

The branching pattern of the superficial branch of the radial nerve: *Description of a third branching type*

A.R. Poublon¹

E.T. Walbeehm²

J.H. Coert³

G.J. Kleinrensink¹

¹ Dept. of Neuroscience and Anatomy, Erasmus MC, Rotterdam, The Netherlands

² Dept. of Plastic Surgery, Radboud UMC, Nijmegen, The Netherlands

³ Dept. of Plastic Surgery, UMC Utrechts, Utrecht, The Netherlands

European Journal of Anatomy 2013;17:237-42.

ABSTRACT

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 preventing iatrogenic damage during surgical reconstruction. The SBRN is also known for its involvement in hard to treat 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, 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 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) were previously described in 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 described in detail, could help in the early identification of SBRN lesion and prevent iatrogenic damage.

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 flap¹⁻³. 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 disabling⁴.

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 nerve⁵⁻¹³, and its branching pattern. Mok et al.¹⁴ (2006) described two distinct branching patterns. However, Robson et al.¹⁵ (2008) described only one variation and Kiliç et al.¹⁶ (2009) identified the same branching pattern as Robson. Gupta et al.¹⁷ (2012) describes 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.

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 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 60 D camera with a Sigma 50 mm 1:2,8 DG MACRO lens for further reference.

General assessments

The following data was collected to describe the general course of the SBRN (tab. 1):

Tabel 1

RSN Variation	Left/Right	Male/Female	Length lower arms (mm)	Emergence SBRN from lister (mm)	Ratio: Emergence SBRN/Length lower arm
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

Tab 1. Measurements performed on the specimens. Left/right, Male/female, length of the arm from epicondyle to MCP 2 joint, emergence of SBRN from Lister's tubercle and a ratio of emergence of the SBRN divided by the length of the arm.

1. The distance between listers tuberculum and the point of emergence of the SBRN.
2. In order to correct for the difference in the length of the arms, a ratio was computed between the length of each arm and the distance of SBRN to lister's tuberculum
3. The point of emergence of the SBRN, volar or dorsal to the Brachioradialis muscle

Branching patterns

Two observers each inspected the course of the SBRN and its branching pattern independently using the same method as described by Ikiz and Üçerler¹⁸. 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 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 Brachioradialis (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 (SR 3) runs a course to the radial side of the thumb; one branch (SR 2) runs to the first webspace 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 (SR 1) runs a course to the second webspace 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.

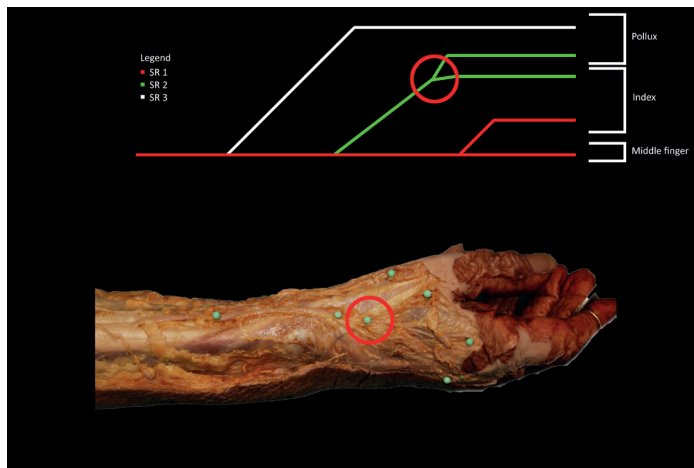


Figure 1. Branching pattern I.

Pattern II (fig 2): one branch (SR 3) 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 (SR 1) runs to the second webspace and divides into two branches, innervating the ulnar side of the index finger and the middle finger.

Pattern III (fig 3-4): two branches (SR 3 and SR 2) run a course to the radial and ulnar aspects of the thumb. The third (SR 1) 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.

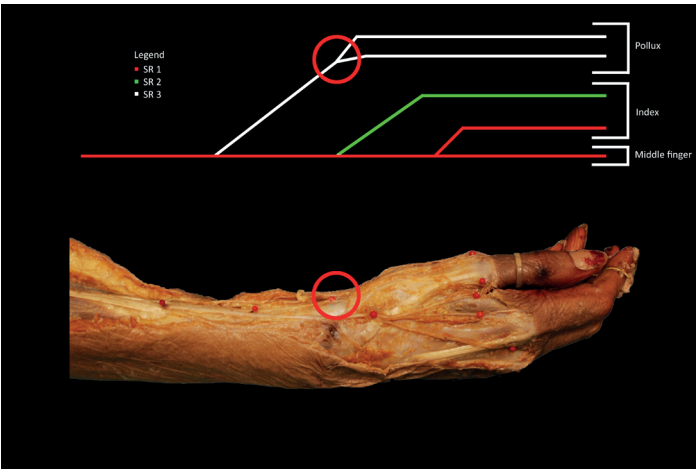


Figure 2. Branching pattern II.

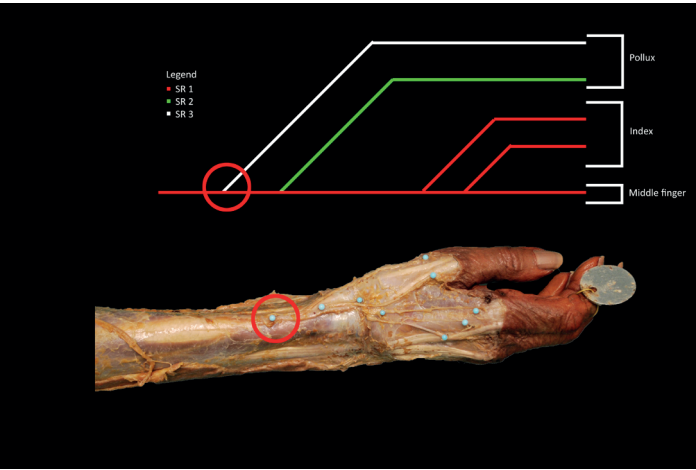


Figure 3. Branching pattern III.

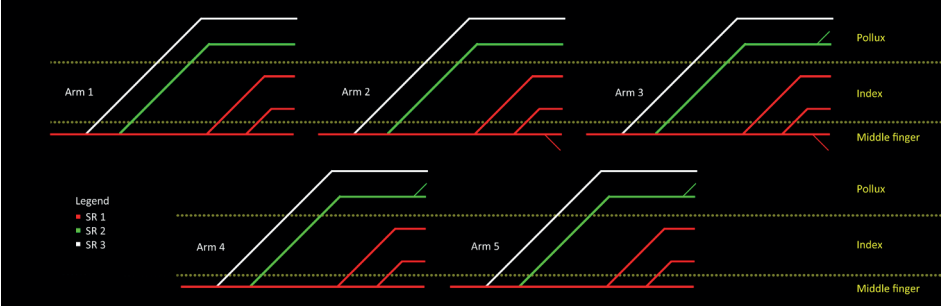


Figure 4. Diagram of all five specimens in pattern III.

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 fascia between the ECRL and BR tendons^{14, 15, 19-22}. In our study however, three out of 20 dissected arms (15%) showed, that the SBRN pierced the deep fascia volar to the Brachioradialis tendon. During proximal pin placement, when for instance applying an external fixator, surgeons expect the nerve between the BR and 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 previously described. All three patterns that we described, are also described in the study of Gupta et al. but they categorize by number of fingers innervated. Gupta et al. 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 is more important during wrist surgery and 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 most 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.

REFERENCES.

1. Singh S, Trikha P, Twyman R. Superficial radial nerve damage due to Kirschner wiring of the radius. *Injury*. 2005 Feb;36(2):330-2.
2. Emami A, Mjoberg B. A safer pin position for external fixation of distal radial fractures. *Injury*. 2000 Nov;31(9):749-50.
3. Mellor SJ, Ferris BD. Complications of a simple procedure: de Quervain's disease revisited. *Int J Clin Pract*. 2000 Mar;54(2):76-7.
4. Stokvis A, van der Avoort DJ, van Neck JW, Hovius SE, Coert JH. Surgical management of neuroma pain: a prospective follow-up study. *Pain*. 2010 Dec;151(3):862-9.
5. Madhavi C, Holla SJ. Dual sensory innervation of the dorsum of the thumb. *Clin Anat*. 2003 Jul;16(4):344-5.
6. Marx SC, Kumar P, Dhalapathy S, Marx CA, D'Souza AS. Distribution of sympathetic fiber areas of radial nerve in the forearm: an immunohistochemical study in cadavers. *Surg Radiol Anat*. 2010 Nov;32(9):865-71.
7. Auerbach DM, Collins ED, Kunkle KL, Monsanto EH. The radial sensory nerve. An anatomic study. *Clin Orthop Relat Res*. 1994 Nov(308):241-9.
8. Abrams RA, Brown RA, Botte MJ. The superficial branch of the radial nerve: an anatomic study with surgical implications. *J Hand Surg Am*. 1992 Nov;17(6):1037-41.
9. Huanmanop T, Agthong S, Luengchawapong K, Sasiwongpakdee T, Burapasomboon P, Chentanez V. Anatomic characteristics and surgical implications of the superficial radial nerve. *J Med Assoc Thai*. 2007 Jul;90(7):1423-9.
10. Loukas M, Louis RG, Jr., Wartmann CT. The cutaneous innervation of the dorsal hand: Detailed anatomy with clinical implications. *J Hand Surg Am*. 2006 Dec;31(10):1699-700.
11. Khuroo YS, Babu SR, Bargawa HSM, Anand A, Rajendran M. Anatomical variation of superficial branch of radial nerve - A Cadaveric Study. *JK-Practitioner*. 2006 Jul;13(3):169-72.
12. Bargallo X, Carrera A, Sala-Blanch X, Santamaria G, Morro R, Llusa M, et al. Ultrasound-anatomic correlation of the peripheral nerves of the upper limb. *Surg Radiol Anat*. 2010 Mar;32(3):305-14.
13. Linell EA. The Distribution of Nerves in the Upper Limb, with reference to Variabilities and their Clinical Significance. *J Anat*. 1921 Jan;55(Pt 2-3):79-112.
14. Mok D, Nikolis A, Harris PG. The cutaneous innervation of the dorsal hand: detailed anatomy with clinical implications. *J Hand Surg Am*. 2006 Apr;31(4):565-74.
15. Robson AJ, See MS, Ellis H. Applied anatomy of the superficial branch of the radial nerve. *Clin Anat*. 2008 Jan;21(1):38-45.
16. Kilic A, Kale A, Usta A, Bilgili F, Kabukcuoglu Y, Sokucu S. Anatomic course of the superficial branch of the radial nerve in the wrist and its location in relation to wrist arthroscopy portals: a cadaveric study. *Arthroscopy*. 2009 Nov;25(11):1261-4.
17. Gupta R, Aggarwal A, Sahni D, Harjeet K, Barnwal M. Anatomical survey of terminal branching patterns of superficial branch of radial nerve in fetuses. *Surg Radiol Anat*. 2012 Jul;34(5):415-20.
18. Ikiz ZA, Ucerler H. Anatomic characteristics and clinical importance of the superficial branch of the radial nerve. *Surg Radiol Anat*. 2004 Dec;26(6):453-8.
19. Beldner S, Zlotolow DA, Melone CP, Jr., Agnes AM, Jones MH. Anatomy of the lateral antebrachial cutaneous and superficial radial nerves in the forearm: a cadaveric and clinical study. *J Hand Surg Am*. 2005 Nov;30(6):1226-30.
20. Mackinnon SE, Dellon AL. The overlap pattern of the lateral antebrachial cutaneous nerve and the superficial branch of the radial nerve. *J Hand Surg Am*. 1985 Jul;10(4):522-6.

21. Dellon AL, Mackinnon SE. Susceptibility of the superficial sensory branch of the radial nerve to form painful neuromas. *J Hand Surg Br.* 1984 Feb;9(1):42-5.
22. Tryfonidis M, Charalambous CP, Jass GK, Jacob S, Hayton MJ, Stanley JK. Anatomic relation of dorsal wrist arthroscopy portals and superficial nerves: a cadaveric study. *Arthroscopy.* 2009 Dec;25(12):1387-90.