Technical Note

Arthroscopic Assisted Treatment of Thumb Metacarpal Base Articular Fractures

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Abstract: Fracture of the base of the thumb metacarpal (M1) is a common finding in hand trauma. Closed reduction and K-wire fixation and open reduction—internal fixation are traditional treatments of choice. The arthroscopic assisted technique has been introduced to improve intra-articular fragment reduction and to preserve fragment vascularization and capsular and ligamentous integrity along with joint stability. Indications for arthroscopic assistance are all types of intra-articular fractures or pending malunions involving the base of M1 and/or the trapezium. The aim of this article is to describe the surgical technique used in managing articular fractures of the base of M1, with arthroscopic assistance. Our experience with this technique confirms the advantages of a minimally invasive method that provides articular reduction under direct vision, with limited soft-tissue damage, and allows early rehabilitation (from day 1 after surgery). This technique is extremely valuable for high-demand patients such as manual workers or athletes. The relative disadvantage of the technique is its technical difficulty, which requires experience with small-joint arthroscopy.

Fracture of the base of the thumb metacarpal (M1) is a common finding in hand trauma. The mechanism of injury consists of an axially directed force through M1, associated with torsion or twisting forces, as seen after a fall or associated with combat sports. The injury presentation varies from a simple dislocation to fracture or fracture-dislocation. The fracture pattern of the articular surface of the base of M1 consisting of a single volar-ulnar fragment is termed the “Bennett fracture.” Gedda described the type of injury according to the involvement and size of the fragment and dislocation of the basal joint of the thumb. The fracture pattern involving multiple fragments, often comminuted, and the M1 metaphysis is termed the “Rolando fracture.”

As a rule of thumb, all intra-articular fractures of the first carpometacarpal (CMC-1) joint require early treatment. Techniques of closed reduction and K-wire fixation, as well as open reduction—internal fixation, are traditional treatments of choice. The arthroscopic assisted technique has been introduced as an alternative and effective method of treatment to improve intra-articular fragment reduction and to preserve fragment vascularization and capsular and ligamentous integrity along with joint stability. The aim of this article is to describe the surgical technique used in managing articular fractures of the base of M1, with arthroscopic assistance.

Surgical Technique

The patient undergoes a radiographic examination of the CMC-1 joint as the method of choice for identifying the fracture. Specific oblique views or reverse (ante-roposterior) views are used to improve the definition of the fracture pattern. A computed tomography scan is requested in doubtful cases of a small fragment fracture of the base of M1 (Gedda type 3) or an associated trapezium fracture. Magnetic resonance imaging is rarely needed, but it might help to reveal “occult” fractures of M1 or other carpal bones and associated ligament injury.

The patient is positioned supine on the operation table with a tourniquet applied on the affected arm. The
arm is abducted at 90° and the elbow is flexed at 90°, allowing a vertical position of the forearm, wrist, and hand. A conventional arthroscopic vertical traction system (Amatech; Allen Medical Systems) is applied to the CMC-1 joint through a thumb trap and countertraction of 1 to 2 kg at the elbow. The traction device should allow wrist rotation to enable the surgeon to work freely into the CMC-1 joint. The surgeon

| Type   | Description                                                                 |
|--------|-----------------------------------------------------------------------------|
| Type 1 | Large single ulnar fragment with subluxation of metacarpal base             |
| Type 2 | Impaction fracture without subluxation of thumb metacarpal                  |
| Type 3 | Small ulnar avulsion fracture fragment in association with metacarpal dislocation |

Fig 1. Position of surgeon in relation to wrist (left wrist in the foto), performing first carpometacarpal (CMC-1) joint arthroscopy. The wrist is supinated by the assistant orienting the CMC-1 joint toward the surgeon, who stands in front of the CMC-1 joint. The monitor is placed on the other side of the patient, allowing comfortable visualization by the surgeon and assistant.

Fig 2. Box concept adapted to first carpometacarpal (CMC-1) joint (illustration for left wrist). The position of all the portals for CMC-1 arthroscopy should be noted: The 1-radial (1R) portal is located radial to the abductor pollicis longus tendon, the 1-ulnar (1U) portal is just posterior-ulnar to the extensor pollicis brevis tendon, the dorsal distal portal (D2) lies just distal to the dorsal intermetacarpal ligament, and the volar thenar portal is positioned just radial to the superficial and deep oblique ligaments of the CMC-1 joint. (The radial portal is missing.)
Fig 3. (A) Intraoperative view of position of all portals in patient with right Bennett fracture. The trocar is in the radial portal, and the needles are in the 1-radial (1R) and volar portals. The 1-ulnar (1U) portal skin incision is marked by an asterisk. (B) Artist’s rendering of Bennett fracture with portals and thumb traction (red arrow). The scope is seen entering the different portals: volar, radial, 1R, and 1U (from left).

Fig 4. Radiograph (A) and artist’s rendering (B) of left Bennett fracture with displaced volar fragment (white dashed line in A).

Fig 5. Artist’s rendering of steps of arthroscopic assisted reduction and pinning of acute Bennett fracture of the right wrist. (A) Displaced acute Bennett fracture before traction. (B) Vertical traction (red arrow) with a finger trap placed on the thumb is sufficient to reduce the fracture. After fracture reduction, a K-wire is drilled percutaneously to fix the reduction. (C) A second K-wire stabilizes the fracture.
should stand in front of the CMC-1 joint, that is, facing the radial side of the wrist (Fig 1). A comfortable position is easily permitted by the assistant who helps during the procedure, maintaining the forearm in supination. A 1.9-mm wide-angle video arthroscope (Smith & Nephew) is recommended to explore the joint. We always use a dry technique for CMC 1 joint arthroscopy. The traditional portals used for CMC-1 arthroscopy are termed 1R and 1U: The 1-radial (1R) portal is located radial to the abductor pollicis longus tendon, and the 1-ulnar (1U) portal is just posterior-ulnar to the extensor pollicis brevis tendon. It is important to remember that the inclination of the CMC-1 joint is null or 10° upward; then, the orientation of the needle, to check the direction of the portal prior to joint entry, is opposite that used when placing standard wrist portals. The scope is positioned in the 1R or 1U portal, and the optic is rotated 90° ulnarward to permit an improved view, by taking advantage of the 30° viewing angle of the optic. Portal switching and scope rotation are generally used to achieve complete joint exploration. However, according to the “box concept,” other portals might be used (Fig 2). In some cases, accessory portals may be created: The radial...
portal\(^8\) and the thenar portal\(^9\) may help to improve joint surface exploration and fracture reduction (Fig 3).

A 10-mL syringe should be used to inject saline solution and wash out the joint debris and blood clogs, which are then removed by the suction of the shaver. In a fresh fracture, the vertical traction used for arthroscopy also allows one to achieve provisional fracture reduction. This is confirmed by fluoroscopy and then checked by arthroscopy and manipulated according to these latter findings. Arthroscopic visualization of the entire joint may also reveal associated ligament injury. Delayed fracture of the base of M1 should be reduced by fragment manipulation using a probe or periosteal elevator (Video 1). Multiple portals can be used for this purpose. Once the correct reduction of the articular fragments is obtained, a proper method of stabilization or fixation should be applied. K-wires usually represent an easier—and the least expensive—method of fixation.

In case of a Bennett fracture (Fig 4), percutaneous pinning is performed while the thumb undergoes traction in the vertical position used for arthroscopy. A 1.2-mm K-wire is drilled under fluoroscopic control through the dorsal distal shaft of M1 in a proximal and oblique direction to reach the volar-ulnar fragment only. A second K-wire may be added to improve
fixation stability. Arthroscopy is used to confirm that K-wires do no penetrate the articular surface. Accessory pinning of M1 with the second metacarpal (Figs 5-7) or crossing CMC-1 joint is seldom necessary. When possible, fixation with a lag screw (Linos; KLS Martin) or headless screw (HBS2 Mini; KLS Martin) is recommended because it provides improved fracture stability (Figs 8 and 9). In this case, the soft tissues are elevated subperiosteally, and the nerves and/or tendons are protected through a short incision to permit correct contact of the screw’s head against the M1 cortex.

In case of a Rolando fracture, it is important to stabilize the dorsal fragment first. Then, the volar-ulnar fragment is reduced and fixed using the same method described for the Bennett fracture (Figs 10-14).

Complications

Owing to the scarce number of publications, the literature on this subject has reported no complications. However, some potential complications may be considered, which may be divided into 2 main groups: The first group (group A) is related to the arthroscopic surgical technique, and the second group (group B) is related to the general issues with any treatment of an intra-articular fracture. Group A includes (1) injury (axonotmesis or neurapraxia) to the terminal branches of the dorsal sensory branch of the radial nerve; (2) injury to the radial artery and its branches; (3) tendon injury (abductor pollicis longus, extensor pollicis brevis, and extensor pollicis longus); and (4) cartilage damage caused by the arthroscopic instruments. Group B includes (1) incomplete fracture reduction with fragment step-off or rotation; (2) malunion; (3) nonunion; (4) pin-tract infection; (5) K-wire mobilization with secondary fracture redislocation; (6) deep infection; (7) protruding or headless screw; (8) stiffness; (9) secondary early arthritis; and (10) complex regional pain syndrome. Each type of complication should be managed in a specific manner. In our series, we observed none of these complications.

Discussion

The first description of CMC-1 joint arthroscopy was presented by Richard A. Berger at the American Academy of Orthopaedic Surgeons—American Society for Surgery of the Hand Wrist Arthroscopy Course in Chicago (unpublished data, May 1995). Then, Luchetti and Berger (1996) published the first description of the technique in an Italian article, in which the treatment of intra-articular fractures was included among the potential indications for CMC-1 arthroscopy. Consequently, in 1997, Berger3 published the first article in the international literature, reporting the use of arthroscopic assistance to reduce and fix 4 Bennett fractures. Since the early publication in 1996, small-joint arthroscopy has evolved, smaller optics have been made available, and high-definition imaging systems and small instruments have been introduced. These changes have allowed hand surgeons to better approach small joints of the hand such as the CMC-1 joint.

The indications for CMC-1 arthroscopy are all types of intra-articular fractures or impending malunions of the base of M11,3-6,10,11 or of the trapezium or with
involvement of both. Therefore, Bennett and Rolando fractures represent an appropriate indication for arthroscopic assisted treatment. In case of fresh fractures, the traction itself achieves a good provisional reduction of fragments, whereas in a pending malunion scenario, the fracture site needs to be manipulated by a Freer dissector to reach a satisfactory reduction. Use of the dorsal portals (1U and 1R) facilitates the reduction of the anterior fragment in Bennett fractures because the base of M1 is elevated by the scope. However, using

**Fig 10.** (A) Rolando fracture of the right wrist. (B) Traction by itself (red arrow) reduces the volar fragment but not the dorsal one because it is displaced by the abductor pollicis longus tendon. (C) First, the dorsal fragment is reduced and pinned. (D) Consequently, the volar fragment is reduced and pinned to the first metacarpal.
Fig 11. (A, B) Radiographs of dislocated Rolando fracture of the left wrist. The white dashed lines outline the fracture fragments. (M1, first metacarpal; T, trapezium.)

Fig 12. Arthroscopic view of left Rolando fracture. Fragments of the base of the first metacarpal (1 and 2) are dislocated and separated by a black dashed line (fracture line). The asterisk indicates the shaver blade. (T, trapezium.)

Fig 13. Arthroscopic view of left Rolando fracture with scope inserted in radial portal. (A) A Freer dissector (asterisk) introduced through the 1-ulnar (1U) portal can be used to reduce the fragments of the base of the first metacarpal (1 and 2). The dashed line indicates the fracture, and the continuous lines indicate the joint surface for each fragment. One should note the step-off and malalignment. (B) Under arthroscopic control, the dissector is introduced in the fracture line and used to manipulate the fragments. (C) After reduction, alignment of the fragments’ joint surfaces is restored (the alignment of the black lines should be noted) and the base of the metacarpal is congruent with the trapezium (T).
the same portals may create an obstacle in the reduction of a Rolando fracture because the dorsal segment is unstable. In this case, other portals (radial and thenar) should be used to stabilize the dorsal fragment first so that the stabilization of the anterior fragment may be performed in a similar way to that described for the Bennett fracture.

Our experience with the described technique confirms that all articular fractures of the CMC-1 joint are amenable to an arthroscopic assisted reduction and pin fixation or internal fixation, with the advantages of a minimally invasive method, that still permits fragment reduction under direct visual control and limits soft-tissue damage, which allows early postoperative rehabilitation (from day 1 after surgery). High-demand patients, such as manual workers or athletes, will absolutely benefit from this technique. A relative disadvantage of the technique is the inherent technical difficulty of small-joint arthroscopy that requires an appropriate learning curve and experience (Table 2).

**Table 2. Tips and Tricks of Described Technique**

| Tips and Tricks | Advantages |
|-----------------|------------|
| With the thumb in vertical traction, the surgeon should stand in front of the CMC-1 joint (i.e., toward the radial aspect of the wrist). A dry arthroscopy technique is recommended. | This position permits the surgeon to better manipulate, reduce, and stabilize the fragments. |
| The radial and thenar portals are frequently used along with the classic 1U and 1R portals. Vertical traction is applied as a method of reduction. In the Rolando fracture, fixation of the dorsal fragment needs to be performed first after reduction. In pending intra-articular malunions of M1, the Freer dissector is a key instrument. | This facilitates the visualization of joint anatomy and fragments and simplifies management of soft tissues to achieve proper reduction and fixation. Both portals are useful to improve the view of the articulation and manipulate fracture fragments. In case of fresh Bennett and Rolando fractures, traction itself reduces the volar-ulnar fragment. Stabilizing the dorsal fragment first will facilitate stabilization of the entire fracture. The Freer dissector facilitates mobilizing the fragments, debriding the fracture site, and holding the fragments while stabilizing them with a K-wire. |

CMC-1, first carpometacarpal; M1, first metacarpal; 1R, 1-radial; 1U, 1-ulnar.

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**Fig 14.** Radiographic (A) and clinical (B) results 1 week after arthroscopic assisted reduction and percutaneous K-wire fixation of a left wrist Rolando fracture. (white dashed lines, fracture lines; M1, first metacarpal; T, trapezium.)
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