

# Anatomical variation of the superficial branch of the radial nerve and brachioradialis tendon: a case report with embryological and clinical insights

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**Received:** 13 August 2024 ♦ **Accepted:** 3 October 2024 ♦ **Published:** 26 February 2025

**Citation:** Verma A, Singh S, Borthakur D, Kusuma H. Anatomical variation of the superficial branch of the radial nerve and brachioradialis tendon: a case report with embryological and clinical insights. *Folia Med (Plovdiv)* 2025;67(1): e134607. doi: 10.3897/folmed.67.e134607.

## Abstract

Anatomical variation of the peripheral nerves are important because they may have therapeutic implications. The variation of the brachioradialis muscle (BRM) and the superficial branch of the radial nerve (SBRN) was noted during a regular teaching dissection of the upper extremity of a cadaver. There was splitting of the brachioradialis tendon (BRT), and the SBRN emerged, and it eventually became cutaneous. Following that, it bifurcated and ran superficial to the extensor retinaculum and gave off digital branches. The SBRN may be compressed by the BRM/BRM tendon contraction, which may result in Wartenberg's syndrome. This anatomical variation likely results from a complex interplay of genetic factors, molecular signals, and embryological development. For the purpose of differentiating between pain and paresthesia on the dorsoradial aspect of the hand, awareness of this neuromuscular variation is clinically significant.

## Keywords

brachioradialis, superficial branch of radial nerve, variation

## Introduction

Peripheral nerve variations are clinically important because they can have implications for diagnosis and surgery. These changes fall into two categories: altered nerve course or distribution, which may lead to misdiagnosis and surgical errors, and structural differences in surrounding tissues such as bones, ligaments, muscles etc. that could compress or entrap nerves, causing entrapment neuropathies.<sup>[1]</sup> In 1926, entrapment of the sensory branch of radial nerve was first described, which later came to be known as Wartenberg's syndrome or cheiralgia paresthetica. This rare condition (with an approximate incidence of about 0.003%) is often not recognized.<sup>[2-4]</sup> The transit of the superficial branch

of the radial nerve (SBRN) between a split brachioradialis tendon is seldom documented. Our study aimed to investigate and document this anatomical variation.

## Case report

*We dissected the upper extremities of a properly embalmed and preserved 75-year-old male donated cadaver for teaching purposes, with no documented history of trauma. The superficial fascia around the forearm extensor muscles was carefully removed. In the right upper limb we observed that*

the SBRN emerged from behind the brachioradialis muscle (BRM), split the BRM tendon into two parts, and became cutaneous (Fig. 1A). The nerve was then traced distally.

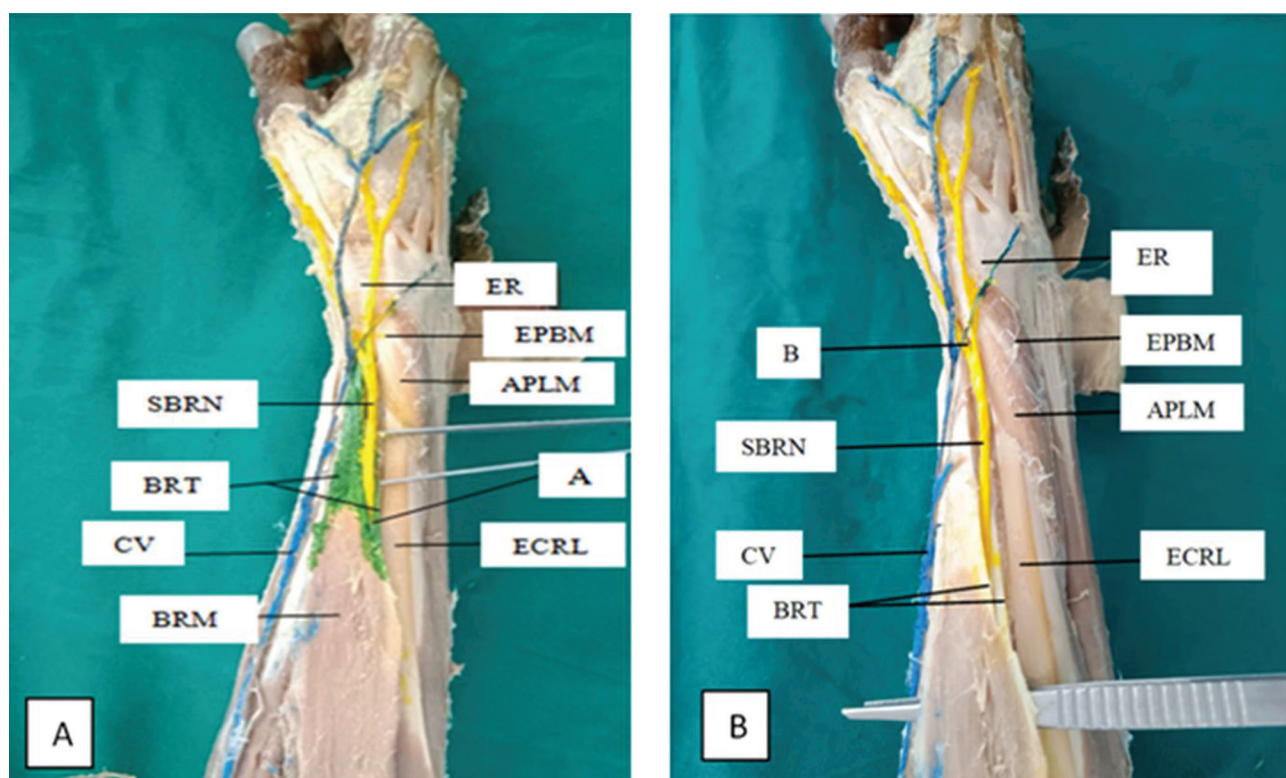
The length of the right BRM from its origin to its distal attachment, just proximal to the styloid process was 31.52 cm. The distance from the split point of the BRM to the origin of the BRM was 20.5 cm, while the distance from the split point of the BRM to the attachment of the tendon was 11.02 cm. The width of the lateral part of the split tendon was 0.25 cm, and the medial split tendon was 1.5 cm in the upper part. The length of the lateral part of the split tendon was 9.5 cm, and it joined the medial part of the split tendon to reunite proximally to the styloid process. The length of the reunited tendon was 1.52 cm. The SBRN was bifurcated into two branches 2.53 cm proximal to the extensor retinaculum and then gave off digital branches (Fig. 1B). The attachment of the tendon of the BRM and the distribution of SBRN on the left side followed the standard description in textbooks.

## Discussion

The brachioradialis muscle (BRM) is the most superficial muscle on the radial side of the forearm, originating from the lateral supracondylar ridge of the humerus and attaching near the styloid process of the radius. Variations include

splitting into multiple slips or being absent or duplicated. In the current case report, right BRM tendon split into two parts: the thick medial part and the thin lateral part. The radial nerve innervates the muscle, with its branch arising near the lateral epicondyle. The radial nerve divides into the posterior interosseous and SBRN at the level of the tip of the lateral epicondyle. The SBRN supplies the skin of the lateral two third of the dorsum of the hand and skin of the dorsal aspect of the thumb, index, middle and lateral half of ring fingers, except the distal parts, which are supplied by the median and ulnar nerves. However, the superficial terminal branch of the radial nerve may supply the whole dorsum of the hand.<sup>[5]</sup> In the present case, the SBRN emerged between split BRM tendons and bifurcated before giving off digital branches. This anatomical variation may lead to SBRN compression, potentially capable of causing Wartenberg's syndrome.

Traumatic transection of the distal forearm can cause painful neuroma due to damage to the SBRN.<sup>[6]</sup> Activities like tennis or cricket may lead to SBRN compression between the split BRM tendon during forearm rotation, causing sensory loss and paresthesia in the hand. In this case, the SBRN divided proximally to the extensor retinaculum, making it vulnerable to chronic compression neuropathy, known as Wartenberg's syndrome.<sup>[7]</sup>



**Figure 1.** Right forearm and hand. **A.** The brachioradialis tendon divides into two parts, with the superficial branch of the radial nerve emerging between these two slips (point A) and becoming subcutaneous at this location. **B.** The superficial branch of the radial nerve bifurcates into two branches proximal to the extensor retinaculum at point B. CV: cephalic vein; ECRL: extensor carpi radialis longus; BRT: brachioradialis tendon; BRM: brachioradialis muscle; ER: extensor retinaculum; APLM: abductor pollicis longus muscle; EPBM: extensor pollicis brevis muscle.

The observed anatomical variation in our case in which the SBRN passed through the split BRM tendon, likely results from a complex interplay of genetic factors, molecular signals, and embryological processes. The developmental origin of peripheral nerves including the SBRN is from neural crest cells, which migrate and differentiate into various peripheral nerves. The BRM and its tendon develop from the somatic mesoderm, specifically the myotome that forms limb musculature. Neurotrophic factors such as BDNF, NGF, and GDNF are crucial for guiding neuron growth, while ephrins, Eph receptors, N-cadherin, and integrins play roles in axonal pathfinding and cell interactions.<sup>[8-10]</sup> If the SBRN receives abnormal guidance cues, it may take an atypical route through the tendon. Similarly, variations in the development of the BRM and tendon could influence the nerve's path.

Although this variation may cause symptoms like paresthesia, dysesthesia, and pain, sensory loss is generally limited due to overlap with other nerves like the lateral cutaneous nerve of the forearm and the dorsal cutaneous branch of the ulnar nerve.<sup>[7]</sup>

Wartenberg's syndrome, often misdiagnosed as De Quervain's disease, seems to be more common than expected. Prompt diagnosis and regular clinical assessments are crucial to choosing the right treatment and avoiding potential complications.<sup>[2]</sup> Variations in the SBRN that result in complete or predominant supply to the dorsal hand can hinder hand and reconstructive surgeons during surgical procedures. Additionally, these variations may complicate neurologists' interpretations of electromyograms and evaluations of atypical symptoms.<sup>[15]</sup> Studies have documented various anatomical variations of the SBRN and the BRM tendon (**Table 1**). Recently, a previously unreported BRM with two distinct heads of origin has been described. One head originated from the lateral aspect of humerus between the deltoid and the lateral head

of triceps brachii and the second muscular head originated from the BRM and eventually inserted into the radius styloid process like normal BRM. This unique variation has been termed brachioradialis longus.<sup>[16]</sup> Understanding these variations is essential for anesthesiologists, physiotherapists, pain management therapists, and surgeons involved in treating compressive neuropathies or nerve entrapments. The split BR tendon is particularly relevant in hand surgery, as it can compress the emerging SBRN, leading to painful neuritis.

## Conclusion

This anatomical variation, where the superficial branch of the radial nerve passes through the split brachioradialis tendon, likely results from a complex interplay of genetic factors, molecular signals, and embryological development. Understanding this variation is essential for clinicians and surgeons to anticipate and manage potential complications during surgical procedures.

## Funding

The authors have no funding to report.

## Competing interests

The authors have declared that no competing interests exist.

## Acknowledgements

The authors have no support to report.

**Table 1.** Various studies showing different variations of SBRN and BRM tendon variation

| Authors                                 | Year | Findings   |
|---|------|--|
| Linell EA. <sup>[11]</sup>              | 1921 | Fusion of the BRM tendon and extensor carpi radialis longus (ECRL) tendon, with the SBRN piercing the fused tendon.                        |
| Turkof E, et al. <sup>[12]</sup>        | 1994 | Between two split portions of the BRM tendon, a SBRN emerged.  |
| Tryfonidis M, et al. <sup>[7]</sup>     | 2004 | BRM tendon was pierced by the SBRN and then became subcutaneous.   |
| Capkin S, Kaleli T. <sup>[13]</sup>     | 2018 | A case of SBRN compression caused by fibroma of the BRM tendon sheath.   |
| Herma T, et al. <sup>[14]</sup>         | 2022 | Duplication of SBRN with two bellies of BRM and compression of one SBRN.   |
| Georgiev GP, et al. <sup>[15]</sup>     | 2024 | SBRN supplied lateral 3/4 of the dorsum of hand, and the dorsal surface of the 4 lateral fingers and lateral half of the little finger.    |
| Triantafyllou G, et al. <sup>[16]</sup> | 2024 | The morphology of a previously unreported accessory brachioradialis muscle (ABR) has been described and termed the brachioradialis longus. |
| Current case report                     | 2024 | SBRN emerged between two parts of the split tendon of the BRM and bifurcated proximal to the extensor retinaculum.                         |

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