Surgical Anatomy of the Superior Cerebellar Artery

Superior Serebeller Arterin Cerrahi Anatomisi

EMEL AVCI, DAMİREZ FOSSETT, MEHMET ASLAN, AYHAN ATTAR, NİHAT EGEMEN

George Washington University Department of Neurosurgery, (EA, DF) Washington
Ankara Üniversitesi Tıp Fakültesi Nöroşirürji Ana Bilim Dalı, (MA, AA, NE) Ankara

Received : 17.5.2001 ⇔ Accepted : 14.8.2001

Abstract: In this study twenty-one brains (42 sides) and 5 cadavers (10 sides) were studied especially for surgical anatomy of the superior cerebellar artery. The superior cerebellar artery is the most constant and least anomalous artery arising from the vertebrobasilar system. The superior cerebellar artery was found in all specimens. In 67% of sides there was a single superior cerebellar artery, duplication was seen in 26%, and triplication was seen in 7%. The first branch was always the largest. The average distance from the superior cerebellar artery origin to its bifurcation was 20.4mm. The location of the bifurcation was anterior to the brainstem in 25% of sides, lateral to it in 70%, and no bifurcation was found in 5%. The number of superior cerebellar artery perforators was generally the greatest in the rostral trunk. In 70% of sides the superior cerebellar artery was found to be touching III. cranial nerve In 95% of sides the superior cerebellar artery was touching IV. cranial nerve and in 45% it was touching V. cranial nerve. All of the segments of the superior cerebellar artery have some relationship to III, IV, and V cranial nerves. This is important in all supratentorial procedures to the interpeduncular and parapeduncular cistern, combined petrosal approaches to the region of the tentorial incisura and approaches for the guadrigeminal plate

Key words: caudal trunk, oculomotor nerve, rostral trunk, surgical approach, superior cerebellar artery, trochlear nerve, trigeminal nerve

Özet: Bu çalışma 21 beyin hemisferi (42 taraf) ve 5 kadavra spesimeni (10 taraf) üzerinde yapılmış olup superior serebeller arterin özelikle cerrahi anatomisi üzerine dikkat çekmektedir. Superior serebeller arter baziler arterden orijin alan serebeller arterler içinde en az anomaliye sahip olan arter olup bu arterin agenezisi çok az sayıdadır. Bu çalışmada tüm spesimenlerde superior serebeller arter bulunmuş olup, superior serebeller arter %67 oranında baziler arterden tek bir dal halinde çıkarken, çift superior serebeller arter %26 oranında görülmüş, üçlü superior serebeller arter ise %7 oranında görülmüştür. Birden fazla superior serebeller artere sahip olan spesimenlerde ilk superior serebeller arter herzaman en geniş çapa sahip idi. Superior serebeller arterin baziler arterden orijin aldığı noktadan arterin iki dal haline ayrıldığı yere olan uzaklığı ortalama 20 mm olup bu ikiye ayrılma noktası %25 spesimende beyin sapının önünde yer alırken %70 oranında beyin sapının yanında yer alıyordu ve 5% oranında ise bifurkasyon tespit edilemedi. Arterden çıkan perforanlar en fazla rostral trunktan çıkmakta idi. Spesimenlerin %70'inde superior serebeller arter III. kranial sinir ile temas ederken, IV. kranial sinir ile temas %95 oranında görülmüş ve V. kranial sinir ile temas ise %45 oranında bulunmuştur. Superior serebeller arterin tüm segmentleri III, IV, V. kranial sinirler ile farklı anatomik ilişkileri olup bu farklılıklar interpedinküler ve parapedinküler sisterne uygulanacak supratentorial girişimlerde, tentorial insisura bölgesine ulaşmak için uygulanacak kombine petrozal girişimlerde ve quadrigeminal platele ulaşmak için uygulanacak cerrahi yaklaşımlarda önemlidir.

Anahtar kelimeler: cerrahi yaklaşım, kaudal dal, okulomotor sinir, rostral dal, superior serebeller arter, troklear sinir, trigeminal sinir

INTRODUCTION

The superior cerebellar artery can be seen in multiple supratentorial, infratentorial and combined petrosal surgical approaches. It may also be used for revascularization procedures in the posterior circulation. For these reasons, we examined the surgical anatomy of the superior cerebellar artery (SCA), and its relationship to cranial nerves III, IV, and V from the surgical perspective.

MATERIAL AND METHODS

This study was performed in Harvey Ammerman Neurosurgical laboratory at the George Washington University and Ankara University Department of Neurosurgery. Twenty-one brains (42 sides) and 5 cadavers (10 sides) were studied. The internal carotid arteries and the basilar artery of each brain were cannulated, irrigated with saline to remove luminal clots, and then perfused with microfil. The brains were then placed in a 10% formaldehyde solution for one week to prepare them for micro-dissection utilizing the Carl Zeiss Universal S2 operating microscope. Measurements were made with the Marathon 8 inch/200 mm Electronic Digital Calipers. The cadaver specimens were fixed in a paraldehyde solution, perfused with colored silicon, and then underwent orbitozygomatic, transpetrosal and supracerebellar-infratentorial approaches for the purpose of evaluating the surgical anatomy of the superior cerebellar artery (SCA).

RESULTS

The SCA was found in all specimens. In 67% of sides there was a single SCA (Figure 1). Duplication was seen in 26% (Figure 2), and triplication was seen in 7%. In cases of multiple SCAs the diameter of the first SCA was 0.95 – 2.25 mm (avg. 1.56), the diameter of the second SCA 0.35 – 1.58 mm (avg. 0.89), and the diameter of the third SCA was 0.42 – 0.71 mm (avg. 0.55). The distance between the SCA and posterior cerebral artery (PCA) was 0.49 – 2.17 mm (avg. 1.15). The SCA was never seen to arise from the PCA. The distance from the SCA origin to the SCA bifurcation was 6.64 – 21.18 mm (avg. 20.4). We found two SCAs that did not bifurcate into rostral and caudal trunks. The marginal artery was seen arising from the caudal trunk in 41% of sides; its destination was the superior part of the petrosal surface of the cerebellum. The average diameter of the marginal artery ranged from 0.35- 1.2 (avg. 0.9 mm). The location of the SCA bifurcation was anterior to the brainstem in 25% of sides, lateral to brainstem in 70%, and no bifurcation was found in 5%. The diameter of the rostral trunk ranged from 0.58 – 1.60 mm (avg. 1.1), and the diameter of the caudal trunk ranged from 0.45 – 1.50 mm (avg. 0.98).

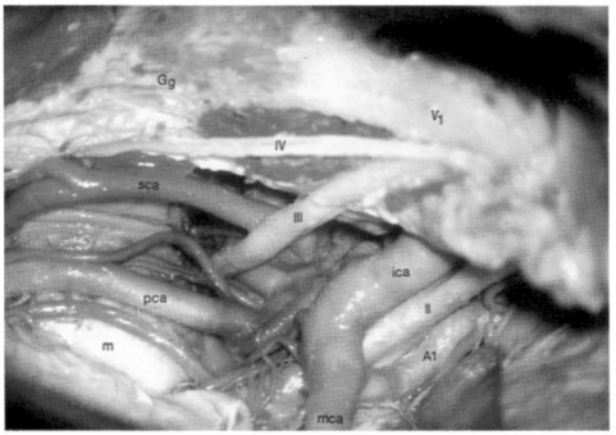

Figure 1: The superior cerebellar artery main trunk and bifurcation are seen. sca = superior cerebellar artery, pca = posterior cerebral artery, m = mesencephalon, Gg = gasserian gangion, V1 = ophtalmic nerve, IV = trochlear nerve, III = oculomotor nerve, II = optic nerve, ica = internal carotid artery, A1 = anterior cerebral artery, mca = middle cerebral artery.

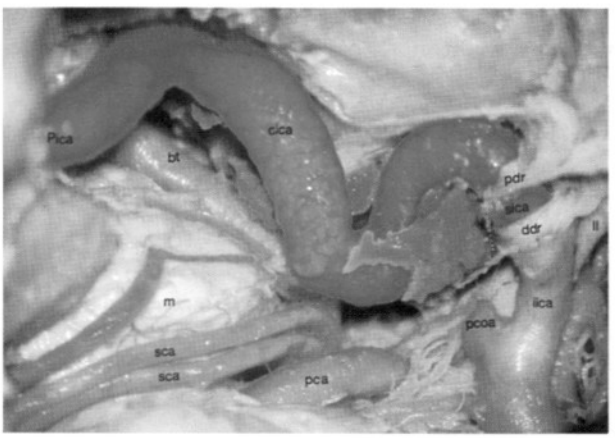

Figure 2: The cavernous sinus neural structures have been removed. Duplication of superior cerebellar artery is seen. Pica = petrous segment of internal carotid artery, cica = cavernous segment of internal carotid artery, pdr = proximal dural ring, sica = subclinoid internal carotid artery, ddr = distal dural ring, pcoa = posterior communicating artery, II = optic nerve, iica = intradural internal carotid artery, pca = posterior cerebral artery, sca = duplication of superior cerebellar artery, m = mesencephalon, bt = basilar artery trunk.

The diameter of P1 segment of the PCA ranged from 1.0 – 3.2 mm (avg. 2.25). The diameter of perforators from the main trunk of the SCA ranged from 0.15 – 0.68 mm (avg. 0.24), the rostral trunk, 0.1 – 0.36 mm (avg. 0.18), and the caudal trunk, 0.1 – 0.4 mm (avg. 0.23). The number of SCA perforators was generally the greatest in the rostral trunk, ranging from 0-7(avg. 4), main trunk was with 0-4 (avg. 3), and the caudal trunk with 1-5 (avg. 3) perforators. In 70% of sides the SCA was found to be touching the inferior surface of the oculomotor nerve. In 92%, the main trunk was touching CN III, and in 8% the rostral trunk was touching it. The distance between the origin of the SCA and the touching point ranged from 1.6-10.0 mm (avg. 4.7). In 95% of the sides the SCA was touching the IV cranial nerve. The main trunk was found to be touching CN IV in 30% of sides. The rostral trunk was touching it in 60%; the caudal trunk was touching it in 5%, and both the rostral and caudal trunks were touching it in 5%. The distance between the origin of the SCA and the touching point of CN IV ranged from 17.6-36.2 mm (avg. 22.5). Any part of the SCA was touching CN V in 45%. The main trunk was touching it in 31%, the rostral trunk in 6%, and the caudal trunk in 57%, and both the rostral and caudal trunks were touching 6%. The distance between the origin of the SCA and the touching point on the trigeminal nerve was 13.4 – 35.5 mm (avg. 22.7).

The height of the basilar bifurcation was documented using the pontomesencephalic junction as the reference point. The bifurcation was considered to be normal if it occurred at the pontomesencephalic junction, high if it occurred anterior to the midbrain, and low if it was anterior to the pons. The incidence of a normal basilar bifurcation in our study was 65%, a high bifurcation was 28%, and a low bifurcation was 7%. The diameter of the basilar artery (BA) ranged from 2.95 – 5.80mm (avg. 4.2) at the level of the BA apex. In 55% of hemispheres there was deviation of the BA from the midline. In 45% the BA was midline. Results are shown in Tables 1-3.

DISCUSSION

The superior cerebellar artery can be seen in the transsylvian approach to the interpeduncular cistern (Figure 3), subtemporal approaches to the para-peduncular cistern, combined petrosal approaches to the pontomesencephalic junction (Figure 4), occipital transtentorial and supracerebellar-infratentorial approaches to the quadrigeminal plate (Figure 5), and in lateral suboccipital approaches to the cerebellopontine angle (2,9,11,14). The SCA may also be used for revascularization procedures in the posterior circulation. For this reason, we examined the anatomy of the SCA from the surgical perspective.

Table 1:

Distance	Range (mm)	Average (mm)
SCA-PCA	0.49-2.17	1.15
SCA- SCA Bifurcation	6.64-21.18	20.4
SCA-III	1.6-10.0	4.7
SCA-IV	17.6-36.2	22.5
SCA-V	13.4-35.5	22.7

SCA: Superior cerebellar artery, PCA : Posterior cerebral artery, III: Oculomotor nerve
IV: Trochlear nerve, V: Trigeminal nerve
SCA-III: Distance between the origin of the SCA and the touching point of the III. nerve
SCA-IV: Distance between the origin of the SCA and the touching point of the IV. nerve
SCA-V: Distance between the origin of the SCA and the touching point of the V. nerve

Table 2:

Diameter	Range (mm)	Average (mm)
First SCA	0.95-2.25	1.56
Second SCA	0.35-1.58	0.89
Third SCA	0.42-0.71	0.55
Rostral Trunk	0.58-1.60	1.1
Caudal Trunk	0.45-1.50	0.98
P1	1.0-3.2	2.25
Main trunks perforator	0.15-0.68	0.24
Rostral Trunks perforator	0.1-0.36	0.18
Caudal Trunks perforator	0.1-0.4	0.23
Basilar artery	2.95-5.8	4.2

SCA: Superior cerebellar artery
PI : Posterior cerebral artery precommunicating segment

Table 3: Superior Cerebellar artery: Relationship to the III, IV, V Cranial Nerves (42 Hemispheres)

	III Nerve	IV Nerve	V Nerve
Contact the nerve (no, %)	29 (%70)	40 (%95)	19 (%45)
Part of contact (no, %) Main trunk	27 (%92)	12 (%30)	6 (%31)
Rostral trunk	2 (%8)	24 (%60)	1 (%6)
Caudal trunk		2 (%5)	11 (%57)
Caudal and Rostral trunk		2 (%5)	1 (%6)

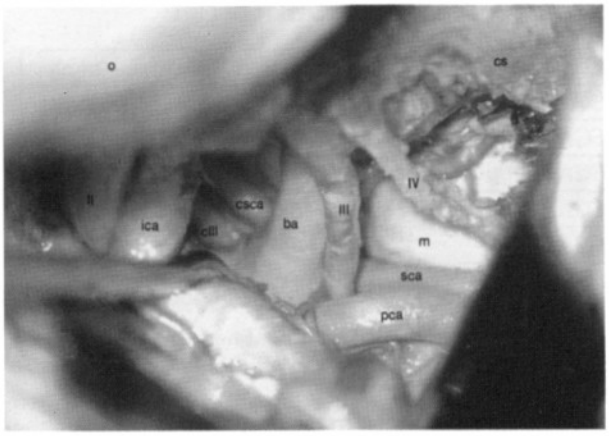

Figure 3: The cranioorbitozygomatic approach has been performed. The anterior pontomesencephalic segment is seen. ba = basilar artery, pca = posterior cerebral artery, sca = superior cerebellar artery, m = mesencephalon, cIII = contralateral oculomotor nerve, csca = contralateral superior cerebellar artery, ica = internal carotid artery, II =optic nerve, IV = Trochlear nerve, o = orbit, cs = cavernous sinus, III =oculomotor nerve.

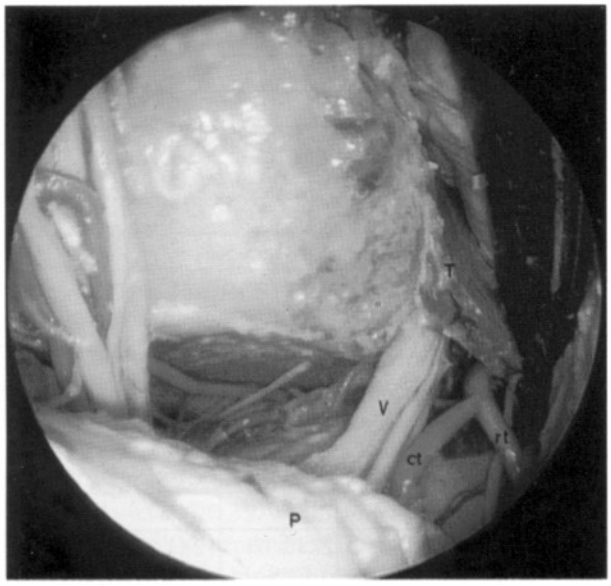

Figure 4: The transpetrosal approach has been performed. Note the relationship of the caudal and rostral trunks to CN IV & V. T = tentorium, V = trigeminal nerve, IV = trochlear nerve, ct = caudal trunk, rt = rostral trunk, P = pons.

The SCA is the most constant and least anomalous artery arising from the vertebrobasilar system (2,4,6,13). Salamon and Huang found a duplication rate of 20% (10), while Rhoton found the

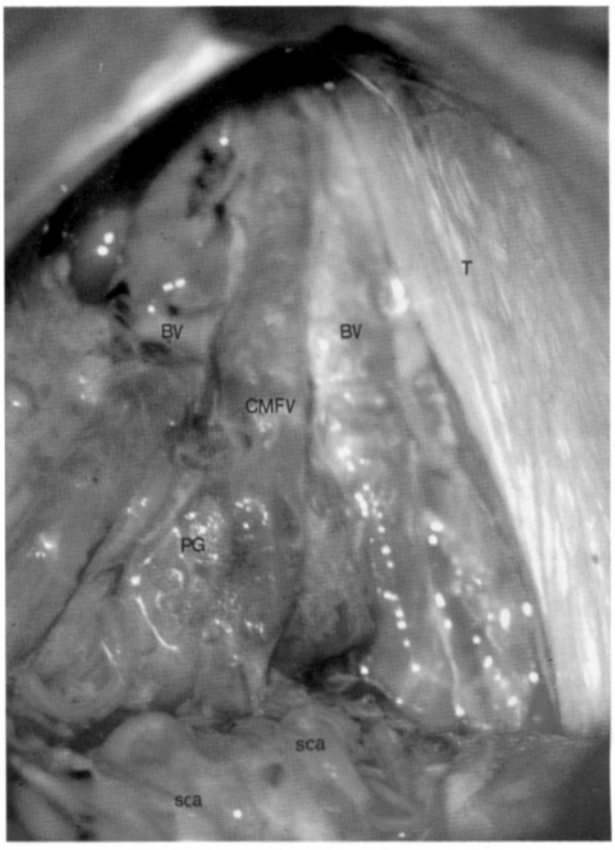

Figure 5: The supracerebellar infratentorial approach has been performed. The cortical branches of the superior cerebellar artery are seen. T = tentorium, BV = basal vein, CMFV = vein of cerebellomesenhephalic fissure, PG = pineal gland, sca = superior cerebellar artery.

incidence to be 13% (2). We saw duplication in 26%, and triplication in 7%. In our cases with multiple SCAs, the diameter of each main trunk differed; the first SCA was always the largest.

In the literature the SCA is divided into four segments: anterior ponto-mesencephalic segment (anterior pontine segment) (Fig 3), lateral pontomesencephalic (ambient segment) (Fig 6), cerebellomesencephalic segment (quadrigeminal segment), cortical segment (Fig 7) (2,3,8). All of the segments of the SCA have some relationship to the cranial nerve (CN) III, IV, and V (1,5,7,12). As seen in the literature, we found the SCA to be the most common artery in proximity to the CN IV; touching it in 95% of sides. In the lateral pontomesencephalic segment of the SCA, the caudal trunk was in contact with CN V in 57% of sides, and the rostral trunk of the SCA was in contact with the CN IV in 60%. This

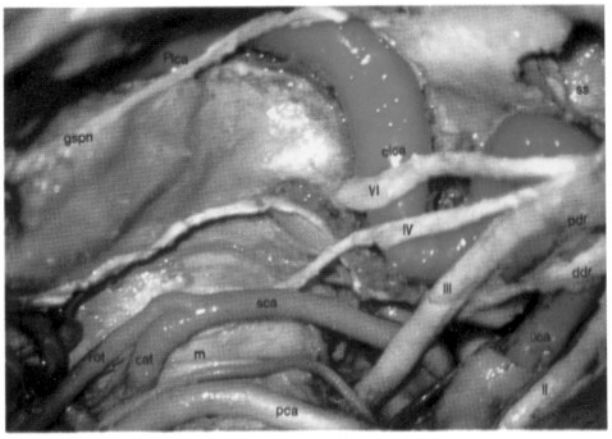

Figure 6: Relationship between the superior cerebellar artery and cranial nerve III & IV. sca = superior cerebellar artery, pca = posterior cerebral artery, cat = caudal trunk, rot = rostral trunk, m = mesencephalon, III = oculomotor nerve, IV = trochlear nerve, VI = abducens nerve, cica = cavernous segment of internal carotid artery, Pica = petrous segment of internal carotid artery, gspn = greater superficial petrosal nerve, ss: sphenoid sinus, pdr = proximal dural ring, ddr = distal dural ring, iica = intradural internal carotid artery, II = optic nerve.

relationship is important in all lateral and combined petrosal approaches to the region of the tentorial incisura.

The anterior pontomesencephalic segment is the origin of the SCA from the basilar quadrification and extends to the anterolateral margin of the brain stem (Fig 8). This segment is composed of the main trunk, courses inferior to the third nerve, and contains on average, three perforators. Salamon and Huang found the bifurcation of the SCA anterior to the brain stem in 30% and lateral to it in 70% (10); we found it anterior to the brain stem in 25%, lateral to it in 70%, and no bifurcation was found in 5%. The average distance of the bifurcation from the origin of the SCA was found to be 20.0mm. The average distance of the contact point between the SCA and the third nerve was found to be 4.7mm. The main trunk was found to be in contact with CN III in 92%. The bifurcation of the SCA is best accessed with combined petrosal, lateral supracerebellar-infratentorial, occipital transtentorial, or subtemporal approaches; it cannot be easily accessed via the transsylvian approach.

For revascularization procedures, the rostral or caudal trunks of the SCA can be used. The bifurcating trunks are most easily accessed for

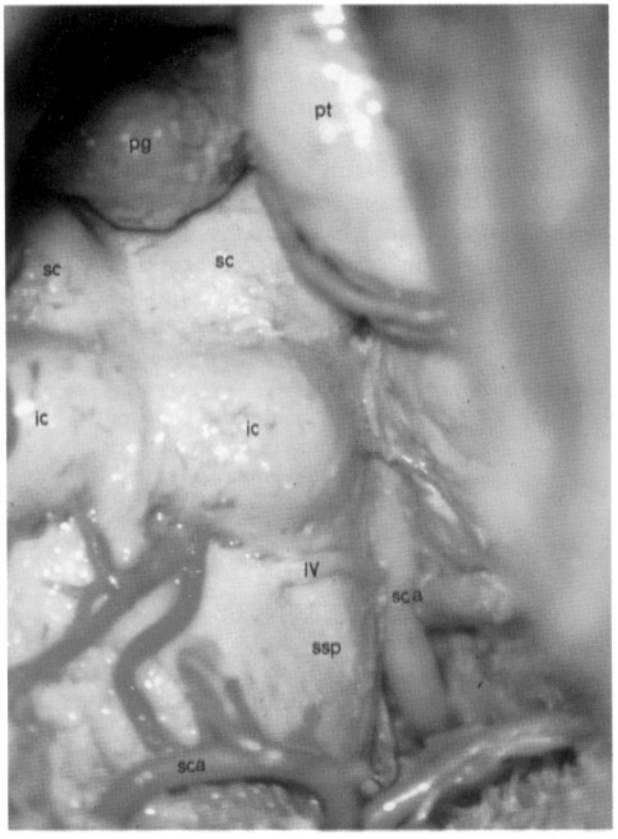

Figure 7: The relationship of the superior cerebellar artery, superior cerebral peduncle and inferior colliculus in the region of the quadrigeminal plate. pt = pulvinar thalami, pg = pineal gland, sc = superior colliculus, ic = inferior colliculus, IV = trochlear nerve, ssp = superior cerebral peduncle, sca = superior cerebellar artery.

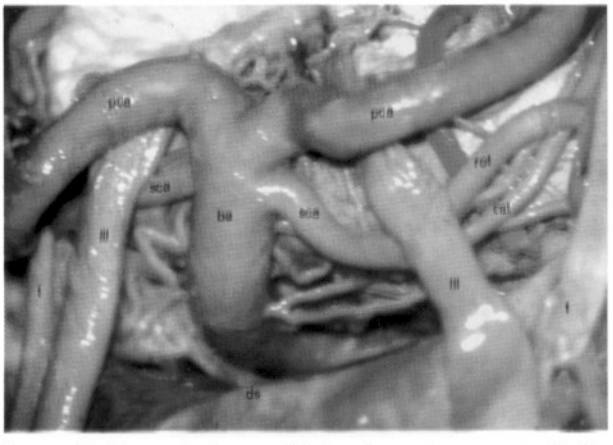

Figure 8: The anterior and lateral pontomesencephalic segments of the superior cerebellar artery are seen. Note the relationship of the superior cerebellar artery to oculomotor nerve. sca = superior cerebellar artery, pca = posterior cerebellar artery, rot = rostral trunk, cat = caudal trunk, t = tentorium, III = oculomotor nerve, ds = dorsum sella, ba = basilar artery.

revascularization procedures utilizing a combined petrosal, lateral supracerebellar-infratentorial, or subtemporal approach. Generally the largest trunk of the SCA is the rostral trunk, however, the rostral trunk contains more perforating branches than the main trunk, caudal trunk and marginal branch, and the rostral trunk more commonly comes into contact with CN IV. If the rostral trunk is to be used for revascularization, consideration should be given to the potential risk of injury to CN IV and the potential for perforator infarcts.

Correspondence: Emel Avcı MD
George Washington University
Department of Neurosurgery
2150 Pennsylvania Avenue NW,
Washington DC 20037/ USA
e-mail:avciemel@hotmail.com

REFERENCES

1. Hardy DG, Rhoton Jr AL: Microsurgical relationships of the superior cerebellar artery and the trigeminal nerve. J Neurosurg 49:669-678, 1978
2. Hardy DG, Peace DA, Rhoton Jr, AL: Microsurgical anatomy of the superior cerebellar artery. Neurosurgery 6:10-28, 1980
3. Hoffman, H.B., Margolis M.T., Newton T.H: The superior cerebellar artery: Section I. Normal gross and radiographic anatomy. In Radiology of the Skull and Brain. Angiography: Vol. II, 1809-1830, St Louis, C.V. Mosby, 1974
4. Icardo JM, Ojeda JL, Garcia-porrero JA, Hurle JM: The cerebellar arteries: Cortical patterns and vascularization of the cerebellar nuclei. Acta anat. 1982;113:108-116.
5. Klun B, Prestor B: Microvascular relations of the trigeminal nerve: An anatomical study. Neurosurgery 19:535-539, 1986
6. Marinkovic SV, Gibo H: The surgical anatomy of the perforating branches of the basilar artery. Neurosurgery 33:80-87, 1993
7. Marinkovic S, Gibo H: The neurovascular relationships and the blood supply of the oculomotor nerve: The microsurgical anatomy of its cisternal segment. Surg Neurol 42: 505-516, 1994
8. Marinkovic S, Kovacevic M, Gibo H, Milisavljevic M, Bumbasirevic: The anatomical basis for the cerebellar infarcts. Surg Neurol 44:450-461, 1995.
9. Matsushima T, Fukui M, Suzuki S, Rhoton Jr. A: The microsurgical anatomy of the infratentorial lateral supracerebellar approach to the trigeminal nerve for Tic Douloureux. Neurosurgery 24:890-895, 1989.
10. Salamon G. and Huang Y.P: Radiologic Anatomy of the Brain. Berlin, Springer- Verlag, 1976, pp. 307-322.
11. Visteh AG, David CA, Marciano FF, Coscarella E, Spetzler RF: Extreme lateral supracerebellar infratentorial approach to the posterolateral mesencephalon: Technique and clinical experience. Neurosurgery 46:384-389, 2000.
12. Yamamoto I, Kageyama N: Microsurgical anatomy of the pineal region. J Neurosurg 53:205-221, 1980.
13. Yasargil MG: Microneurosurgery: Microsurgical Anatomy of the Basal Cistern and Vessels of the Brain. Stuttgart, Georg Thieme, 1984, Vol I
14 Yaşargil MG: Microneurosurgery: Microneurosurgery of CNS Tumors. Stuttgart, Georg Thieme, 1996, vol IVB, pp 58-60

Superior cerebeller arteries are considered the most constant of the cerebeller vessels. They course around the brain stem in the groove between the pons and the midbrain