Anatomic Characteristics and Surgical Implications of the Superficial Radial Nerve

Thanasil Huanmanop MD, MSc*, Sithiporn Agthong MD, PhD*,
Krisada Luengchawapong MD*, Thananed Sasiwongpakdee MD*,
Pattarin Burapasomboon*, Vilai Chentanez MD, PhD*

* *Department of Anatomy, Faculty of Medicine, Chulalongkorn University*

Background: *Superficial radial nerve (SRN) that lies superficially on the radial side of the distal forearm and dorsum of the hand, can be injured by various procedures. Thus, precise knowledge in its variation is crucial.*
Objective: *Since there were no such data in Thai population, provide the variation data of the SRN in Thai cadavers. This is likely to be more accurate when applied in Thailand*
Material and Method: *The authors studied the branching pattern and the course of SRN in 40 Thai cadavers.*
Results: *The extra type, replacement of SR3 by a branch of the lateral antebrachial cutaneous nerve, was found (4.7%) and the incidences of other patterns were different from those of previous reports. Moreover, asymmetry and gender difference were also demonstrated. The authors observed the higher frequencies of the SRN lying over the snuffbox and first dorsal compartment of the wrist compared to other reports. The distances to important landmarks were measured and the presented data were comparable to those of other studies with no significant differences between sides or genders.*
Conclusion: *These findings suggest that the different variations of the SRN among various races should be concerned during the relevant procedures.*

Keywords: *Superficial radial nerve, Anatomical variation, Side, Gender*

J Med Assoc Thai 2007; 90 (7): 1423-9
Full text. e-Journal: *http://www.medassocthai.org/journal*

Superficial radial nerve (SRN) is the sensory nerve lying in the subcutaneous layer on the radial side of the dorsum of the hand and distal forearm. Injuries or surgical procedures in this area may cause sensory loss. These procedures include decompression of the first dorsal compartment in De Quervain's disease[1], venipuncture of cephalic vein[2], wrist arthroscopy and K-wire fixation in the distal radius[3]. Moreover, if necessary, the SRN can also be used as an autologous graft for peripheral nerve repair. Therefore, anatomical variations of this nerve are crucial to prevent the injuries and facilitate the nerve harvest. Previous studies have examined the course of the SRN in relation to the adjacent structures and landmarks including lateral antebrachial cutaneous nerve, cephalic vein, brachioradialis tendon, anatomical snuffbox and the first dorsal compartment of the wrist[4-9]. Moreover, the branching pattern was also studied[5,6,10]. However, no extensive anatomical study in Thai subjects has been done. Hence, the present study was aimed to provide the variation data of the SRN in Thai cadavers which are likely more accurate to be applied in Thailand. In addition, comparisons of these data between sides and genders were also done. The results show several discrepancies among this and other studies and suggest the importance of asymmetry and gender difference.

Correspondence to : Chentanez V, Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Rama IV Rd, Pathumwan, Bangkok 10330, Thailand. Phone: 0-2256-4281, Fax: 0-2252-7028, E-mail: fmedvct@md.chula.ac.th

Material and Method

Subjects

Forty formalin-preserved cadavers (18 males and 22 females) in the Department of Anatomy, Faculty of Medicine, Chulalongkorn University, were used. Bilateral distal forearms and hands were dissected to

expose the SRN and all of its branches with the cephalic vein and lateral antebrachial cutaneous nerve (LACN) preserved. The right arm of one female was excluded due to the extensive hematoma in the dissection area. As a result, 79 arms in total were included in the present study.

Gross observation

At the point where the SRN emerged from under the brachioradialis tendon (BRT), the presence of split BRT and whether the SRN was between the two tendon slips were recorded. Terminal branching of the SRN was categorized into three types according to Ikiz and Ucerler, 2004[10]. Briefly, Type 1 was designated when the SRN gave rise to two branches: SR3 and common trunk of SR1 and SR2 (Fig. 1). The SR1 and SR2 were on the dorsum of the hand to the index finger and the first metacarpal space, respectively. The SR3 run to the lateral side of the thumb. In Type 2, the SRN had trifurcation with no common trunk of the SR1 and SR2. Type 3 was similar to Type 2 except the presence of accessory branch on the third metacarpal space more ulnar than the SR1.

Moreover, the relation of the SRN to the cephalic vein and the LACN was noted. For the latter, neural connections were also studied. The course of any SRN branch over the snuffbox or first dorsal compartment was recorded.

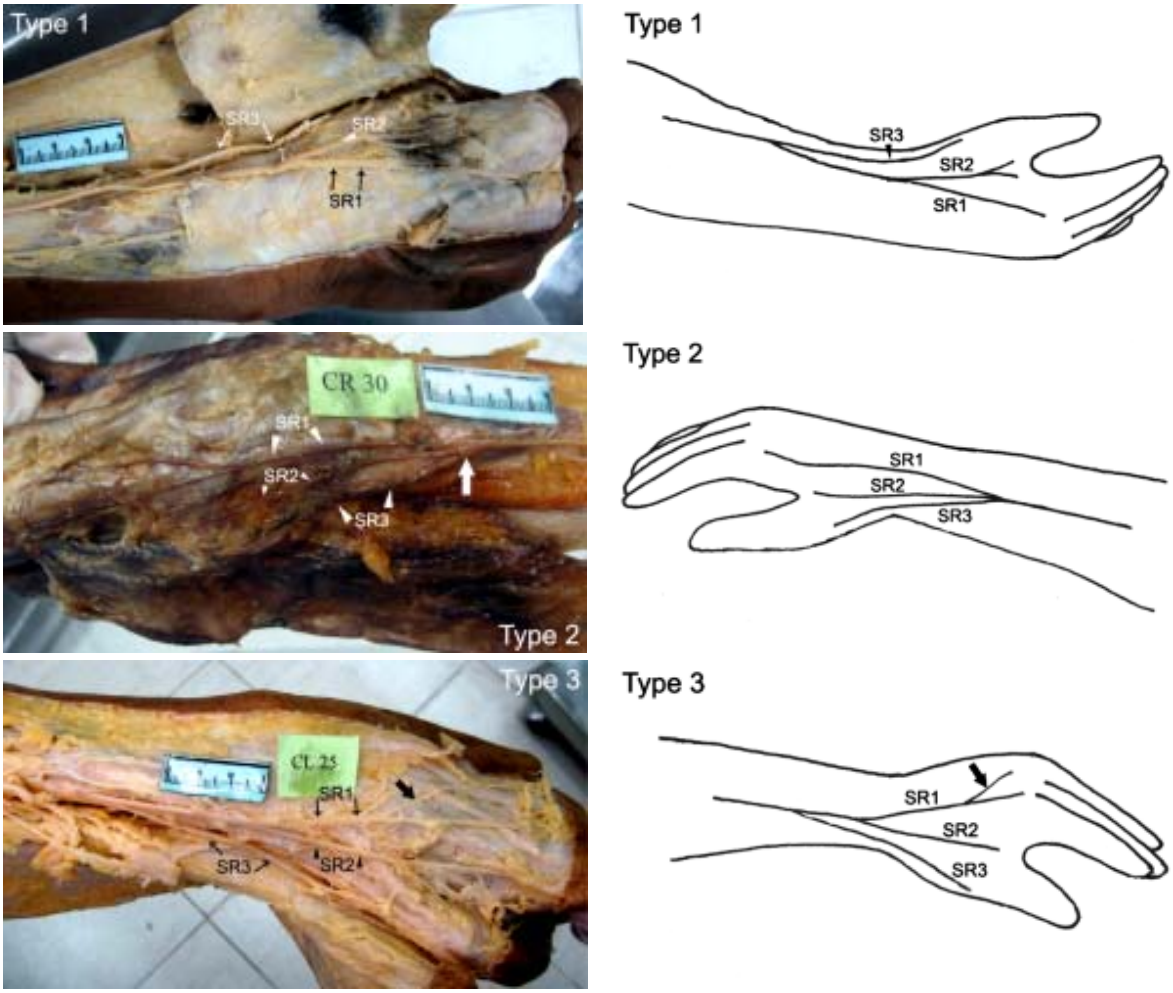

Fig. 1 Types of the branching pattern of the superficial radial nerve (SRN). Images from cadavers and corresponding diagrams are on the left and right columns, respectively. White arrow in Type 2 indicates the trifurcation point of the SRN, Dark arrows in Type 3 indicate the accessory branch of the SRN ulnar to the SR1

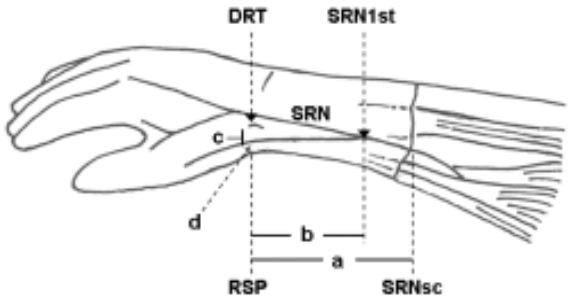

Fig. 2 Diagram showing the measurements performed in this study
SRN = superficial radial nerve
a = distance between the radial styloid process (RSP) and the point that the SRN emerges to the subcutaneous layer (SRNsc)
b = distance between the RSP and the first branching point of the superficial radial nerve (SRN1st)
c = distance between the closest branch of the SRN and the dorsal radial tubercle (DRT)
d = distance between the closest branch of the SRN and the RSP

Measurements

The course and branches of the SRN were referred to the landmarks. They included the radial styloid process (RSP) and the dorsal radial tubercle (DRT or Lister's tubercle). The distances from the RSP to the point where the SRN pierced the deep fascia into the subcutaneous layer, the first point of branching and the nearest branch of the SRN were measured using a digital caliper. These values were compared to the distance between the lateral epicondyle (LE) of humerus and the RSP, which was used to represent the forearm length. In addition, the distance from the DRT to the closest branch of SRN was also determined. All measurements are summarized in Fig. 2.

Statistical analysis

The measurement data were presented by means of mean and standard error of mean (SEM) and compared between genders and sides using Student's t-test. A $p < 0.05$ was considered statistically significant.

Results

Type 1 was the most common branching pattern of SRN in both genders [22 male arms (61.1%) and 29 female arms (67.4%)] (Table 1). Type 3 was found with less frequency and Type 3 was found in only one female arm. It is worth noting that the extra type in which the SR3 was replaced by the branch of LACN was observed in two female arms (2 of 43, 4.7%) (Fig. 3). Moreover, asymmetry of the branching pattern of the SRN between sides was found in 17 cadavers. Between genders, the frequency of each type in the right arm was almost identical (Table 1). In contrast, on the left side, Type 2 was the most common in males, whereas Type 1 was the most frequently found in females.

The BRT was not divided in the majority of cases. However, in three arms (3.8%, 2 from the same male and 1 female), the SRN emerged between the two slips of the split BRT to become superficial (Fig. 4).

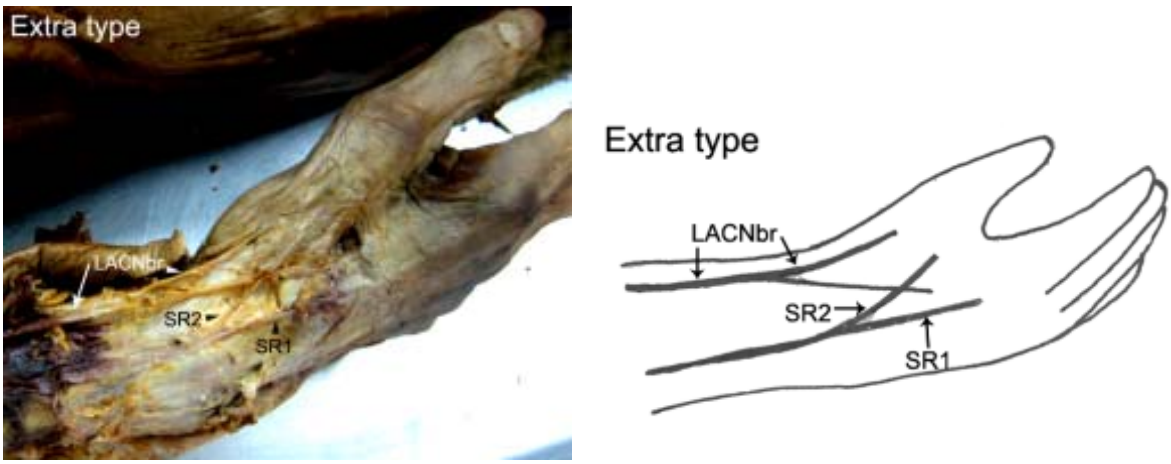

Fig. 3 Extra type of the superficial radial nerve in which a branch of the lateral antebrachial cutaneous nerve (LACNbr) replaces the SR3

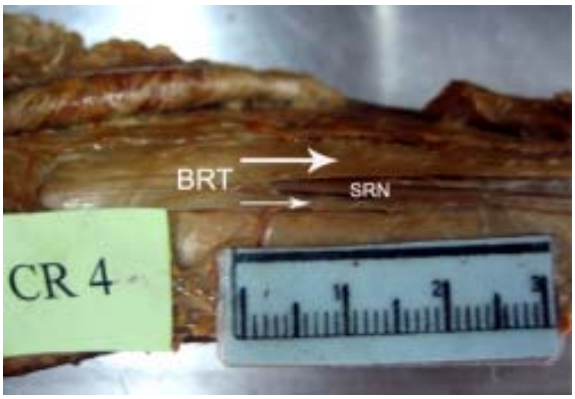

Fig. 4 Split brachioradialis tendon (BRT). Arrows indicate two tendon slips with the superficial radial nerve (SRN) in the middle

Table 1. Incidence of each type of the branching pattern of the superficial radial nerve

Type	Male		Female	
	Right n (%)	Left n (%)	Right n (%)	Left n (%)
1	14 (77.8)	8 (44.4)	15 (71.4)	14 (63.6)
2	0	0	1 (4.8)	0
3	4 (22.2)	10 (55.6)	4 (19.0)	7 (31.8)
Extra	0	0	1 (4.8)	1 (4.6)
Total	18 (100)	18 (100)	21 (100)	22 (100)

More distally, the SRN was along the cephalic vein in the more dorsal position than the LACN in 77 arms (97.5%). There were connections between the LACN and SRN in 34 arms (43%, 14 males and 20 females). The SR3 was mainly involved in these connections (85.3%). However, the links with the SR2 and the common trunk of SR1 and SR2 were also seen but with less incidences. At the wrist, the SRN, mainly SR2, was over the snuffbox in 51 arms (64.6%). In 30 arms (38%), the SRN was above the first dorsal compartment.

As for the measurements, the distances between the emerging point of SRN from the deep fascia to the subcutaneous layer and the RSP were in the range of 7 to 8 cm (7.3 cm in average) for both genders (Table 2). This was approximately 30% of the forearm length indicated by the distance from the LE to the RSP. On a similar word, the point where the SRN became superficial to the deep fascia could be located at 3 of 10 parts of the forearm length from the RSP. Mean distances from the first major branch point of the SRN to the RSP were 5.3-5.4 and 3.9-4.2 cm, which were approximately 21% and 17% of the forearm length for males and females, respectively. Furthermore, the closest branch of SRN was approximately 3 mm in average away from the RSP in both genders. The mean distances between the closest branch of SRN and the DRT were over 10 mm in males compared to less than 10 mm in females. There were no significant differences in any parameter between genders and sides.

Discussion

The authors found that Type 1 was the most

Table 2. Measurement data

Measurement	Male		Female		All n = 79
	Right n = 18	Left n = 18	Right n = 21	Left n = 21	
LE – RSP (cm)	25.2 ± 1.2	25.1 ± 1.0	23.0 ± 1.2	23.1 ± 1.1	24.0 ± 1.5
SRNsc – RSP (cm)	7.7 ± 1.5	8.0 ± 2.0	6.9 ± 0.9	7.0 ± 1.5	7.3 ± 1.5
SRN1st – RSP (cm)	5.3 ± 1.3	5.4 ± 1.5	3.9 ± 1.4	4.2 ± 1.1	4.6 ± 1.5
SRNcb – RSP (mm)	3.0 ± 2.0	2.9 ± 2.0	2.8 ± 1.8	3.0 ± 1.7	2.9 ± 1.8
SRNcb – DRT (mm)	10.8 ± 3.9	10.2 ± 4.6	9.1 ± 3.4	9.9 ± 3.5	10.0 ± 3.8

Data are means ± SEM
LE = Lateral epicondyle of humerus
RSP = Radial styloid process
SRNsc = Emerging point of the superficial radial nerve to the subcutaneous layer
SRN1st = The first branching point of the superficial radial nerve
SRNcb = The closest branch of the superficial radial nerve
DRT = Dorsal radial tubercle

common branching pattern of the SRN regardless of gender or side (64.6%) which was similar to the previous reports[5,10]. However, in the present study, the incidence of Type 3 (31.6%) was markedly higher than that of Ikiz and Ucerler, 2004 (2.08%)[10]. Type 2 was observed with less frequency in the present study (1.3%) compared to those of Ikiz and Ucerler, 2004 (8.33%)[10] and Abrams et al, 1992 (15%)[5]. The explanation for these discrepancies might be the different races used as the presented specimens were Orientals while theirs were Westerners. As a result, the above findings may emphasize the different branching pattern of the SRN among various races and suggest that trifurcation of the SRN is likely to be less common in a Thai population.

Moreover, the authors also found the extra type of branching pattern in which the SR3 was replaced by the branch from the LACN (2.5%). This pattern has not been previously reported. In addition to this special pattern, the connections between the SRN and LACN were also observed in 43% of cases. In the literature, the figures were relatively diverse: 70%[4], 34%[5], 20.8%[10], 10%[8]. As for the specific branch of the SRN forming the connections, the SR3 was mostly involved in the present study (83.5%). Ikiz and Ucerler, 2004[10] also found that all connections were between the SR3 and LACN. Hence, the connections between the SRN, mainly the SR3, and the LACN were observed in various races including Thai and this may be responsible for unsuccessful surgical treatment of the neuroma of SRN.

Considering side, asymmetry of the branching pattern was found in 17 cadavers (42.5%) indicating that one cannot always assume the pattern of one side from the other. Moreover, when comparing between genders, there were differences in the branching pattern on the left arm. Type 3 was more common than Type 1 in males but the opposite finding was seen in females. It is also noteworthy that the extra type was found in females, not in males. These data, for the first time, suggest that asymmetry and gender difference in the branching pattern of the SRN should be made aware.

As for the course of the SRN, split BRT was observed in 3.8% of the presented specimens and all had the SRN between the two tendon slips. Turkof et al[7] reported a similar figure (3.3%) but also showed that some SRN did not emerge between the tendons of the split BRT. Abrams et al, 1992[5] and Tryfonidis et al, 2004[8] reported the higher incidences, 10% and 20%, respectively. This variation may cause entrapment of the SRN. At the wrist, the authors found that the SR3 passed over the snuffbox in 64.6% of cases. Ikiz and Ucerler, 2004[10] found less frequency (16.67%). The higher incidence of SR3 in the snuffbox area in Thai cadavers suggests that procedures within this landmark should be performed with caution. For example, percutaneous K-wire fixation has been shown to cause the SRN injury[11]. The first dorsal compartment is also another clinically important landmark since a release operation of this tunnel is done to treat De Quervain's disease. In the present study, the SRN lay over this compartment in 38% of the arms. This figure was more

Table 3. Comparison of the important measurement data among this and other studies

	LE-RSP (cm)	SRNsc-RSP (cm)	SRN1st-RSP (cm)	SRNcb-RSP (mm)	SRNcb-DRT (mm)
Abrams[5]	25.5	9 (36%)[a]	5.1 (20%)[a]	-	16
Auerbach[6]	-	6	5.3	-	-
Ikiz[10]	26.8	9.2	4.9	-	16
Tryfonidis[8]	-	7.8	-	-	-
Beldner[8]	-	8.3/9.3[b]	-	-	-
Present study	24.0	7.3 (30%)[a]	4.6 (20%)[a]	2.9	10.0

LE = Lateral epicondyle of humerus
RSP = Radial styloid process
SRNsc = Emerging point of the superficial radial nerve to the subcutaneous layer
SRN1st = The first branching point of the superficial radial nerve
SRNcb = The closest branch of the superficial radial nerve
DRT = Dorsal radial tubercle
a = Percent of the forearm length
b = Female/male

than double of that reported by Ikiz and Ucerler, 2004[10], 16.67%. Therefore, release of the first dorsal compartment should be done with more caution in Thai subjects in order to avoid the SRN injury. There were no major differences in the above data between sides or genders.

As for the measurement data, comparisons among this and other studies are shown in Table 3. The mean distance between the points, where the SRN pierced the deep fascia to the subcutaneous layer and the RST, was 7.3 cm regardless of gender or side. This was similar to what was reported by Tryfonidis et al (7.8 cm)[8], longer than that of Auerbach et al, 1994 (6 cm)[6] and shorter than those of other studies (8-9 cm)[5,9,10]. Despite these differences in the absolute length, the relative values compared to the forearm length (the RST to the lateral epicondyle of humerus) were comparable between this and one of those previous reports[5], 30% and 36%, respectively. Furthermore, the distance from the first branching point of the SRN to the RST was 4.6 cm in average similar to those of other studies, 5.1[5], 5.3[6] and 4.9 cm[10]. Again, the relative value of this distance to the forearm length in the present study was identical to that of one study[5] (20%). The mean distances from the closest branch of the SRN to the RST and DRT were 2.9 and 10.0 mm, respectively. The presented distance between the closest branch and the DRT was shorter than those of other studies (16 mm)[5,10]. Several discrepancies in the above data among this and other studies may be due to the use of different races. The presented absolute distances tend to be shorter. However, the values relative to the forearm length were constant among the reports suggesting that this parameter is likely more useful in various populations. It is worth noting that there were no significant differences in any distance between genders or sides.

In summary, the anatomical variations of the SRN in Thai cadavers in the present study had both similarities and differences in comparison with those of other studies. Moreover, asymmetry and gender difference were also demonstrated. Therefore, this data should be noted when performing procedures on the radial side of the dorsum of hand and distal forearm to avoid the SRN injury.

Acknowledgements

The authors wish to thank Supakit Pisitpaibool, Supawadee Suksaree, and Nathara Duangmardpol for their assistance during the dissection and measurement. This work was supported by Ratchadapiseksompoj Research Fund 2549 (Grant No. RA039/49).

References

1. Braidwood AS. Superficial radial neuropathy. J Bone Joint Surg Br 1975; 57: 380-3.
2. Boeson MB, Hranchook A, Stoller J. Peripheral nerve injury from intravenous cannulation: a case report. AANA J 2000; 68: 53-7.
3. Singh S, Trikha P, Twyman R. Superficial radial nerve damage due to Kirschner wiring of the radius. Injury 2005; 36: 330-2.
4. 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; 10: 522-6.
5. Abrams RA, Brown RA, Botte MJ. The superficial branch of the radial nerve: an anatomic study with surgical implications. J Hand Surg [Am] 1992; 17: 1037-41.
6. Auerbach DM, Collins ED, Kunkle KL, Monsanto EH. The radial sensory nerve. An anatomic study. Clin Orthop Relat Res 1994; 308: 241-9.
7. Turkof E, Puig S, Choi MS, Schilhan R, Millesi H, Firbas W. Superficial branch of the radial nerve emerging between two slips of a split brachioradialis muscle tendon: a variation of possible clinical relevance. Acta Anat (Basel) 1994; 150: 232-4.
8. Tryfonidis M, Jass GK, Charalambous CP, Jacob S. Superficial branch of the radial nerve piercing the brachioradialis tendon to become subcutaneous: an anatomical variation with clinical relevance. Hand Surg 2004; 9: 191-5.
9. 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; 30: 1226-30.
10. Ikiz ZA, Ucerler H. Anatomic characteristics and clinical importance of the superficial branch of the radial nerve. Surg Radiol Anat 2004; 26: 453-8.
11. Steinberg BD, Plancher KD, Idler RS. Percutaneous Kirschner wire fixation through the snuff box: an anatomic study. J Hand Surg [Am] 1995; 20: 57-62.

ลักษณะทางกายวิภาคและความเกี่ยวข้องทางศัลยกรรมของเส้นประสาท superficial radial

ธนศิลป์ หวลมานพ, สิทธิพร แอกทอง, กฤษฎา เหลืองชวพงศ์, ธนเนตร์ ศศิวงศ์ภักดี, ภัทริน บูรพาสมบูรณ์, วิไล ชินธเนศ

เส้นประสาท superficial radial (SR) อยู่ในชั้นใต้ผิวหนังด้าน radial ของปลายแขนและหลังมือ จึงอาจเกิดการบาดเจ็บได้ง่ายจากการทำหัตถการต่าง ๆ ดังนั้นความรู้ด้านความแตกต่างทางกายวิภาคของเส้นประสาทนี้จึงมีความสำคัญยิ่ง เนื่องจากยังไม่มีการศึกษารายละเอียดในคนไทย ผู้รายงานจึงได้ศึกษารูปแบบการแตกแขนงและทางเดินของเส้นประสาท SR ในศพดองคนไทยจำนวน 40 ศพ พบว่ามีลักษณะการแตกแขนงพิเศษคือ SR3 ถูกแทนที่ด้วยแขนงของเส้นประสาท lateral antebrachial cutaneous 4.7% และมีความแตกต่างในการพบรูปแบบอื่น ๆ เมื่อเทียบกับการศึกษาก่อนหน้านี้ รวมทั้งพบความแตกต่างระหว่างเพศและข้างด้วย เส้นประสาทที่พาดผ่าน snuff-box และ dorsal compartment ที่ 1 หลังข้อมือมีสัดส่วนสูงกว่าที่เคยมีรายงานไว้ นอกจากนี้ได้วัดระยะจากเส้นประสาทไปยังตำแหน่งสำคัญต่าง ๆ ในบริเวณใกล้เคียง โดยส่วนใหญ่มีค่าใกล้เคียงกับผลการศึกษาอื่น และไม่มีความแตกต่างอย่างมีนัยสำคัญระหว่างเพศหรือข้าง ข้อมูลข้างต้นนี้บ่งชี้ว่าความแตกต่างทางกายวิภาคของเส้นประสาท SR ในเชื้อชาติต่าง ๆ มีความสำคัญในการทำหัตถการที่เกี่ยวข้อง