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A simple tool for volar tilt restoration during volar plate osteosynthesis of distal radius fracture: A technical note

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ABSTRACT

Anatomical restoration of volar tilt is a technical challenge in a displaced distal radius fracture with a dorsally angulated fracture pattern accompanied by dorsal metaphyseal comminution. We adopted a reduction technique using a mini-Hohmann retractor, to accomplish the desired volar tilt in a controlled fashion. We would like to present this technical note through a case example describing the technique specifics along with one-year postoperative outcomes.

Introduction

Volar plate osteosynthesis is the most common procedure in the operative management of a distal radius fracture [1]. While standard reduction techniques may restore alignment in different planes, complete restoration of desired volar tilt can be challenging in a dorsally angulated fracture pattern with metaphyseal comminution. Despite the advent of newer implant systems and improved techniques, it's not uncommon to notice insufficient correction of volar tilt post-fixation [2,3]. Residual sagittal plane malalignment has been shown to alter ulnocarpal contact forces and joint kinematics leading to suboptimal outcomes, especially in young and high-demand patients [4,5]. To effectively reestablish the anatomic volar tilt, we present a reduction technique using a mini-Hoffmann retractor through a case example describing the technique specifics along with one-year postoperative outcomes.

Case

A 23-year-old male sustained a fall on the outstretched hand while playing baseball, resulting in a closed injury to the dominant right wrist. Plain radiographs demonstrated a dorsally displaced distal radius fracture with 50 degrees of dorsal tilt, dorsal comminution, and radial shortening (Fig. 1). The skin and soft tissues were intact, and the neurovascular exam was unremarkable. He previously had malunited fractures of 4,5 metacarpals from a different injury with no residual functional impairment. The fracture was reduced under conscious sedation and immobilized with a sugar-tong splint. All treatment options were discussed, and given the fracture characteristics, operative management with a volar locking plate system was recommended.

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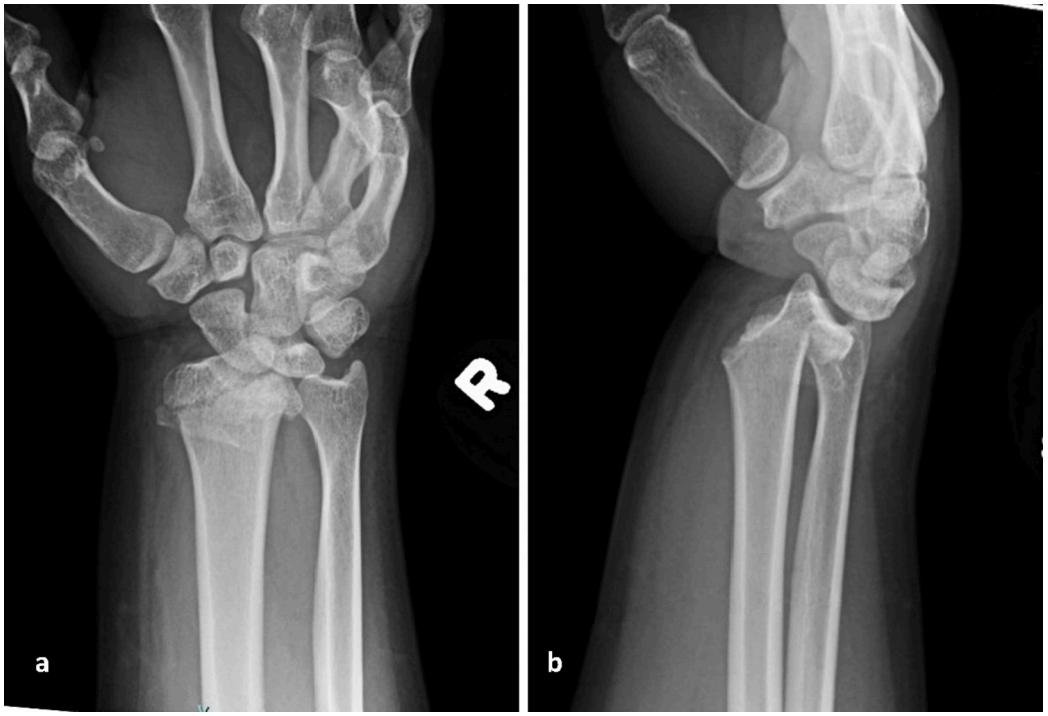

Fig. 1. Posteroanterior (PA) and lateral radiographs of the right wrist showing dorsally displaced distal radius fracture with shortening, comminution at the dorsal cortex, and 50 degrees of dorsal angulation.

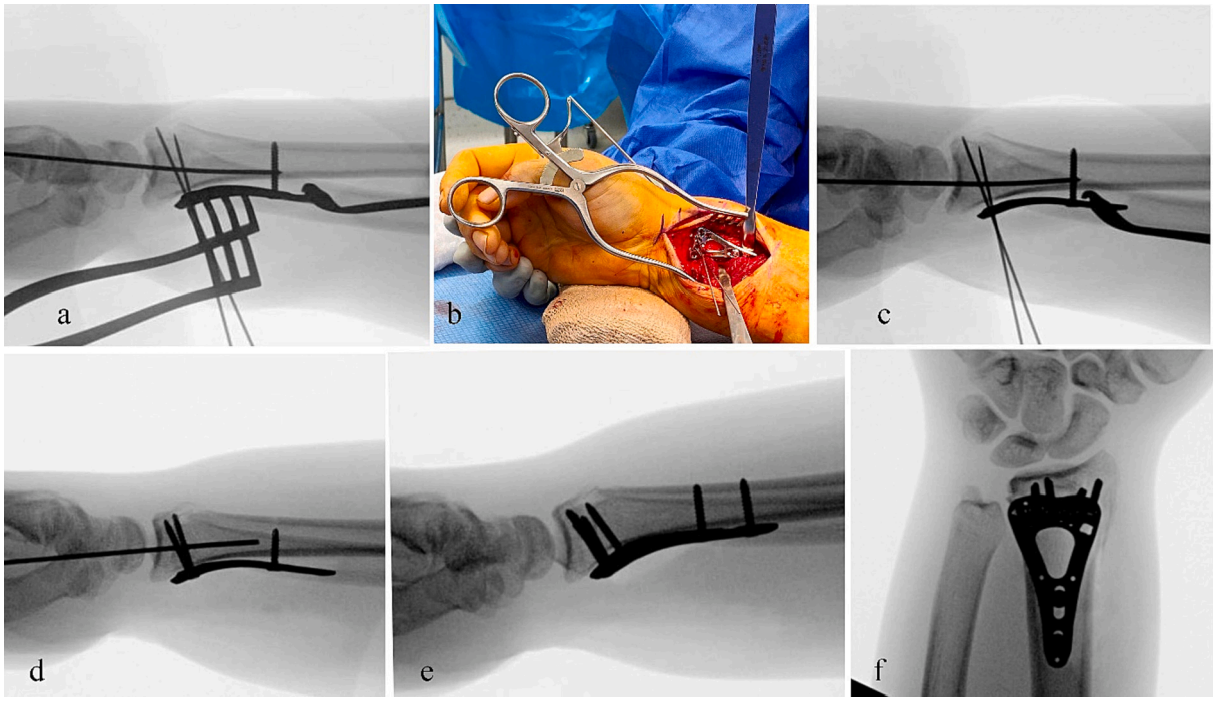

Fig. 2. Intraoperative images: a, use of a mini-Hoffmann retractor to prop the plate up while a bicortical screw is inserted in the oval hole. Fracture is held with a provisional radial styloid K-wire while two additional K-wires stabilize the plate distally; b, clinical image with mini-Hoffmann retractor introduced from the radial side for the desired plate lift; c, controlled lift-off effect as the screw is fully seated; d, screw exchange after distal fixation; e and f, final fluoroscopic images showing anatomic reduction with a 10-degree volar tilt.

Fig. 3. One-year postoperative follow-up images showing a similar volar tilt on both sides.
As measured by the Jamar dynamometer, the grip strength value was 97 lb. on the affected right side (dominant hand), while the contralateral side had 88.5 lb. Similar ROM was noted on both sides, including 85 degrees of volar flexion, 80 degrees of dorsiflexion, 36 degrees of ulnar deviation, 35 degrees of radial deviation, 90 degrees of supination, and 90 degrees of pronation (Fig. 4). The 1-year Disabilities of the Arm, Shoulder, and Hand (DASH) score was 0/100, indicating no disability in the injured extremity.

Operative technique

A standard volar approach through the flexor carpi radialis tendon sheath was utilized to gain access to the distal radius. The fracture was reduced by traction and manipulation, followed by provisional pinning with a percutaneous Kirschner wire (K-wire) inserted from the radial styloid. A 2.4 mm variable angle distal radius locking plate (DePuy Synthes, West Chester, PA, USA) was placed 2 mm proximal to the watershed line and pinned distally with two K-wires inserted through the dedicated holes in the plate. The plate fixation began with applying a bicortical non-locking screw into the elongated combi-hole proximal to the fracture. Attention was paid to selecting a 4 mm longer screw than the measured size. Before the screw tip engaged the far cortex, a mini-Hohmann retractor was placed between the plate and radial shaft to directly elevate the proximal portion of the plate off of the bone (Fig. 2a and b).

As the screw was tightened into the far cortex, the instrument's curved tip wedged between the plate and bone, creating a 'lift-off' effect (Fig. 2c). Attention was then turned to distal fixation starting with a bicortical non-locking screw to achieve adequate plate-bone contact, which was later exchanged with a unicortical locking screw. Four additional unicortical locking screws were inserted in a 'drill-and-fill' fashion. After completing the distal fixation, the trapped mini-Hohmann retractor was removed, and the proximal oversized screw was exchanged with a screw of appropriate length to avoid extensor tendon irritation (Fig. 2d). As the screw was fully seated, the plate with the attached distal segment was brought flush with the radial shaft, thus correcting the dorsal tilt without the aid of additional reduction maneuvers. The remaining proximal-most plate hole was drilled and filled with another bicortical non-locking screw, completing fracture fixation (Fig. 2e and f). Finally, the wound was closed in layers, followed by applying a short-arm splint.

Fig. 4. Final clinical images showing equal ROM of the wrist and forearm on both sides.

Postoperative follow-up

The splint was changed to a brace at two weeks allowing wrist motion, followed by graduated strengthening exercises at six weeks. At 12 weeks, the patient resumed unrestricted physical activity with no residual wrist pain, neurological symptoms, or hardware irritation. During the final evaluation, one-year post-surgery, the radiographic parameters, including volar tilt, were similar between the affected and unaffected sides (Fig. 3).

Discussion

We present a novel technical tip to restore the volar tilt of the distal radius more anatomically using a common Orthopaedic surgical tool. With a mini-Hohmann retractor, the proximal portion of the plate can be held at a sufficient offset from the radial shaft in a controlled fashion, facilitating later correction of dorsal tilt by taking advantage of the plate's pre-contoured anatomical design.

There is a broad consensus among surgeons to aim for restoring volar angulation of the distal radial articular margin to an anatomic value during osteosynthesis. Although various reduction techniques have been described [6–9], it's not always been easier to get a full sagittal plane correction in every situation. In the case of a distal radius fracture with a dorsally directed force vector, the dorsal metaphyseal cortex typically fails under compression producing increased comminution than the volar side. Thus, the resultant asymmetric fracture pattern makes adequate restoration of volar tilt a specific challenge [1,3].

With its pre-built anatomical shape, the volar locking plate can be used as a powerful reduction tool applied either by proximal-first fixation method or distal-first fixation method [6]. Commonly, the plate is first fixated to the distal articular block, and after that, the proximal shaft segment is indirectly reduced to the plate using bicortical non-locking screws, thus allowing correction of dorsal angulation. However, as the proximal portion of the plate is left unsupported during distal fixation, a troublesome off-centering in the frontal plane is likely when the plate is reduced back to the radial shaft.

The described technique has a few specific advantages. Besides achieving controlled lift-off, the mini-Hoffmann retractor with the adjacent bicortical screw maintains the plate alignment in the frontal plane until all distal screws are fixated into the plate hood, thus eliminating the risk of implant off-centering. By increasing the leverage of the retractor, the lift-off distance can be increased, allowing greater correction of sagittal tilt when desired. Lastly, the tool serves as a soft tissue retractor maintaining adequate exposure during osteosynthesis.

The technique is not without limitations. One non-locking screw is typically wasted during the exchange process, adding an extra cost. Also, the ultimate sagittal tilt correction depends on the plate's pre-built anatomical angle, which frequently suffices.

Conclusion

A mini-Hohmann retractor is a simple and reliable tool to effectively restore and fine-tune volar tilt during volar plate osteosynthesis of a distal radius fracture. Thus, it would be of benefit to surgeons by serving as an additional option to the current choice of reduction techniques.

CRediT authorship contribution statement

1. the conception and design of the study, or acquisition of data, or analysis and interpretation of data
2. drafting the article or revising it critically for important intellectual content
3. final approval of the version to be submitted.

Declaration of competing interest

The authors don't have any financial and personal relationships with other people or organizations that could inappropriately influence the presented work.

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