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# The branching pattern of the superficial branch of the radial nerve: description of a third branching type

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## SUMMARY

In emergency medicine, damage to the superficial branch of the radial nerve (SBRN) is often seen in patients with distal radius fractures. Knowledge of the complex SBRN anatomy is paramount in recognizing nerve damage after distal radius fractures, or in preventing iatrogenic damage during surgical reconstruction. The SBRN is also known for its involvement in difficult, therapy-resistant neuropathic pain syndromes (3-5%). Therefore the SBRN has been the subject of interest for many researchers.

In 20 embalmed arms, the SBRN was dissected and categorized, and the course in each arm was mapped. Furthermore, the distance from the point where the SBRN emerges from under the deep fascia and lister's tuberculum was measured.

The point at which the SBRN emerged from under the Brachioradialis muscle (BR) was consistently located at 33% of the forearm. Furthermore, three distinct branching patterns of the SBRN were identified: Pattern 1 (N=10) and pattern 2 (N=5) have previously been described in the literature. In pattern 3 (N=5), two branches run a course to the radial and ulnar aspects of the thumb. The third and fourth branches run a course to the index finger, and the fifth branch runs a course to the middle finger. Despite the fact that the course of the SBRN is well defined in current literature, the SBRN is still one of the most damaged nerves in the human body. The discovery of a third pattern, not previously reported in detail, could help in the early identification of SBRN lesions and in the prevention of iatrogenic damage.

**Key words:** superficial branch of the radial nerve – branching pattern – nerve damage – neuroma – neuropathic pain

## INTRODUCTION

The superficial branch of the radial nerve (SBRN) can easily be damaged during surgical procedures around the wrist. Due to the anatomical location of the nerve, there is an increased risk of iatrogenic damage during surgery, such as volar plating, placement of Steinman pins for external fixation for distal radius fractures, first dorsal extensor compartment release for De Quervain's disease, and elevating a radial forearm flap (Emami and Mjoberg, 2000; Mellor and Ferris, 2000; Singh et al., 2005). The SBRN is also known for its frequent involvement (3-5%) in pain syndromes after lesion of one of its branches. These pain syndromes are often difficult to treat and can be very disabling (Stokvis et al., 2010).

Its anatomical course at the dorso-radial aspect of the arm and wrist therefore remains of interest for surgeons. Hence, detailed knowledge of the branching pattern is essential to prevent (iatrogenic) damage during surgery.

A number of papers have described the course of the nerve (Linell, 1921; Abrams et al., 1992; Auerbach et al., 1994; Madhavi and Holla, 2003;

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Loukas et al., 2006; Khuroo et al., 2006; Huanmanop et al., 2007; Bargallo et al., 2010; Marx et al., 2010), and its branching pattern. Mok et al. (2006) described two distinct branching patterns. However Robson et al. (2008) described only one variation, and Kiliç et al. (2009) identified the same branching pattern as Robson's. Gupta et al. (2012) describe 3 different patterns based on the number of fingers innervated by the SBRN. In their study, however, they do not describe in detail the proximal branching pattern of the SBRN, the part of special interest in surgical procedures.

During several dissections of the lower arm and hand, the authors found an additional third branching pattern. Therefore, the goal of this research is to identify the different branching patterns of the SBRN and investigate their incidence and relevance to daily clinical practice.

## MATERIALS AND METHODS

Twenty arms (9 male, 11 female; mean age 79.35, range 61-90; 15 right, 5 left) were flushed with anubifix (www.anubifix.com) to regain flexion after rigor mortis and embalmed with a 4.4% formalin solution. None of the arms showed macroscopic signs of disease or shrinkage artifacts. All dissections were performed using a 5 diopter magnifying glass.

In each arm the Superficial Branch of the Radial Nerve was located at the point where it emerges from the deep fascia between the Brachioradialis (BR) muscle and the Extensor Carpi Radialis Longus (ECRL). The point where the nerve emerges was marked with a colored pin. Then the SBRN was dissected distally until the level of the metacarpo-phalangeal joints. Each arm was photographed using a Nikon 60D camera with a Sigma 50 mm 1:2,8 DG MACRO lens for further reference.

### *General assessments*

The following data were collected to describe the general course of the SBRN (Table 1):

The distance between listers tuberculum and the point of emergence of the SBRN.

In order to correct for the difference in the length

**Table 1.** Measurements performed on the specimens

| RSN Variation | Left/Right | Male/Female | Length lower arms (mm) | Emergence SBRN from lister (mm) | Ratio: Emergence SBRN/ Length |
|---|---|---|---|---|---|
| Var I (n=10) | L | F | 236 | 68 | 0.29 |
| | L | F | 225 | 60 | 0.26 |
| | R | F | 218 | 78 | 0.36 |
| | R | M | 279 | 115 | 0.41 |
| | R | F | 225 | 67 | 0.30 |
| | R | M | 281 | 111 | 0.40 |
| | R | F | 220 | 72 | 0.33 |
| | R | F | 209 | 85 | 0.41 |
| | R | M | 256 | 67 | 0.26 |
| | R | M | 251 | 62 | 0.25 |
| Var II (n=5) | L | M | 219 | 73 | 0.33 |
| | L | F | 234 | 74 | 0.32 |
| | R | M | 262 | 59 | 0.23 |
| | R | F | 241 | 68 | 0.28 |
| | R | F | 231 | 87 | 0.38 |
| Var III (n=5) | L | M | 253 | 97 | 0.38 |
| | R | F | 221 | 86 | 0.39 |
| | R | M | 231 | 90 | 0.39 |
| | R | M | 275 | 102 | 0.37 |
| | R | F | 216 | 69 | 0.32 |

Left/right, Male/female, length of the arm from epicondyle to MCP 2 joint, emergence of superficial branch of the radial nerve (SBRN) from Lister's tubercle and a ratio of emergence of the SBRN divided by the length of the arm.

of the arms, a ratio was computed between the length of each arm and the distance of SBRN to lister's tuberculum

The point of emergence of the SBRN, volar or dorsal to the Brachioradialis muscle

### *Branching patterns*

Two observers inspected the course of the SBRN and its branching pattern independently, using the same method as described by Ikiz and Üçerler (2004). The course of each SBRN was documented as a diagram. Different branching patterns were identified and each specimen was denominated to a specific group. Then inter-observer conformity was assessed. Finally, the branching patterns were compared to patterns described in the literature.

## RESULTS

The SBRN pierces the deep fascia at a mean distance of 79.5mm (60-115) from listers tuberculum with a computed ratio of 0.33 range (0.23-0.41). In 85% of cases (n=17) the SBRN can be found at the junction between the ECRL and the BR. However, in 15% (n=3) of cases the nerve was found to emerge volar to the BR muscle to then cross the tendon 5 cm distally.

Three distinct branching patterns of the SBRN were independently identified by both observers:

**Pattern I** (Fig. 1): one branch (SR3) runs a course to the radial side of the thumb; one branch (SR2) runs to the first web space and divides into two end branches and innervates the skin of the ulnar side of the thumb and the radial side of the index finger. A third branch (SR1) runs a course to the second web space and divides into 2 branches, one to the ulnar side of the index finger, and the other branch runs a course to the middle finger.

**Pattern II** (Fig. 2): one branch (SR3) divides into two end branches and runs a course to the radial and ulnar aspect of the thumb. The second branch (SR2) runs to the radial side of the index finger, and the third branch (SR1) runs to the second web space and divides into two branches, innervating the ulnar side of the index finger and the middle finger.

**Pattern III** (Figs. 3-4): two branches (SR3 and SR2) run a course to the radial and ulnar aspects of the thumb. The third (SR1) branch runs a course to the dorsal side of the wrist and divides into three branches, innervating both sides of the index finger and the middle finger. All nerves supplied the dorsum of the thumb and index finger and half the whole of the middle finger.

Two observers were able to identify the three patterns independently. Concerning the categorization of the three patterns, the inter-observer agreement was 100%.

## DISCUSSION

In many studies on the course of the SBRN, it is stated that the nerve always pierces the deep

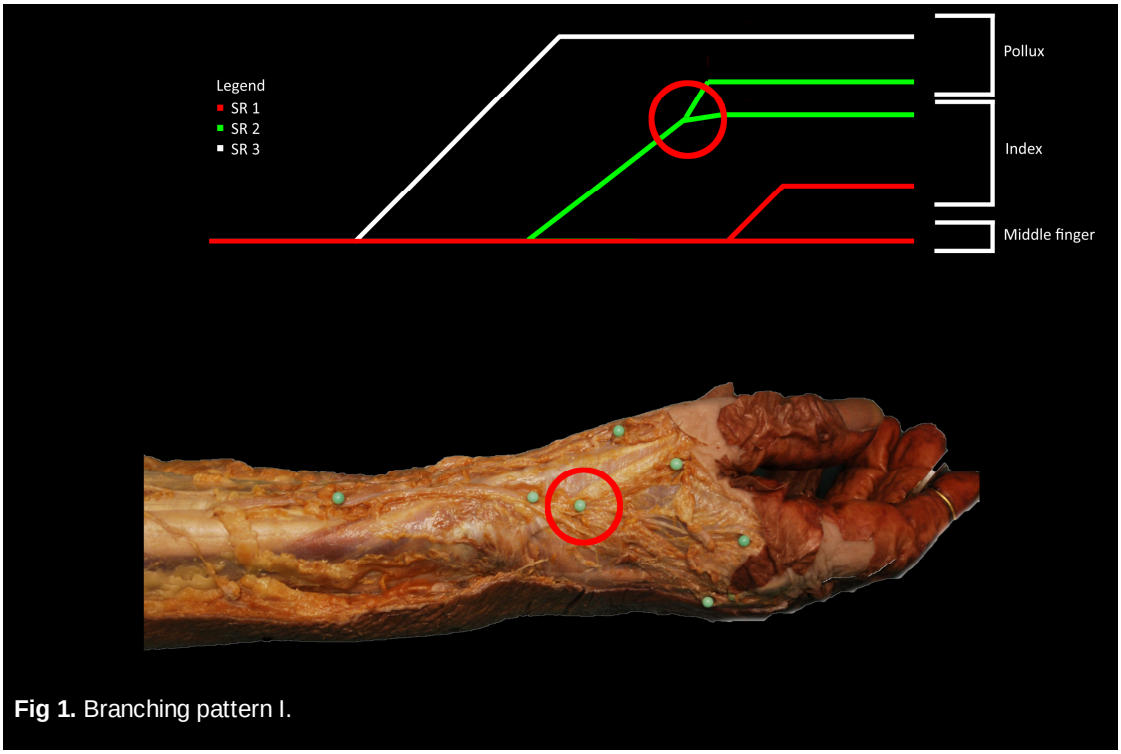


**Fig 1.** Branching pattern I.

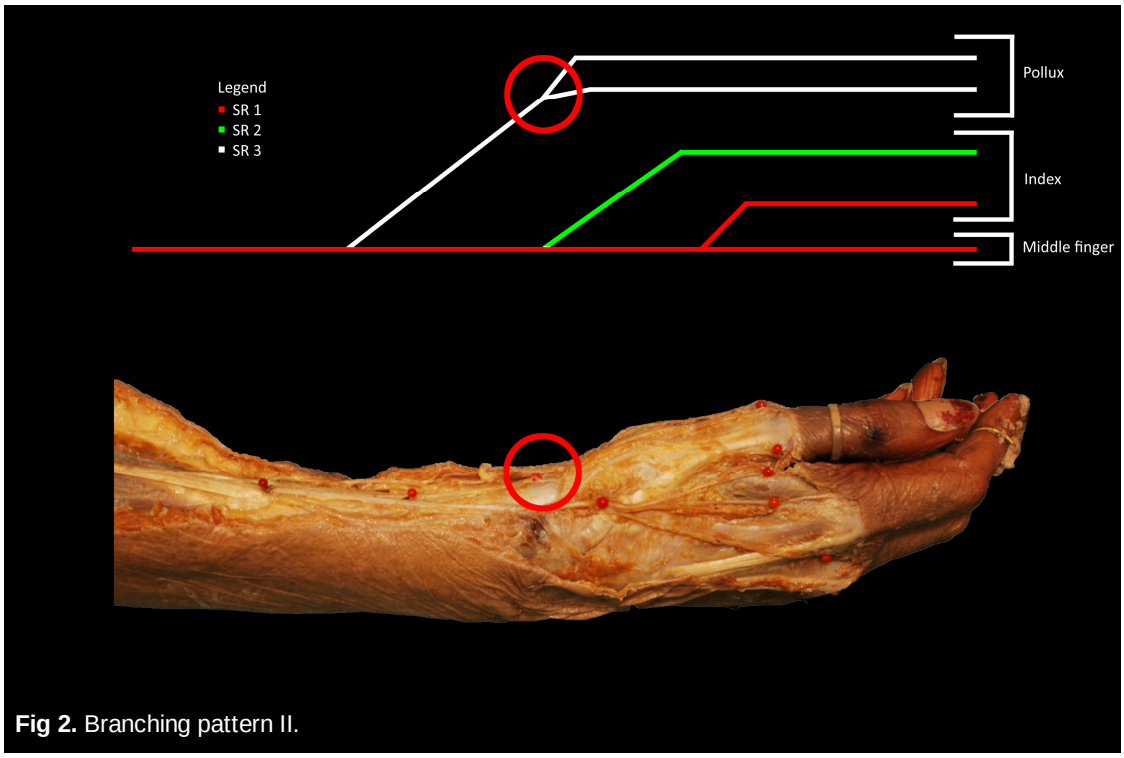


**Fig 2.** Branching pattern II.

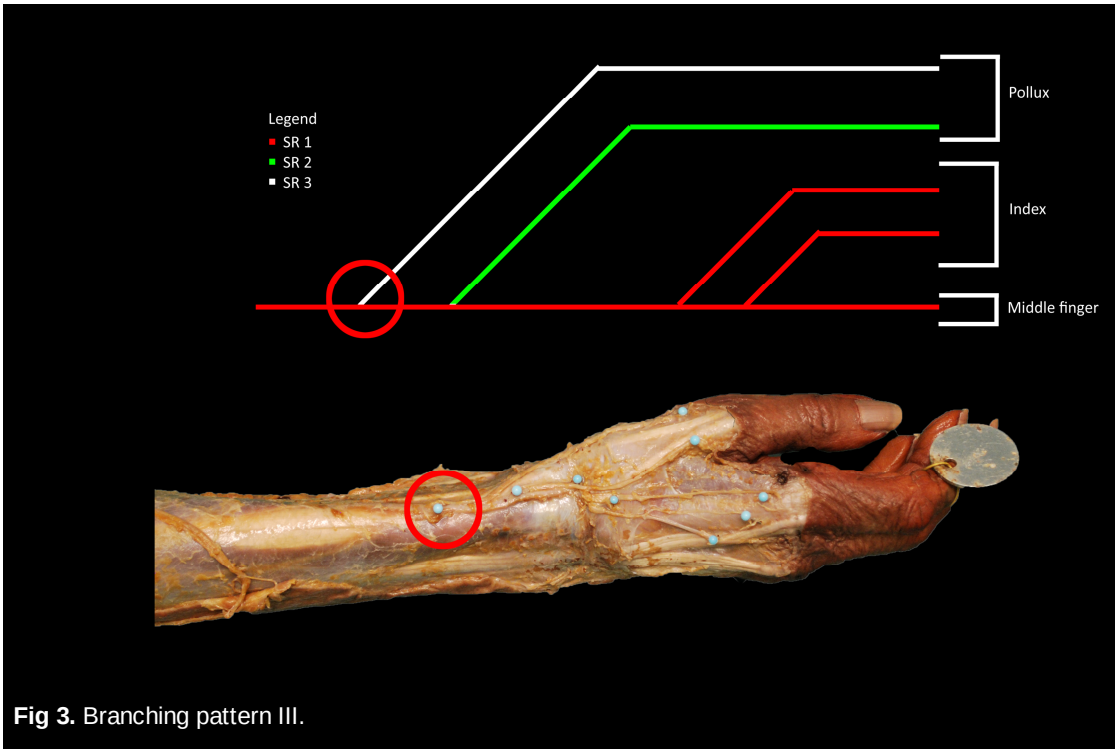


**Fig 3.** Branching pattern III.

fascia between the ECRL and BR tendons (Dellon and Mackinnon, 1984; Mackinnon and Dellon, 1985; Beldner et al., 2005; Mok et al., 2006; Robson et al., 2008; Tryfonidis et al., 2009). In our study, however, three out of 20 dissected arms (15%) showed that the SBRN pierced the deep fascia volar to the BR tendon. During proximal pin placement, when for instance applying an external fixator, surgeons expect the nerve between the BR en ERCL tendons. However, in the three specimens described above, the SBRN crossed the BR tendon, 5 cm distal to the site where the nerve emerged.

The course of the SBRN has been a point of interest for the last 20 years because, if damaged, it can lead to (chronic) pain syndromes. Pattern I and pattern II are consistent with the patterns as described by Mok, Robson and Kiliç, but pattern III clearly differs from the two patterns

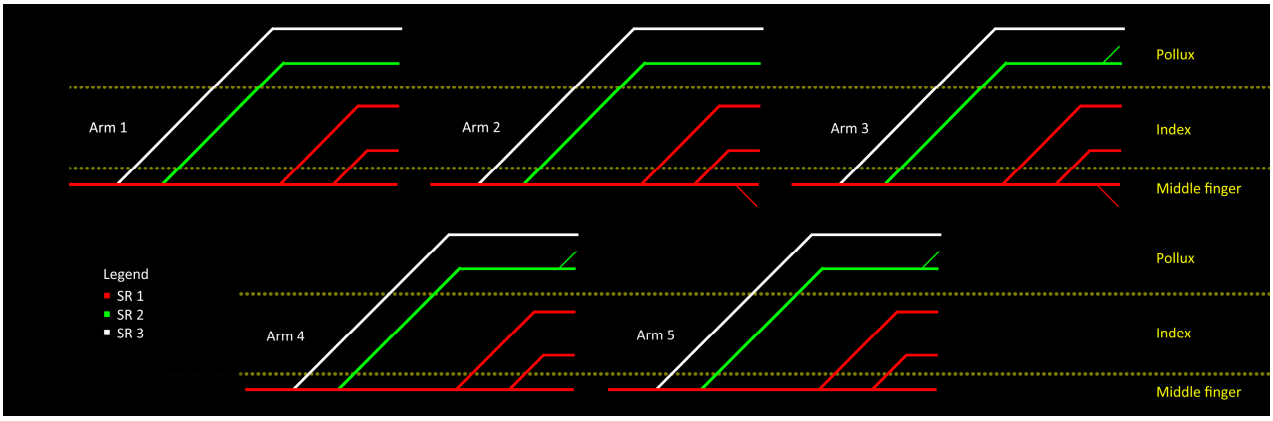


**Fig 4.** Diagram of all five specimens in pattern III.

previously described. All three patterns we described were also described in the study of Gupta et al. (2012), but categorized by number of fingers innervated. They also state in their article that the branching pattern described in their study is useful for anesthesia. In our opinion, the course of the three main branches of the SBRN around the wrist is more important during surgery. Division into three categories by branching is more useful to surgeons. And as a result it could prevent nerve damage during surgery. In the third identified pattern, the skin at the ulnar and radial side of the thumb and the radial side of the index finger is innervated separately.

A surgeon expects only one branch at the radial aspect of the wrist running to the thumb. In the described third branching pattern, two separate branches run along the radial aspect of the wrist to the thumb. When a surgeon is operating on the radial aspect of the wrist and comes across a branch of the SBRN, he could falsely believe that that branch is the utmost radial branch and unknowingly damage the radial branch of the thumb.

The fact that two independent observers were able to link all arms to one of the three patterns with such a high consistency, and the fact that out of 20 arms, five arms (25%) were recognized as belonging to pattern III, makes the finding of this third pattern consistent and relevant for surgery at the dorso-lateral side of the wrist.

### *Concluding remarks*

The significantly high occurrence of this third branching pattern could explain why lesions of this nerve still occur regularly as a complication of surgery to the wrist, despite the fact that most surgeons are aware of the presence of the SBRN, and are able to recognize the nerve to be at risk in surgical procedures in this region. The previously identified patterns do not fully cover the actual course of the SBRN.

Furthermore, knowledge of this third pattern could help identify damage to the SBRN due to trauma in an early stage.

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