

Anatomy of the palmar cutaneous branch of the median nerve: A review

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ABSTRACT

The palmar cutaneous branch of the median nerve (PCBm) supplies afferent innervation to the volar aspect of the hand. It consistently originates from the radial side of the median nerve, travels in relation to the tendons of the palmaris longus and flexor carpi radialis muscles, and courses superficially through fascial planes to reach the surface of the palm. Because it is at risk of injury in numerous operations, this review serves to provide a summary of anatomical findings regarding the PCBm across various studies to aid orthopedists and other clinicians in anticipating the location of the nerve during surgical procedures.

1. Introduction

The palmar cutaneous branch of the median nerve (PCBm) is located in the volar forearm and supplies afferent fibers to the palmar surface of the hand. It is at risk of damage in a range of surgical procedures, including carpal tunnel release, volar synovectomy, tendon transfer, ganglion resection, and volar plate fixation of distal radius fractures.¹ Harm may result in pain on wrist extension, paresthesia, anesthesia, hyperesthesia, and/or dysesthesia. Therefore, knowledge of the anatomy of the PCBm and its position relative to surface landmarks is crucial to preventing iatrogenic injury. To this end, the following review presents a comprehensive summary of various anatomical characterizations of the PCBm.

2. Discussion

2.1. Prevalence and origin

The palmar cutaneous branch of the median nerve (PCBm) is a constant structure. Only rarely has it been reported absent, such as in the study by Richards et al., where the nerve was nonexistent in two of twenty specimens.¹ This frequency is in agreement with a similar finding in Borne et al., in which the PCBm was present in 92% of limbs.²

The PCBm is consistently described in the literature as originating from the radial side of the median nerve.^{1,3–10} Extensive variation exists in the site of origin of the PCBm, with most studies utilizing the

distal wrist crease as a point of reference^{1,3,4,6,8,9,11,12}. Average distances of origin proximal to the volar wrist crease range from 4.1 cm^{9,11} to 8.4 cm³ in the literature, with a range of raw distances spanning 2 cm⁹ to 15 cm⁸. The differences in findings may be attributed to preparation and dissection methods, as well as the anatomical variations in the location of the distal wrist crease. Chaynes et al. describe the crease as originating a mean of 1.4 mm distal to the bistylloid line (an axis relating the lateral side of the radial styloid process to the medial side of the ulnar styloid process), with a maximal distance of 11.2 mm⁷ distal. In the same study, the distal wrist crease and the bistylloid line were located at the same level in 14 specimens. For this reason, other studies have examined the origin of the PCBm relative to the bistylloid line and the most superficial aspect of the scaphoid tubercle, with average measurements of 4.43 cm⁷ and 5.24 cm¹, and 7.60 cm¹ described, respectively. In a study by Bonnel et al., the origin of the PCBm relative to the bistylloid line was between 7 and 8 cm in 44% of dissections and between 4 and 5 cm in 50% of cases.¹³ Greater consistency was found between measurements when using the bistylloid line as reference compared to the distal wrist crease,¹ but the quantified values remained comparable to those for the distal wrist crease. Fig. 1 provides a depiction of the main reference points relative to the PCBm.

2.2. Course

After stemming from the radial side of the median nerve, the PCBm traverses between the tendons of the palmaris longus (PL) and flexor

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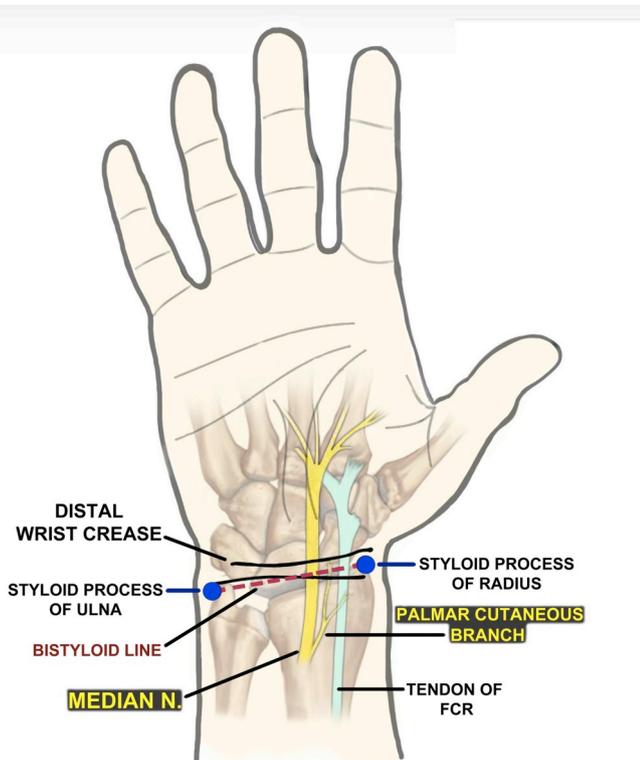


Fig. 1. Depiction of important anatomical reference points found in the literature. Shown here are the distal wrist crease and bistyloid line relative to the median nerve and PCBm. The distance between the two lines can vary, with instances of the lines located at the same level, and so one possibility is illustrated. As noted, the PCBm originates on the radial aspect of the median nerve, becoming close in proximity to the FCR tendon.

carpi radialis (FCR) muscles deep to the antebrachial fascia.^{3–8,12} Taleisnik et al. described the PCBm as remaining bound to the body of the median nerve for 16–25 mm before attaining such a position.¹⁰ In some cases, about 1–1.5 cm proximal to the wrist crease,⁴ the nerve is described as continuing more radially toward the FCR tendon, traveling intimately with the ulnar side of its sheath or piercing the sheath and traveling within it.^{4,5,8} Naff et al. observed the PCBm entering the FCR sheath on average 1.5 cm proximal to the tubercle of the scaphoid.⁵ In rare cases, the PCBm may associate with the tendon of the palmaris longus, as seen in 2 of 49 specimens in Dowdy et al.⁹

The PCBm then begins to progress superficially. Bezerra et al. described the PCBm as entering the antebrachial aponeurosis a mean of 0.79 cm proximal to the extension axis of the third finger meeting the distal wrist crease, with a range of 0.36 cm–1.86 cm proximal.¹² In comparison, DaSilva et al. reported the PCBm as piercing the antebrachial aponeurosis on average 1.9 cm proximal to the distal wrist crease, always radial to the PL, with a range of 1.4–2.5 cm proximal.¹⁴ Richards et al. detailed the penetration of the transverse carpal ligament by the PCBm, which occurred 1.09 cm distal to the bistyloid line, 1.07 cm distal to the distal wrist crease, and 2.27 cm medial to the scaphoid tubercle. Alternatively, Chaynes et al. described the PCBm passing through the flexor retinaculum 3 mm medial to the thenar crease at the level of the distal wrist crease.⁷ Taleisnik documented the PCBm as attaching to the underside of the antebrachial fascia immediately under the ulnar margin of the PCR tendon 9–16 mm proximal to the proximal border of the palmar carpal ligament, or the antebrachial fascia.¹⁰ The variation in reference points across various studies and the anatomical variations in the path of the nerve prove to be complicating factors in predicting its location.

According to many accounts, the PCBm travels within its own tunnel to reach the superficial region of the hand,^{1,4–8,10} with the

length of the tunnel dependent on its location. Through the flexor retinaculum, the tunnel was found to be between 1 mm and 16 mm long,^{7,8,10} 2 mm lateral to 3 mm medial to the thenar crease at the level of the distal wrist crease.^{7,11} Relative to the antebrachial fascia or thickened portion of the palmar carpal ligament, the tunnel was measured to be 2 cm.⁸ In one case, the tunnel was only 3 mm in distance through the antebrachial fascia and remained in the subcutaneous plane until termination.⁸ In three of the cases detailed in Bezerra et al., the PCBm travelled on the surface of the flexor retinaculum and no tunnel could be identified.¹² Often, the nerve was closely associated with the distal tendon or terminal fibers of the palmaris longus upon exiting the tunnel.^{4,8,9}

At its exit from the tunnel, the PCBm then proceeds to the more superficial layers of the palm. When traveling through its tunnel in the antebrachial fascia, the PCBm is reported as emerging 0.76 cm distal to the extension axis of the third finger meeting the distal wrist, with a range of 0.17–1.86 cm.⁵ As reported by Naff et al., relative to the palmar aponeurosis, the nerve pierces this structure 1.5 cm distal to the tubercle of the scaphoid to then innervate the palmar skin.⁵ Alternatively, DaSilva et al. found the nerve to arise superficial to the palmar aponeurosis within 1.5 cm of the distal wrist crease.¹⁴ Chaynes et al. describe the PCBm as becoming subcutaneous midway between the radial and ulnar styloid processes, with the mean position of this emergence 5.7 mm proximal to the bistyloid line, ranging from 15.3 mm proximal to 9.6 mm distal to this line.⁷ Taleisnik's account of the PCBm becoming subcutaneous is in the midpalm, relative to an axis of the ray of the ring finger.¹⁰ It is at this point in the palm, superior to the palmar aponeurosis, that the major sensory branches of the nerve exist.

2.3. Branching

Branching of the PCBm is variable, even within the same study,¹¹ which is in-sync with the inconstant pathway of the main trunk of the PCBm. The earliest offshoots of the PCBm reported are present before the nerve enters its tunnel; these branches provide innervation to the scaphoid or lunate bones, reaching 12 mm in length on average.^{4,7} Other branches detailed in the literature contributing to innervation below the palmar aponeurosis include smaller divisions running on the undersurface of the aponeurosis, which terminate in the superficial aspect of the transverse carpal ligament.^{10,14}

Superficial to the palmar aponeurosis, there are several branching patterns detailed in the literature. In Hobbs et al., an average of four radial branches were observed at a mean of 1.6 cm (range of 0.9–4 cm) from the extension axis of the third digit.³ Two ulnar branches were typically encountered 0.4 cm (range of 0–1 cm) relative to the axis of the third digit. Similarly, in Matloub et al., the major branching pattern described involved the PCBm dividing in a “Y” fashion, giving rise to a dominant radial branch and a secondary ulnar branch, with each secondary branch further splitting into between one and five tertiary branches.⁴ The second most common configuration in the same study consisted of several radial or ulnar sub-branches stemming from the PCBm prior to the Y-shaped division; on average, three radial and two ulnar branches were observed.⁴ The least common organization involved two PCBm trunks originating directly from the median nerve, with each giving off secondary and tertiary branches respectively. The distance from the radial-most terminal branch of the PCBm was recorded to be 5 mm on average (range of 2–9 mm) from the thenar crease, with the ulnar-most terminal end averaging 12 mm from the thenar crease. Alternatively, DaSilva et al. described two main branch patterns, one in which the PCBm divided into three main trunks (lateral, intermediate, and smaller ulnar branches, 58% of cases) and the other consisting of numerous non-distinct branches (42% of cases).¹⁴

In the majority of specimens (58%) studied in Bezerra et al., two main branches were encountered, one termed lateral and the other intermediate, which innervated the skin of the thenar and intermediate

Table 1
Summary of key anatomical data.

Origin:	Proximal to distal wrist crease: Relative to bistyloid line:	Ave range of 4.1–8.4 cm Mean measurements of 4.43, 5.24, and 7–8 cm
Initial subcutaneous position:	Naff: 0.76 cm distal to the extension axis of the third finger meeting the distal wrist crease DaSilva: Within 1.5 cm of the distal wrist crease Chaynes: Mean of 5.7 mm proximal to bistyloid line	Range of 0.17–1.86 cm
Branching:	Hobbs: An average of 4 radial branches a mean of 1.6 cm from the extension axis of the third digit Matloub: Most commonly observed Y pattern of dominant radial and ulnar branches, with between 1 and 5 tertiary branches each DaSilva: Two main branch patterns observe. Either division of PCBm into three main trunks (lateral, intermediate, smaller ulnar branches) or numerous non-distinct branches. Bezerra: Patterns encountered include two main branches (lateral and intermediate), three main branches (lateral, small medial, intermediate), few cases with only medial and intermediate branches	Range of 15.3 mm proximal to 9.6 mm distal to bistyloid line An average of 2 ulnar branches, 0.4 cm relative to the same axis Radial-most terminal branch of the PCBm was 5 mm on average from thenar crease; ulnar most terminal end an average of 12 mm from thenar crease Lateral branch noted to be located parallel to first metacarpal, terminated close to base of the thumb. Intermediate branch follows thenar crease. Medial branch shortest and never spanning beyond a line corresponding to the ulnar border of the fourth metacarpal
Termination:	Hobbs: 4.5 cm distal to the distal wrist crease Matloub: 1.9 cm distal to the distal wrist crease	Range of 3–6 cm Range of 1.0–2.5 cm

regions of the hand, respectively.¹² Thirty-four percent of specimens presented a second pattern of three main branches, with a lateral branch responsible for thenar innervation, a small medial branch directed toward the hypothenar region, and an intermediate division associated with supplying sensation to the area in between the thenar and hypothenar regions. In four specimens, only an intermediate and medial branch were detected, directed toward the skin of the intermediate regions of the palm and the thenar region, respectively.¹² When present, the lateral branch was located parallel to the first metacarpal and terminated close to the base of the thumb, while the intermediate branch followed the path of the thenar crease. The medial branch was shortest, never spanning beyond a line corresponding to the ulnar border of the fourth metacarpal. Chaynes et al. described the presence of two main branches in the majority of specimens, with three main branches observed in the remaining cases.⁷ As is apparent, it is difficult to define universal branching patterns of the PCBm.

2.4. Length and termination

Bezerra et al. recorded the length of the PCBm as 5.24 cm (range of 2.05–8.93 cm), which they defined as the distance between its point of origin and its first branches. Chaynes et al. described a similar length of 5.46 ± 13.4 cm (range of 9.2–21.7 mm)⁷; interestingly, the length of the PCBm did not show any significant variation relative to the measurement of the length of the forearm. Hobbs et al. found the termination to be 4.5 cm distal to the distal wrist crease, with a range of 3–6 cm, whereas Matloub et al. documented an average distance of 1.9 cm (range of 1.0–2.5 cm) to the most distal bifurcation point in the palm from the distal wrist crease.^{3,4} A summary of key anatomical data regarding the PCBm relative to surface anatomy, including origin, initial subcutaneous position, branching patterns, and termination, can be found in Table 1.

2.5. Anomalous variations

In rare cases, there are anomalous variations in the anatomy of the PCBm. As mentioned previously, two separate PCBm's may arise from the median nerve.^{3,4,11,14} In the study by Hobbs et al., these two trunks, with origins on average 4.1 cm apart, were connected in all cases by a communicating branch within 1 cm distal to the distal wrist crease, with the duplicate PCBm running in the same position as the constant PCBm but on a deeper plane.³ At the point where the communicating branch joined the two nerves, the duplicated PCBm coursed superficially through the palmar fascia. In another variation, the extra PCBm penetrated the radial aspect of the transverse carpal ligament 1.4 cm

distal to the distal wrist crease and divided into two deep branches, as well as superficial branches that innervated the deep thenar muscles and smaller branches that terminated in the distal transverse carpal ligament. Deep branches have also been observed communicating with the digital nerve originating directly from the median nerve.¹⁴ Communication between the PCBm and a superficial branch of the radial nerve has been encountered as well, with frequency ranging from 4% to 40%, depending on the study.^{7,12}

3. Conclusion

The pathway of the PCBm is inconstant within and across a number of studies, due to anatomical variation between individuals and the use of inconsistent reference landmarks. Thus, while it is difficult to fully predict the nerve's location during procedures, such as carpal tunnel release, the above composite of data presents a comprehensive view of the range in which the nerve or its branches may lie. Therefore, this review serves as a resource to aid in minimizing iatrogenic injury to the PCBm and resulting surgical complications.

Author contributions

Conception of the work was led by NAE. Collection and analysis of data, composition of manuscript, and creation of figure and tables was completed by JLS.

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Declarations of interest

The authors have no conflicts of interest, financial or otherwise.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jor.2019.06.010>.

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