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Case Report

The sole rupture of flexor digitorum tendons to the index finger following volar locking plate fixation of distal radius fracture: A case report

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ABSTRACT

Distal radius fracture is a common injury, especially in elderly people, and internal fixation with volar locking plate (VLP) is becoming an increasingly popular technique for the management of displaced and/or unstable distal radius fractures. One of the most common complications of this treatment is the flexor tendon rupture, mostly of the flexor pollicis longus (FPL). While the rupture of flexor digitorum tendons to the index (FDI) mostly occurs concomitantly with the rupture of FPL after the treatment using volar plating for distal radial fracture, sole rupture of the FDI without FPL rupture is very rare. Here, we report a case of the sole rupture of FDI after volar locking plating and analyze its pathogenesis indicating that the lift-up of the distal ulnar edge of the plate related to the malcorrection of the fracture site is the culprit for this specific complication.

Introduction

Distal radius fracture is one of the most common injuries especially in elderly people. The incidence per 100,000 Japanese population per year was 76.9 in 2005, and it has been increasing constantly [1]. Internal fixation with volar locking plate (VLP) is becoming an increasingly popular technique for management of displaced and/or unstable distal radius fractures [2]. However, flexor tendon irritation has been reported as an uncommon but critical late complication of this technique, the incidence of eventual rupture ranging from 1.4% to 1.6% [3–5]. A systematic review of 21 studies comprising 47 cases suggested that the most affected flexor tendon is flexor pollicis longus (FPL) at 57% and the second common tendon is flexor digitorum profundus to the index (FDP2) at 15% [6]. Interestingly, most of FDP2 ruptures occur concomitantly with other flexor tendon ruptures, especially FPL, thus a sole rupture of flexor digitorum tendon to the index (FDI) after VLP fixation is rare. Here, we report our experience of a sole rupture of FDI with intact FPL after the fixation with volar locking plate for the distal radius fracture and discuss the pathogenesis of this rare condition.

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Fig. 1. The figure shows the distal and proximal interphalangeal joints of her index finger did not passively flex when her wrist was fully extended, indicating that dynamic tenodesis effect was not present.

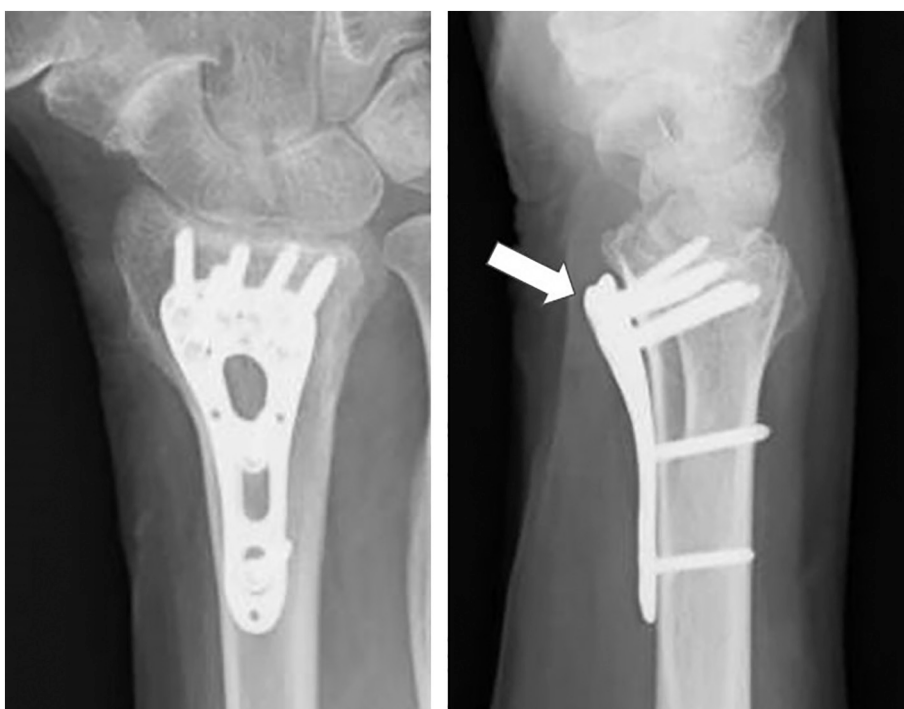


Fig. 2. The X-ray shows the malcorrection of palmar tilt that caused the lift-up of the ulnar side of distal edge of the plate from the surface of radial bone.

A case report

A 72-year-old female, who has received an open reduction and internal fixation with VLP for her right distal radius fracture in another hospital 21 months ago, was referred to our hospital due to the inability to flex of her index finger for 8 weeks. Her symptom occurred suddenly without any triggers or traumas and was not accompanied with any pain, other digits' disabilities, numbness or loss

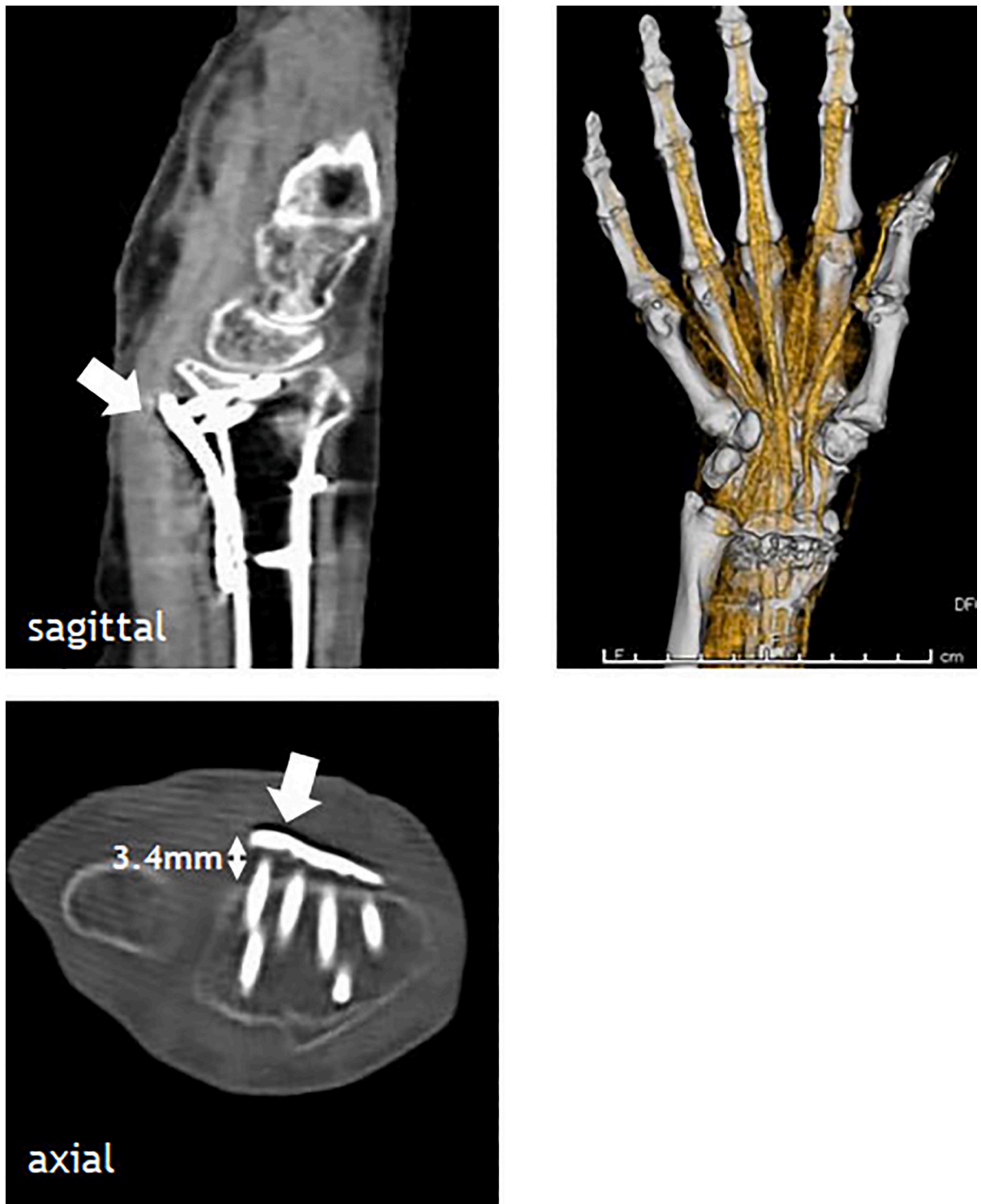


Fig. 3. Computed tomography scan indicates that the distance between the distal edge of the plate and the volar surface of the distal radius was 3.4 mm and the flexor digitorum tendon to the index were ruptured.

of sensation. Clinical findings revealed that she was unable to actively flex the distal and proximal interphalangeal joints of her index finger, and both joints did not passively flex when her wrist was fully extended, indicating that dynamic tenodesis effect was not present. There are also no neurological findings. These findings indicated the rupture of both flexor digitorum superficialis and flexor

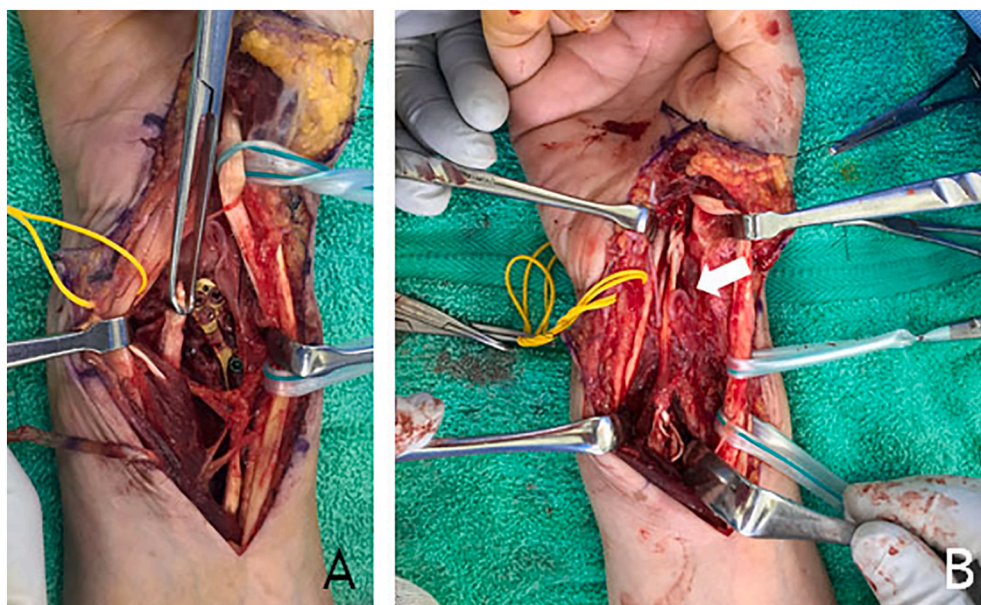


Fig. 4. A: FDP2 tendon was completely ruptured and proximal stump was shrunk and distal stump remained at the distal carpal tunnel. Both of ruptured stump were strongly degenerated. In addition, FDS2 was also ruptured at the same place and FDP3 was slightly damaged. B: Removal of the volar locking plate and reconstruction of FDP2 with the palmaris longus (PL) tendon graft (arrow).

digitorum profundus to the index finger (FDS2 and FDP2, respectively) (Fig. 1).

X-ray showed malcorrection of palmar tilt of the distal radius causing the lift-up of the ulnar side of the distal edge of the VLP from the volar surface of the distal radius (Fig. 2). CT scan indicated that the distance between the distal edge of the plate and the volar surface of the distal radius was 3.4 mm and the FDS2 and FDP2 were ruptured around the distal edge of the plate (Fig. 3).

Operative exploration using the trans-FCR approach confirmed complete ruptures and degeneration of FDS2 and FDP2 tendons. The ulnar side of the distal edge of the plate was lifted up from the volar surface of the distal radius and exposed directly to the sliding course of flexor tendons to the index finger, and it was not covered by soft tissues such as pronator quadratus muscle (PQ). The volar locking plate was removed, the FDP2 was reconstructed with a palmaris longus (PL) tendon graft, and FDS2 was sacrificed (Fig. 4A, B).

Post-operative course went very well with intensive hand therapies including the early mobilization based on Kleinert method for first 2 weeks. The active range of motion (ROM) of the DIP, PIP, and MP joints were $-10^{\circ}/50^{\circ}$, $-5^{\circ}/75^{\circ}$, and $10^{\circ}/70^{\circ}$ (extension/flexion), respectively, at 3 months after operation. Total active motion of the index finger was 190° , which was 86.3% of the unaffected side, and grip strength was 15.3 kg, which was 76% of the uninjured hand.

Discussion

The sole rupture of FDI tendon after VLP fixation is rare because most of the ruptures occur concomitantly with other flexor tendon ruptures, especially FPL. Although the flexor tendon rupture after VLP fixation is mainly caused by excessive distal placement of the plate or prominent screw head [4,6–8], there was no excessive distal placement of the plate or any prominent screws observed in our case. However, malreduction of the fracture which caused the lift up of distal ulnar edge of VLP from the volar surface of the radius was observed, and it was directly involved in the irritation between FDP2 and plate edge. The location of FPL and FDP2 tendons has been reported at an average of 3.1 mm and 2.4 mm respectively at the watershed line in a MRI study [9]. Thus, if the ulnar side of the distal edge of the plate was lifted up more than 2.4 mm, FDPs rather than FPL would be more prominently irritated by the direct contact to the plate. In addition, since FDS2 is located right above the FDP2, it might rupture simultaneously with FDP2. From this perspective, accurate reduction of the fracture and placement of the VLP, covering the distal ulnar edge of the plate with the soft tissues including PQ are especially important to prevent FDI tendon rupture. In addition, early removal of the plate should be considered if there is a possibility of the pathogenesis described above.

Some techniques have been reported for the treatment of flexor tendon ruptures after VLP fixation, i.e. tendon grafts, tendon transfers, end-to-end repair and arthrodesis of interphalangeal joints, however, by any means a worse outcome has been reported compared to the usual flexor tendon injuries [5]. Flexor tendon ruptures after VLP fixation could be categorized in zone V tendon injuries, and there are few reports on the outcome of the zone V tendon repair [10]. Rubensson et al. reported that the results of ROM after reconstruction with free tendon graft are as good enough as the previous reports about flexor tendon reconstructions [5], but the decision regarding which of the various techniques should be applied is possibly dependent on the condition of ruptured tendon stumps. Since both sides of the ruptured tendon stumps were degenerated and shrunk into muscle bellies on the proximal and distal side respectively in our obsolete case, it was impossible to repair the primary end-to-end tendon suture. Therefore, we performed the

reconstruction of the FDP2 using the PL tendon graft after the removal of the VLP. Post-operative course went very well as the total active motion (TAM) of the index finger has improved to 190° (86.3% of the unaffected side), which is defined as 'good' in the functional assessment of Japanese Society of Surgery of the Hand (JSSH) and is comparable enough to the previously published outcomes [5].

In conclusion, it is important to understand the pathogenesis of sole rupture of FDI without any involvement of other tendons including the most commonly affected tendon of FPL. Accurate fracture reduction and plating are the minimum requirements and surgeons must pay attention to the lift-up of the ulnar edge of the plate as a result of poor correction or loss of correction of palmar tilt. It is also important to take into consideration an early removal of the plate to prevent flexor tendon ruptures in such a case.

Ethical consideration

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

The patient was informed that data concerning this case would be submitted for publication and she provided consent.

Declaration of competing interest

All authors have no conflict of interest to be disclosed.

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