

ANATOMICAL VARIATIONS OF THE SUPERIOR CEREBELLAR ARTERY: A CADAVERIC STUDY AT THE UNIVERSITY TEACHING HOSPITALS, LUSAKA, ZAMBIA

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ABSTRACT

The superior cerebellar artery usually arises from the terminal end of the basilar artery. It may also originate from the posterior cerebral artery and or from a common trunk with the posterior cerebral artery. The anatomical variations of superior cerebellar artery show ethnic differences, but there are few reports on African populations in particular none from Zambia. Variations of the superior cerebellar artery might cause compression symptoms of cranial nerves III, IV and V. Furthermore, the presence of such variations has been considered to be a factor in the aetiology of aneurysms and thrombus formation leading to cerebellar infarcts. The objectives of the study were to explore anatomical variations on the *origin* of the superior cerebellar artery; to measure the outer *diameter* at its origin and the *length* of superior cerebellar artery to its first bifurcation; to establish the presence of *duplication*, *triplication*, *hypoplasia*, *agenesis*, *fenestration* and any other anomalies that were detectable. This was a descriptive cross-sectional study in which 46 post-mortem human cadaveric brains were systematically sampled. A total of 113 superior cerebellar arteries were identified in 42 male and four female cadavers of age ranging between 18 and 65 years (mean 34.05±9.237mm). Superior cerebellar artery arose from the basilar artery as a single vessel in 49.5%, the common trunk arose in 6.2% and posterior cerebral artery origin was seen in 5.7%. Overall *duplication* of the superior cerebellar artery was seen in 35.5% and *triplication* in 5.3%. Nineteen (16.8%) of the superior cerebellar arteries were *hypoplastic* (less than 1mm) and ninety-four (83.2%) were normal. The *diameter* of the superior cerebellar artery at its origin ranged 0.25mm to 2.48mm (mean 1.42±0.54mm). The *length* of the superior cerebellar artery to its first bifurcation ranged from 3.77mm to 33.53mm (mean 21.92±7.40mm). Statistically, gender had no significant association of superior cerebellar artery variations ($p>0.05$). This knowledge will improve diagnosis and management of patients with vascular disorders of the posterior circulation. The newly identified patterns could be a contribution to the SCA classification system.

Key words: Superior cerebellar artery, duplication, triplication and hypoplasia

INTRODUCTION

The superior cerebellar artery (SCA) arises at the terminal end of the basilar artery, immediately before the formation of the posterior cerebral artery (PCA) (Standring, 2008). It may also originate from the PCA and or from a common trunk with the PCA (Ogeng'o *et al.*, 2015; Kalaiyarasi and Chitra, 2018). A number of variations have been described in the literature which includes *origin* and pattern of SCA. The

presence of SCA variations has been considered to be a factor in the aetiology of aneurysms and thrombus formation leading to cerebellar infarct (Padmavathi, 2014). The SCA is intimately related to oculomotor, trochlear and trigeminal nerves. Therefore, variations of the SCA can alter its relationship with cranial nerves causing compression symptoms (Zheng *et al.*, 2012).

Anatomical variations of the SCA show ethnic differences, but there they are scant reports on African populations (Ogeng’o *et al.*, 2015). Knowledge on anatomical variations of the SCA will improve the diagnosis and management of posterior vascular occlusion. The Knowledge on anatomical variations of the SCA will improve the diagnosis and management of posterior vascular occlusion. Such information can be of benefit to

anatomists in teaching anatomy, vascular surgeons, neurosurgeons and interventional radiologists. Furthermore, with the advent of a Catheter Laboratory at the University Teaching Hospitals detailed knowledge on cerebral vascular anomalies in a Zambian population could form an important foundation for the future development of the specialties of endovascular diagnosis and surgery.

MATERIAL AND METHODS

This was a cross-sectional descriptive study by design that was conducted at the Pathology Department, University Teaching Hospitals, Lusaka, Zambia. A total of 113 SCAs were identified in 42 male and four female cadavers of age ranging between 18 and 65 years (mean 34.05±9.237mm). A systematic sampling was employed to select cadavers.

A coronal incision was made between the two mid-ear points with the scalp being reflected, the anterior flap anteriorly and the posterior flap posteriorly. The brain was removed extradurally; the base was detached from the floor of the cranial cavity and the arachnoid mater exposed.

RESULTS

The data captured showed majority forty-two (91.3%) were male and compared to four (8.7%) were female cases. A total of 113 SCAs were identified in 46 cadavers of age ranging between 18 and 65 years (mean

34.05±9.237mm). The SCA arose from the BA in fifty-six cases (49.6%), overall duplication was seen in forty cases (35.5%) and triplication was observed in six cases (5.3%).

Table 1: Origin of the SCA and patterns of variations

Pattern of SCA	Origin of the SCA	Right	Left	No. of cases	Percentage
Single vessel	From BA	28	28	56	49.6%
	From PCA	3	2	5	4.4%
	From common trunk	2	4	6	5.3%
Duplication	From BA	16	20	36	31.9%
	From PCA	2	0	2	1.8%
	Common Trunk	0	2	2	1.8%
Triplication	From BA	6	0	6	5.3%
Total		57	56	113	100%

The most common origin of the SCA was a single vessel which took origin from the BA was observed in fifty-six cases (49.9%). The commonest variation of the SCA was duplication

from the BA which was seen in thirty-six cases (31.9%) while triplication accounted for six cases (5.3%).

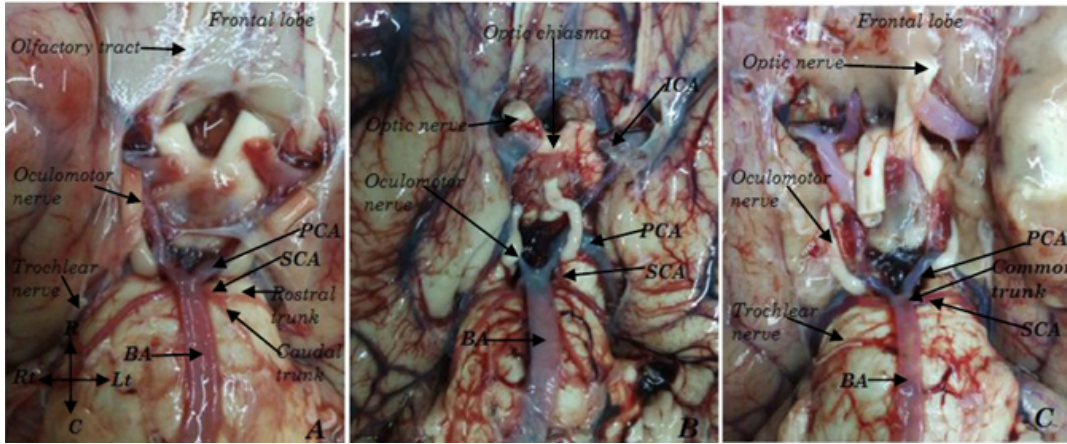


Figure 1: (A) Single vessel origin of the SCA from the BA, (B) PCA origin of the left SCA, (C) Common trunk origin of the SCA.

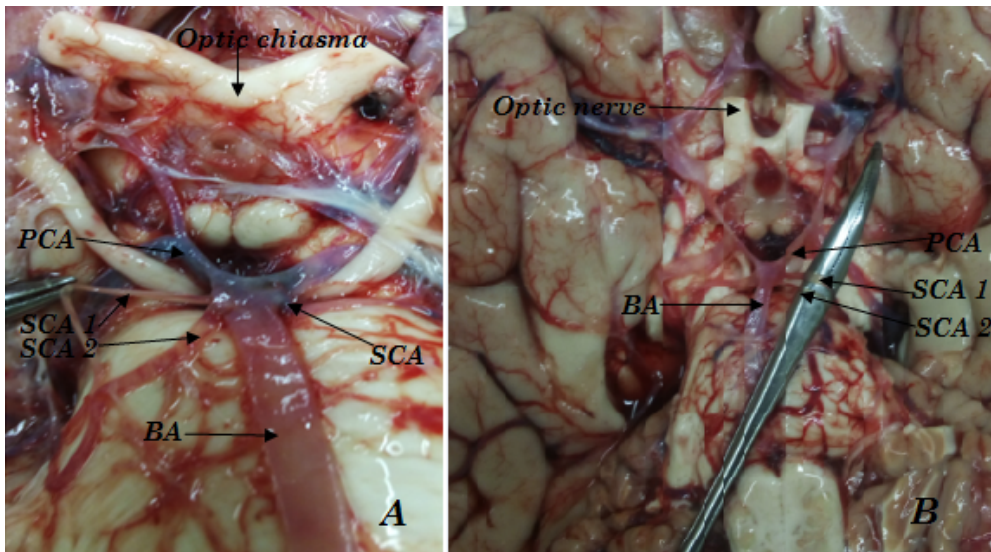


Figure 2: (A) Right duplicated SCAs, (B) Left duplicated SCAs

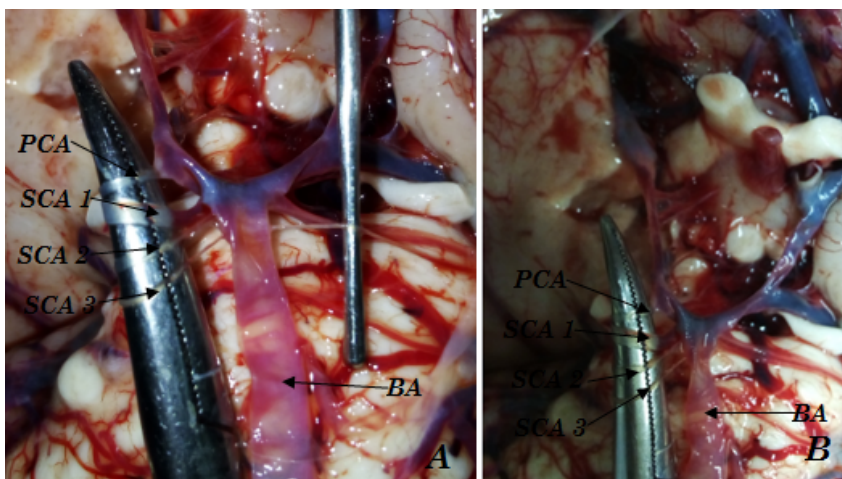


Figure 3: (A) and (B) Right triplication of SCAs

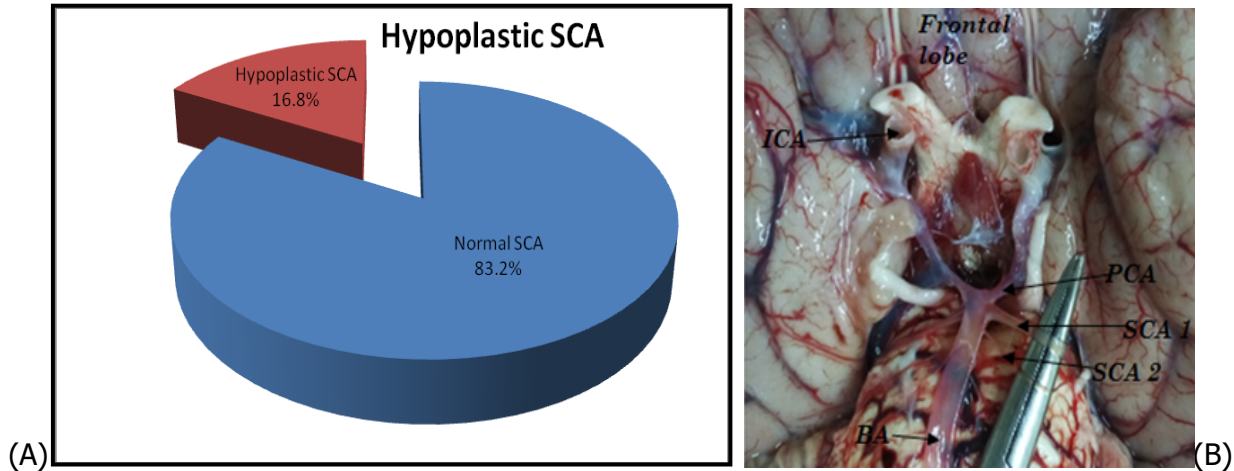


Figure 4: (A) Hypoplasia (less than 1mm) of the SCA was observed in nineteen (15.6%) of the cases were and ninety four (83.2%) were normal. (B) Lt second hypoplastic SCA

The length of the SCA was measured from origin to the point of its first bifurcation which ranged from 3.77mm to 33.53mm (mean was 21.92±7.40mm).

Table 2: Descriptive Statistics (Diameter of the SCA)

Characteristics	N	Minimum	Maximum	Mean	SD
Rt SCA 1	46	1.02	2.22	1.6152	.40458
Lt SCA 1	46	.39	2.48	1.5255	.49128
Rt SCA 2	11	.25	1.23	.5745	.27908
Lt SCA 2	4	1.00	1.56	1.3625	.26487
Rt SCA 3	6	.33	.96	.6700	.25282

Table 4 shows that the diameter of the SCA ranged between 0.25mm to 2.48mm.

Table 3: Krzyzewski's Classification of SCA

Type	Frequency	Percent	Cumulative Percent
Type 1	28	60.9	60.9
Type 3a	3	6.5	67.4
Type 3b	6	13.0	80.4
Type 4a	1	2.2	82.6
Type 4b	2	4.3	86.9
Type 5b	2	4.3	91.2
Unclassified	4	8.7	100.0
Total	46	100.0	

The majority twenty eight (60.9%) were type 1 while four cases (8.7%) were unclassified.

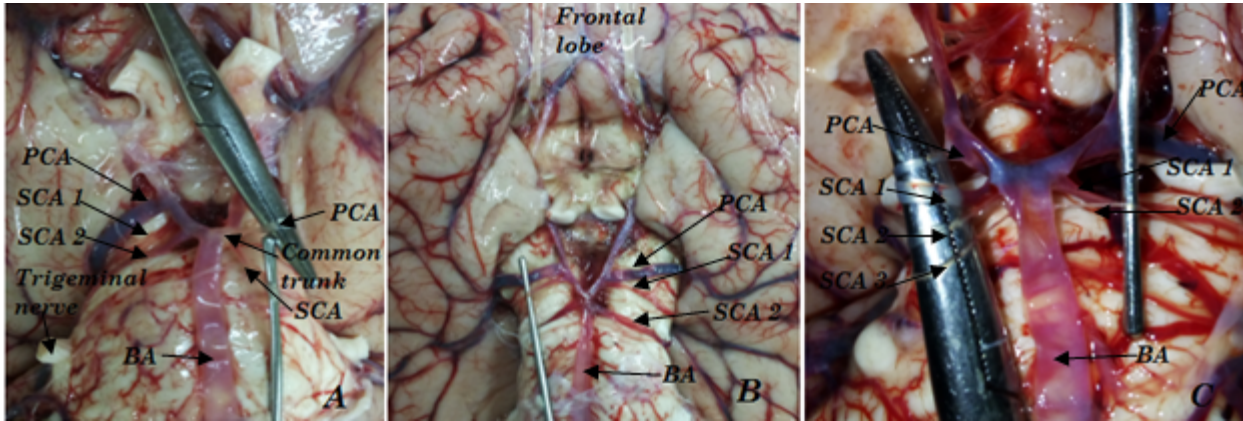


Figure 5: (A) and (b): Picture (a) right SCA originating from the PCA and left duplicated SCA originating from the common trunk, and (b) bilateral origin from both the BA and PCA (black arrows pointing at the SCAs).

Table 4: Relationship of the SCA variations and the demographic data

Variable		Variations in SCA		Total	Fisher's Exact Test	P value
		Normal	Abnormal			
Gender	Male	Count	26	16	.637	.641
		%	56.2%	34.8%		
	Female	Count	2	2		
		%	4.4%	4.4%		
Total	Count	28	18	46		
	%	60.9%	39.2%	100.0%		

The abnormal patterns of the SCA were found in sixteen (34.8%) were male and while in two (4.4%) were female. The P-value > 0.05 was considered not statistically significant.

DISCUSSION

In the present study it was found that the most common origin of the SCA was from the BA as a single trunk in 49.6%. Previously, a number of studies have documented that the commonest origin of the SCA is a *single* trunk from the BA with its frequency ranging from 48.7% to 96.33%. Our findings were almost similar with Nagawa *et al.* (2018), who reported the origin of the SCA as a single vessel in 51.3% in a black Ugandan population. However, these results were contrary to the findings of Ogeng'o *et al.* (2015) who reported a higher rate of single origin of the SCA from the BA with a frequency of 72.1% in a black Kenyan population.

In the current study, the SCA took origin from the PCA in 5.7% of the cases. This finding is consistency with various studies that have

reported the origin of the SCA from the PCA with the frequency ranging between 2 – 4.8% (Aydin *et al.*, 2011; Bala *et al.*, 2013; Dodevski *et al.*, 2015). Such common variations of the SCA may lead to misdiagnosis and mismanagement of diseases related to the SCA (Dagcinar *et al.*, 2007; Kalani *et al.*, 2013).

The SCA also took origin from the common trunk of the PCA and the SCA at a frequency of 6.2% in the present study. The current study is in agreement with other studies that reported a frequency ranging from 2.5% to 9.4%. This anomaly is as a result of abnormal development during embryogenesis and fusion of primitive neural arteries.

The overall duplication of the SCA was observed at the rate of 35.5%. The current study finding is almost comparable with Ogeng'o *et al.* (2015) who reported duplication as the most common anomaly of the SCA with the frequency of 21.3%. The duplication of the SCA is due to direct origin of branches of SCA such as the marginal artery from BA (Dagcinar *et al.*, 2007; Kalaiyalasi & Chitra, 2018). Therefore, the clinical significance of this anatomical variant is that the additional artery may provide alternative circulation in the case of a thromboembolism (Ogeng'o *et al.*, 2015).

In the present study, triplication was observed in 4.9% of the cases, all were right unilateral SCAs arising from the BA. This finding is slightly lower than the reported cases of 6.1% by Nagawa *et al.* (2018) in a Ugandan black population. On the other hand, the present study finding is almost comparable with the study done by Gunnal *et al.* (2014) who reported triplication at the rate of 5.29%. However, in their study they considered triplication of the SCA arising from BA, PCA and the common trunk altogether.

Table 5: Comparison on the origin of the SCA with other studies

Studies	No of SCA studied	Origin of the SCA			Patterns	
		BA	PCA	Common trunk	Duplication	Triplication
Current study	113	49.5%	6.2%	7.1%	35.5%	5.3%
Kalaiyalasi & Chitra, 2018	160	75.6%	1.9%	3.1%	17.5%	1.9%
Padmavathi, 2014	150	49.4%		25.3%	23.3%	2%
Krzyzewski <i>et al.</i> 2014	388	76.1%		2%	3.09%	None
Ogeng'o <i>et al.</i> 2015	394	72.1%	2.5%	4.0%	21.3%	None

The diameter of the right SCA measured between 0.25mm to 2.22mm (mean 1.41 ± 0.56 mm) and left SCA was 0.33 to 2.48mm (mean 1.42 ± 0.53 mm). Literature reported the diameter of the SCA ranged between hypoplastic (less than 1mm) to 2.46mm. In the current study, the findings are contrary to Padmavathi (2014) who reported the mean diameters of the SCA to be 2.0 ± 0.4 mm on the right and 1.9 ± 0.3 mm on the left side.

Comparing the diameter of the SCA on the same side, we found the diameter of the first right SCA ranged between 1.02mm to 2.22mm (mean 1.62 ± 0.41 mm), second right SCA ranged

between 0.25mm to 1.23mm (mean 0.58 ± 0.28 mm) and the third right SCA ranged between 0.33mm to 0.96mm (0.67 ± 0.25 mm). Therefore, it was observed that the diameter of the second SCAs reduced progressively but this was inconclusive in the case of a third SCAs. This finding was consistent with the reports on the SCA variations that the diameter progressively reduced in multiple SCAs (Avci *et al.*, 2001; Dodevski *et al.*, 2015). The clinical significance of the outer *diameter* of the vessel is that it may influence the frequency and severity of neurovascular events. On the other hand,

multiple SCAs may provide alternative circulation in the case of occlusion.

Concerning the length of the SCA, it was measured from origin to its first bifurcation which ranged from 3.77mm to 33.53mm (mean was 21.92 ± 7.40 mm). These findings were inconsistent with both Padmavathi (2014) who reported the length of the SCA ranging between 6mm to 23mm and, Kalaiyalasi and Chitra (2018) reported 9mm to 24mm. Hypoplasia of the SCA was considered with outer diameter less than 1mm (Habibi *et al.*, 2011; Padmavathi, 2014).

The current study found nineteen (16.8%) of the SCAs were hypoplastic and ninety four (83.2%) were normal (more than 1mm). This finding was significantly contrary to Padmavathi (2014) who reported the frequency of hypoplasia of the SCA at rate of 0.7%. The majority of studies didn't report about SCA hypoplasia. This form of vascular anomaly can contribute to altered dynamics of blood flow and the development of aneurysms (Nair & Panikar, 2015; Kalaiyalasi & Chitra, 2018). Agenesis and fenestration were not observed in the present study.

Table 6: Comparisons of various studies on the diameter of the SCA

Study	Right side	Left side
Padmavathi 2014	2.0 ± 0.4 mm	1.9 ± 0.3 mm
Kalaiyalasi and Chitra 2018	1.8 ± 0.5 mm	1.6 ± 0.4 mm
Ogeng'o et al 2015	Not reported	Not reported
Present study	1.41 ± 0.56 mm	1.42 ± 0.53 mm

Table 7: Comparison of various studies on the length of the SCA

Study	Length of the SCA to its first bifurcation
Padmavathi 2014	6mm to 23mm
Kalaiyalasi and Chitra 2018	9mm to 24mm
Ogeng'o <i>et al.</i> 2015	Not reported
Present study	3.77mm to 33.53mm

In conclusion, the study found that in the majority the SCA arose from the BA as a single trunk in 49.6%. The most common anomaly was overall duplication of the SCA which observed at the rate of 35.5% while triplication of the SCA was seen in 4.9%. In multiple SCAs, the diameter of the second SCAs reduced progressively but this was inconclusive in the

case of a third SCAs. Nineteen were hypoplastic representing 16.8% of the SCAs while hundred and three (82.3%) were normal. Agenesis and fenestration were not seen in the present study. The Knowledge on the anatomical variations of the SCA can improve diagnosis and management of posterior vascular occlusion and compression syndromes of cranial nerves III, IV and V.

ACKNOWLEDGEMENT

Special gratitude goes to Professor Krikor Erzingatsian and other faculty members; Dr Mutemwa, Dr Kafumukache, Mrs Siwale and my colleagues. This work would not have been possible without their support. I am indebted to them.

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