

The Safety of the Thenar Portal: An Anatomical Study of the Thumb Carpometacarpal Arthroscopy

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Abstract

Purpose To define the localization of the distal course of the motor branches of median nerve (MBMN) and its arborization and its quantitative relationships to the thenar portal of the carpometacarpal (CMC) joint in the hope of evaluating the safety of this portal.

Method In 16 embalmed cadaveric upper extremities, the localization of the course of the MBMN and its arborization were defined. In 14 fresh-frozen cadaver upper extremities, the CMC arthroscopic portals, 1-U, 1-R, and a thenar portal, were established, after which the limbs were dissected. Measurements were taken from the portals to the superficial radial nerve, radial artery, and the MBMN.

Results The distal course of the MBMN and its terminal branches were all located in the proximal third of the thenar muscles, where the thenar portal was introduced. The mean distances between vital structures and each traditional portal (1-R or 1-U) were consistent with the previously published studies. Both the superficial and the profound branches of MBMN were very close to the thenar portal, and the distance between these two main terminal branches and the thenar portal was 1.2 mm (range: 0–6.2; standard deviation [SD] = 2) and 2.2 mm (range: 0–7; SD = 2.1), respectively. Five (35.7%) of the 14 fresh-frozen specimens indicated the superficial branch lay directly over the portal. One hand (7.1%) had the profound branch crossed over the thenar portal. Four hands (28.5%) indicated both the superficial and profound branches directly overlay the thenar portal. The superficial palmar branch of the radial artery was found in six hands, and in four of them, it crossed over the thenar portal.

Conclusion The distal course of the MBMN and its terminal branches were all located in the proximal third of the thenar muscles, where the thenar portal was introduced.

Clinical Relevance The thenar portal could improve the view of the CMC joint of the thumb and provide better performance of procedures in this joint. We should bear in mind that the arborization of the MBMN was mostly located in the proximal third of the thenar muscle, and any operation in this area should be performed with great caution.

Keywords

- arthroscopy
- carpometacarpal
- portal

Thumb carpometacarpal (CMC) arthroscopy has been used for the evaluation and treatment of CMC osteoarthritis.¹ It gives a magnified view of intra-articular structures and

allows assessment of the joint surfaces, ligaments, and synovium with minimal disruption of the important ligamentous complex.² Two standard portals for CMC arthroscopy have

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been previously reported, the 1-R and 1-U portals, and they have gained widespread use.³ Both arthroscopic portals allow visualization of the majority of the distal articular surface of the trapezium and the proximal articular surface of the first metacarpal. However, the most lateral joint capsule or joint surface can be difficult to visualize arthroscopically.⁴

A thenar portal was reported for better visualization and performance of the procedures in this joint,⁴⁻⁷ but the anatomical study has been not performed for vital structures including the terminal branch of motor branch of median nerve (MBMN) around the thenar portal, although Walsh et al reported the distance between origin of motor branch and thenar portal.⁵ What is more, though there are a large number of studies dealing with the morphological variations of MBMN, there are few studies that consider the localization of the distal course of this branch.

The purpose of this anatomical study was to define the localization of the distal course of the MBMN and its arborization and to clarify safety of the thenar portal for CMC joint arthroscopy

Materials and Methods

To define the localization of the course of the MBMN and its arborization, 16 embalmed cadaveric upper extremities were dissected. The skin was longitudinally incised along the ulnar aspect of the palm. Transverse incisions were completed 2 cm proximal to the wrist flexion crease and 2 cm distal to the distal palmar crease, and the skin and superficial fascia were reflected radially and ulnarly. The median nerve was separated into its branches. The motor branches were isolated and traced distally to their entry into the muscles of the thenar eminence. The muscles were cut carefully to expose the distal course of the MBMN in the muscles. To observe the course of the MBMN, we divided the thenar eminence into three zones: the proximal one-third zone, the middle one-third zone, and the distal one-third zone. The location of the origin of MBMN, the angle formed by MBMN and the median nerve, and the location of the distal course of the MBMN were recorded.

To describe the anatomical relationships of the thenar portal of the CMC joint with the distal course of MBMN and its arborization, 14 fresh-frozen adult cadaver upper extremities were used. Each hand was examined to exclude trauma, deformity, or disease. Three portals were established in all specimens while suspended using a traction tower and applying 3.3 kg of longitudinal traction through a single finger trap placed to the thumb. As described by Orellana and Chow,⁴ and Carro et al,⁶ a pen was used to mark the anatomical structures and portals. The 1-U portal was marked just ulnar to the extensor pollicis brevis (EPB) tendon at the level of the joint. The 1-R portal was marked just radial to the abductor pollicis longus (APL) tendon. The thenar portal, which was different from the original thenar portal described by Walsh,⁶ was marked just distal to the oblique ridge of the trapezium following a line referencing the radial edge of the flexor carpi radialis (FCR) tendon.^{3,4} A 2.7-mm arthroscope was introduced from the 1-U portal described by Menon and Berger, pointing the light source to the thenar portal, and a 25-gauge needle

was inserted just distal to the trapezium ridge. The thenar portal was created in the same fashion as the 1-U portal. The 1-R portal was placed using the same technique as for the 1-U portal. After placement of each of the portals, the arthroscope was inserted to confirm intra-articular placement. The arthroscope was then removed and the sleeve was maintained in position. The obturator touched with India ink was inserted into the sleeve several times when the sleeve was withdrawn to label the portal tracks with the ink.

After the arthroscopic procedure, the specimens were removed from the tower, thumbs were positioned in dorsal adduction, and anatomical dissections were performed carefully under 3× loupe magnification. The following structures were exposed and measured: the sensory branch of the radial nerve was exposed on the dorsoradial aspect of distal forearm and traced distally to find its major distal branches surrounding the thumb; the radial artery was identified at the anatomical snuff box; the superficial palmar branch of radial artery, when present, was dissected distally to trace its course. The origin of MBMN was identified, and the trunk was traced distally to its entry into the muscles of the thenar eminence. At the level of the joint, the distances from the center of blackened portal tracks to the sensory branch of the radial nerve and the radial artery, the distances from the center of blackened thenar portal to the origin of the MBMN and the major branch point of the MBMN, and the distance from the thenar portal to the superficial palmar branch of the radial artery were measured.

After the measurement of the aforementioned superficial structures, the abductor pollicis brevis (APB) was then transected carefully to show the arborization of the MBMN in the thenar muscles. The distances from the center of blackened thenar portal to individual major branches of the MBMN were measured.

Results

In 15 of the 16 embalmed cadaveric upper extremities, the origin of the MBMN was located in the middle one-third zone of thenar eminence, and in 1, it was located in the proximal one-third zone.

The mean distances between each portal and the vital structures are noted in ▶ **Table 1**. There were two major distal branches of the sensory branch of the radial nerve, named the SR2 and SR3 branches by Steinberg et al,⁸ and surrounding this arthroscopic field, the mean distances between vital structures and each traditional portal (1-R or 1-U) were consistent with the previously published studies.^{4,5,9,10}

Table 1 Mean distances (mm) from neurovascular structures to portals

	SR2	SR3	RA
1-U	8.1 ± 2.6	8.6 ± 2.7	5.9 ± 2
1-R	22.4 ± 3.2	5 ± 3.3	19 ± 2.9
Thenar portal	31.2 ± 4.4	21.6 ± 4.9	29.2 ± 4.2

Abbreviation: RA, radial artery.

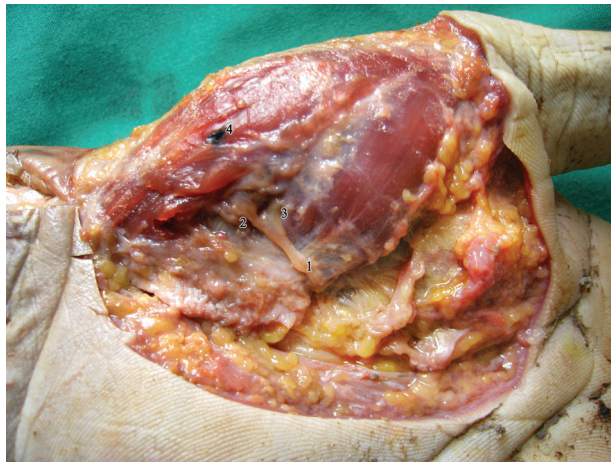


Fig. 1 The motor branch of median nerve (MBMN) curved radially and proximally, forming a 45-degree angle with the median nerve, and directed up to the thenar portal. 1, The main trunk of MBMN; 2, the superficial branch of MBMN; 3, the profound branch of MBMN; 4, the thenar portal.

The MBMN ran from its origin up to the medial margin of the flexor pollicis brevis (FPB), and went around or through the transverse carpal ligament (TCL). Once around the TCL, the MBMN curved radially and proximally across the superficial surface of FPB, forming a 45-degree angle with the median nerve and perpendicular to the thenar muscle fibers (►Fig. 1). The MBMN entered the plane between the FPB and the APB, and then at once giving off two terminal branches, the superficial one entered the ulnar edge of the abductor and

innervated it and the profound one passed deep to the abductor to supply the opponens pollicis and the flexor. The course between the origin of MBMN and the point of its division in the space between APB and FPB averaged 13.7 mm (range: 10.4–17.9; standard deviation [SD] = 2.23). The distal course of the MBMN and its terminal branches were all located in the proximal third of the thenar muscles, where the thenar portal was introduced.

The distance between the thenar portal and the MBMN or its major terminal branches is shown in ►Table 2. The distance between the origin of MBMN and the thenar portal averaged 26 mm (range: 19.2–31.1; SD = 3.26). The interval between the major branch point of MBMN and the portal was a mean of 13.9 mm (range: 7.3–19.5; SD = 2.2). We found that both the superficial and the profound branches of MBMN were very close to the thenar portal, and the distance between this two main terminal branches and the thenar portal was only 1.2 mm (range: 0–6.2; SD = 2) and 2.2 mm (range: 0–7; SD = 2.1), respectively. Five (35.7%) of 14 specimens had the superficial branch that lay directly over the portal (►Fig. 2). One hand (7.1%) indicated the profound branch crossed over the thenar portal (►Fig. 3). Four hands (28.5%) demonstrated both the superficial and profound branches directly overlay the thenar portal (►Fig. 4A, B).

The superficial palmar branch of the radial artery was found in six hands (42.8%). It passed through the thenar musculature, and in four of them, it reached the superficial palmar arch (type I; ►Figs. 2 and 5), in the remaining two specimens, it proceeded distally and formed the radial proper palmar digital artery of the thumb (type II; ►Fig. 6). In two

Table 2 Distances of thenar portal to motor branches of median nerve

Sample	The origin of MBMN	The major branch point of MBMN	The superficial branch of MBMN ^a	The profound branch of MBMN ^b
1	27.5	19.5	0.0	7.0
2	24.8	15.5	0.0	0.0
3	30.1	11.7	2	4
4	29	18	0.0	4.5
5	24.4	16	6.2	3.8
6	26.9	17.7	0.0	0.0
7	29	12.2	1.2	0.0
8	24.8	18.6	0.0	0.0
9	31.1	13.4	3.4	2.1
10	24.7	12.9	4.3	1.4
11	27	7.3	0.0	2.2
12	23.1	10.4	0.0	2.3
13	19.2	12	0.0	2.4
14	22.6	10.5	0.0	0.0
Mean ± SD	26 ± 3.26	13.9 ± 3.6	1.2 ± 2	2.2 ± 2.1

Abbreviations: MBMN, motor branches of median nerve; SD, standard deviation.

^aEntered the ulnar edge of the abductor pollicis brevis (APB) and innervated it. ^bPassed deep to the APB to supply the opponens pollicis and the flexor pollicis brevis.

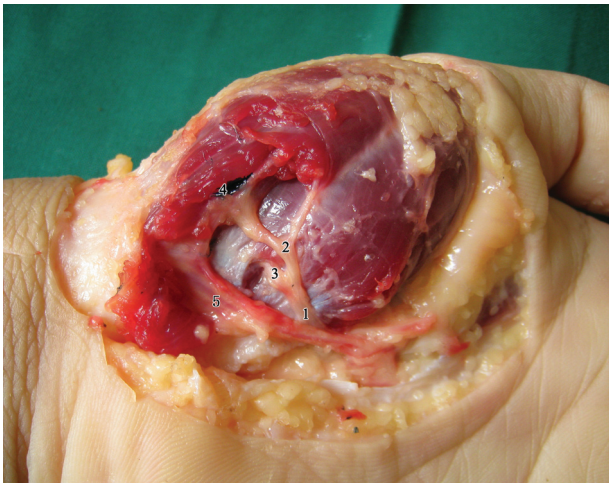


Fig. 2 Part of the abductor pollicis brevis was cut and the superficial branches was showed. It directly overlay the thenar portal. 1, The main trunk of motor branch of median nerve (MBMN); 2, the superficial branch of MBMN; 3, the profound branch of MBMN; 4, the thenar portal; 5, the superficial palmar branch of the radial artery

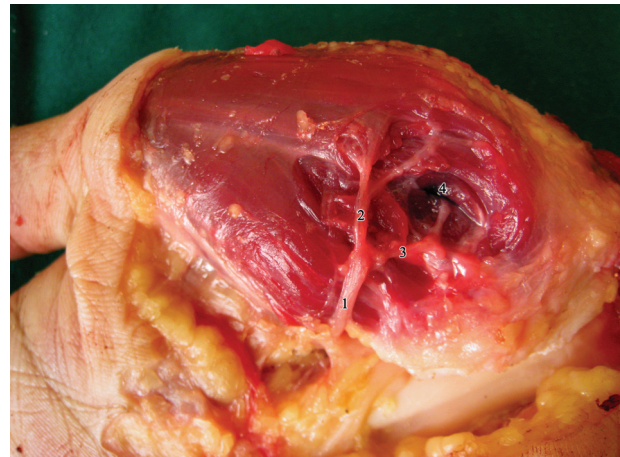


Fig. 3 Part of the abductor pollicis brevis was removed and the superficial and the profound branch of motor branch of median nerve (MBMN) were shown. The superficial branch passed distal to the thenar portal, whereas the profound branch directly overlay the thenar portal. 1, The main trunk of MBMN; 2, the superficial branch of MBMN; 3, the profound branch of MBMN; 4, the thenar portal.

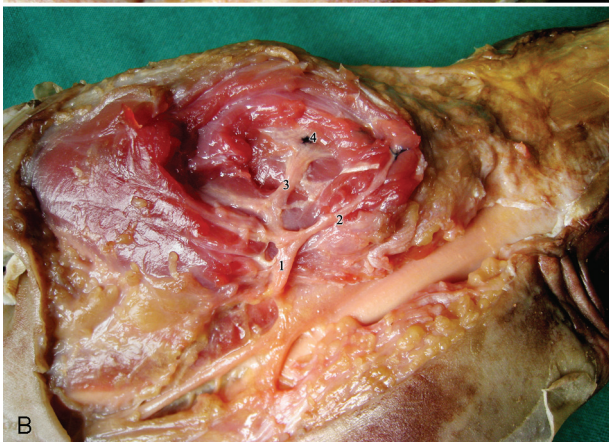
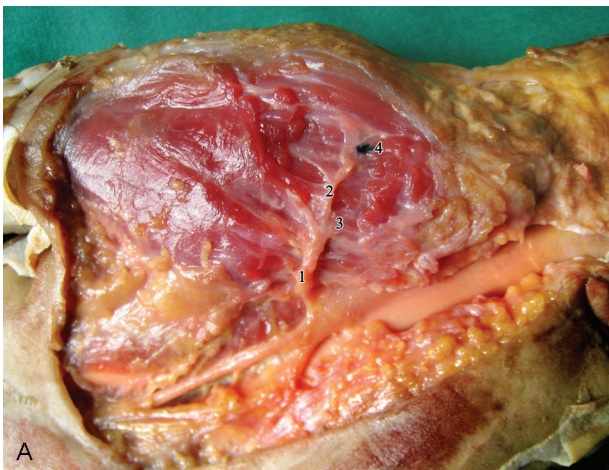


Fig. 4 Both the superficial and profound branches directly overlay the thenar portal in one specimen. (A) The superficial branches overlay the thenar portal. (B) The abductor pollicis brevis was transected and reflected proximally to show the profound branch. The profound branch directly overlay the thenar portal. 1, The main trunk of motor branch of median nerve (MBMN); 2, the superficial branch of MBMN; 3, the profound branch of MBMN; 4, the thenar portal.

specimens, the superficial palmar branch passed proximal to the thenar portal with a distance of 9 and 9.4 mm, respectively (►Fig. 2). In the other four specimens, it unfortunately crossed over the thenar portal (►Figs. 5 and 6).

Discussion

Thumb CMC arthroscopic surgery has increased in popularity in recent years because of both technologic advances and better understanding of thumb CMC arthritis.^{1,2,11} Two standard portals for CMC arthroscopy were mostly used^{1-3,9}: 1-R portal is radial to the APL and 1-U portal is ulnar to the EPB tendon. However, these portals are relatively angled less than 90 degrees, and it is difficult to assess the lateral side of the



Fig. 5 Type I superficial palmar branch of the radial artery. It lay over the thenar portal. 1, The main trunk of motor branch of median nerve; 2, the thenar portal; 3, the superficial palmar branch of the radial artery.



Fig. 6 Type II superficial palmar branch of the radial artery. It proceeded distally and formed the radial proper palmar digital artery of the thumb. It crossed over the thenar portal. 1, The main trunk of motor branch of median nerve; 2, the thenar portal; 3, the superficial palmar branch of the radial artery.

joint and require more manipulation at the portal site to visualize the CMC joint, thereby increasing the possibility of violating the surrounding vital structures.⁵

A more user-friendly portal, the thenar portal, was proposed for improving the view and better performance of the procedures in the CMC joint.^{2,4-7} The portal seems to be safe because only mild complication was reported (transient scar tenderness).⁷ However, the periportal anatomy has not been well elucidated, and the published data delineating the relationships between the MBMN and its terminal branches and the thenar portal were seldom found. Walsh et al⁵ reported that MBMN was an average of 23 mm from this portal, however, which point of the MBMN to the portal measured was not described. Orellana and Chow⁴ measured the distances between the thenar portal and the superficial radial nerve and the radial artery, whereas the distance between MBMN and the portal was not calculated. Carro et al⁶ proposed a three-portal technique for CMC arthroscopy, and their volar portal was similar to that of Orellana and Chow; the relationships of vital structures to the portal site were not reported.

Our dissection showed that MBMN was an average of 26 mm from the thenar portal, which was consistent with the distance between the origin of MBMN and the portal in Walsh's study⁵ (23 mm on average). Both the superficial and the profound branches of MBMN were very close to the thenar portal, and the distance between these two main terminal branches and the thenar portal was only 1.2 and 2.2 mm, respectively. In 10 (71.4%) of 14 specimens, one of the terminal branches of MBMN, or both, lay directly over the portal. This meant that they were at high risk of being injured during CMC arthroscopy using the thenar portal. It was highly probable that injury to the MBMN or its terminal branches might have been underrecognized and reported.

Additionally, we found that the superficial palmar branch of radial artery, which reached the superficial palmar arch or directly formed the radial proper palmar digital artery of the

thumb in our study, could possibly be injured because it lay quite close to the thenar portal. The superficial palmar branch of the radial artery was found in six hands (42.8%). In four of the six specimens, it passed directly over the thenar portal.

Walsh et al did not describe entry point of thenar portal, and the entry we used in this study just radial border to FCR was extremely close to terminal branch of the MBMN. Therefore, more precise and safer location should be explored. The anatomy of MBMN has been extensively described in the literature¹²⁻¹⁶; however, to the best of our knowledge, few studies stated the location of the arborization of the terminal MBMN. Our dissection showed that the distal course of the MBMN and its terminal branches were all located in the proximal third of the thenar muscles, where the thenar portal was introduced. It is difficult to find out a nerve-bare area for the thenar portal. If we dorsally extend and adduct the thumb when establishing the thenar portal, fewer thenar muscles will be involved and injury of the nerve could be avoided.

Only mild complication of transient scar tenderness with the thenar portal of CMC arthroscopy was reported.⁷ There were several possible reasons for few injury of the nerve. First, it was the terminal divisions, not the main trunk of MBMN, that could be most at risk of iatrogenic injury. Complete loss of thumb abduction was not evident, only with some degree of weakness of the thenar muscles. Second, thenar muscles may have multiple nerves innervation. Seventy-five percent specimens have "accessory thenar nerve."¹² Third, blunt dissection is applied when thenar portal is established, and thus the rupture of the nerve is not likely to occur. However, we should bear in mind that the arborization of the MBMN was mostly located in the proximal third of the thenar muscle, and any operation in this area should be performed with great caution.

Note

The work was performed at the Prince of Wales Hospital, Shatin, Hong Kong. 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 was needed for this manuscript.

Conflict of Interest

None.

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