SURGICAL TECHNIQUES

INTRAMEDULLARY PINNING FOR DISPLACED
FIFTH METACARPAL NECK FRACTURES:
CLOSED REDUCTION AND FIXATION USING
EITHER AN OPEN ANTEGRADE OR
PERCUTANEOUS RETROGRADE TECHNIQUE

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Introduction

Although the majority of fifth metacarpal neck fractures can be treated nonoperatively, surgery may be indicated when there is severe shortening or angulation of the metacarpal bone¹. Several surgical techniques have been used to treat displaced fifth metacarpal neck fractures. The most commonly used are the open antegrade intramedullary pinning technique and the retrograde percutaneous intramedullary pinning technique. Both techniques provide satisfactory outcomes with minimal complications^{1,2}.

Antegrade intramedullary pinning involves a small skin incision and drilling of the fifth metacarpal base followed by antegrade intramedullary insertion of Kirschner wires. By comparison, percutaneous retrograde intramedullary pinning consists of retrograde percutaneous insertion of intramedullary Kirschner wires through the metacarpal head, extraction of the wire ends proximally, and bending of the wires dorsally.

Indications & Contraindications

Indications

- Angular displacement of the fifth metacarpal neck angle by $>30^\circ$ on the injured side compared with that on the contralateral, uninjured side in a 30° pronated oblique radiograph (Figs. 1-A through 1-D).
- Shortening of >3 mm compared with the contralateral, uninjured metacarpal measured in a posteroanterior radiograph.
- Any degree of rotational deformity that is evident by physical examination.

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Contraindications

- Angulation or shortening that is less than the amount noted above.
- Low-demand patients.
- Skeletal immaturity as indicated by an open or visible growth plate adjacent to the fifth metacarpal neck.

Fig. 1-A

Fig. 1-B

Fig. 1-C

Fig. 1-D

Figs. 1-A through 1-D Measurement of the fifth metacarpal neck angle. **Fig. 1-A** The fifth metacarpal neck angle is measured on a 30° pronated oblique radiograph. **Fig. 1-B** The metacarpal shaft line connects the dots at the center of the distal and the proximal third of the fifth metacarpal cortex. **Fig. 1-C** The metacarpal neck line connects the dots at the center of the fifth metacarpal neck and head. **Fig. 1-D** The metacarpal neck angle is defined as the angle between the metacarpal shaft line (dashed line) and the metacarpal neck line (solid line).

Step 1 (Antegrade Intramedullary Pinning): Operating-Room Setup and Making the Incision (Video 1 and Figs. 2-A, 2-B, and 2-C)

Proper positioning of the image intensifier and the treating surgeons is important.

- Place the patient in the supine position with his or her arm extended on a radiolucent hand table. Use an axillary block or general anesthesia. Apply an upper-extremity tourniquet and drape the arm using a sterile procedure.
- The surgeon is positioned on the side of the fifth digit when the forearm is pronated, the assistant is at the distal end of the hand table, and the image intensifier is placed opposite the surgeon.
- After inflating a tourniquet, place the forearm in the pronated position. Apply a bolster underneath the hypothenar area to create a flat surface for the dorsum of the hand.
- Identify the fifth carpometacarpal (CMC) joint under the image intensifier (Fig. 3) and make a 5-mm transverse incision along the fifth CMC joint (Fig. 4).
- Using blunt dissection, expose the osseous surface of the fifth metacarpal base while taking care to avoid the dorsal sensory branch of the ulnar nerve, extensor digitorum longus of the fifth digit, and extensor digiti minimi.

Fig. 2-A

Fig. 2-B

Fig. 2-C

Fig. 3

Fig. 4

Video 1 Surgical procedure for antegrade intramedullary pinning.

Figs. 2-A, 2-B, and 2-C A patient with a fifth metacarpal neck fracture who was managed with antegrade intramedullary pinning. (Reproduced, with permission, from: Kim JK, Kim DJ. Antegrade intramedullary pinning versus retrograde intramedullary pinning for displaced fifth metacarpal neck fractures. Clin Orthop Relat Res. 2015;473[5]:1747-54.) **Fig. 2-A** The fifth metacarpal neck angle (intersection of dashed and solid lines) of the injured side was 58°. **Fig. 2-B** The fifth metacarpal neck angle on the contralateral, uninjured side was 18°. Therefore, the increase in the fifth metacarpal neck angle on the injured side was 40°, which was the surgical indication. **Fig. 2-C** After antegrade intramedullary pinning, the fifth metacarpal neck angle on the injured side decreased to 21°, which implies that the increase in the fifth metacarpal angle on the injured side was 3° postoperatively.

Fig. 3 The fifth CMC joint is identified using the Adson forceps under image-intensifier guidance.

Fig. 4 A transverse incision is made along the fifth CMC joint line.

Step 2 (Antegrade Intramedullary Pinning): Bend the Kirschner Wires

Prepare and bend the Kirschner wires before insertion.

- Prepare two 1.4-mm Kirschner wires.
- Measure the length of the fifth metacarpal using an image intensifier and paper ruler. Bend the Kirschner wires 90° with pliers at a length of 1 to 2 cm greater than the measured length of the fifth metacarpal (Fig. 5).
- Using vise-grip pliers, bend the distal 5-mm tip of the Kirschner wire approximately 20° so that it is in the form of a hockey stick (Fig. 5).

Fig. 5

Fig. 5 A photograph of a pre-bent Kirschner wire. Note that the Kirschner wire is bent by 90° at a point 1 to 2 cm longer than the metacarpal and its tip is bent by 20° to facilitate its passage within the medullary canal.

Step 3 (Antegrade Intramedullary Pinning): Make a Hole in the Fifth Metacarpal Base

Create a hole for Kirschner wire insertion in the center of the fifth metacarpal base.

- Under image-intensifier guidance, locate the drill guide in the center of the fifth metacarpal base (Figs. 6-A and 6-B). The hand tends to be placed obliquely when it is put on the table in the pronated position. Therefore, the anatomical location and observed location of the image intensifier will probably differ, unless the dorsum of the hand is flat using a bolster under the hypothenar area.
- It is easy to maintain the position of the drill guide when it is located at the proximal end of the fifth metacarpal base (the distal end of fifth CMC joint), because the teeth on the end of the drill guide engage the soft tissue and osseous prominence of this area (Fig. 7).
- Initially, make a small hole using a 1.4-mm Kirschner wire through the drill guide. Then, enlarge the hole using a 2.4-mm followed by a 3.2-mm drill-bit. Because the entry hole is made in the center of the fifth metacarpal base, the extensor carpi ulnaris tendon, which inserts on the medial side of the fifth metacarpal base, is not injured while making a drill-hole.

Fig. 6-A

Fig. 6-B

Fig. 7

Figs. 6-A and 6-B Creating a hole for Kirschner wire insertion in the center of the fifth metacarpal base. **Fig. 6-A** When making the hole, a drill guide is used to protect the surrounding soft tissue. **Fig. 6-B** An image intensifier is used to find the exact location of the drill guide.

Fig. 7 Placement of the drill guide on the dorsal surface of the fifth CMC base helps to prevent drill slippage over soft tissue, allowing precise control and protection of the surrounding tissue.

Step 4 (Antegrade Intramedullary Pinning): Insert Kirschner Wires and Close the Wound

Insert the Kirschner wires through the hole of the fifth metacarpal base.

- The first Kirschner wire is held with pliers.
- The wire is placed in the hole made during the previous step with the bent distal tip of the wire directed toward the dorsal surface of the fifth metacarpal. It is then inserted into the medullary canal by tapping the pliers with a hammer (Fig. 8).
- Stop the distal advancement just proximal to the fracture line. The assistant then reduces the fracture using the Jahss maneuver³. In this maneuver, the surgeon places his or her thumb on the proximal interphalangeal joint with the proximal phalanx at an angle of 90° relative to the fifth metacarpal. The thumb then applies a dorsal, upward force, along the proximal phalanx toward the patient's injured fifth metacarpophalangeal (MCP) joint. Other fingers are used to apply a counterforce at the fracture site over the apex of the deformity. Fracture reduction is then checked under the image intensifier. If the reduction is satisfactory, the Kirschner wire is advanced across the fracture line with the assistant maintaining the fracture reduction (Fig. 9).
- Advance the Kirschner wire to the subchondral bone of the fifth metacarpal head. Make sure that its distal tip does not penetrate the articular surface in the image-intensifier views. Then, cut the Kirschner wire at 2 cm from the skin, leaving the protruding wire to facilitate insertion of the second Kirschner wire.
- Insert the second Kirschner wire in the same manner using the same entry hole; however, after fully inserting the wire, rotate it to locate its tip in a divergent direction. It is acceptable if the distal tip is located slightly (1 to 3 mm) proximal to the tip of the first Kirschner wire.

Fig. 8

Fig. 9

Fig. 8 The Kirschner wire can be easily inserted and advanced in the antegrade direction without penetrating the volar cortex by keeping the distal tip of the wire facing in the dorsal direction.

Fig. 9 With reduction maintained with the help of an assistant, the Kirschner wire is advanced across the fracture line until it arrives at subchondral bone just beneath the articular cartilage.

- Under image-intensifier control, check the coronal and sagittal alignment and check for Kirschner wire tip penetration.
- Flex and extend the MCP and interphalangeal joint passively and evaluate the rotational alignment by checking the nail alignment and distance to the 4th finger.
- Cut the wires, leaving an appropriate length to facilitate later removal (Fig. 10).
- Close the skin with 5-0 nylon suture (Fig. 11).

Fig. 10

Fig. 11

Fig. 10 Wires are cut at a length appropriate for later removal.

Fig. 11 Skin closure with 5-0 nylon suture.

Step 5 (Antegrade Intramedullary Pinning): Postoperative Care

An additional skin incision is necessary to remove the Kirschner wires after bone union.

- Apply an ulnar-gutter short arm splint with finger joint immobilization in the intrinsic plus position for 1 week. The splint is then changed to a short arm splint allowing full range of motion of the MCP and interphalangeal joints.
- Remove the short arm splint at 5 weeks postoperatively and encourage the patient to perform active and passive wrist and finger motion exercises.
- Remove the Kirschner wires through the previous skin incision under local anesthesia at 3 months postoperatively.

Step 1 (Percutaneous Retrograde Intramedullary Pinning): Operating-Room Setup (Figs. 12-A, 12-B, and 12-C)

Proper positioning of the image intensifier and treating surgeon is important.

- Place the patient in the supine position with his or her arm extended on a radiolucent hand table. Use an axillary block or general anesthesia. Apply an upper-extremity tourniquet and drape the arm using a sterile procedure.
- The surgeon is positioned at the distal end of the hand table, the assistant is on the side of fifth digit when the forearm is pronated, and the image intensifier is on the side opposite the assistant.

Fig. 12-A

Fig. 12-B

Fig. 12-C

Figs. 12-A, 12-B, and 12-C A patient with a fracture of the fifth metacarpal neck who had percutaneous retrograde intramedullary pinning. (Reproduced, with permission, from: Kim JK, Kim DJ. Antegrade intramedullary pinning versus retrograde intramedullary pinning for displaced fifth metacarpal neck fractures. Clin Orthop Relat Res. 2015;473[5]:1747-54.) **Fig. 12-A** The fifth metacarpal neck angle on the injured side was 68°. **Fig. 12-B** The fifth metacarpal neck angle on the contralateral, uninjured side was 17°. Therefore, the increase in the fifth metacarpal neck angle on the injured side was 51°, which was the surgical indication. **Fig. 12-C** After percutaneous retrograde intramedullary pinning, the fifth metacarpal neck angle of the injured side decreased to 20°, which implies that the increase in the fifth metacarpal angle on the injured side was 3° postoperatively.

Step 2 (Percutaneous Retrograde Intramedullary Pinning): Fracture Reduction

Reduce the fifth metacarpal neck fracture using the Jahss maneuver.

- The surgeon uses one hand to reduce the fracture using the Jahss maneuver³ (Fig. 13), as described above (see Step 4 of the antegrade intramedullary pinning technique).
- Check the fracture reduction status under the image intensifier.

Fig. 13

Fig. 13 Fracture reduction using the Jahss maneuver. Briefly, the surgeon places his or her thumb on the proximal interphalangeal joint with the proximal phalanx at an angle of 90° relative to the fifth metacarpal. The thumb then applies a dorsal, upward force, along the proximal phalanx toward the patient's injured fifth MCP joint. Other fingers are used to apply a counterforce at the fracture site over the apex of the deformity.

Step 3 (Percutaneous Retrograde Intramedullary Pinning): Insert Kirschner Wires

Fix the reduced metacarpal neck fracture using 2 Kirschner wires placed percutaneously in a retrograde direction, with the second wire inserted after the first wire passes the fracture site but before it passes the metacarpal base.

- While maintaining the fracture reduction with one hand, the surgeon uses the other hand to hold a wire-driver drill fitted with a 1.4-mm Kirschner wire (Fig. 14).
- Place the tip of the Kirschner wire in the articular surface of the metacarpal head, and check the entry point under the image-intensifier control (Fig. 15).
- When the Kirschner wire passes through the fracture site, check the fracture reduction and the Kirschner wire location using the image intensifier. If the fracture reduction and Kirschner wire location are satisfactory, the Kirschner wire is advanced to the fifth metacarpal base.
- Cut the distal tip of the Kirschner wires and hammer the distal tip to advance the Kirschner wire further, in a retrograde direction, through the dorsal cortex of the metacarpal base to emerge at the dorsal skin with the patient's wrist fully flexed (Figs. 16-A and 16-B). Because the metacarpal base does not have hard cortical bone, it is not difficult to penetrate the bone by hammering the Kirschner wire. When there is difficulty in penetrating the metacarpal base by hammering the Kirschner wire, the surgeon may alternatively use a wire driver to advance the wire in the retrograde direction until it just penetrates the metacarpal base. Further advancement of the Kirschner wire is then done with a hammer to prevent soft-tissue engagement as the Kirschner wire passes through the dorsal soft tissues.

Fig. 14

Fig. 15

Fig. 16-A

Fig. 16-B

Fig. 14 While the fracture reduction is maintained, a Kirschner wire is introduced in a retrograde manner through the metacarpal head.

Fig. 15 The Kirschner wire is placed on the metacarpal head and the entry point is checked under image-intensifier control.

Figs. 16-A and 16-B Intraoperative photograph (**Fig. 16-A**) and radiograph (**Fig. 16-B**) showing the Kirschner wire being advanced farther through the dorsal cortex of the metacarpal base to emerge at the dorsal skin with the wrist fully flexed.

- Once the proximal end of the Kirschner wire penetrates the dorsal skin at the wrist, it is grasped with pliers. The Kirschner wire is then pulled proximally by hammering the pliers until the distal end of the wire is located at subchondral bone of the metacarpal head (Fig. 17).
- The second 1.4-mm Kirschner wire is then inserted in the same manner as the first Kirschner wire.

Fig. 17

Fig. 17 The proximal tip of the wire is held with pliers and struck with a hammer in a retrograde direction until the distal end of the wire is located at the subchondral bone of the metacarpal head.

Step 4 (Percutaneous Retrograde Intramedullary Pinning): Kirschner Wire Management

The proximal end of the Kirschner wire penetrating outside the dorsal skin of the wrist enables the surgeon to percutaneously retrieve the Kirschner wire after fracture union.

- Under image-intensifier control, check the coronal and sagittal alignments and check for Kirschner wire tip penetration.
- Flex the fingers passively and check for rotational alignment.
- Because the Kirschner wire lies on the dorsum of the wrist, the wrist position is dependent on the angle of the Kirschner wire. Therefore, extend the wrist forcefully while the Kirschner wire is protruding proximally to allow a more functional position of the wrist (Fig. 18).
- Cut the proximal end of the wires, leaving the tip protruding through the dorsal skin for ease of removal later.

Fig. 18

Fig. 18 The proximal portions of the wires are bent with the wrist in extension to allow a more functional position of the wrist during postoperative management.

Step 5 (Percutaneous Retrograde Intramedullary Pinning): Postoperative Care

The percutaneous Kirschner wire is retrieved.

- Apply an ulnar-gutter short arm splint with finger joint immobilization in the intrinsic plus position for 1 week. The splint is then changed to a short arm splint allowing full range of motion of the MCP and interphalangeal joints.
- Remove the splint at 5 weeks postoperatively and encourage the patient to perform active and passive wrist and finger motion exercises.
- After radiographic confirmation of bone healing, usually between 5 and 8 weeks postoperatively, the Kirschner wires are removed by pulling the proximal tips protruding through dorsal skin. The wires are retrieved percutaneously without anesthesia.

Results

In a previous prospective randomized analysis of patients treated with antegrade intramedullary pinning and percutaneous retrograde intramedullary pinning for displaced fifth metacarpal neck fracture¹, we found that the flexion arc of the MCP joint, visual analog pain scale score, grip strength, and DASH (Disabilities of the Arm, Shoulder and Hand) score⁴ were significantly better in the antegrade intramedullary pinning group at 3 months postoperatively. However, none of these clinical parameters showed a significant difference at 6 months postoperatively. Furthermore, no significant intergroup difference was observed with respect to radiographically determined apex dorsal angulation and metacarpal shortening.

Yamine and Harvey showed that antegrade intramedullary pinning provided better grip strength and fifth digit range of motion, lower pain scores, and fewer complications than percutaneous transverse pinning or miniplate fixation in their meta-analysis of fifth metacarpal neck fracture treatment². However, percutaneous retrograde intramedullary pinning was not included in their analysis.

Pitfalls & Challenges

Antegrade Intramedullary Pinning

- The distal tips of the Kirschner wires are bent to avoid penetration of the volar cortex of the fifth metacarpal. Because the entry hole should be developed in the dorsal cortex of the fifth metacarpal base, Kirschner wires should be advanced distally in a volar direction. Thus, the bent tips of the Kirschner wires should be directed at the dorsal surface of the metacarpal to avoid penetration of the metacarpal volar cortex (Fig. 8).
- A negative aspect of antegrade intramedullary pinning is the need to make an incision in the skin for inserting and removing Kirschner wires. For this reason, some authors^{5,6} have suggested performing antegrade intramedullary pinning percutaneously. We prefer the mini-open technique of making a small incision in order to minimize the risk of injury to important anatomical structures, such as the dorsal sensory branch of the ulnar nerve, the extensor digitorum longus tendon of the fifth digit, and the extensor digiti minimi, as they are all close to the entry point. Thus, we do not favor percutaneous Kirschner wire insertion for antegrade intramedullary pinning.

Percutaneous Retrograde Intramedullary Pinning

- When a Kirschner wire penetrates the metacarpal head, it inevitably damages articular cartilage and the extensor hood, although the amount of tissue damage is small.
- When a Kirschner wire penetrates dorsal soft tissue of the wrist, it may cause injury to the extensor tendon and dorsal sensory branch of the ulnar nerve. In our experience, 2 patients had extension lag of the MCP joint during the early postoperative period. We believe that the probable cause of this extension lag was tethering of the extensor tendon in the wrist, because in both patients the extension lag slowly improved after Kirschner wire removal.

- Pin management is also a procedural problem at the point where the pin exits the skin on the dorsum of the hand. When surgery is performed during the acute stage immediately after the fracture, the shape of the dorsal aspect of the hand will probably change with time as the swelling subsides and cause the protruding wire to act as pressure source on the skin along the dorsum of the hand.

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