Original Article

Incidence of tendon rupture following volar plate fixation of distal radius fractures: A survey of 2787 cases

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ABSTRACT

This study assessed the comprehensive incidence of tendon rupture following volar locking plate (VLP) surgery for a large number of patients with distal radius fractures (DRFs) at multiple facilities in one prefecture, Japan. During the 4-year period, 2787 patients with DRFs underwent fixation using VLP. The overall incidence rates of rupture of the FPL, the extensor pollicis longus, the flexor digitorum profundus of the index finger, and the extensor digitorum communis were 0.35% (10 patients), 0.29% (8 patients), 0.04% (1 patient), and 0.04% (1 patient), respectively.

1. Introduction

The volar locking plate (VLP) has been widely used for patients with distal radius fractures (DRFs), and its use has increased over the past decade.^{1–4} The VLP system provides stable internal fixation to allow early rehabilitation for osteoporotic patients; however, several complications have been reported, including carpal tunnel syndrome, tendon irritation, and tendon rupture.^{2–5}

Flexor pollicis longus (FPL) ruptures are serious complications after use of the VLP system; the prevalence of flexor tendon injury has been reported to be as high as 12%.^{5–7} Several surgeons have tried to identify risk factors for tendon rupture associated with the VLP system.^{8–10} Protrusion of the plate, improper plate position, protruding screw heads, and loss of reduction are recognized as risks for tendon rupture.^{6,11} The plate selection or position should be changed according to the fracture site and relies on the surgeon's technique. In Japan, because of the increase in the elderly population, general orthopedic surgeons, hand surgeons, and trauma surgeons are treating more patients with DRFs. VLP fixation can be performed differently according to the skills of the surgeon. Most reports of FPL rupture associated with VLP fixation are case series with limited sample sizes and involve a limited number of surgeons and institutions available for treatment.^{1,6,7} Therefore, the incidence of tendon rupture following VLP surgery remains unclear. The purpose of the present study was to assess the incidence of tendon rupture by focusing on FPL rupture in a large number of patients with DRFs who were treated with the VLP system. Furthermore, the considerations of the surgeon to prevent FPL rupture-related VLP fixation were also investigated.

2. Materials and methods

A retrospective study was conducted using a questionnaire distributed in Iwate prefecture in Japan. This study was given ethical approval by our institution. The questionnaire was administered by an orthopedic surgeon who performed the surgeries for patients with DRFs; it consisted of two parts. The first part comprised the number of patients who underwent surgery using the VLP system and the number of patients who experienced a tendon rupture between January 2011 and December 2014. Using this questionnaire, the frequency of tendon rupture associated with the VLP system and the incidence of surgery using the VLP system for patients with DRFs were identified. The second part comprised the surgeon's considerations for prevention of FPL rupture-related VLP fixation. It was composed of four questions about plate position, plate selection, repair of the pronator quadratus (PQ), and implant removal after bone union.

Iwate prefecture is located in the northeast part of Japan. The average temperature in January in the capital city is -2.1°C . Iwate prefecture is the second largest prefecture in Japan, with an area of approximately 15,280 km². In January 2015, the population was approximately 1.27 million. Cities are scattered throughout the prefecture because mountainous districts occupy the land. Hospitals able to treat most injuries are located in each area; therefore, people rarely travel to another prefecture for treatment of minor fractures such as DRFs. There are 30 institutions with operating suites and orthopedic surgeons (1 level-1 trauma center, 27 hospitals, and 2 clinics). All 30 institutions enrolled in this study participated, and 53 orthopedic surgeons who were working at these institutions answered the second part of the questionnaire. The mean doctor-years of experience was 13.1 years

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Table 1
Incidence of volar locking palte surgery and tendon rupture during a 4-year period.

	Number of cases
VLP surgery	2787
Tendon rupture	
FPL	10 (0.35%)
EPL	8 (0.29%)
FDPI	1 (0.04%)
EDC	1 (0.04%)

VLP: volar locking plate.

FPL: flexor pollicis longus.

EPL: extensor pollicis longus.

FDPI: flexor digitorum profundus of the index finger.

EDC: extensor digitorum communis.

(range, 3–39 years). Adult patients with DRFs are exclusively treated using the VLP system in this prefecture. Except for open fractures or complications, methods involving pinning or external fixators are rarely used.

3. Results

During the 4-year period, 2787 patients with DRFs underwent fixation using VLP. FPL rupture occurred in 10 patients (0.35%). Extensor pollicis longus (EPL) rupture occurred in 8 patients (0.29%), rupture of the flexor digitorum profundus (FDP) of the index finger occurred in 1 patient (0.04%), and rupture of the extensor digitorum communis (EDC) occurred in 1 patient (0.04%) (Table 1).

Regarding the question about plate position, 46 surgeons mentioned that they cared about the plate position very much, 7 surgeons said they cared about the plate position a little, and no surgeons said that they do not care about the plate position (Fig. 1).

Regarding the plate selection, 19 surgeons said they care about the plate selection very much, 29 surgeons said they care about the plate selection a little, and 5 surgeons said they do not care about the plate selection (Fig. 2).

Regarding the question about PQ repair, 20 surgeons said they repair the PQ whenever possible, 31 surgeons said they repair the PQ if possible, and 2 surgeons said they do not care about the PQ (Fig. 3).

Regarding implant removal, 26 surgeons said they remove the implant in almost all cases, 26 surgeons said they remove the implant depending on the case, and 1 surgeon said that he usually does not remove the implant (Fig. 4).

4. Discussion

Over the course of 4 years, 2787 VLP surgeries were performed in Iwate prefecture, with an incidence of approximately 697 per year. Sakuma reported that the incidence of DRF in Japanese people was 108.6 per 100,000 in the geographically defined area of Sado Island.¹²

Fig. 1. Question about plate position. Do you care about plate location?. Answer 1. Very much 2. A little 3. Do not care.

Fig. 2. Question about plate selection. Do you care about plate selection?. Answer 1. Very much 2. A little 3. Do not care.

Fig. 3. Question about repair or preservation of the pronator quadratus (PQ). Do you repair PQ to cover the plate?. Answer 1. Whenever possible 2. If possible 3. Do not care.

Fig. 4. Question about implant removal. Do you remove the implant after bone union?. Answer 1. Almost all cases 2. Depends on the case 3. Usually do not.

Based on the reported incidence of DRF and the population of our prefecture (approximately 1.27 million), the number of patients with DRF was approximately 1379 per year. Therefore, the incidence of VLP surgery was estimated as 505 per 1000 patients with DRF in Iwate prefecture.

The overall incidence rate of FPL rupture after VLP fixation in the current study was 0.35% (10/2787). FPL rupture rates after VLP fixation were reported as 1.8% (2/114 patients) in 2007⁴ and 1.9% (7/353 patients) in 2009.⁶ However, a recent study reported that FPL rupture occurred after VLP fixation in 2 out of 665 patients (0.3%) in 2013.³ Satake reported that no instances of FPL rupture occurred after 694 VLP fixation procedures in 2016 and that attention was given to the relationship between the implant and the tendon.² Several reports have contributed to the reduction in hardware-related tendon rupture.^{9,10} Soong reported that implant protrusion at the watershed line of the distal radius may increase the risk of tendon rupture.⁹ Kitay recommended implant removal for symptomatic patients with plate positions within 3 mm of the volar rim and suggested the necessity of implant removal when plate protrusion was more than 2.0 mm volar to the critical line.¹⁰ These reports presented the possible implications of plate placement and implant removal.

In addition, flexor tendon injury occurs in the flexor digitorum profundus of the index finger (0.04%). However, except for injury of

the FPL tendon, flexor tendon injuries following VLP surgery occur less often.^{3,4,11} Cross reported a case of compound ruptures of FPL and FDP of the index finger and mentioned that both run along the radial column of the radius.⁷ This anatomical feature is considered to be related to the fragility of FDP of the index finger after VLP fixation. The overall incidence rate of EPL rupture in the current study was 0.29% (8 patients). EDC rupture occurred in 1 patient (0.04%). EPL tendon rupture was a commonly reported extensor injury related to VLP surgery because of locking screw protrusion or drilling of the EPL tendon during surgery.^{2,4} In addition, with conservative treatment, the EPL rupture rate for patients with DRF has been reported to be as high as 5%.¹³ Therefore, the incidence of EPL rupture caused by the implant or operative technique was difficult to conclude.

Several measurements would reduce the risk of FPL rupture-related VLP fixation, such as plate position, low-profile plate design, PQ repair, and implant removal.^{1,6,10} In the present study, most surgeons supported the importance of plate location to avoid FPL rupture. One-third of the surgeons regarded plate selection as very important. In addition, PQ maintenance was also considered very important by one-third of the surgeons. A survey of American Society for Surgery of the Hand in the United States reported that most hand surgeons (83%; 608/753) attempted to repair the PQ after fixation.¹⁴ To prevent FPL rupture, the distal end of the plate should be covered with healthy muscles. However, repaired PQ is not always suitable for covering the edge of the plate because the coverage depends on the plate location, plate shape, and quality of remaining PQ.¹⁵ Further investigation is necessary to determine the validity of PQ repair after VLP fixation.

Regarding the question about implant removal, half of the surgeons mentioned that they remove the implant in almost all cases and half of the surgeons answered that they remove the implant depending on the case. Although several studies tried to identify risk factors for tendon rupture after VLP surgery, there are only a few studies regarding the incidence of hardware removal.^{1,8} Lutsky investigated hardware removal for patients treated with VLP at a single institution and reported that 37 of 374 patients (10%) had their implant removed, with no case of flexor tendon rupture.⁸ Snoddy reported the incidence of and reasons for hardware removal after VLP surgery at a level-1 trauma center.¹ They removed the implant from 33 of 1041 patients (3.17%) during the study period from 2007 to 2013.¹ They reported that reasons for hardware removal were pain, tenosynovitis, plate malposition, malunion, hardware failure, infection, nonunion, and flexor tendon rupture (1 patient). Among these reasons, pain was the only significant predictor of hardware removal.¹ Marked differences regarding the frequency of implant removal were found between the two reports and our study. Because these two reports were conducted in the United States, insurance might have influenced the decision regarding hardware removal. In Japan, patients are not concerned about the cost of implant removal because all people are covered by national health insurance. Many surgeons and patients would rather remove the implant than risk tendon rupture. In this issue, the greater cost of hardware removal after VLP should be considered. Because appropriate indications for hardware removal have not been determined, evidence-based treatment guidelines and further investigations are needed.

This study had several limitations. First, no institution provided information regarding radiographic features of patients. Therefore, we

could not investigate radiographic parameters or compare implant protrusion in patients with and without FPL rupture. In addition, the effects of plate placement on implant removal and tendon rupture were unknown. Second, this study was retrospective in nature during the 4-year period and we did not know when the patients with tendon rupture underwent surgery. It is possible that patients were treated before the study period and that further tendon rupture could occur in the future. Therefore, this study provides an overview of the incidence of tendon rupture after VLP surgery. Finally, this study used chart review data from each institution, and there was no way to determine the accuracy of these data.

One strength of this study was the large number of patients with DRF (2787) treated at 30 institutions. To our knowledge, no other study has investigated such a large sample size and so many facilities. This study revealed the comprehensive incidence of tendon rupture associated with VLP surgery treated at different facilities.

Conflict of interest

None.

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