The Course of the Terminal Posterior Interosseous Nerve and Its Relationship with Wrist Arthroscopy Portals

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Abstract

Purpose The terminal branches of the posterior interosseous nerve (PIN) are the main articular branch on the dorsal aspect of the wrist. Its relationship to dorsal wrist arthroscopic portals has not yet been elucidated. The purpose of this study was to quantitatively describe the anatomical relationships between the dorsal wrist arthroscopic portals and the PIN.

Methods Dorsal wrist arthroscopic portals were established in 28 cadaver extremities, after which the limbs were dissected. Measurements were taken from the portals to the PIN.

Results The PIN passed ulnar to the 3/4 portal with a mean distance of 4.8 mm (range: 1.2–12.0, standard deviation [SD] = 2.6). The PIN passed radial to the 4/5 portal with a mean interval of 9.0 mm (range: 3.8–12.7, SD = 2.3). The main trunk of PIN or its closest terminal branch was a mean of 7.2 mm (range: 0.0–13.2 mm, SD = 3.1) radial to the midcarpal radial (MCR) portal. In 2 of the 28 specimens, one terminal branch of PIN lay directly over this portal. The distance between the midcarpal ulnar (MCU) portal and the PIN or its closest terminal branch was only a mean of 1.6 mm (range: 0–6.4 mm, SD = 2.0). In 15 of the 28 specimens, the PIN lay directly over the MCU portal, or the portal was located between the terminal branches of PIN.

Conclusion The MCU portal was the most precarious, due to the close proximity of PIN and its terminal branches. The 3/4 and MCR portals were also at risk, while the 4/5 portal was relatively safe for the PIN.

Keywords

- ▶ arthroscopy
- ▶ wrist joint
- ▶ posterior interosseous nerve
- ▶ anatomy

Wrist arthroscopy has been used extensively in recent years as both a diagnostic and therapeutic procedure.^{1,2} Dorsal portals are regularly used. Although the periportal anatomy has been well described,^{3–8} complications do occur.^{9–11} The terminal branches of the posterior interosseous nerve (PIN) are the main articular branches to the dorsum of the wrist. Perineural fibrosis and neuroma of the PIN have been reported as causes of persistent pain in the dorsum of the

wrist.^{12,13} Injury to the PIN or its terminal branches may occur during wrist arthroscopy¹⁴ and may be a cause of unsatisfactory result after wrist arthroscopy. To our knowledge, there is no detailed description of the anatomy of the PIN and their relationships to the arthroscopic portals in the English literature. The purpose of this study was to quantify the anatomic relationships between the PIN and the wrist arthroscopy portals.

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Materials and Methods

A total of 28 cadaver extremities (4 fresh and 24 embalmed) were examined. The specimens were evaluated as follows: 5 to 6 mL saline solution was instilled into the radiocarpal joint with an 18-gauge needle through the 3/4 portal. All portals were established by incising the skin longitudinally just through the dermis, taking care not to penetrate the subcutaneous layer. A fine hemostat was used to spread the subcutaneous tissue down to the capsule, after which the capsule was penetrated with a blunt trocar. The portal tracks were then labeled with India ink. The skin was removed, and the deep tissues including the extensor tendons were exposed. The portal tracks were followed into the joint to confirm proper portal placement. Then the extensor tendons were excised. The PIN was identified and traced to the dorsum of the wrist. Each portal was filled by the trocar in turn and measurements were taken with calipers from the trocar to the PIN or the closest branch. It was noted if any of PIN had been divided while placing the trocar. The 3/4, 4/5, midcarpal radial (MCR), and midcarpal ulnar (MCU) portals in all 28 specimens were measured in turn.

Results

The PIN proceeded distally on the interosseous membrane in the distal forearm together with the posterior branch of the interosseous artery. The nerve was wrapped in perineural fat. At the level of the extensor retinaculum, the PIN was consistently found on the radial wall of the fourth dorsal compartment covered by a sturdy fascia. Enlargement of the nerve was seen beneath the sturdy fascia adjacent to Lister tubercle. At the level of the radiocarpal joint, the PIN passed ulnar to the 3/4 portal, then proceeded ulnarly and divided into two to four terminal branches to supply the midcarpal joint and the second, third, and fourth carpometacarpal joints distally (►Fig. 1).

Fig. 1 Arborization of the PIN. It was on the radial wall of the fourth compartment at the level of Lister tubercle, then it curve ulnarly and divided into two to four terminal branches to supply the intercarpal joint and the second, third, and fourth carpometacarpal joints. The left side is proximal. PIN, posterior interosseous nerve.

Relationships between PIN and 3/4, 4/5 Portals

Distances of 3/4 and 4/5 portals from the PIN are shown in ►Table 1. The PIN passed ulnar to the 3/4 portal with a mean distance of 4.8 mm (range: 1.2–12.0, standard deviation [SD] = 2.6). Further-on it passed radial to the 4/5 portal, and the mean interval was 9.0 mm (range: 3.8–12.7, SD = 2.3).

Relationships between PIN and MCR, MCU Portals

The PIN, then curved ulnarly just distal to the radiocarpal joint. At the level of midcarpal joint, it divided into two to four terminal branches in all specimens. Usually, the PIN lay close to

Table 1 Distances of wrist arthroscopic portals from the PIN

Sample	3–4 portal (mm)	4–5 portal (mm)	MCR portal (mm)	MCU portal (mm)
1	2.8	9.4	5.4	6.4
2	4.8	12.0	4.5	1.7 ^a
3	5.0	11.5	1.8	3.8
4	4.2	11.2	4.7	0.0
5	11.5	7.75	13.2	1.2
6	7.8	9.4	8.0	2.6
7	3.4	7.6	10.4	0.0
8	6.6	8.4	3.3	0.6
9	7.9	8.5	13.1	1.2 ^a
10	3.5	8.4	0.0	6.2
11	3.0	9.8	7.4	0.0
12	2.4	9.7	9.2	5.0 ^a
13	3.6	7.8	6.8	2.9
14	1.2	12.7	0.0	0.0
15	1.4	5.7	6.2	0.0
16	4.7	6.4	5.2	4.3
17	4.4	5.5	6.8	0.0
18	5.0	9.3	5.6	0.0
19	5.7	7.6	6.8	0.0
20	1.4	10.0	7.1	0.0
21	5.1	9.6	10.0	1.3
22	6.0	11.7	7.9	4.7
23	2.6	9.9	7.4	0.0
24	3.5	9.2	8.8	0.0
25	4.1	5.0	7.6	0.0 ^a
26	12.0	3.8	10.0	1.2
27	7	11.7	9.3	1.6
28	3.8	12.0	10.0	1.2
Mean	4.8	9.0	7.3	1.6
SD	2.6	2.3	3.1	2.0

Abbreviations: MCR, midcarpal radial; MCU, midcarpal ulnar; PIN, posterior interosseous nerve; SD, standard deviation.

^aThe portal located among the terminal branches of PIN.

the MCU portal (► **Fig. 2A**). Distances of MCU and MCR portals from the PIN are shown in ► **Table 1**. The interval between the MCU and PIN or any closest branch was a mean of 1.6 mm

(range: 0–6.4, SD = 2.0). In 15 of the 28 specimens (54%), the PIN lay directly over the portal (► **Fig. 2B**), or the branches were separated and the portal was found located between the

Fig. 2 Three types of relationships between the MCU portal and the PIN. (A) Usually, the PIN or its terminal branches lay close to the MCU portal. The right side is proximal. (B) The main trunk of PIN directly lay over the MCU portal. The right side is proximal. (C) One of the terminal branches lay over the MCU portal. The right side is proximal. MCU, midcarpal ulnar; PIN, posterior interosseous nerve.

terminal branches (→ Fig. 2C). The PIN or any closest branch was a mean of 7.2 mm (range: 0–13.2, SD = 3.1) radial to the MCR portal. In 2 of the 28 specimens, one terminal branch lay directly over the portal.

Discussion

The radiocarpal and midcarpal joint, combined together may be innervated by as many as eight separate branches, and the PIN is the main articular branch on the dorsal aspect of the wrist. It innervates the radiocarpal and midcarpal joints in the zone between the extensor carpi radialis brevis and ulnaris tendons.¹⁵ Any injuries or disorders affecting the wrist and distal forearm may damage the PIN, leading to perineural fibrosis, intraneural fibrosis, and microneuromas, thereby contributing to or causing persistent dull aching pain in the dorsal aspect of the wrist. Transection of the PIN may provide pain relief and improvement in wrist function.¹²

Wrist arthroscopy has been used increasingly for the diagnosis and treatment of wrist disorders over the past 20 years. The technical aspects of wrist arthroscopy have been described in detail.^{1,2} Although the periportal anatomy has been well elucidated,^{3–8} we have not found published data delineating the relationships between the PIN and its terminal branches and the wrist arthroscopy portals. A more thorough understanding of their relationships would improve the safety of the portals and may explain some of the poor results after wrist arthroscopy.

Several anatomic studies have been published on the PIN, describing its size, location, and the number of fascicular bundles.^{15,16} At the level of the extensor retinaculum, the PIN is usually found on the radial wall of the fourth compartment. Just distal to the radiocarpal joint, the PIN divides into three to four terminal branches to supply the midcarpal joint and distally reaching the second, third, and fourth carpometacarpal joints. The result of our study was consistent with these reports. The course of the nerve was in the zone among the dorsal portals for arthroscopy of the wrist. Theoretically, injury to this nerve may occur during wrist arthroscopy. del Piñal et al have reported a case of total avulsion of the PIN during wrist arthroscopy.¹⁷ After their arthroscopic examination, an open repair was required, and during the exposure they found that the PIN was avulsed in relation to the 3/4 portal.¹⁷ Several reports have discussed the complications of wrist arthroscopy, and neurological complications have been reported. But as far as we know, no PIN injury was mentioned. Beredjiklian et al⁹ reviewed 210 consecutive wrist arthroscopy procedures, and identified a total of 11 complications (5.2%). Among them, three patients developed transient superficial dorsal ulnar sensory neurapraxia. No PIN injury was reported. Culp¹⁰ and Rodeo et al¹⁸ reviewed the neurological complications of wrist arthroscopy but did not identify any PIN injury. Warhold and Ruth¹⁴ mentioned that injury to this nerve may occur during wrist arthroscopy, but no such case was reported in their article.

Our anatomical study found that the mean interval between the PIN and the 3/4 portal was 4.8 mm and at the level of the radiocarpal joint, the PIN was covered by a sturdy

fascia, and proximally the nerve is tightly adherent to the radial wall of the fourth extensor compartment. Culp¹⁰ has emphasized that during portal development it is important to avoid deep insertion of a scalpel blade through the skin, and instead the soft tissues are spread with a fine-point hemostat before instrument insertion. This enables the nerve to slide or roll away from blunt instruments. However, the PIN is different from other mobile nerves. Because of the proximal fixation of the nerve at the radial wall of the fourth extensor compartment, it is more vulnerable to direct crush when the arthroscope or instruments are introduced through the 3/4 portal. Entanglement of the nerve when instruments are introduced or retrieved from the joint is also possible.¹⁷

Just distal to the radiocarpal joint, the PIN proceeded ulnarly and divided into two to four terminal branches. It lay far to the radial side of the MCR portal (mean 7.2 mm). In only 2 of the 28 specimens, one terminal branch of PIN laid directly over the portal. The PIN or its terminal branches lay quite close to the MCU portal (mean 1.6 mm). In over half (15 of the 28 specimens), the PIN passed directly over the portal, or the portal was located between its terminal branches. This means that they are at high risk of being injured during wrist arthroscopy using the MCU portal. It is highly probable that injury to the PIN or its terminal branches may be more common than previously suspected but have been underrecognized and reported.

There are several possible reasons for failing to recognize injury of the nerve. First, the PIN is the main articular branch on the dorsal part of the wrist. It innervates the radiocarpal, midcarpal, the carpometacarpal joints,¹⁶ and has no cutaneous innervation. There is no cutaneous sensory loss after injury.¹² Therefore, injury of the nerve is difficult to be recognized. Second, most wrist arthroscopies are not followed by any open procedure, and there is no way to discover the hidden injury. Finally, dorsal wrist pain that persists after wrist arthroscopy may be erroneously attributed to the underlying condition unless that represented a new symptom that may arouse the suspicion of any inadvertent nerve injury.

An alternative result of any PIN injury is the argument that avulsion of the nerve could provide symptomatic improvement in certain patients due to partial wrist denervation. Dellon¹² and Carr and Davis¹³ reported, respectively, that partial dorsal wrist denervation has achieved relief of pain and improvement in wrist function in patients who had diversified causes of chronic dorsal wrist pain, including “sprains,” wrist fractures, fracture-dislocations, carpal bone problems, residual problems after ganglionectomy, and radiocarpal or proximal carpal row arthritis. The denervation procedure appears to be effective in pain reduction for these disorders. Further studies are necessary to focus on the true incidence of PIN injury in wrist arthroscopy, and the positive and negative influence of the nerve injury.

The study is limited in that it was performed mainly on formalin-preserved upper limbs in one position only. Wrist arthroscopy is a dynamic procedure and the anatomical relationships of the joint and the PIN may well differ in different positions of flexion and extension or pronation and supination.

Note

This work was performed at the Prince of Wales Hospital, Shatin, New Territories, Hong Kong SAR. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. No ethical committee approval is needed for this article.

Conflict of Interest

None.

References

- 1 Park MJ, Yao J. Advances in hand and wrist arthroscopy. *Plast Reconstr Surg* 2014;134(5):758e–765e
- 2 Obdeijn MC, Tuijthof GJ, van der Horst CM, Mathoulin C, Liverneux P. Trends in wrist arthroscopy. *J Wrist Surg* 2013;2(3):239–246
- 3 Bettinger PC, Cooney WP III, Berger RA. Arthroscopic anatomy of the wrist. *Orthop Clin North Am* 1995;26(4):707–719
- 4 Abrams RA, Petersen M, Botte MJ. Arthroscopic portals of the wrist: an anatomic study. *J Hand Surg Am* 1994;19(6):940–944
- 5 Viegas SF. Midcarpal arthroscopy: anatomy and technique. *Arthroscopy* 1992;8(3):385–390
- 6 Esplugas M, Lluch A, Garcia-Elias M, Llusà-Pérez M. How to Avoid Ulnar Nerve Injury When Setting the 6U Wrist Arthroscopy Portal. *J Wrist Surg* 2014;3(2):128–131
- 7 Poubelon AR, Kraan G, Lau SP, Kerver AL, Kleinrensink GJ. Anatomical study of the dorsal cutaneous branch of the ulnar nerve (DCBUN) and its clinical relevance in TFCC repair. *J Plast Reconstr Aesthet Surg* 2016
- 8 Corella F, Ocampos M, Cerro MD, Larrainzar-Garijo R, Vázquez T. Volar Central Portal in Wrist Arthroscopy. *J Wrist Surg* 2016;5(1):80–90
- 9 Beredjikian PK, Bozentka DJ, Leung YL, Monaghan BA. Complications of wrist arthroscopy. *J Hand Surg Am* 2004;29(3):406–411
- 10 Culp RW. Complications of wrist arthroscopy. *Hand Clin* 1999;15(3):529–535, x
- 11 Ahsan ZS, Yao J. Complications of wrist arthroscopy. *Arthroscopy* 2012;28(6):855–859
- 12 Dellon AL. Partial dorsal wrist denervation: resection of the distal posterior interosseus nerve. *J Hand Surg Am* 1985;10(4):527–533
- 13 Carr D, Davis P. Distal posterior interosseous nerve syndrome. *J Hand Surg Am* 1985;10(6 Pt 1):873–878
- 14 Warhold LG, Ruth RM. Complications of wrist arthroscopy and how to prevent them. *Hand Clin* 1995;11(1):81–89
- 15 Fukumoto K, Kojima T, Kinoshita Y, Koda M. An anatomic study of the innervation of the wrist joint and Wilhelm's technique for denervation. *J Hand Surg Am* 1993;18(3):484–489
- 16 McCarthy CK, Breen TF. Arborization of the distal posterior interosseous nerve. *J Hand Surg Am* 1995;20(2):218–220
- 17 del Piñal F, Herrero F, Cruz-Camara A, San Jose J. Complete avulsion of the distal posterior interosseous nerve during wrist arthroscopy: a possible cause of persistent pain after arthroscopy. *J Hand Surg Am* 1999;24(2):240–242
- 18 Rodeo SA, Forster RA, Weiland AJ. Neurological complications due to arthroscopy. *J Bone Joint Surg Am* 1993;75(6):917–926