

Surgical Treatment of Distal Radius Fractures Complicated by Concomitant Flexor Carpi Radialis Brevis: A Case Series and Surgical Techniques

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Learning Point of the Article:

Muscle-type flexor carpi radialis brevis can be sutured to the hypoplastic pronator quadratus to cover the volar locking plate.

Abstract

Introduction: The flexor carpi radialis brevis (FCRB) is a rare anatomical variation, with a reported prevalence ranging from 0.9% to 8.7%. Our previous report showed three cases of FCRB in distal radius fracture (DRF) and found that hypoplastic pronator quadratus (PQ) adjacent to the FCRB muscle made it difficult to cover a volar locking plate (VLP). As we subsequently experienced additional six FCRBs, we report on new findings and surgical tips.

Case Report: VLP fixation was performed on DRF with FCRB in nine limbs of eight patients. The prevalence was 2.9% (9 of 310 limbs). Of the seven patients that underwent unilateral surgery, six were muscle type and one was tendon type. One patient who underwent bilateral surgery had a muscle type on the left and a tendon type on the right. In three muscle types, as the FCRB muscle belly was widely attached to the radial side of the radius and the radial side of the PQ was hypoplastic, postoperative covering of the plate by repair of the PQ was impossible. Then, in two of those cases, the PQ and FCRB were sutured and the plate was covered. FCRB muscle could be retracted to the radial side in all cases. One patient with a tendon type had a ruptured tendon, which was left unrepaired. All patients had no postoperative problems.

Conclusion: In the muscle-type FCRB, the muscle should be retracted to the radial side for VLP fixation. The muscle belly might occupy the radial side of the radius, and the PQ might be hypoplastic and unrepairable. However, the plate can be covered by suturing the PQ and FCRB.

Keywords: Flexor carpi radialis brevis, distal radius fracture, hypoplastic pronator quadratus.

Introduction

The flexor carpi radialis brevis (FCRB) is a rare anatomical variation, with a reported prevalence ranging from 0.9% to 8.7% [1-13]. Nowadays, the most common distal radius fracture (DRF) surgery is volar locking plate (VLP) fixation, and there are many opportunities to expose the palmar side of the radius. The presence of the FCRB has been reported [1-8], and its morphology has been reported to be of the muscle type and tendon type [1, 2]. Our previous report showed three cases of

FCRB in DRF and found that hypoplastic pronator quadratus (PQ) adjacent to the FCRB muscle made it difficult to cover a VLP [3]. As we subsequently experienced additional six FCRBs, we report on new findings and surgical tips.

Case Report

VLP fixation was performed on DRF with FCRB in eight cases and nine limbs from April 2011 to March 2023 (Table 1). The operation was performed with a transflexor carpi radialis (FCR)

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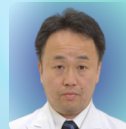
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Case	Age/Sex	Fracture side	FCRB appearance	PQ appearance	VLP covering with PQ	Comment	Presence of a contralateral FCRB
1	72/W	R	Muscle type	Thin	possible		Muscle type*
2	67/W	L	Muscle type	Thin	possible		None*
3	77/W	R	Muscle type	Radial Hypoplasia	impossible	PQ Unrepairable	Muscle type*
4	74/W	R	Muscle type	Thin	possible		Unknown
5	71/W	R	Tendon type	Thin	possible	Lack of FCR and PL	Muscle type
		L	Muscle type	Radial Hypoplasia	impossible	Sutured FCRB and PQ	Tendon type
6	24/W	L	Tendon type	Normal	possible	Tendon ruptured	Muscle type*
7	65/M	R	Muscle type	Normal	possible		Muscle type*
8	65/W	R	Muscle type	Radial Hypoplasia	impossible	Sutured FCRB and PQ	None*

W: Woman, M: Man, FCRB: Flexor carpi radialis brevis, PQ: Pronator quadratus, VLP: Volar locking plate, FCR: Flexor carpi radialis, PL: Palmaris longus, *Confirmed by ultrasonography

Table 1: Clinical details, findings, and outcomes.

approach in all cases. Nine of 310 limbs (2.9%) had FCRB. Of the patients with FCRB, five of seven patients (71%) had bilateral FCRB (checked by ultrasonography; GE Healthcare Japan L4-12r-RS6). All patients had no FCRB-related symptoms before the injury.

Six of the seven patients that underwent unilateral surgery had muscle-type FCRB and one had tendon-type FCRB. One

patient with bilateral DRF underwent bilateral surgery and FCRB was identified in both hands (Case 5); a muscle type on the left and a tendon type on the right. In all cases, the FCRB could be retracted to the radial side and did not interfere with the surgery. In three of the muscle types (Cases 3, 5, and 8), the FCRB was widely attached to the radial side of the radius and the radial side of the PQ was hypoplastic, so postoperative repair of the PQ was impossible. In Case 3, as previously reported, the PQ could not be repaired, so a new procedure was performed from that experience; in Cases 5 and 8, the PQ and FCRB were sutured so that the plate was covered. One patient with a tendon type had a torn FCRB tendon but was left unrepaired (Case 6). However, there were no subsequent complaints. In all cases, the fractures healed and there were no severe complications.

Representative cases

Case 3 (muscle type)

A 77-year-old woman with a right DRF underwent surgery. Trans-FCR approach was performed and a muscle-type FCRB appeared, occupying the radial side of the radius. Retracting the FCRB muscle to the radial side, a radial-side hypoplastic PQ appeared. VLP fixation was performed as planned, however, the PQ was unrepairable, and

Author	Year	Object	Limbs
Macallister [9]	1864	Cadaver	7/177 (4.0%)
Wood [9]	1867	Cadaver	8/106 (7.5%)
Le Double [9]	1897	Cadaver	7/170 (4.1%)
Inoue [10]	1934	Cadaver	2/100 (2.0%)
Shibata et al. [10]	1976	Cadaver	2/133 (1.5%)
Yoshida et al. [11]	1983	Cadaver	4/450 (0.9%)
Mantovani et al. [6]	2010	DRF	6/172 (3.5%)
Ho et al. [1]	2011	DRF	4/46 (8.7%)
Lee et al. [7]	2014	DRF	2/71 (2.8%)
Nagata et al. [2]	2016	DRF	5/123 (4.1%)
Mimura et al. [12]	2017	CTS (MRI)	7/515 (1.4%)
Cheng et al. [8]	2020	DRF	9/133 (6.8%)
Ninomiya et al. [4]	2021	DRF	7/264 (2.7%)
Akkoc et al. [13]	2022	Not stated (MRI)	34/849 (4.0%)
Present report	2023	DRF	9/310 (2.9%)

DRF: Distal radius fracture, FCRB: Flexor carpiradialis brevis, CTS: Carpal tunnel syndrome, MRI: Magnetic resonance imaging

Table 2: Prevalence of FCRB.



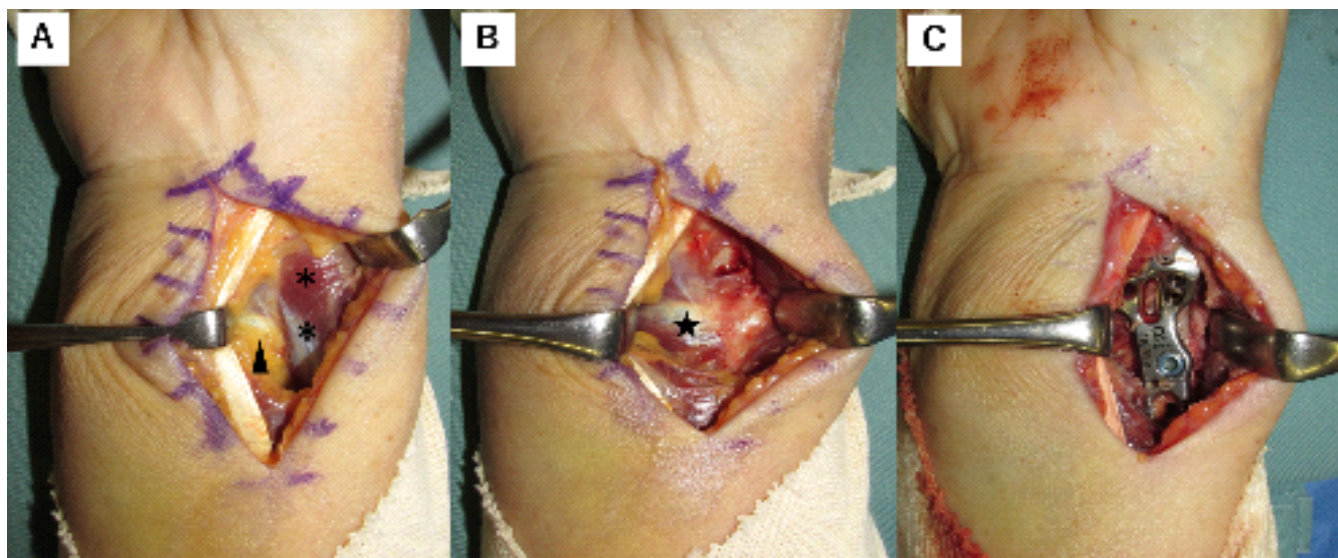


Figure 1: Case 3, muscle type, right hand [3]. (a) Flexor carpi radialis pulled ulnarly; flexor carpi radialis brevis (FCRB) muscle (asterisk) and flexor pollicis longus muscle (arrowhead) seen. (b) Flexor pollicis longus pulled ulnarly and FCRB muscle pulled radially. There is a radial-side hypoplastic pronator quadratus (star). (c) After volar locking plate placement. Hypoplastic pronator quadratus cannot be repaired.

the plate could not be covered (Fig. 1). Ultrasonography 3 months after surgery showed that FCRB and flexor pollicis longus (FPL) were close to the plate, and the FCRB muscle was also found on the healthy side (Fig. 2). Although the patient's progress was good, the plate was removed 9 months postoperatively to avoid FPL tendon rupture.

Case 8 (muscle type)

A 65-year-old woman with a right DRF underwent surgery. Muscle-type FCRB and hypoplastic PQ were confirmed as in Case 3. The radial portion of the PQ was attached to the FCRB. VLP fixation was performed as planned, however, the hypoplastic PQ was likewise unrepairable. Therefore, the FCRB and PQ were sutured and the plate was successfully

covered (Fig. 3). The postoperative course was good, with no signs of FPL interference with the plate, so plate removal was not performed.

Case 5 (tendon type)

A 71-year-old woman with bilateral DRF underwent surgery. On the right hand, tendon-type FCRB was confirmed. The present case additionally lacked the palmaris longus and FCR (Fig. 4). The PQ was thin but repairable after VLP fixation.

Case 6 (tendon type)

A 27-year-old woman with a left DRF underwent surgery. Tendon-type FCRB was identified and ruptured (Fig. 5). There were no tendon degeneration or synovial hyperplasia findings. The tendon component of the FCRB tendon was not found proximally in this surgical field, so it was left unrepaired. The

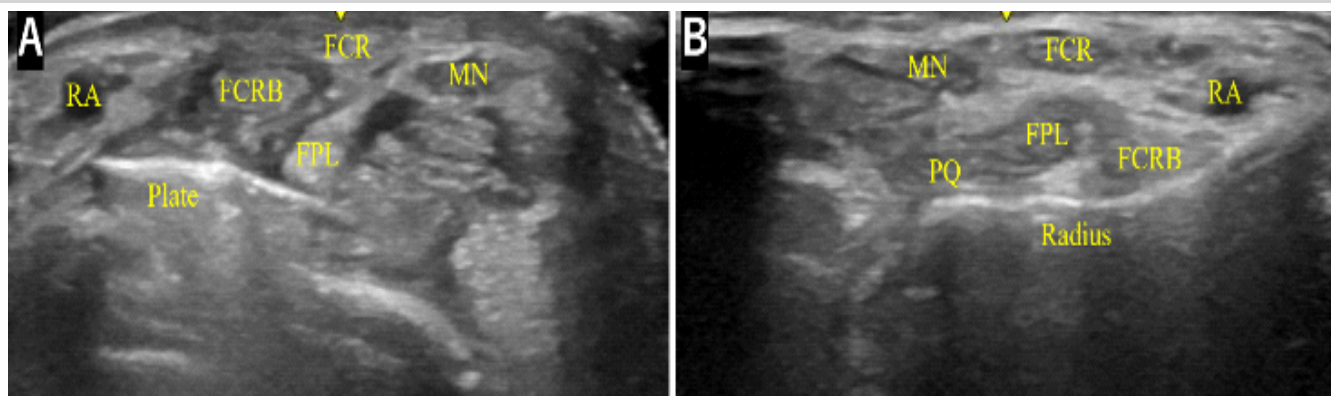


Figure 2: Case 3, ultrasonography 3 months after surgery [3]. FCRB: Flexor carpi radialis brevis, FCR: Flexor carpi radialis, FPL: Flexor pollicis longus, RA: Radial artery, MN: Median nerve. (a) Fracture side. FCRB and FPL are close to the plate. (b) Healthy side. FCRB is identified. pronator quadratus (PQ) is hypoplastic and inserts on the ulnar side of the radius.

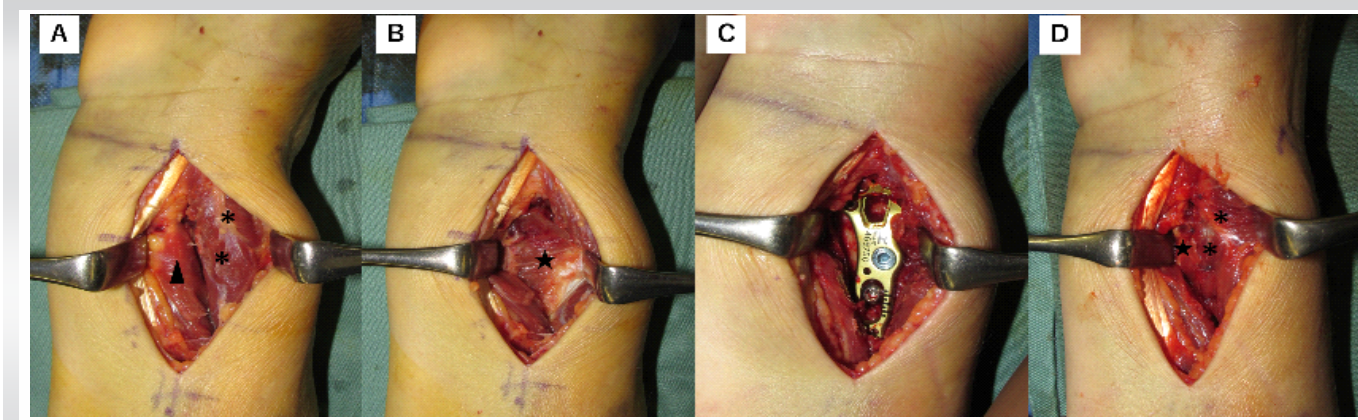


Figure 3: Case 8, muscle type, right hand [5]. (a) Flexor carpi radialis pulled ulnarly; flexor carpi radialis brevis (FCRB) muscle (asterisk) and flexor pollicis longus muscle (arrowhead) seen. (b) Flexor pollicis longus pulled ulnarly and FCRB muscle pulled radially. There is a radial-side hypoplastic pronator quadratus (star). The radial portion of the pronator quadratus is attached to the FCRB. (c) After volar locking plate placement. (d) The plate is covered by suturing the FCRB (asterisk) and pronator quadratus (star).

PQ was normal. VLP fixation was performed as planned and the PQ was repaired. The postoperative course was good and there were no subsequent complaints.

Discussion

FCRB was present in 2.9% (9 of 310) of DRF limbs, similar to previous reports (0.9 to 8.7%) [1-13] (Table 2). First described by Fano in 1851, FCRBs have been sporadically reported in cadavers [9, 10, 11]. Since 2010, FCRBs in DRF surgery have been reported [1-8].

The anatomy is reported to begin on the radial palmar surface of the radius between the distal insertion of the pronator teres and

the PQ, run along the palmar aspect of the PQ into the fibrous sheath of the FCR, and insert at the base of the 2nd–4th metacarpals or at the radial carpal bone (Fig. 6) [9]. In addition to the presence of muscle type and tendon type, there is a possibility that various anomalies may be present, such as hypoplastic PQ as in the present case, deficient FCR and PL as in Case 5, and those that FCRB join the extensor carpi radialis brevis at the palm [10] or pass within the carpal tunnel [11] as reported in previous anatomical studies.

Regarding the surgical approach, the authors retracted all FCRBs radially and had no difficulty with VLP placement; Ninomiya et al. also recommended that the FCRB muscle, which has a large muscle belly, be moved away radially for VLP

fixation [4]. Whereas, Dodds stated that the FCRB could be usually retracted ulnarly but may require complete elevation of the muscle if the origin is distal [14]. To achieve reduction and plate fixation in DRF treatment, Laugharne and Power fully released the FCRB [15], and Werntz et al. resected the FCRB [16]. Because variation in FCRBs has been reported, depending on the shape and size of the FCRB, it might be impossible to move the FCRB to the radial side. Fortunately, we may just not have encountered such a case. However, in the VLP fixation for DRF, because of the importance of exposure of the distal ulnar side of the radius related to the fixation of the volar rim [17], we believe it is better to retract the FCRB to the radial side if possible.

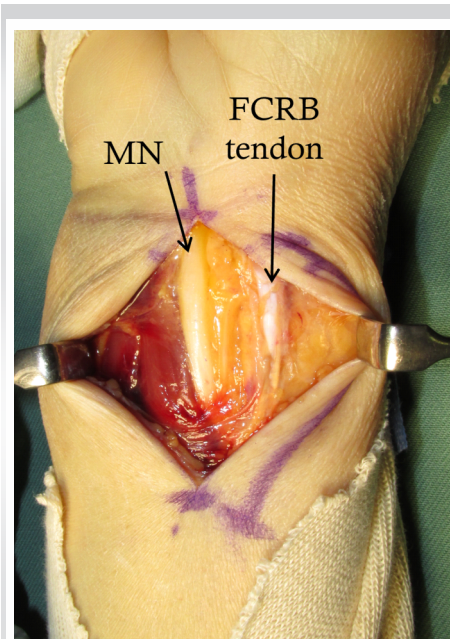


Figure 4: Case 5, tendon type, right hand [5]. Flexor carpi radialis and palmar longus are deficient. The median nerve (MN) and flexor carpi radialis brevis (FCRB) tendon are exposed.



Figure 5: Case 6, tendon type, left hand [5]. Flexor carpi radialis and flexor pollicis longus are pulled ulnarly. The ruptured flexor carpi radialis brevis (FCRB) tendon is grasped with tweezers.

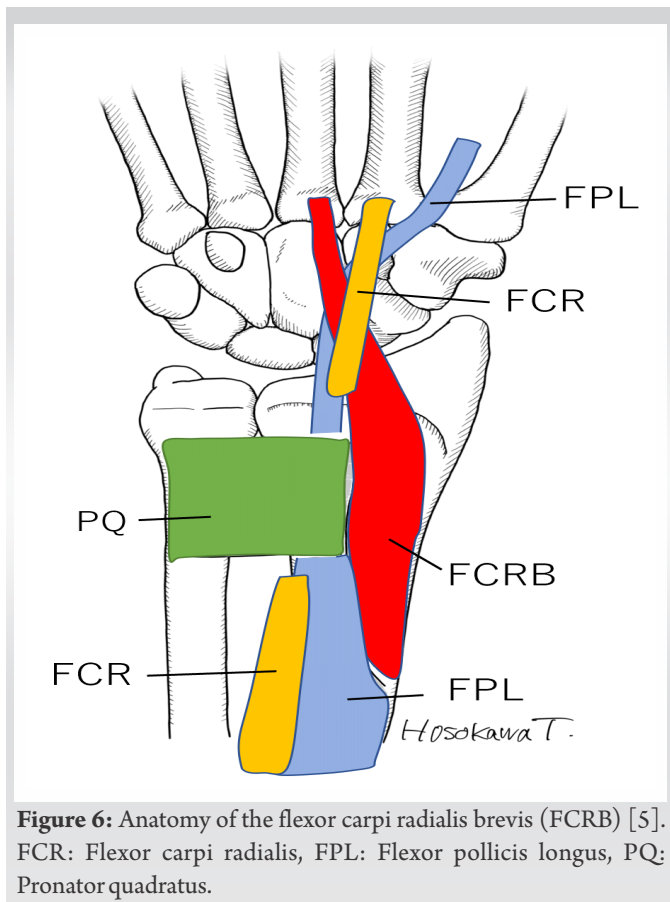


Figure 6: Anatomy of the flexor carpi radialis brevis (FCRB) [5]. FCR: Flexor carpi radialis, FPL: Flexor pollicis longus, PQ: Pronator quadratus.

When a VLP is placed on a DRF, covering the plate by repairing the PQ is recommended to prevent interference between the FPL tendon and the plate [18]. However, past reports noted that if the muscle belly of the FCRB is developed, it may occupy the PQ insertion on the distal radius and cause hypoplastic radial portion of the PQ [2, 3, 4, 5, 14]. We sutured the FCRB muscle and PQ and covered the plate in Cases 5 and 8, based on our experience in Case 3, in which a hypoplastic PQ could not be repaired. Although only two cases, no complaints related to FCRB muscle occurred during the course of the treatment, and

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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we believe that this is a good technique in cases like these.

Meanwhile, when the FCRB is of the tendon type, inflammation and rupture due to interference with the plate are concerned. Nagata et al. reported tenosynovitis of the FCRB tendon in one of two patients with DRF with tendon-type FCRB [2]. In addition, cases of FCRB tendon rupture and tenosynovitis have been reported, although they were not associated with DRF [19, 20]. These reports suggest that the FCRB tendon should be treated with attention to tenosynovitis and that the PQ should be repaired to avoid interference not only with the FPL tendon but also with the FCRB tendon when a VLP is placed on the DRF. However, since the FCRB tendon itself was not functionally important, and no complaints occurred even when the rupture was left untreated as in Case 6, it is considered that repair of the FCRB tendon is not necessarily important when it is ruptured, as long as the FCR is not deficient.

Conclusion

FCRB was present in 2.9% (9 of 310 limbs) of DRF limbs, and 71% (5 of 7 patients) had bilateral FCRB. In the muscle-type FCRB, the muscle should be retracted to the radial side for VLP fixation. The PQ might be hypoplastic and unreparable. Then, the plate can be covered by suturing the PQ and FCRB.

Clinical Message

With the current mainstream of volar plate fixation for DRFs, FCRB is not unlikely to be encountered. Orthopedic surgeons need to be aware of it and deal with it appropriately.

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