The Volar Distal Radioulnar Portal in Wrist Arthroscopy: An Anatomical Study

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Abstract

Background Advances in wrist arthroscopy and the emergence of novel surgical techniques have created a need for new portals to the wrist. The aim of this study was to define and verify the safety of the volar distal radioulnar (VDRU) portal.

Description of the Technique The VDRU portal is located ~5 to 10 mm proximal to the proximal wrist crease, just on the ulnar edge of flexor carpi ulnaris tendon and radial to the dorsal cutaneous branch of the ulnar nerve. The ulnar styloid marks the distal point of the portal.

Methods An anatomical study was performed on 12 upper extremity specimens of 6 human cadavers. Iatrogenic injuries of neurovascular structures potentially at risk were assessed, and the distance from the portal to these structures was measured.

Results No iatrogenic injuries of the structures at risk occurred. Mean distances from the VDRU portal to the ulnar neurovascular bundle, the radial branch of the dorsal sensory branches of the ulnar nerve (DSBUN), and the ulnar branch of the DSBUN were 9.29 ± 0.26 mm, 8.08 ± 0.25 mm, and 10.58 ± 0.23 mm, respectively. There were no differences between left and right wrists. The distances from the VDRU portal to the ulnar neurovascular bundle and the ulnar branch of the DSBUN were significantly shorter in women; this distance was not less than 7 mm in any case.

Conclusions The VDRU portal is safe, reproducible, and facilitates the implementation of various techniques related to triangular fibrocartilage complex pathology.

Keywords
- wrist arthroscopy
- volar distal radioulnar portal
- triangular fibrocartilage complex
- radioulnar joint

Most wrist arthroscopy techniques can be performed adequately through classic dorsal portals,[1] but advances in wrist arthroscopy and the emergence of novel surgical techniques have created a need for new portals to the wrist.[2] Volar portals can facilitate the implementation of these techniques. The development of surgical procedures to repair acute and chronic lesions of the triangular fibrocartilage complex (TFCC) prompted us to design a volar portal at the ulnar level that would provide access to both the distal radioulnar and radiocarpal joints, to facilitate the performance of these procedures and avoid injuring important structures.[3] The volar distal radioulnar (VDRU) portal allows us to have a volar view of both the distal radioulnar joint (DRUJ), if performed proximal to the TFCC, and the radiocarpal joint if performed distal to it.

The aim of this study was to define the VDRU portal, to specify the surgical techniques in which it may be useful, and to verify its safety with an anatomical study by measuring distances to the main neurovascular structures from the ulnar edge of the wrist.

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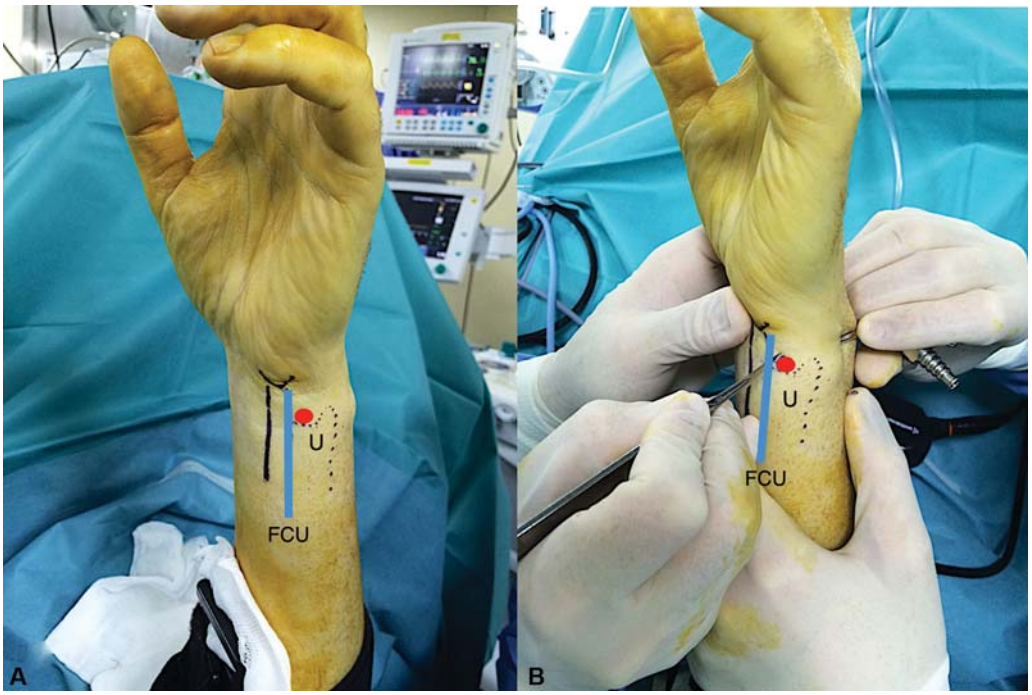

Fig. 1 (**A** and **B**) Anatomical references for the volar distal radioulnar portal in an arthroscopic procedure. FCU, flexor carpi ulnaris tendon; U, ulna.

Surgical Technique: Creation of the Volar Distal Radioulnar Portal

With the hand suspended from a traction tower with 5 to 6 kg of countertraction, standard dorsal radiocarpal portals 3 to 4 and 6R and the dorsal distal DRUJ portal are created. The VDRU portal is located ~5 to 10 mm proximal to the proximal wrist crease, just on the ulnar edge of the flexor carpi ulnaris (FCU) tendon and radial to the dorsal cutaneous branch of the ulnar nerve. Ulnar styloid marks the distal point of the portal (►**Fig. 1**). To facilitate accurate localization, the portal is created by transillumination through the dorsal distal DRUJ portal. This portal can be established using an outside-in technique with a needle or a switch back technique by removing the trocar at the previously marked portal site.

Materials and Methods

A total of 12 upper extremity (including the elbow) anatomy specimens from 6 frozen human cadavers were examined. Three male and three female cadavers were used, with a mean age of 62 years (range, 45–80 years). None of the specimens had a history of sequelae or surgery on the upper extremity.

A standard wrist arthroscopy was performed and the VDRU portal was established as described. The portal and all measurements were made in neutral pronosupination.

An anatomical study was then performed after making a volar skin flap to expose all the structures to be analyzed. Standard dissection instruments and retractors were used. The volar ulnar portal and structures potentially at risk were marked: (1) the ulnar neurovascular bundle; (2) the radial branch of the dorsal sensory branches of the ulnar nerve (DSBUN);[4] and (3) the ulnar branch of the DSBUN[4] (►**Fig. 2**). All dissections were performed using 3.5× loupe magnification to avoid damaging the structures during dissection. Two data were recorded and analyzed: (1) presence of any injury to the structures at risk; and (2) distances to these structures from the VDRU portal. These distances were measured as the shortest distance from the needle (located in the portal) to the structure at risk on a perpendicular line to the axis of the forearm (►**Fig. 3**). The measurements were taken by the same surgeon using a standard surgical ruler, observed by two other surgeons to ensure the quality of the measurements. All measurements were obtained after removing the retractors and recorded every 0.5 mm.

Statistical Analysis

Statistical Package for the Social Sciences software for Windows (version 26.0; SPSS, Chicago, IL) was used for statistical analysis. This consisted of a descriptive analysis of the variables, calculating the frequency distribution for the qualitative variables and the arithmetic mean and standard error of the mean for the quantitative variables. Comparison of the values obtained for the different quantitative variables studied in relation to the independent variables (sex and laterality) was performed using the Mann-Whitney *U*-test. Statistically significant differences were considered for p values <0.05.

Results

After anatomical dissection, three partial lesions of the FCU tendon sheath were recorded, with no tendon injury. There was no iatrogenic damage to the ulnar neurovascular bundle or to the radial and ulnar sensory branches in any of the cadavers.

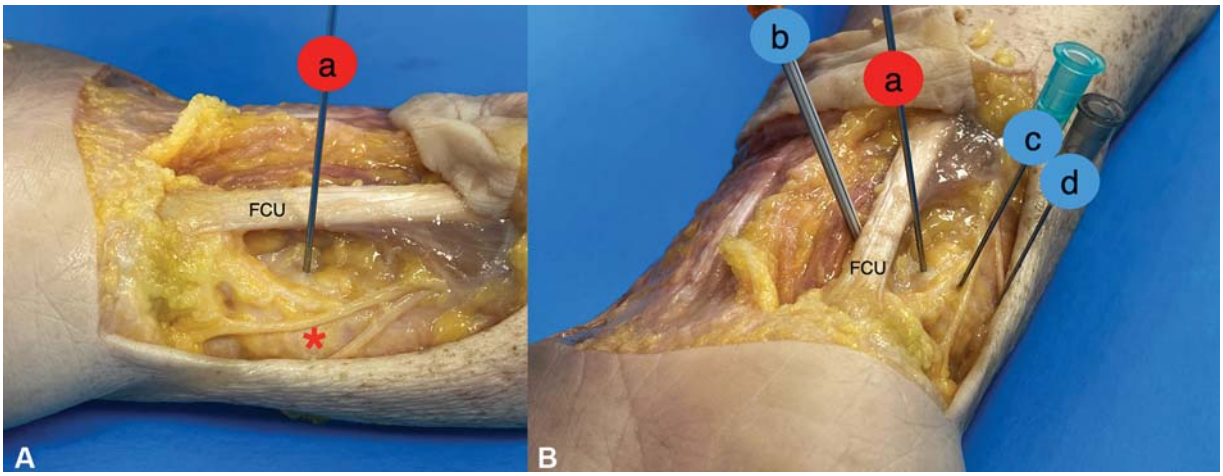

Fig. 2 (**A** and **B**) Anatomical dissection of the volar wrist. (**a**) Volar distal radioulnar portal. (**b**) Neurovascular ulnar bundle. (**c**) Radial branch of the DSBUN. (**d**) Ulnar branch of the DSBUN. DSBUN, dorsal sensory branches of the ulnar nerve; FCU, flexor carpi ulnaris tendon. *Ulnar head.

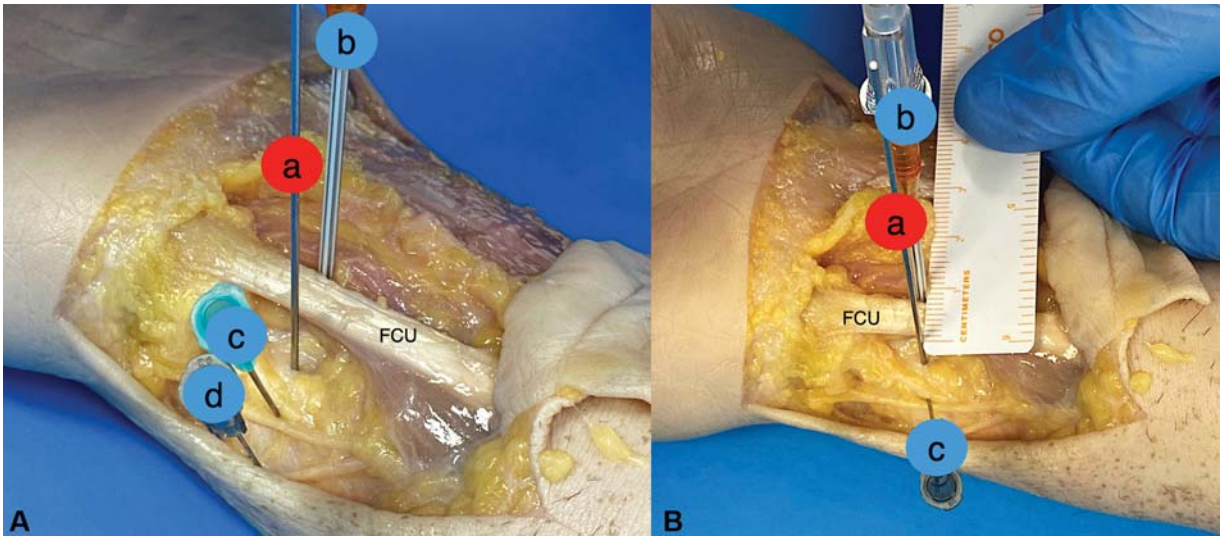

Fig. 3 (**A** and **B**) Measures of the distance to ulnar structures at risk: anatomical dissection view. (**a**) Volar distal radioulnar portal. (**b**) Neurovascular ulnar bundle. (**c**) Radial branch of the DSBUN. (**d**) Ulnar branch of the DSBUN. DSBUN, dorsal sensory branches of the ulnar nerve; FCU, flexor carpi ulnaris tendon.

The mean distances from the VDRU portal to the ulnar neurovascular bundle, the radial branch of the DSBUN, and the ulnar branch of the DSBUN were 9.29 ± 0.26 (range, 8–11) mm, 8.08 ± 0.25 (range, 7–10) mm, and 10.58 ± 0.23 (range, 9.5–12) mm, respectively (►**Table 1**). No statistically significant differences were found between the right and left sides for any of the measured distances. The distance from VDRU portal to the ulnar neurovascular bundle was significantly shorter in women ($p = 0.002$), as was the distance to the ulnar branch of the DSBUN ($p = 0.026$). There were no statistically significant differences between sexes from the portal described to the radial branch of the DSBUN.

Discussion

The VDRU portal is a safe portal, since it is located at a sufficient distance from any neurovascular structures that could potentially be damaged. Although most wrist arthroscopy techniques described can be performed through classic dorsal portals,[1] access through the volar surface is sometimes very useful. Slutsky described several volar portals whose usefulness is widely accepted.[5,6] These have the advantage of allowing the dorsal structures and the volar portions of the carpal ligaments to be visualized, but the drawback of jeopardizing a large number of neurovascular structures that traverse the volar part of the wrist. More recently, Corella et al[2] devised a volar central portal whereby all the volar neurovascular structures were protected by tendons, allowing access to both the radiocarpal and midcarpal joints.

The description of this novel VDRU portal could improve visualization of the DRUJ and the ulnar edge of the wrist from volar, and aid in the development and improvement of different wrist arthroscopy techniques.

In this study, we observed that the VDRU portal is at a mean distance of 8 to 10.5 mm away from the three neurovascular structures that can potentially be injured; moreover, in the 12

Table 1 Mean distances from the VDRU portal to the ulnar neurovascular bundle, the radial branch of the DSBUN, and the ulnar branch of the DSBUN

Specimen	Laterality	Distances to VDRU portal (mm)		
		NV ulnar bundle	Radial branch of DSBUN	Ulnar branch of DSBUN
Man 1	Right	9.5	8	11
	Left	9.5	8	11
Man 2	Right	10	8	11
	Left	9.5	8	10
Man 3	Right	11	10	12
	Left	10.5	9.5	11.5
Woman 1	Right	8	7	9.5
	Left	8	7	9.5
Woman 2	Right	9	8	10
	Left	9	7.5	10
Woman 3	Right	9	8	11
	Left	8.5	8	10.5
Mean		9.29	8.08	10.58
SEM		0.26	0.25	0.23

Abbreviations: DSBUN, dorsal sensory branches of the ulnar nerve; NV, neurovascular; SEM, standard error of the mean; VDRU, volar distal radioulnar.

wrists studied, the shortest distance recorded from the portal to any of these three structures was at least 7 mm, which is a sufficient margin of safety. The shortest distance from the portal to the ulnar neurovascular bundle and the ulnar branch of the DSBUN in women, while significant, does not pose a risk since, as indicated, these structures were located at a distance of $\geq$7 mm in all cases. This portal is therefore at least as safe as the volar radial portal[5] and the volar central portal.[2]

Prior to Slutsky's description of the volar ulnar portal in 2002,[5] few studies had described the usefulness of the volar portals. In 1994, Jantea et al,[7] using cadavers, described two ulnar radiocarpal portals that were medial and lateral to the FCU tendon. Subsequently, Slutsky described two volar portals in detail,[6] created through a 2-cm incision in the skin. The volar ulnar portal is created under the flexor tendons, and its approach extends between the ulnar neurovascular bundle and all the flexor tendons of the fingers. The entry point to the radiocarpal joint is through the ulnolunate ligament adjacent to the radial insertion of the triangular fibrocartilage. The author discovered tears in the volar aspect of the lunotriquetral ligament that were undetectable from a dorsal portal. Compared with the volar ulnar portal,[6] radiocarpal access of the VDRU portal is ulnar to the ulnotriquetral ligament, and the ulnar neurovascular bundle is protected by the FCU tendon. Radiocarpal access from the VDRU portal could theoretically cause injuries to the volar ulnocarpal ligaments (class IC lesions of the TFCC).[8]

Atzei et al[9,10] devised a direct foveal (DF) portal. This is the working portal for the debridement and bone fixation of TFCC proximal tears (Atzei class 3). As a reference for placement of the portal, they used a 22-gauge needle inserted 1 cm proximal to the 6U portal, just volar to the ulnar styloid. Full forearm supination and careful blunt dissection of the soft tissues are required to create the DF portal, to minimize the risk of injury to the DSBUN. Unlike the DF portal, the VDRU portal is more volar and radial, so the risk of injury to the DSBUN is much smaller and allows better triangulation in the distal radioulnar space due to greater distance from the dorsal distal DRUJ portal.

The dorsal branch of the ulnar nerve is divided into an ulnar branch and a radial branch, with the dividing point located at a mean of 22.3 ± 12.2 mm proximal to the ulnar styloid.[4] The VDRU portal takes the styloid ulnar processes as the most distal reference, so the bifurcation point does not appear to be at risk.

Creating this portal (VDRU) may be useful when performing some techniques for the treatment of TFCC. The procedures in which this portal is most frequently used are foveal reattachment of the TFCC in Atzei class 3 proximal tears[3] (►**Fig. 4**), TFCC ligamentoplasty in Atzei class 4 tears,[11] and palliative techniques such as wafer resections[12] (►**Fig. 5**) and arthroscopic Sauvé-Kapandji procedures.[13] This portal also allows access to both the distal radioulnar and radiocarpal joints (►**Figs. 6** and **7**), and the volar structures at risk are protected both by the distance to the portal and the tendons.

The advantage of this portal is that, in injuries where the TFCC articular disc is intact, it can be used as a working and visualization portal in the DRUJ, without having to pierce TFCC disc. Another advantage in arthroscopic ligamentoplasty of the TFCC[11] is that it provides optimal guidance when making tunnels in the sigmoid notch of the radius, while in repairs to the dorsal portion of the TFCC, it helps to visualize these lesions more easily from an opposite view instead of from a peripheral one.

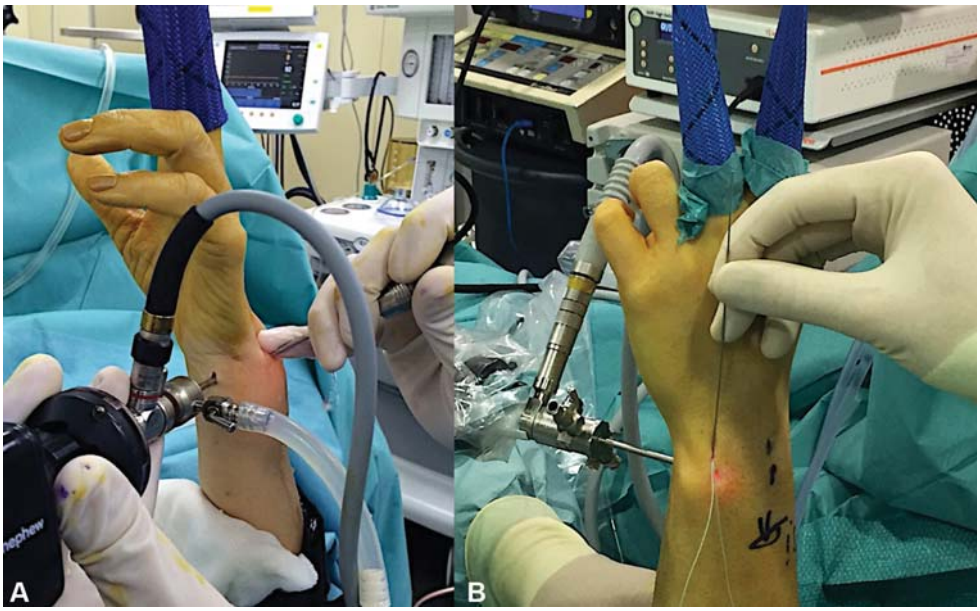

Fig. 4 (**A** and **B**) Foveal triangular fibrocartilage complex reattachment technique: use of volar distal radioulnar portal for vision.

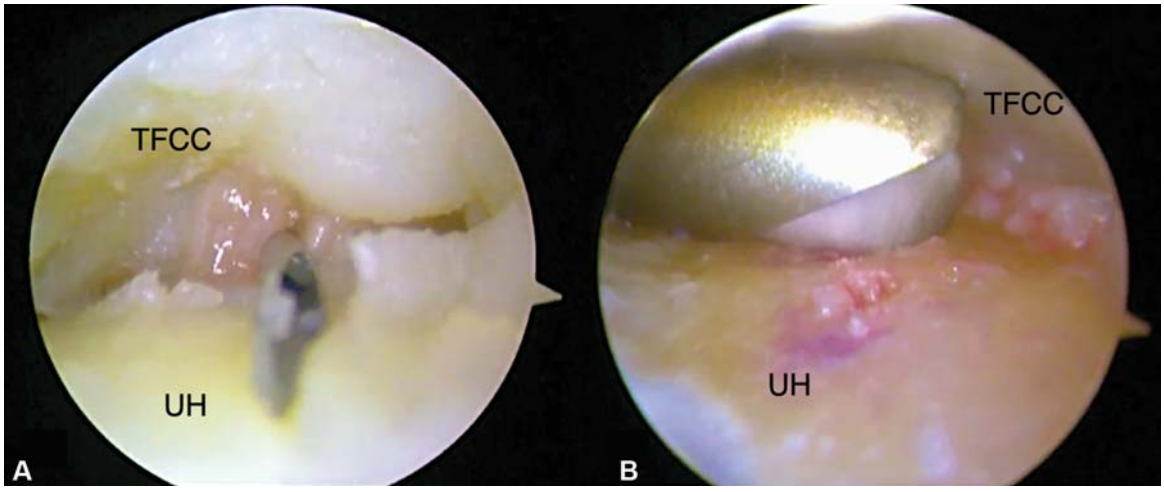

Fig. 5 Arthroscopic view from the dorsal distal DRUJ portal. (**A**) Performance of the VDRU portal. (**B**) Use of the VDRU portal in a wafer procedure. DRUJ, distal radioulnar joint; TFCC, triangular fibrocartilage complex; UH, ulnar head; VRDU, volar distal radioulnar.

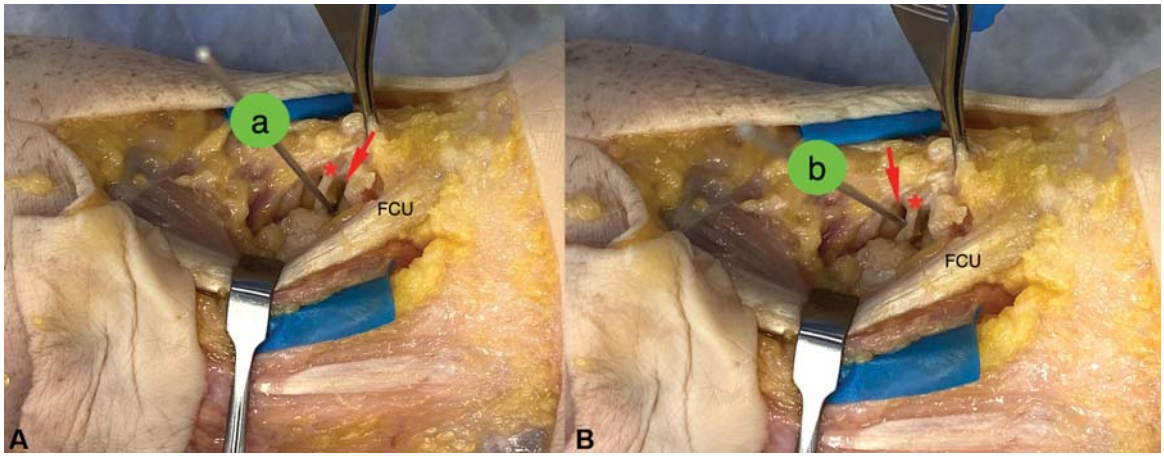

Fig. 6 (**A** and **B**) Anatomical view of the volar wrist. (**a**) Volar distal radioulnar portal in radiocarpal joint (arrow). (**b**) Volar distal radioulnar portal in distal radioulnar joint (arrow). FCU, flexor carpi ulnaris tendon. *Triangular fibrocartilage complex.

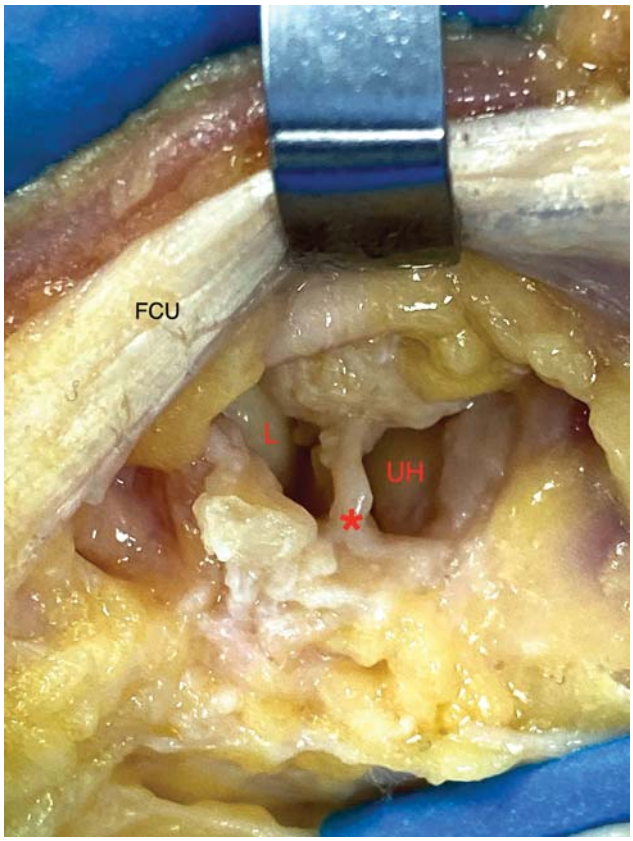

Fig. 7 Anatomical view of the volar distal radioulnar portal localization. FCU, flexor carpi ulnaris tendon; L, lunate bone; UH, ulnar head. *Triangular fibrocartilage complex.

Conclusions

The VDRU portal is a safe, reproducible portal that facilitates the implementation of various techniques related to TFCC pathology. This portal also allows access to both the distal radioulnar and radiocarpal joints, and the volar structures at risk are protected both by the distance to the portal and the tendons.

Note
The work was performed at the Unidad de Cirugía de Mano y Miembro Superior, Hospital QuirónSalud Valencia.

Conflict of Interest
None declared.

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