NEUROLOGIA I NEUROCHIRURGIA POLSKA 48 (2014) 229–235

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/pjnns

Original research article

Variations and morphometric analysis of the proximal segment of the superior cerebellar artery

Roger M. Krzyżewski [a,1], *Magdalena K. Stachura* [a,1], *Anna M. Stachura* [a], *Justyna Rybus* [a], *Krzysztof A. Tomaszewski* [a,*], *Wiesława Klimek-Piotrowska* [a], *Paweł Brzegowy* [a,b], *Andrzej Urbanik* [b], *Jerzy A. Walocha* [a]

[a] *Department of Anatomy, Jagiellonian University Medical College, Krakow, Poland*
[b] *Department of Radiology, Jagiellonian University Medical College, Krakow, Poland*

ARTICLE INFO

Article history:
Received 5 May 2014
Accepted 11 July 2014
Available online 21 July 2014

Keywords:
Anatomical variations
Computed tomography
Neuro-vascular conflict
Posterior cerebral circulation
Superior cerebellar artery

ABSTRACT

Introduction: The superior cerebral artery is a clinically significant vessel, but little is known about its radiological anatomy. The aim of this study was to describe the anatomical variations of the proximal segment of the superior cerebellar artery using Computed Tomography Angiography.

Materials and methods: The study group consisted of 200 subjects (54.5% female, mean age ± SD 56.2 ± 17.2 years) that had undergone head Computed Tomography Angiography. Subjects with any intracranial pathologies were excluded. Images in Maximum Intensity Projections were used to study the anatomical anomalies of the superior cerebellar artery.

Results: In 200 subject 388 superior cerebellar arteries were found. Twelve (3.09%) SCAs were duplicated in 11 patients and all originated from the basilar artery. In 8 (4.00%) patients the superior cerebellar artery was absent. The origin of the SCA was most often bilateral, mainly from the basilar artery (76.29%). The superior cerebellar artery diameter, measured at the site of the origin, was statistically significantly different depending on the place of the origin: wider when originating from the basilar artery as a single vessel (1.48 ± 0.42 mm vs. 1.34 ± 0.52 mm; $p = 0.03$) and narrower when originating as duplicated one (1.38 ± 0.48 mm vs. 1.46 ± 0.44 mm; $p = 0.55$).

Conclusion: Superior cerebellar artery usually originates bilaterally from the basilar artery as a single trunk. Its diameter is significantly wider in that type in comparison to other anatomical variations.

* *Corresponding author at*: Department of Anatomy, Jagiellonian University Medical College, 12 Kopernika Street, 31-034 Krakow, Poland. Tel.: +48 12 422 95 11; fax: +48 12 422 95 11.
E-mail address: krtomaszewski@gmail.com (K.A. Tomaszewski).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.pjnns.2014.07.006
0028-3843/

1. Introduction

The superior cerebellar artery (SCA) often arises from the upper part of the basilar artery (BA), passes near the oculomotor, trochlear and trigeminal nerves and supplies the upper part of the cerebellum, part of the pineal gland, the anterior medullary velum and the part of the choroid plexus of the third ventricle called the "tela chorioidea" [1]. The SCA might be a cause of a neurovascular conflict which is defined as a subgroup of cranial nerve dysfunction due to a contact between a blood vessel and the nerve, that usually occur in the cerebropontine angle [2] and may result in trigeminal neuralgia. In 71.5–100% of patients with a diagnosed idiopathic trigeminal neuralgia, a neurovascular conflict was detected during microvascular decompression of the trigeminal nerve [3]. In 66.5–88% of cases, this was caused by the SCA [3].

The relationship between the SCA and the trigeminal nerve was also identified in cadavers without a history of facial pain. In a study by Ramesh and Premkumar [4], conducted on 100 hemispheres, the offending vessel was found in 39% of studied material. In 53.8–86.6% of cases the compression of the trigeminal nerve is caused by the SCA [4–6]. SCA aneurysms can also cause oculomotor palsy. The third cranial nerve usually lies between the posterior cerebral artery (PCA) and the SCA (97.86%) [7], but its location between two SCA branches was also reported (2.14%) [7]. Different anatomical variations such as a common SCA–PCA trunk or a duplicated SCA can predispose to oculomotor nerve compression [7,8]. SCA aneurysms are rare (1.7%) [9], but in context of their specific anatomy are characterized by a high frequency of treatment complication [10,11].

Although the anatomy of the posterior circulation is very complex and the SCA is the most consistent artery in terms of origin and location [8], many variations of the SCA have been described. A sound of knowledge of SCA anatomy and its adjacent structures is crucial for conducting surgical procedures used to treat compression syndromes, aneurysms or ischemic infarcts.

Despite its clinical importance, the anatomy of the proximal segment of the SCA has not been widely described. To our best knowledge only one study by Uchino et al. [12] described the anatomy of the SCA using Magnetic Resonance Angiography. Several cadaveric studies were also performed, in which different variations of the SCA have been described [1,6,13–16]. However, SCA diameter, its distance to the P1 segment of the PCA and its relation to side or gender was not fully described. A thorough description of vascular variations of the SCA seems to be lacking.

The aim of this study was to describe the anatomical variations of the proximal segment of the SCA using Computed Tomography Angiography.

2. Materials and methods

2.1. Study group

The study group consisted of 200 adult subjects (54.5% female, mean age ± SD: 56.2 ± 17.2 years) that had undergone head CTA in the Department of Radiology, Jagiellonian University Medical College. The study population was recruited from among patients undergoing radiological examination due to mild head trauma (without an intracranial hematoma) or viscerocranial pathologies (i.e. chronic rhinosinusitis). Patients with mild head trauma in our study group that underwent head CT angiography are limited to few cases when the presence of other signs and symptoms such as dizziness, vomiting, prolonged headache and slight meningeal signs. Above mentioned can indicate a cerebrovascular pathology. These patients underwent unenhanced CT and when the cause of prolonging symptoms was not diagnosed a CT angiography was performed. In all cases the underlying pathology was not found and patients were discharged in good condition.

Patient exclusion criteria were: signs of vascular (aneurysm, cavernous angioma, arteriovenous malformation etc.) or non-vascular (neoplasm, hematoma etc.) intracranial pathologies, stroke or previous intracranial surgical interventions. Low quality images or images containing artifacts were excluded. Patients were analyzed as an entire group, then divided according to the side from which the SCA originated.

2.2. Imaging and analysis

Images were acquired using a multi-row computed tomography (Somatom Sensation 16; Siemens AG, Germany) with the following study parameters: exposure: 120 kV, 74 mA, 120 mAs; rotation time: 0.75; slice thickness: 3 mm; pitch: 1.5. Patients were injected intravenously with an iodine contrast medium (Ultravist, Bayer, Germany) to achieve angiographic images. Collected data were transferred to a

Table 1 – Side of SCA origin depending on its anatomical variant.

Origin	Total	Left side	Right side	*p*-value
Total SCA, *n* (%)	388	193 (49.74)	195 (50.26)	0.58
BA, *n* (%)	347 (89.43)	172 (44.33)	175 (45.10)	0.66
Duplicated SCA, *n* (%)	12 (3.09)	8 (2.06)	4 (1.03)	0.24
Single SCA, *n* (%)	335 (86.34)	164 (42.23)	171 (44.07)	0.34
PCA, *n* (%)	18 (4.64)	8 (2.06)	10 (2.58)	0.63
Common SCA and PCA from BA, *n* (%)	23 (5.93)	13 (3.35)	10 (2.58)	0.52
Aplastic SCA, *n* (%)	12 (3.09)	7 (1.80)	5 (1.29)	0.56

BA – basilar artery, SCA – superior cerebellar artery, PCA – posterior cerebral artery, *p*-value was calculated using the χ^2 Pearson's test.

Table 2 – Laterality of SCA origin depending on its anatomical variant.

Origin	Bilateral	Unilateral	*p*-value
BA, patients (arteries)	149 (298)	40 (49)	<0.01
Duplicated SCA, patients (arteries)	1 (2)	10 (10)	<0.01
Single SCA, patients (arteries)	148 (296)	39 (39)	<0.01
PCA, patients (arteries)	0 (0)	18 (18)	<0.01
Common SCA and PCA from BA, patients (arteries)	4 (8)	15 (15)	<0.01
Aplastic SCA, patients (arteries)	4 (0)	4 (0)	<0.01
Total SCA, patients (arteries)	157 (306)	43 (82)	200 (388)

BA – basilar artery, SCA – superior cerebellar artery, PCA – posterior cerebral artery, *p*-value was calculated using the χ^2 Pearson's test.

workstation equipped with an IMPAX 6.4 Solution Software (Agfa HealthCare, Belgium). Maximum intensity (MIP) and Volume Rendering (VR) reconstructions were examined in three planes: coronal, sagittal and axial. All images were carefully studied by two independent neuroradiologist, with 15 and 20 years of experience. If a difference of opinion on particular patients occurred, the patients were examined together by both researchers. The proximal part of the SCA was studied, taking into consideration its origin, number of branches, the internal diameter measured at the site of the origin, and distance from the SCA to the P1 segment of the PCA.

2.3. *Statistical analysis*

Statistical analysis was conducted using computer software Statistica 10.0 PL by Statsoft. Elements of descriptive statistics were used (mean, standard deviation, percentage distribution). We used the χ^2 Pearson's test to compare proportions, the Student's *t*-test and the Mann–Whitney *U* test to compare continuous variables as appropriate. *p*-values of less than 0.05 were considered to indicate statistical significance.

2.4. *Ethics*

All patients gave their written and informed consent prior to inclusion into the study. The research protocol was approved by the Jagiellonian University Ethics Committee (registry number KBET/299/B/2012). The study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

3. Results

The frequency of different anatomical anomalies depending on the side of origin is shown in (Table 1). In 200 patients we have found 388 SCAs. In 11 patients, there were 12 duplicated (3.09%) SCAs. All of them originated from the BA, in 1 patient

Table 3 – The diameter of the SCA in different anatomical variants.

Origin/type	Diameter of SCA originating From the BA	Diameter of SCA originating Not from the BA	*p*-value
BA, mm, mean (SD)	1.47 (0.42)	1.32 (0.53)	**0.04**
Duplicated SCA, mm, mean (SD)	1.38 (0.48)	1.46 (0.44)	0.55
Single SCA, mm, mean (SD)	1.48 (0.42)	1.34 (0.52)	**0.03**
Origin/type	**Diameter of SCA originating From the PCA**	**Diameter of SCA originating Not from the PCA**	***p*-value**
PCA, mm, mean (SD)	1.36 (0.33)	1.46 (0.44)	0.31
Origin/type	**Diameter of SCA originating Common SCA–PCA origin from the BA**	**Diameter of SCA originating Not common SCA–PCA origin from BA**	***p*-value**
Common SCA and PCA from BA, mm, mean (SD)	1.30 (0.66)	1.47 (0.42)	0.07

p-value shows the results of comparison between the SCA diameter originating from specific region (second column) in comparison to all other SCA originating from different region (third column). *p*-Value was calculated using the Student's *t*-test. Values in bold mark statistical significance. Diameter was measured at the site of the origin of the SCA; BA – basilar artery, SCA – superior cerebellar artery, PCA – posterior cerebral artery, SD – standard deviation. The values for in single and duplicated SCA are not given in case of origine from PCA and common origin of SCA and PCA from BA because we only found duplicated SCA originating from BA.

on both sides. In 8 (4.00%) patients the SCA was absent: on the left side in 3 patients, on the right side in 1 patient and on both sides in 4 patients. In 1 case we have found a left hypoplastic SCA, and in two cases we have found a right hypoplastic SCA. There was no significant difference ($p > 0.05$) between the sides from which the duplicated SCA originated.

Symmetry of the SCA is presented in (Table 2). Most commonly the SCA originated as a single vessel bilaterally from the BA (76.29%). A common site of origin of the SCA and the PCA was present more frequently unilaterally (3.87%). This was also the case when the SCA originated from the PCA (4.64%).

There was no difference in the inner SCA diameter, measured at the site of origin, between the left and right sides (1.46 ± 0.42 mm vs. 1.45 ± 0.46 mm; $p = 0.88$). Differences in SCA diameter, measured at the site of origin, between male and female subjects, showed borderline statistical significance (1.50 ± 0.44 mm vs. 1.42 ± 0.43 mm; $p = 0.07$). The diameter of the SCA was significantly different depending on the place of origin (Table 3). The diameter of the lower vessel in duplicated

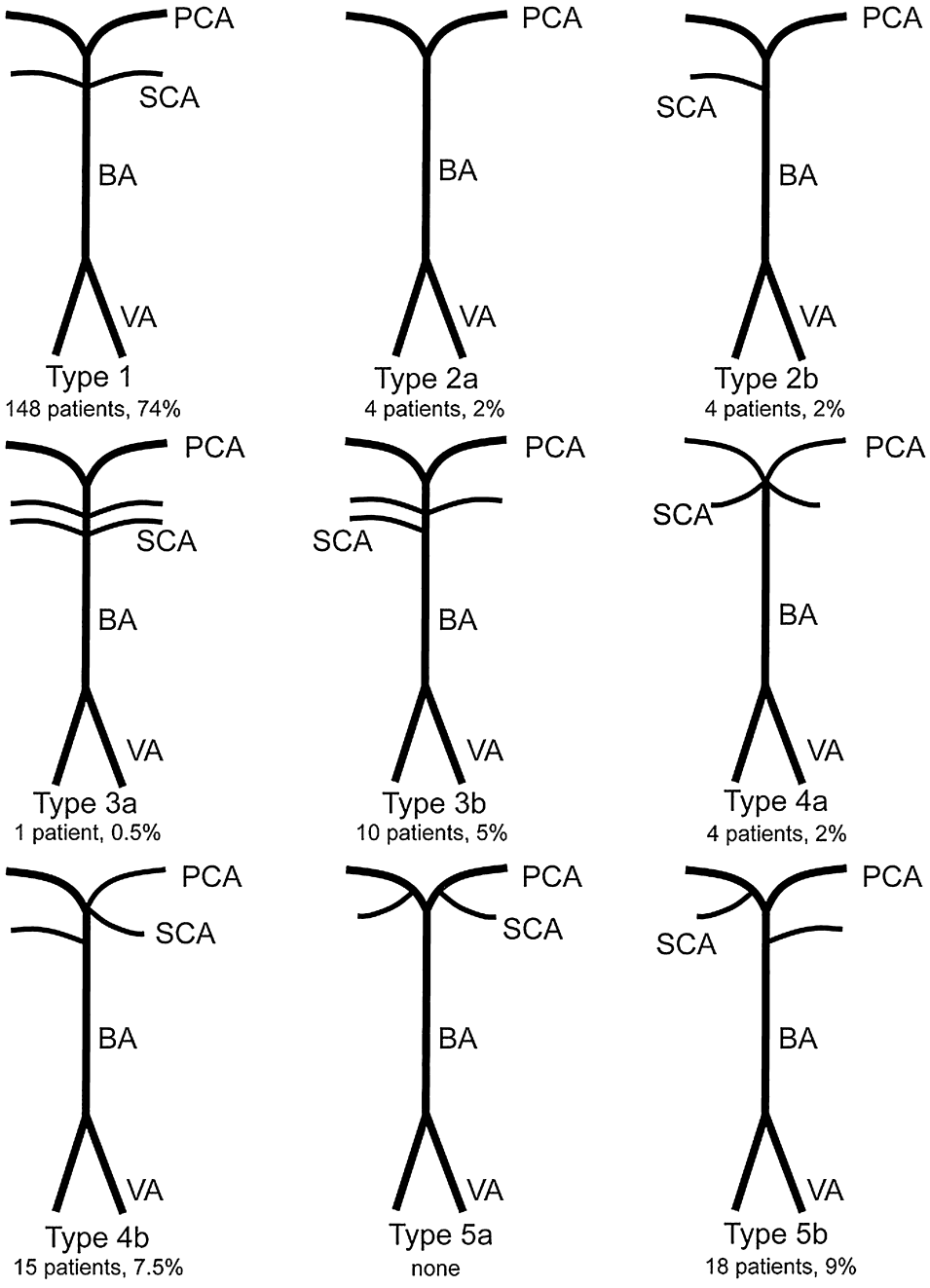

Fig. 1 – Superior cerebellar artery – anatomical variations and frequency of their occurrence in our study [patients (%)]. Type 1 – typical configuration (both SCAs originate from the BA); Type 2 – aplastic SCA (2a – bilaterally; 2b – unilaterally); Type 3 – duplicated SCA (3a – bilaterally; 3b – unilaterally); Type 4 – common origin of PCA and SCA from BA (4a – bilaterally, 4b – unilaterally); Type 5 – SCA originates from the PCA (5a – bilaterally; 5b – unilaterally). SCA – superior cerebellar artery; BA – basilar artery; PCA – posterior cerebral artery.

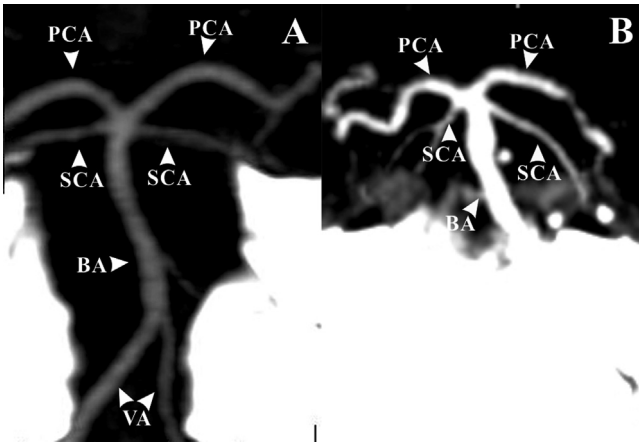

Fig. 2 – Computed Tomography Angiography – maximum intensity projection images showing typical configuration (A), and typical configuration with early bifurcation of SCA on the left (B). PCA – posterior cerebral artery; SCA – superior cerebellar artery; BA – basilar artery; VA – Vertebral artery.

SCA cases was comparable on both sides (right vs. left: 1.23 ± 0.33 mm vs.1.24 ± 0.35 mm; $p = 0.95$; diameter range: 0.8–1.6 mm), but in comparison to the upper branch, the lower vessel had a significantly smaller diameter (1.45 ± 0.44 mm vs. 1.23 ± 0.33 mm; $p = 0.04$).

There were no significant differences between the distance from the SCA to the P1 segment of the PCA on either side (left vs. right 2.72 ± 1.96 mm vs. 2.75 ± 1.80 mm; $p = 0.90$). In 14 patients we have found the fetal origin of the PCA. Hence, the measurement was impossible to take.

3.1. *SCA origin classification*

Based on the observations made in this study, we propose the following SCA classification [Fig. 1]. We classified the SCA, taking into account its origin, into 5 types: Type 1 – typical configuration (both SCAs originate from the BA) [Fig. 2]; Type 2 – aplastic SCA (2a – bilaterally; 2b – unilaterally); Type 3 – duplicated SCA (3a – bilaterally; 3b – unilaterally); Type 4 – common origin of PCA and SCA from the BA (4a – bilaterally, 4b – unilaterally) [Fig. 3]; Type 5 – SCA originates from the PCA (5a – bilaterally; 5b – unilaterally) [Fig. 3].

4. Discussion

In this prospective study we have described the anatomical variations of SCA origin using CTA. There is only one other study, in which the SCA was assessed using MRA (Magnetic Resonance Angiography). In that study 145 MRA images were analyzed [12]. The SCA was also described in several cadaveric studies, but these are of limited use due to the very small size of the studied number ($n = 20$–31) of cadaveric brains [1,6,8,13,14,16]. Only one study by Songur et al. [16] included a significantly larger number of brains ($n = 110$) in their investigation. In our study 200 patients were examined.

Duplicated SCAs have been reported in 5.9–28.0% [1,6,8,12,14–16]. All duplicated arteries, in our study, originated from the BA, while other works show that duplicated SCAs can originate also from the PCA [12,13,17]. Bilateral duplication is rare, and its frequency ranges from 2% to 8% [12,15,18]. Triplication of the SCA is also a rare finding and was seen in only one case in two separate studies by Hardy et al. [18] and Habibi et al. [14], and in 8% of cases in the study by Mani et al. [15]. In the present study we have found a smaller incidence of duplicated SCAs – unilateral duplication in 12 cases (3%) and bilateral duplication in one case (0.25%). Aplasia of the SCA has not been previously reported [1,8,18], while in our study 12 (3%) arteries were aplastic, in 4 patients unilaterally and in 4 bilaterally. This phenomenon can potentially be explained by the fact that small arteries may not be hemodynamically efficient, therefore are not visible in angiographic studies and thus were considered as aplastic. Recent studies prove that MRA and 3D Rotational Angiography are more suitable for imaging detailed anatomy of cerebral blood vessels [18]. Frequency of aplastic arteries can also be explained by the limited resolution of CTA, and thus the difficulty in demonstrating the small SCA [13].

The origin of the SCA varies in different studies. The most common anatomical variant of the SCA is a single trunk originating from the BA – its frequency ranging from 84% to 90% [1,8,18]. This is consistent with our study (84%). An SCA arising from the PCA was reported in 2.6–10% of analyzed cases [12,16,18]. In our study the SCA originated from the PCA in 4.5%. This type of origin was present only unilaterally, while in other studies, cases of bilateral SCA origin from the PCA were noted [12,13,17]. A common site of origin of the PCA and the SCA from the upper part of the BA was found in 5.75% of cases in our study, in contrary to a study by Gonzalez et al. [1] where

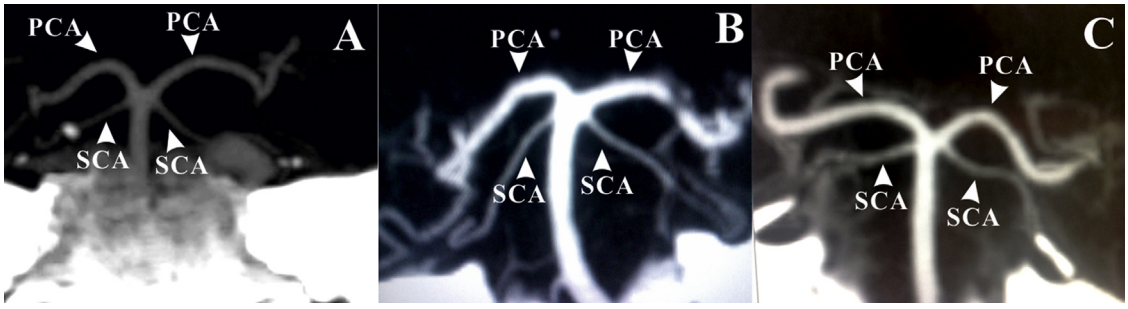

Fig. 3 – Computed Tomography Angiography – maximum intensity projection images. Type 4a (A); Type 4b (B); Type 5b (C). PCA – posterior cerbral artery; SCA – superior cerebellar artery.

such type of anatomy was reported in 35%. However in a study by Songur et al. [16] this variant has been found in 6.3% on right and in 10.0% on left side, pointing to significant discrepancies between studies.

The diameter of the SCA, taking into account the SCAs side of origin, to the best of the authors' knowledge, has not yet been described. Taking into account the literature data, the mean width of the right SCA ranges from 1.28 to 1.64 mm and for the left 1.27–1.66 mm [1,8,14,16]. Our measurements are consistent with the above mentioned ones (right 1.45 mm, left 1.46 mm). The study by Bullitt et al. [19] shows different cerebral arteries diameter depending on gender. However in our study, differences in SCA diameter, between men and women, show only borderline statistical significance. This could be due to the differences in study group size.

The diameter of the SCA differs significantly depending on its origin – it is the largest when arising from the BA. We have not found a single study, in which such dependency would be reported. This could carry practical implications. Narrower vessels are more likely to predispose to ischemic events, especially after surgical manipulations. The diameter of the vessel and its site of origin may influence the frequency and severity of a neurovascular conflict. In our study the diameter of the upper artery was larger than that of the lower one in duplicated SCAs. This is similar to the results obtained by Garcia-Gonzalez et al. [1]. However this was studied when measuring the branches of the SCA after bifurcation (upper was larger than lower) and not trunks [1]. The distance between the SCA and the P1 segment of the PCA was, in our study, larger than in the results obtained by other researchers (right side: 2.75 mm vs. 1.19–1.45 mm and left side: 2.72 mm vs. 1.19–1.33 mm; $p = 0.9$) [1,7]. The comparison between cadaveric studies and radiological studies is not possible because radiological studies provide us only with internal blood vessel diameter and cadaveric studies provide only the external vessel diameter. Greater distance between PCA and SCA is probably caused by the fact that we have only studied the internal diameter of the artery.

Multiplicity of SCA anatomy occurs probably due to its embryogenesis. The SCA derives from the Internal Carotid Artery, and during development connects to the BA. Depending on the time and location of the merging of the two longitudinal neural arteries a BA arises. In view of that, the SCA can connect to the posterior circulation in different places [17].

Our study has a number of limitations. Although the size of our study group is the largest among studies considering SCA anatomy, it is still inadequate to determine anatomical variation precisely. Secondly, radiological imaging only allows us to assess hemodynamically efficient arteries. This fact may justify the high frequency of aplastic arteries. Furthermore, a 16-row Computed Tomography might not be sufficient enough to visualize small abnormalities such as arterial fenestrations and hypoplastic arteries. Moreover, radiological imaging is not as accurate as cadaveric studies. Results of other studies assessing SCA anatomy are depicted in (Table 4).

Anatomical variations in cerebral circulation may cause important clinical issues for neurologists, radiologists and neurosurgeons. Thorough knowledge and understanding of anatomy may allow for better diagnosis and pathology treatment, as well as help to avoid dangerous pitfalls.

Table 4 – Comparison of studies on superior cerebellar artery.

Study	Study group	Study type	Duplication	Aplasia	SCA origin			Diameter of the SCA in site of origin						SCA-P1 segment of PCA distance	
					From the BA	From the PCA	Common origin of SCA and PCA from the BA	Left	Right	Male	Female	From the BA	From the PCA	Common origin of SCA and PCA from the BA	Left	Right
[8]	25	Cadaveric	8 (16.00)	0 (0.0)	–	1 (2.00)	–	1.6	1.4	–	–	–	–	–	–	–
[12]	145	MRA	16 (5.9)	–	–	7 (2.6)	–	–	–	–	–	–	–	–	–	–
[18]	25	Cadaveric	7 (14.0)	0 (0.0)	–	2 (4.0)	–	–	–	–	–	–	–	–	–	–
[15]	30	Cadaveric	– (28.0)	–	–	–	–	–	–	–	–	–	–	–	–	–
[1]	20	Cadaveric	4 (10.0)	0 (0.0)	17 (42.5)[a]	3 (7.5)	16 (40.0)[b]	1.38	1.38	–	–	–	–	–	1.19 (mean, without side differentiation)	
[15]	31	Cadaveric	8 (12.9)	0 (0.0)	62 (100)	–	–	1.66	1.64	–	–	–	–	–	–	–
[16]	110	Cadaveric	60 (27.3)	0 (0.0)	–	–	Left: 22 (10.0), Right: 14 (6.3)	1.27	1.28	–	–	–	–	–	–	–
This study	200	CTA	12 (3.09)	12 (3.09)	347 (89.43)	18 (4.64)	23 (5.93)	1.46	1.45	1.50	1.42	1.47	1.30	1.36	2.72	2.75

[a] 35% (14 arteries) bilaterally, 3 unilaterally.
[b] 35% (14 arteries) bilaterally, 2 unilaterally; number of arteries, numbers in parentheses show the percentage of total SCA found in particular stud.

Presented data may be especially useful for neurosurgeons operating in the field of the vertebrobasilar system. A smaller SCA originating from PCA may by more prone to injury during surgery. A common origin of PCA and SCA from the BA trunk creates a risk of accidental closing of one of those vessels during clipping of PCA or SCA aneurysms.

In this study we have presented the variety of SCA origins from the vessels of the posterior circulation. The results of this study enabled us to identify several types of SCA anatomy (Fig. 1), thus allowing for the creation of a new SCA classification system.

Conflict of interest

None declared.

Acknowledgement and financial support

This study has been funded by the Jagiellonian University statutory funds (grant no K/DSC/002093). Krzysztof A. Tomaszewski received a scholarship to prepare his PhD thesis from the National Science Center – Poland under award number DEC-2013/08/T/NZ5/00020.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

REFERENCES

[1] Garcia-Gonzalez U, Cavalcanti DD, Agrawal A, Spetzler RF, Preul MC. Anatomical study on the "perforator-free zone": reconsidering the proximal superior cerebellar artery and basilar artery perforators. Neurosurgery 2012;70(3):764–72.
[2] Broggi M, Acerbi F, Ferroli P, Tringali G, Schiariti M, Broggi G. Microvascular decompression for neurovascular conflicts in the cerebello-pontine angle: which role for endoscopy? Acta Neurochir (Wien) 2013;155(9):1709–16.
[3] Sindou M, Howeidy T, Acevedo G. Anatomical observations during microvascular decompression for idiopathic trigeminal neuralgia (with correlations between topography of pain and site of the neurovascular conflict). Prospective study in a series of 579 patients. Acta Neurochir (Wien) 2002;144(1):1–13.
[4] Ramesh VG, Premkumar G. An anatomical study of the neurovascular relationships at the trigeminal root entry zone. J Clin Neurosci 2009;16(7):934–6.
[5] Klun B, Prestor B. Microvascular relations of the trigeminal nerve: an anatomical study. Neurosurgery 1986;19(4):535–9.
[6] Hardy DG, Rhoton Jr AL. Microsurgical relationships of the superior cerebellar artery and the trigeminal nerve. J Neurosurg 1987;49(5):669–78.
[7] Esmer AF, Sen T, Comert A, Tuccar E, Karahan ST. The neurovascular relationships of the oculomotor nerve. Clin Anat 2011;24(5):583–9.
[8] Pai BS, Varma RG, Kulkarni RN, Nirmala S, Manjunath LC, Rakshith S. Microsurgical anatomy of the posterior circulation. Neurol India 2007;55(1):31–41.
[9] Peluso JP, van Rooij WJ, Sluzewski M, Beute GN. Superior cerebellar artery aneurysms: incidence, clinical presentation and midterm outcome of endovascular treatment. Neuroradiology 2007;49(9):747–51.
[10] Iizuka H, Miyachi S, Ohshima T, Izumi T, Tsurumi A, Yoshida J. Morphological study of aneurysms at the junction of the superior cerebellar artery. Interv Neuroradiol 2008;14(3):259–66.
[11] Jin SC, Park ES, Kwon do H, Ahn JS, Kwun BD, Kim CJ, et al. Endovascular and microsurgical treatment of superior cerebellar artery aneurysms. J Cerebrovasc Endovasc Neurosurg 2012;14(1):29–36.
[12] Uchino A, Sawada A, Takase Y, Kudo S. Variations of the superior cerebellar artery: MR angiographic demonstration. Radiat Med 2003;21(6):235–8.
[13] Caruso G, Vincentelli F, Rabehanta P, Giudicelli G, Grisoli F. Anomalies of the P1 segment of the posterior cerebral artery: early bifurcation or duplication, fenestration, common trunk with the superior cerebellar artery. Acta Neurochir (Wien) 1991;109(1–2):66–71.
[14] Habibi Z, Meybodi AT, Maleki F, Tabatabai S. Superior and anterior inferior cerebellar arteries and their relationship with cerebello-pontine angle cranial nerves revisited in the light of cranial cephalometric indexes: a cadaveric study. Turk Neurosurg 2011;21(4):504–15.
[15] Mani RL, Newton TH, Glickman MG. The superior cerebellar artery: an anatomic-roentgenographic correlation. Radiology 1968;91(6):1102–8.
[16] Songur A, Gonul Y, Ozen OA, Kucuker H, Uzun I, Bas O, et al. Variations in the intracranial vertebrobasilar system. Surg Radiol Anat 2008;30(3):257–64.
[17] Aydın ME, Kaya AH, Kopuz C, Demir MT, Corumlu U, Dagcinar A. Bilateral origin of superior cerebellar arteries from the posterior cerebral arteries, and clues to its embryologic basis. Anat Cell Biol 2011;44(2):164–7.
[18] Hardy DG, Peace DA, Rhoton Jr AL. Microsurgical anatomy of the superior cerebellar artery. Neurosurgery 1980;6(1):10–28.
[19] Bullitt E, Zeng D, Mortamet B, Ghosh A, Aylward SR, Lin W, et al. The effects of healthy aging on intracerebral blood vessels visualized by magnetic resonance angiography. Neurobiol Aging 2010;31(2):290–300.