge both the 4th and 5th CMCJs instead of using two separate plates.

All patients in our study had good recovery of range of motion. The median palmar flexion and dorsiflexion of the wrist were 56° and 65°, respectively, which was within normal range of motion [20]. All patients had full finger range

Table 2 Injury patterns, method of operative fixation and complications

Method of injury	Side	Description	Classification	Number of plates	Type of plate	Removal of implant (reason)	Post operative complications
Fall	Right	5th CMCJ fracture dislocation	1	1	Y plate (reversed)	No	None
Fall	Left	5th CMCJ fracture dislocation	1	1	Ladder plate	Yes (plate breakage)	Decreased sensation over 4th webspace dorsum
Fall	Right	5th CMCJ fracture dislocation	1	1	Ladder plate	No	None
Fall	Left	5th CMCJ dislocation, 4th metacarpal base fracture	2A	2	Straight plate Ladder plate	Yes (pain)	None
Fall	Right	5th CMCJ fracture dislocation with 4th metacarpal base fracture	2A	2	Ladder plate Straight plate	No	Numbness over 4th webspace, hypersensitivity over scar
Punch door	Right	5th CMCJ dislocation, 4th metacarpal fracture	2A	2	2 straight plates	Yes (pain)	Pain on dorsum when cold
Fall	Right	4th and 5th CMCJ fracture dislocation	2B	2	Straight plate Y plate (reversed)	No	None
Fall	Right	4th and 5th CMCJ fracture dislocation	2B	2	Ladder plate Straight plate	Yes (plate broke)	None
Fall	Right	4th and 5th CMCJ fracture dislocation	2B	1	Ladder plate	No	None
Hand slam by door	Right	Hamate fracture with CMCJ dislocation	3	1	Y plate	Yes (pain)	None
Fall	Right	Hamate fracture with CMCJ dislocation	3	1	Ladder plate	No	None

of motion with no scissoring. However, there was some loss of grip strength compared to the uninjured side at a mean follow-up of 34 weeks. This loss in grip strength was also reported in a previous study which used K-wires [17]. The loss of grip strength may be a sequelae of such injuries in the short term.

Plate breakage occurred at 8 and 10 months in two patients in our series. All the plate breakages occurred in ladder plates. There were no plate breakages among the straight, Y or T plates in this series. This suggests that the ladder plates may be less suitable for dorsal buttress plate fixation of ulnar CMCJ injuries.

We would recommend dorsal buttress plating in the management of reducible and unstable ulnar CMCJ injuries as it allows early postoperative rehabilitation at the ulnar CMCJ. If possible, strong low profile T, Y or straight plates (minimum 1.5 mm, preferably locking systems) are used over ladder plates to minimize the risk of plate breakage. With K-wire fixation, finger alignment is fixed by the surgeon at the point of surgery. As such, perfect finger alignment has to be achieved during surgery to avoid "finger scissoring" postoperatively. Dorsal buttress plating avoids this issue as there is no fixation distally. Operative time is reduced as the surgeon's task is simplified. Although secondary surgery is not mandatory, 55% of patients do undergo implant removal for symptoms related to the plate or its breakage.

Compliance with ethical standards

Conflict of interest There is no conflicting interest.

Ethical approval Ethics approval was obtained from the Institutional Ethical Review Board (CIRB Reference Number: 2014/887/D).

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