



## Distal radius fracture after proximal row carpectomy

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### ARTICLE INFO

#### Article history:

Received 14 October 2014

Received in revised form 11 January 2015

Accepted 13 January 2015

Available online 15 January 2015

#### Keywords:

Distal radius fracture

Proximal row carpectomy

Kienböck disease

### ABSTRACT

**INTRODUCTION:** We encountered a patient with distal radius fracture (DRF) after proximal row carpectomy (PRC). The mechanism of the DRF after PRC is discussed in this report.

**PRESENTATION OF CASE:** The patient was a 73-year-old female who had undergone PRC due to Kienböck disease before. The wrist range of motion was: 45° on dorsiflexion and 20° on flexion. DRF has occurred at 3 years after PRC. The fracture type was extra-articular fracture. Osteosynthesis was performed using a volar locking plate. No postoperative complication developed, the Mayo score was excellent at 6 months after surgery, and the daily living activity level recovered to that before injury.

**DISCUSSION:** Since the wrist range of motion decreased and the lunate fitted into the joint surface after PRC, making the forearm join with the hand like a single structure, pressure may have been loaded on the weak distal end of the radius from the dorsal side, causing volar displacement and fracture.

**CONCLUSION:** The pressure distribution and range of motion of the radiocarpal joint after PRC are different from those of a normal joint, and the mechanism of fracture also changes due to PRC.

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### 1. Introduction

Proximal row carpectomy (PRC) is a well-established technique for the management of wrist arthritis [1]. Poorer long-term outcomes are likely to result in patients engaged in heavy manual labor, whereas better outcomes may be obtained in patients undergoing PRC for trauma or earlier-stage Kienböck disease [1]. Further, Singh et al. reported that in the patients with scaphoid nonunion advanced collapse and scapholunate advanced collapse wrist, PRC provides better range of motion of the wrist and activities of daily living than before surgery [2]. Therefore, PRC has become a popular surgical procedure for Kienböck disease, especially for stage IIIA or IIIB of Lichtman's classification [3–6].

Distal radius fracture (DRF) after this procedure has not been reported in the English literature. Here, we report a case of DRF that occurred after PRC.

### 2. Presentation of case

The patient was a 73-year-old female who visited the outpatient emergency clinic of our hospital for chief complaints of pain and

deformity of the right wrist joint caused by a fall. She had undergone PRC for Kienböck disease at a hospital 3 years earlier. The range of motion of the wrist joint before injury was 40° on flexion, 30° on dorsiflexion, 90° on pronation, and 90° on supination, and she had no inconvenience in daily living activities (referring to the medical records of the previous hospital). DRF (AO classification; type A2) accompanied by volar displacement was noted on plain radiography (Fig. 1A and B). Since the fracture was volar displacement and the dominant hand was affected, surgical treatment was performed aiming at the early recovery of movement for daily living activities.

The radius was exposed through Henry's approach, and osteosynthesis was performed using a volar locking plate (Acu-Loc 2, Japan Medical Next, Osaka, Japan) (Fig. 2A and B). No immobilization was applied after surgery, and movement of the fingers and wrist joint was permitted as early as possible. At 6 months after surgery, the range of motion of the wrist joint was 35° on flexion, 60° on dorsiflexion, 90° on pronation, and 90° on supination; visual analog scale, 2/10; quick disabilities of the arm shoulder, and hand score, 27.27/100; and modified Mayo score, 84 (excellent). No volar locking plate-associated complication developed, and daily living activities recovered to the pre-injury condition.

The patient was informed that data concerning the case would be submitted for publication, and she consented.

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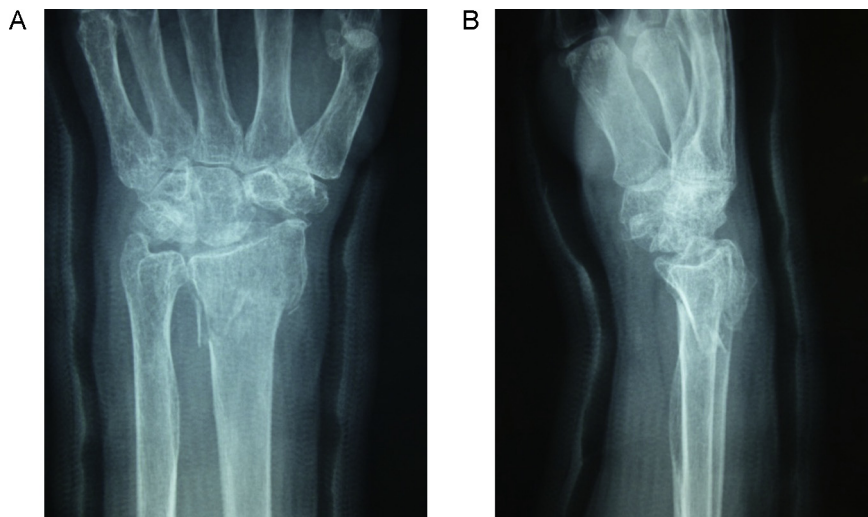


Fig. 1. Distal radius fracture after proximal row carpectomy. A: Frontal view; B: Lateral view.

### 3. Discussion

Many researchers have reported the developmental mechanism of DRF. Lill et al. caused DRF by positioning the wrist joint at 70° on dorsiflexion and 10° on radial deviation in cadavers [7]. Colles' fracture occurred in all cadavers, and the grade of crushing was closely associated with the bone mineral density. Tomizawa et al. investigated the developmental mechanism of DRF using a 3-dimensional bone model based on an experiment reported by Lill et al. [7]. The positions of the lunate and scaphoid with maximum contact areas with the radial joint surface change with movement of the wrist joint. They shift to the volar joint surface on volar flexion and dorsal joint surface on dorsiflexion. Thus, stress was concentrated on the dorsal cortical bone and caused dorsal fracture in the 70° dorsiflexion wrist joint model, and volar fracture occurred in the 70° volar flexion model [8]. Based on these studies, generally, dorsiflexion of the wrist joint is necessary to cause Colles' fracture, and flexion of the wrist joint is necessary for causing Smith's fracture.

In the normal wrist joint, the radiocarpal joint has the largest range of motion on wrist joint flexion, and the angle is about 50°. The flexion angle of the midcarpal joint is about 35°. On wrist joint

dorsiflexion, the angles of the radiocarpal and midcarpal joints are about 35° and 50°, respectively. The region between the lunate and capitate has the greatest range of motion through the midcarpal joint [9]. About 90° flexion and about 70° dorsiflexion of the wrist joint are acquired through the total range of motion of these 2 joints in the normal wrist joint. After PRC, the radiocarpal joint is formed by the capitate and lunate fossa of the radius. Blankenhorn et al. investigated carpal movement after PRC using cadavers, in which the range of motion of the midcarpal joint was larger than that of the radiocarpal joint on flexion and dorsiflexion of the wrist joint [10]. The range of motion of the wrist joint is the total range of motion of the radiocarpal and midcarpal joints in the normal wrist joint, but it decreases after PRC, and the flexion angle of the wrist joint decreases to about 50°. Ulnar deviation is retained, but the range of radial deviation is limited because the triquetrum hits the styloid process of the radius. Because of these, the range of motion of the wrist joint is limited after PRC [10]. Actually, preoperative wrist joint flexion was 40° in this patient.

Although the wrist joint position at the time of injury was unclear, extracapsular volar displacement fracture was caused, suggesting that the injury was due to wrist joint dorsiflexion or flexion.

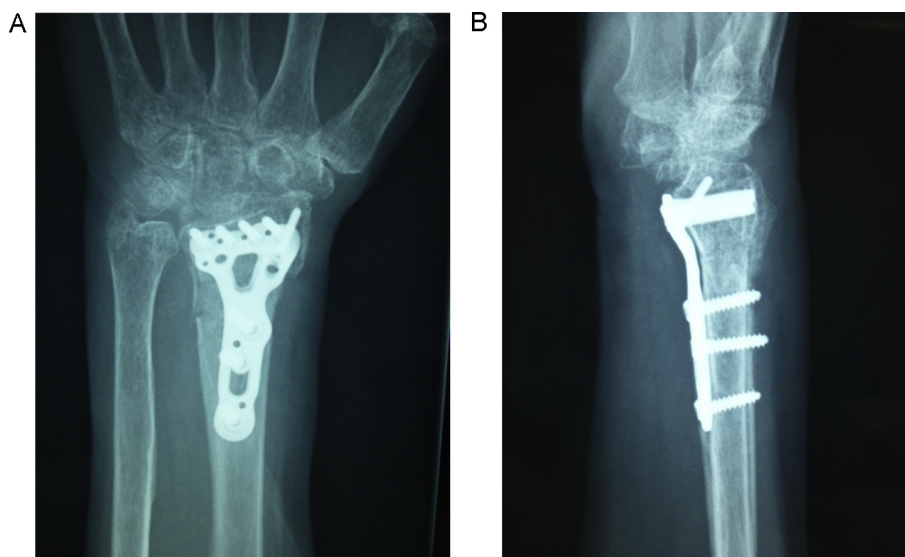


Fig. 2. Postoperative plain radiographs. A: Frontal view; B: Lateral view.

As described above, according to Richou et al., 70° wrist joint dorsiflexion or flexion is necessary to cause DRF [6], but this may be difficult for the wrist joint after PRC. After PRC, the radiocarpal joint is formed by the capitate and lunate fossa of the radius, and the capitate fits into the lunate fossa. Imbriglia et al. reported that the curvature of the head of the capitate accounted for 64 and 60% of the lunate fossa in anterior and posterior views, respectively [11]. Since the contact area of the radius with the lunate fossa is small, axial pressure from the hand may concentrate and cause fracture of the joint surface. However, the range of motion of the wrist joint had decreased and the lunate fitted into the joint surface, which may have joined the forearm with the hand like a single structure. Actually, the range of motion of the wrist joint before injury was 40° on flexion and 30° on dorsiflexion in our case. It is not enough motion to cause fracture of the joint surface. Regarding the carpals over the forearm as one bone, it was assumed that volar fracture was caused by a pressure loaded on the weak distal end of the radius and slight volar flexion of the wrist joint, loading a force from the dorsal side.

Treatment methods for DRF with volar displacement include conservative treatment, pinning with Kirschner wire, and plate fixation. Dzaja et al. compared pinning with Kirschner wire and open reduction/fixation using a volar locking plate, and observed no marked difference in the long-term postoperative outcome [12]. Similarly, Gradl et al. compared non-bridging external fixation and fixation with a locking plate, and observed no difference in the long-term outcome, although a better short-term outcome was noted in the plate-treated patients [13]. Higashi et al. investigated the pressure distribution on the radiocarpal joint after DRF with volar displacement using cadavers [14]. They observed that the contact region in the radiocarpal joint was concentrated on the volar side, and the contact pressure also rose in this region, which may have been a cause of displacement toward the volar side. This displacement may be prevented by applying the buttress plating from the volar side. Based on these, the patient was treated using a volar buttress plate, and a favorable postoperative course was achieved.

#### 4. Conclusion

We encountered a patient with DRF after PRC. The pressure distribution on the radial joint surface after PRC is different from that in the normal radiocarpal joint. Moreover, the range of motion of the wrist joint is limited, suggesting that the developmental mechanism of distal radius fracture is also different from that in the normal radial joint. However, it is possible to treat DRF occurring after PRC by selecting an appropriate treatment method for the fracture type, similarly to the treatment of DRF in typical cases.

#### Conflict of interest

No funds were received in support of this study.

#### Funding

We have no source.

#### Consent

Written informed consent was obtained from patient for publication of this case report and accompanying images. A copy of the written consents are available for review by Editor-in-Chief of this journal on request.

#### Author Contributions

All authors have contributed significantly, and that all authors are in agreement with the content of the manuscript.

Yuka Igeta, Kiyohito Naito, Yoichi Sugiyama, Hiroyuki Obata and Osamu Obayashi performed operation and ward management; Kiyohito Naito, Kentaro Aritomi, Kazuo Kaneko and Osamu Obayashi diagnosed; and Yuka Igeta and Kiyohito Naito wrote the paper.

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