




# Distal Radius Fracture Volar Approach and the *flexor carpi radialis* sheath. A Regional and National Questionnaire Survey

## *Abordaje Volar de las Fracturas de Radio Distal y la Vaina del Flexor Carpi Radialis. Una Encuesta Regional y Nacional*

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### Abstract

**Introduction** Different approaches have been described for volar plating of distal radius fractures. Accordingly, access to the deep volar compartment may be done through the *flexor carpi radialis* (FCR) tendon sheath (FCR approach) or between the radial artery and the FCR tendon, without violating the aforementioned sheath (classic Henry approach). We have not been able to find any study neither comparing both approaches nor focusing on the potential benefits or risks of each. Our hypothesis is that there is a disparity of opinion between surgeons operating distal radius fractures about which approach is better.

**Materials and methods** An anonymous internet cross-sectional self-completion questionnaire was sent as an email to the members of *Societat Catalana de Cirurgia Ortopèdica i Traumatologia (SCCOT)* as well as the members of the *Sociedad Española de Cirugía de Mano (SECMA)* in order to evaluate their preferences on how to manage the FCR tendon sheath during volar distal radius exposure. Analysis was done using SurveyMonkey analyzing software (*Momentive Inc., San Mateo, California, EE. UU.* [www.momentive.ai](http://www.momentive.ai)) with cross-table data, and trends were extrapolated.

**Results** From October 2020-2021 a total of 99 answers were obtained, 55 Upper Limb/Hand and 41 General Orthopaedic Surgeons. 72,72% usually open the FCR sheath and 63% of them think this surgical gesture facilitates their surgery. 21,21% prefer to

### Keywords

- ▶ Radius Fracture
- ▶ volar approach
- ▶ flexor carpi radialis
- ▶ tendon sheath

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preserve FCR tendon sheath and 53% choose this approach because it causes less complications. Excessive scarring and iatrogenic neurovascular injury are the most feared complications.

**Conclusion** The disparity of opinions shown in this survey towards opening or preserving the FCR tendon sheath and the justification given might serve as a basis for designing clinical studies comparing both approaches.

## Resumen

**Introducción** Se han descrito diferentes abordajes volares para para la osteosíntesis de las fracturas de radio distal; algunos de ellos acceden a través de la vaina del *flexor carpi radialis* (FCR) (Abordaje FCR), mientras que otros evitan abrirla (Abordaje Henry clásico). En la literatura no encontramos estudios que comparen si existen diferencias entre ellos. Nuestra hipótesis es que, a pesar de ello, existen diferentes opiniones al respecto entre los cirujanos que operan estas fracturas.

**Materiales y métodos** Se realizó una encuesta online a los miembros de la *Societat Catalana de Cirurgia Ortopèdica i Traumatologia (SCCOT)* y a los de la *Sociedad Española de Cirugía de Mano (SECMA)* a través de un cuestionario anónimo utilizando la plataforma de SurveyMonkey (*Momentive Inc., San Mateo, California, EE. UU.* [www.momentive.ai](http://www.momentive.ai)) con el objetivo de valorar sus preferencias con respecto al manejo de la vaina del tendón del FCR. El análisis de las respuestas se realizó a través de tablas con filtros y tabulaciones cruzadas utilizando el software de análisis del mismo programa.

**Resultados** Desde Octubre 2020-2021 se obtuvieron 99 respuestas, 55 cirujanos de extremidad superior o mano y 41 cirujanos ortopédicos generales. 72,72% abren la vaina del FCR, 63% creen que ello facilita su cirugía. 21,21% prefiere respetar la vaina tendinosa y el 53% opinan que preservarla disminuye el riesgo de complicaciones, siendo el exceso de fibrosis y la lesión yatrogénica de las estructuras neurovasculares las más temidas.

**Conclusiones** Creemos que existe discrepancia de opiniones en cuanto al manejo de la vaina del tendón del FCR en el abordaje volar de las fracturas de radio distal y la justificación de elegir un abordaje u otro. Dada la alta incidencia de estas fracturas y la ausencia de análisis clínicos previos, los resultados obtenidos en esta encuesta podrían servir como base para la realización de estudios clínicos en el futuro.

## Palabras clave

- ▶ Fractura de radio
- ▶ Abordaje volar
- ▶ Flexor carpi radialis
- ▶ Vaina del tendón

## Introduction

Among upper limb fractures, distal radius fracture (DRF) is the most frequent reason for consultation in the emergency department and its incidence appears to be on the rise.<sup>1-3</sup>

Volar plating has become a mainstay for those fractures that need surgery since Orbay described his technique.<sup>4</sup>

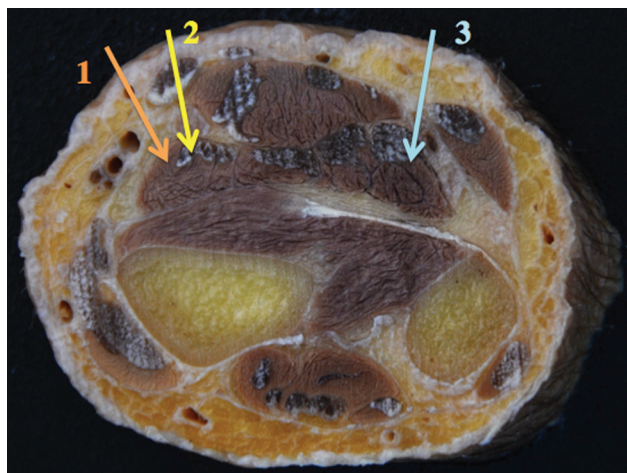
Although there might be some variations, there are mainly three anatomical approaches that allow distal radius volar access. These are: the Henry approach, the *flexor carpi radialis* (FCR) approach, and the volar extended approach.<sup>5</sup> The first two are frequently used since both provide a magnificent exposure of the volar region of the distal radius.

Variations for these approaches have been described.<sup>4-11</sup> All of them are similar regarding the locations of the skin incision and the deepest anatomical dissection. However, they might differ in its superficial dissection, since the access to the deep volar compartment may be through the FCR

tendon sheath (also known as a trans-FCR, FCR approach, or modified Henry approach depending on the literature reviewed) or between the radial artery and the FCR tendon, without violating the aforementioned sheath (classic Henry approach)<sup>5,7</sup> (► **Figure 1**).

The FCR is one of the muscles of the superficial volar muscle compartment in the forearm. Its muscle fibers end about 8 cm before the radiocarpal joint, where its tendinous portion is surrounded by a synovial sheath up to its distal insertion. At the level of the trapezius, the tendon stays isolated from the carpal tunnel by a wide septum which will be part of its own osteofibrous tunnel.<sup>12,13</sup>

Because of its close relationship, there are some neurovascular anatomical structures that run the risk of being damaged while exposing the distal radius through a volar approach<sup>7</sup> (► **Figure 2**). Theoretically, preserving the FCR tendon sheath prevents it from impairing its vascularity, which might have an influence on postoperative scarring and fibrosis<sup>13,14</sup> as well as protecting the palmar cutaneous



**Fig. 1** Volar distal radius fractures (DRF) approaches.<sup>5</sup> 1 (orange): Classic Henry approach, between the radial artery and FCR sheath; 2 (yellow): the FCR or trans-FCR approach; 3 (blue): the volar extended approach.

branch (PCB). However, the radial artery is potentially more at risk.

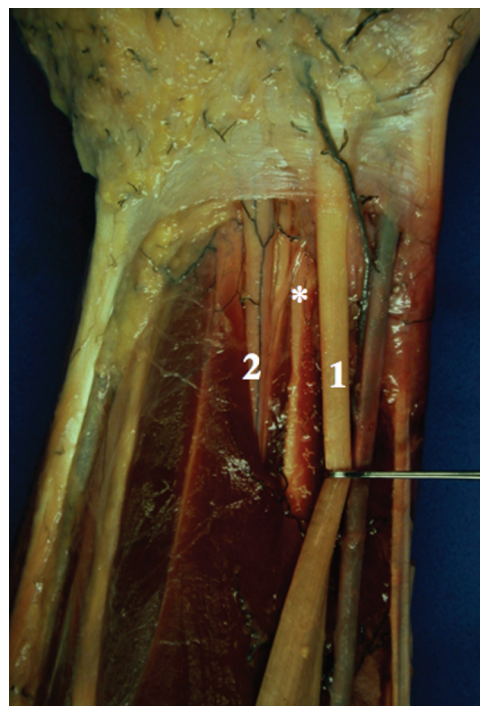
On the contrary, the FCR approach protects the radial artery, as it doesn't require its direct dissection, but it is closer and therefore has more potential risk of damaging the PCB.<sup>7</sup> Another theoretical advantage of this approach is that by opening the FCR sheath it offers a wider view of the anteromedial region of the distal radius, making open reduction of intraarticular distal radius fractures easier, especially those with a volar lunate facet key fragment.<sup>4,6,15,16</sup>

Despite this theoretical reasoning, we have not been able to find any study neither comparing both approaches nor focusing on the potential benefits or risks of opening the FCR sheath during distal radius fracture exposure. Furthermore, we have the feeling that there is controversy among surgeons treating distal radius fractures regarding which approach should be used.

Our hypothesis is that there is indeed controversy among the surgeons who treat these fractures. For this reason, we decided to design a self-completion questionnaire survey. The main aim was to detect disparity in the preference for one approach or another. The secondary objectives were to evaluate whether the preference varies depending on the subspecialty of the surgeon and see the reasons that may influence their choice.

## Materials and Methods

An internet cross-sectional self-completion questionnaire using SurveyMonkey (*Momentive Inc., San Mateo, California, EE. UU.* [www.momentive.ai](http://www.momentive.ai)) comprising 4 multiple choice questions plus an extra free question with descriptive responses was designed in order to answer our hypothesis. The time expected to answer the whole questionnaire was 1 minute. The form was sent as an email to the affiliates of the regional Catalan Orthopaedics and Traumatology Society (*Societat Catalana de Cirurgia Ortopèdica i Traumatologia (SCCOT)*) as well as the members of the national Spanish



**Fig. 2** Anatomical relationship between the median nerve, and its palmar cutaneous branch (PCB) (\*), the median nerve (1) and the *flexor carpi radialis* (FCR) (2)

Hand Surgery Society (*Sociedad Española de Cirugía de Mano (SECMA)*), in order to cover different profiles of surgeons treating distal radius fractures. This email contained a brief introduction covering the topic, its aim, a reminder of its anonymity, and a request not to leave any questions blank. Below, the 4 questions and their multiple-choice answers were exposed, followed by a link plus a QR code that opened the survey program so that it could be completed online. The language used was Spanish for the members of the National Society (*SECMA*) and Catalan for the surgeons of the regional society (*SCCOT*). The survey was anonymous, and the email was only sent once (► **Figures 3** and **4**).

The survey platform was available and open throughout a year (October 2020-2021) so that we could collect as many responses as possible. Statistical analysis was done using SurveyMonkey (*Momentive Inc., San Mateo, California, EE. UU.* [www.momentive.ai](http://www.momentive.ai)) analyzing software with cross-table data and Excel tables, and trends were extrapolated both with raw numbers and percentages.

Absolute and relative frequencies are used to describe the results of the survey. The exact binomial distribution is used to test the preference for opening the FCR sheath and provide an estimation of its 95% confidence interval. To assess whether the preference varied depending on the surgeon's subspecialty, the Fisher exact test was used. The R software was used<sup>17</sup> applying a significance level of 5%.

## Results

A total of 99 surgeons answered the survey, 51 were active members of SCCOT, and 48 were surgeons of SECMA. There

### Fijación de la fractura del radio distal: abordaje volar y vaina del flexor radial del carpo

Las fracturas del radio distal son una de las fracturas más comunes que se presentan en los servicios de urgencias. Desde que Orbay describió su técnica en 2001, las placas de osteosíntesis volares de ángulo fijo se han utilizado con éxito para tratar la gran mayoría de estas fracturas. Para ello, se han descrito diferentes abordajes anatómicos; algunos de ellos acceden a través de la vaina del *flexor carpi radialis* (FCR), mientras otros evitan abrirla con intención de preservar esta estructura.

Desde el Servicio de Traumatología del Hospital Universitario Arnau de Vilanova de Lleida estamos realizando un trabajo de investigación relacionado con este tema.

El propósito de esta encuesta es poder hacerse una idea sobre cuál de estas dos opciones es la más utilizada entre los cirujanos que tratan este tipo de fracturas.

Los datos de esta encuesta son anónimos. Tanto los contenidos como los resultados serán tratados con la máxima confidencialidad.

Por favor, rellene las 4 preguntas que encontrará en el enlace y/o el código QR que se adjuntan continuación sin dejar ninguna en blanco. Muchas gracias por su ayuda.

#### 1. Soy ...

- Cirujano plástico
- Cirujano ortopédico general
- Cirujano ortopédico de extremidades superiores o mano
- Otro (específico)

#### 2. ¿Con qué frecuencia opera fracturas de radio distal?

- Nunca
- <5 al mes
- 5-10 al mes
- > 10 al mes
- Otro (específico)

**Fig. 3** and **4** Email example in Spanish for SECMA members including the questionnaire as well as the Survey link and QR Code in order to access SurveyMonkey (Momentive Inc., San Mateo, California, EE. UU. www.momentive.ai) platform and answer online.

were 55 Upper Limb/Hand Surgeons, 41 surgeons who regarded themselves as General Orthopaedic Surgeons, 1 Plastic Surgeon, 1 considered him or herself a Shoulder Surgeon and there was 1 omitted answer in this question, which was the only one in the entire survey. Generally speaking, 59 of 99 (60%) usually operated less than five distal radius fractures a month. Among responders, there was a clear preference for opening FCR sheath of 72 out of 99 (72,72%), significantly different from indifference (50%), with a p-value < 0.0001 and an estimated exact binomial 95% confidence interval of [62.9%, 81.2%]. However, 21/99

(21,21%) chose Henry's approach, and 6/99 (6%) answered opening FCR sheath just sometimes.

Focusing on General Orthopaedic surgeons, 35/41 (85,36%) were active members from SCCOT, 36/41 (87,80%) operated on less than 5 distal radius fractures a month, 30/41 (73,17%) chose to open the FCR sheath and there was heterogeneity in the reason why their approach was chosen, being the sense of easiness the most picked answer 21/41 (51,22%) among the other options. Concentrating on Upper Limb/Hand surgeons, 41/55 (74,54%) were active members of SECMA, 30/55 (54,54%) operated between 5-10 distal



radius fractures a month, 41/55 (74,54%) opened the FCR sheath during their surgery and 29/55 (52,72%) chose their access to volar distal radius because of its effortlessness. Regarding the choice of one approach or another, there were no statistical significant differences between General Orthopaedic surgeons and Hand/Upper Limb surgeons (Fisher exact test  $p$ -value = 1)

Among the group of surgeons who opened the FCR sheath, 43/72 (61%) were upper limb and/or hand surgeons and 46/72 (63,88%) contemplated this gesture makes their surgery easier, while 15/72 (21%) surgeons operating through the FCR believed that this approach offered less complications. From the 9 answers given to why opening FCR sheath is less risky, 5 considered the approach gives wider and/or more comfortable exposure, 6 thought this approach protects the median nerve as well as the PCB, and 2 named the radial artery as a potential structure at risk if the dissection is made between the FCR tendon and the artery itself.

Of 21/99 (21,21%) surgeons who selected not to open the FCR sheath, 11/21 (52,38%) considered that preserving this structure offers less complications, 2/21 (9,52%) thought it makes its surgery simpler, 4/21 (19,04%) just learned it this way and 4/21 (19,04%) had other reasons which were not specified. In total, 13/21 (62%) who chose this approach were Upper Limb/Hand Surgeons. All of those who decided to give an explanation on why preserving FCR tendon sheath may be less detrimental agreed that this approach avoids painful scarring, fibrosis, and extra articular stiffness.

## Discussion

During the last years, volar plating for distal radius fractures has risen widely and it's still in growth. However, complications after such surgery shouldn't be underestimated. For the purpose of this study, we are just going to name those related to surgical dissection through an anatomical area surrounded by key neurovascular structures. In this regard, radial artery injury has been described. This can be either a direct rupture of the vessel while operating or by creating a pseudoaneurysm because of friction or concussion during the dissection. There are also nerves around this anatomical region potentially at risk. Among them, median nerve neuropathy is the most dreaded. However, smaller neural structures such as the PCB and the superficial branch of the radial nerve are also at risk. Moreover, injury to these sensitive nerves has been related to complex regional pain syndrome, with a rated incidence of 3–10%.<sup>18</sup>

The difference between opening the FCR sheath or not has generated debate over which approach is safer. Hereof, some cadaveric studies have been done based on the conception that thorough comprehension of the anatomy diminishes possible iatrogenic injury.<sup>7,14,19</sup>

According to the survey, some discrepancies between surgeons operating on these fractures were found. Nonetheless, there was a tendency to open the FCR tendon, and

this was not different between hand or general orthopedic surgeons. Similarly, there was no difference between subspecialties in the main reason given for opening the sheath, which was making their surgery easier, and this inclination did not differ between the surgeons who operated more DRF from those who operated less. The main reason for preserving the sheath, however, was not making the access less difficult, but avoiding complications. According to their answers, apparently, painful scarring, fibrosis, and extra articular stiffness seemed to be the main concerns.

Among the 9 surgeons who gave their reasons on why the approach they used may cause less complications, only five talked about the median nerve and/or the PCB. All of them opened the FCR sheath and regarded this approach as safer in this respect, contrary to what some anatomical and observational studies have come up with.<sup>7,19,20</sup> An anatomical study made by *Conti Mica et al (2016)*<sup>7</sup> on volar distal radius approaches showed that when opening the ulnar side of the FCR in the modified Henry approach (which is done by opening the FCR sheath), both the PCB and the median nerve are at hazard. Notwithstanding, the radial artery is closer and therefore more susceptible to being damaged in the classic Henry approach (► **Figure 2**). Their study showed that at an average of 10 proximal to the wrist crease, the median nerve lies at 0,1mm of the FCR tendon. The more distal the more distance between these two structures, being 4,5mm the mean space from one to another at the wrist crease. On the other hand, serious complications such as complex regional pain syndrome, pillar pain, scarring, and fibrosis have been related to PCB injury during volar distal radius approaches. *Samson et al (2017)*<sup>21</sup> identified seven patients with iatrogenic PCB injury during volar DRF osteosynthesis from a retrospective 5-year database revision, two of them presenting CRPS symptoms. The PCB is located on the radial side of the median nerve, close to the FCR tendon at this level (► **Figure 1**). Conclusively, the following ideas are exposed in their study: firstly, bearing in mind these anatomical relationships is paramount when operating distal radius fractures. Secondly, setting aside the FCR to its ulnar side gently should keep the nerves described safe. Thirdly, during the modified Henry approach, the FCR sheath should be opened through its radial side in order to avoid PCB injury.<sup>7</sup>

In contrast with this, there are other studies describing several anomalous branching patterns of the PCB in relation to the FCR tendon have been published.<sup>19,20</sup> *Glickel et al (2019)*<sup>19</sup> for instance, found that anatomical variations of the trajectory of PCB around the FCR sheath can be contemplated in roughly 18.8% of patients. Among these variations, there were PCBs that crossed volar, dorsal or ran within the FCR sheath.<sup>19</sup> Similarly, *Jones et al (2016)*<sup>20</sup> carried out an observational study in which ten surgeons attended DRF surgery in which an FCR approach was used in order to detect PCB anomalies for 7 months (July 2015-January 2016). They concluded that opening the FCR tendon sheath through its radial side is safe most of the time, but one should not forget

that there are anatomical variations one should be aware of.<sup>20</sup>

Because of the nature of the study, there are some evident limitations. The main limitation is the low number of participants. The eagerness of the target population to reply is a common drawback of any survey research study. For this reason, we try to design a really short questionnaire and let it be available for a year. However, we assume that unless it was answered soon or straightforwardly once receiving the e-mail, the chances of forgetting about completing the questionnaire were high. Besides, the questionnaire was sent by email and answered electronically, which produces selection bias by making the computer-literate population more prone to fill it out. Furthermore, they need to be active members of one of the two societies mentioned at the same time. Another source of potential bias is that the survey has only been sent to a national and regional group of surgeons. Spreading these questions to a broader population or outside the country might show either more or less disparity of opinion, a fact that might reinforce or otherwise weaken our hypothesis. The same or else a similar questionnaire could be sent abroad in order to bear out whether this is not geographically influenced.

Nevertheless, there was a low rate of non-answered questions (1 out of 99 × 4 mandatory responses) which shows a high compliance rate.

All in all, despite the aforementioned limitations, we think that this survey shows that, apart from the lack of evidence in this field, there is also disagreement between surgeons who treat DRF. Accordingly, more clinical research need to be done to arrive a conclusion.

## Conclusion

Given the current elevated incidence of distal radius fracture and the disparity of opinions found, in addition to the absence of studies focusing on this field, we think that this survey might serve as a basis for designing studies comparing both approaches in order to determine whether opening or preserving the FCR sheath is somehow better or safer.

### Conflict of Interest

The authors ensure they have no conflict of interest in this subject.

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## References

- MacIntyre NJ, Dewan N. Epidemiology of distal radius fractures and factors predicting risk and prognosis. *J Hand Ther* 2016;29(02):136–145
- Stirling ERB, Johnson NA, Dias JJ. Epidemiology of distal radius fractures in a geographically defined adult population. *J Hand Surg Eur Vol* 2018;43(09):974–982
- Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. *Hand Clin* 2012;28(02):113–125
- Orbay JL, Badia A, Indriago IR, et al. The extended flexor carpi radialis approach: a new perspective for the distal radius fracture. *Tech Hand Up Extrem Surg* 2001;5(04):204–211
- Ilyas AM. Surgical approaches to the distal radius. *Hand (N Y)* 2011;6(01):8–17
- Orbay JL, Gray R, Vernon LL, Sandilands SM, Martin AR, Vignolo SM. The EFCR Approach and the Radial Septum-Understanding the Anatomy and Improving Volar Exposure for Distal Radius Fractures: Imagine What You Could Do With an Extra Inch. *Tech Hand Up Extrem Surg* 2016;20(04):155–160
- Conti Mica MA, Bindra R, Moran SL. Anatomic considerations when performing the modified Henry approach for exposure of distal radius fractures. *J Orthop* 2016;14(01):104–107
- Tannan SC, Pappou IP, Gwathmey FW, Freilich AM, Chhabra AB. The Extended Flexor Carpi Radialis Approach for Concurrent Carpal Tunnel Release and Volar Plate Osteosynthesis for Distal Radius Fracture. *J Hand Surg Am* 2015;40(10):2026–2031.e1
- Igeta Y, Vernet P, Facca S, et al. The minimally invasive flexor carpi radialis approach: a new perspective for distal radius fractures. *Eur J Orthop Surg Traumatol* 2018;28(08):1515–1522
- Gwathmey FW Jr, Brunton LM, Pency RA, Chhabra AB. Volar plate osteosynthesis of distal radius fractures with concurrent prophylactic carpal tunnel release using a hybrid flexor carpi radialis approach. *J Hand Surg Am* 2010;35(07):1082–1088.e4
- Clembosky G, Rodríguez GLG. Fractura de radio distal: abordaje mínimamente invasivo con preservación del pronador cuadrado. *Rev Asoc Argent Ortop Traumatol* 2015;80(03):150–157
- Bishop AT, Gabel G, Carmichael SW. Flexor carpi radialis tendinitis. Part I: Operative anatomy. *J Bone Joint Surg Am* 1994;76(07):1009–1014
- Schmidt HM. Clinical anatomy of the m. flexor carpi radialis tendon sheath. *Acta Morphol Neerl Scand* 1987;25(01):17–28
- Raspanti A, Delcroix L, Ghezzi S, Innocenti M. Study of the tendinous vascularization for the compound radial forearm flap plus flexor carpi radialis tendon. *Surg Radiol Anat* 2016;38(04):409–414
- Alteret et al. - 2019 - Complications of Volar Plating of Distal Radius Fr.pdf.
- Hintringer W, Rosenauer R, Pezzei C, et al. Biomechanical considerations on a CT-based treatment-oriented classification in radius fractures. *Arch Orthop Trauma Surg* 2020;140(05):595–609
- R Core Team. 2022R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>
- Berglund LM, Messer TM. Complications of volar plate fixation for managing distal radius fractures. *J Am Acad Orthop Surg* 2009;17(06):369–377

- 19 Glickel SZ, Glynn SM, Chang AL, Janowski JW, Barron OA, Catalano LW III. Anomalous Courses of the Palmar Cutaneous Branch of the Median Nerve in Relation to the Flexor Carpi Radialis Tendon for ORIF of Distal Radius Fractures. *Hand (N Y)* 2020;15(04):521–525
- 20 Jones C, Beredjikian P, Matzon JL, Kim N, Lutsky K. Incidence of an Anomalous Course of the Palmar Cutaneous Branch of the Median Nerve During Volar Plate Fixation of Distal Radius Fractures. *J Hand Surg Am* 2016;41(08):841–844
- 21 Samson D, Power DM. Iatrogenic Injuries of the Palmar Branch of the Median Nerve Following Volar Plate Fixation of the Distal Radius. *J Hand Surg Asian Pac Vol* 2017;22(03):343–349