

Microsurgical anatomy of the infratentorial arteries: stereoscopic printing study

Anatomia microcirúrgica das artérias infratentoriais: um estudo estereoscópico

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Abstract

Background: The infratentorial space is a region with a complex network of arteries supplying the cerebellum and brainstem. Its complex three-dimensional anatomy must be thoroughly understood by the vascular neurosurgeon and the interventional radiologist.

Objective: To describe the main arteries of the infratentorial space and its trajectory and its relationship to the topography of the neural structures.

Methods: We studied 30 formalin-fixed human brains and we also dissected 6 cadaver heads, using a surgical microscope with 3X to 40X magnification. The brains and all heads were injected with colored silicone. The anatomical dissections were documented with a three-dimensional method, aiming to produce stereoscopic prints.

Results: The neurovascular relationships, segments and branches of the basilar artery, superior cerebellar, anteroinferior cerebellar, cerebellar and posteroinferior vertebral are described.

Conclusion: The microsurgical anatomy of the infratentorial arteries is complex and the stereoscopic images presented are an important tool for documentation.

Keywords: cerebral arteries; microsurgery; stereoscopic vision.

Resumo

Contexto: O espaço infratentorial do crânio é uma região que possui complexa rede de artérias que vascularizam o tecido cerebelar e o tronco encefálico. Sua complexa anatomia tridimensional deve ser profundamente entendida pelo neurocirurgião vascular e pelo radiologista intervencionista.

Objetivo: Descrever as principais artérias do espaço infratentorial e seu trajeto, bem como sua relação com a topografia das estruturas neurais.

Métodos: Foram estudados 30 cérebros humanos, fixados em formalina e 6 cabeças de cadáveres dissecadas, utilizando-se microscópio cirúrgico com 3X a 40X de aumento. Os cérebros e todas as cabeças foram injetados com siloxanos polimerizados ou polisiloxanos (silicone) colorido. As disseções anatômicas foram documentadas utilizando-se técnica para obtenção de imagens tridimensionais (3D), objetivando a produção de impressões estereoscópicas.

Resultados: São descritos o trajeto, segmentos e ramos das artérias basilar, cerebelar superior, cerebelar anteroinferior, cerebelar posteroinferior e vertebral.

Conclusão: A anatomia das artérias infratentoriais é complexa e as imagens estereoscópicas apresentadas são um importante instrumento de documentação, pois permitem uma noção de profundidade da anatomia estudada.

Palavras-chave: artérias cerebrais; microcirurgia; visão estereoscópica.

Introduction

The infratentorial region is an intracranial area below the tentorium cerebellum. In practice, the infratentorial region is closely related to the posterior cranial fossa¹. The posterior cranial fossa is almost fully constituted of the occipital bone and anteriorly separated from the middle

fossa by the petrous temporal bone and the dorsum sellae of the sphenoidal bone¹. This place has all other encephalic structures that do not correspond to the prosencephalon, i.e., mesencephalon, metencephalon (cerebellum and pons) and myelencephalon (bulbus). Many nerves emerge from these structures, which are in charge of the individual's main sensory integrations with the environment¹.

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As the posterior fossa represents a considerable part of the skull base, it has many small bone openings through which run cranial nerves (in the posterior fossa, the openings corresponding to cranial nerves VII, VIII, IX, X, XI and XII) and blood vessels². From the anatomical-surgical perspective, the main characteristic of this skull base region in relation to the others is the communication established in this area between the encephalon and the medulla².

The main points connecting the intracranial structures, medulla and the rest of the body are especially supplied by the foramen magnum, where the sensory-motor integration pathways exit the cranial cavity, and by the jugular foramen, which drains the venous blood from the central nervous system³. The cranial nerves are microstructures in this region (except for the two first nerves) that emerge from the brainstem and run through the foramina to exit the skull³. The fact of having innumerable delicate and vital structures in such a small area makes the surgical approach to this region an extremely cautious procedure. The purpose of this article is to provide a general explanation of the courses and relations of arteries in this region and their relations with other adjacent structures.

The arteries that supply this region come from the vertebral system, which rises from the vertebral arteries and presents more anatomical variations if compared to the carotid system⁴. Its main vessels are the cerebellar arteries and the posterior cerebral arteries. These vessels get mixed with the posterior fossa structures, creating three neurovascular complexes: the superior cerebellar arteries (SCA), the anterior inferior cerebellar arteries (AICA) and the posterior inferior cerebellar arteries (PICA)⁴.

In this article, the authors describe this anatomy based on studies conducted by Rotheron^{5,6} and Yasargil⁷, dissections performed in the investigation period of two and a half years, in two different microsurgical laboratories.

Material and methods

This article is the result of dissections performed by one of the authors (GRI) in the investigation period of two and a half years, in two different microsurgical laboratories. The first dissections were performed at the Microsurgical Laboratory of the Hospital Beneficência Portuguesa de São Paulo – Instituto de Ciências Neurológicas, for one year. The second part of this study was developed at the Microsurgical Laboratory Diane and Gazi Yaşargil Education Center – University of Arkansas for Medical Sciences, for 16 months.

Thirty formalin-fixed human brains and six corpse heads were dissected using a surgical microscope of 3x to

40x magnification. All brains and heads were injected with polymerized siloxanes or colored silicone. The corpses were fixed to a Mayfield skull clamp, the head was stretched and rotated, simulating the surgical position, and after that, petrous and suboccipital craniotomies were performed.

The anatomical dissections were documented using the technique to obtain 3D images, aiming at the production of stereoscopic prints. In this technique, pictures are taken of the same object from two different positions, but on the same horizontal plane. The first position corresponds to the left eye perspective and the second position corresponds to the right eye perspective. The images were superimposed, using a previously defined software program, coordinated and printed. Wearing 3D glasses with color lens is required to visualize the printed images. Nikon D70, 8.0 megapixels with macro lens was used to document the dissections. The device was adapted to a sliding bar assembled on a tripod. The lens and the shutter speed were set at f32 and 1/60 seconds, respectively. The stereoscopic technique employed by the authors is detailed in a previous study conducted by Ribas, Bento e Rodrigues⁸.

The prints made using the stereoscopic technique should be viewed with red-green stereoscopic glasses.

Results

Figures 1 to 9 illustrate the microsurgical anatomy of the infratentorial arteries.

Vertebral artery

The vertebral artery runs in the cervical region, into transverse foramina. After exiting the transverse process of the first cervical vertebra, the vertebral artery changes its route and runs medially, entering the posterior fossa through the atlantooccipital membrane^{9,10}. In its initial intracranial course, this artery passes the lateral cerebellomedullary cistern, reaching the bulbopontine sulcus, where it joins its corresponding artery to form the basilar artery^{9,10}, in the lower one-third of the clivus. The vertebral artery ramifications include several small branches to the anterolateral, lateral e posterolateral portions of the medulla, the anterior spinal artery and, in more than 70% of the cases, the posterior inferior cerebellar artery^{9,10} (Figures 1, 4 and 9).

Basilar artery

The basilar artery (BA) arises from the bulbopontine sulcus, where the two vertebral arteries meet. It runs in the pre-pontine cistern on a sulcus (sulcus to the basilar

artery) at the midline of the pons. Its terminal segment reaches the interpeduncular cistern, where it bifurcates, forming the two posterior cerebral arteries at the level of the dorsum sellae¹¹⁻¹³. The course of this artery is tortuous in most part of the population. Fenestration in the basilar artery occurs in 1% of the cases. The ramifications arising from the BA are the circumferential perforating and paramedian arteries that supply most of the pons and mesencephalon. The longest branches arising from the BA are AICA and SCA¹¹⁻¹³ (Figures 1 and 4).

Superior cerebellar artery

The SCA is the most constant (in relation to its presence, distribution and course) of the infratentorial arteries. It arises near the end of the basilar artery, at the bifurcation point, near the oculomotor nerve, running posterolaterally and winding around the limits between the pons and cerebral peduncle^{14,15}. It runs above the origin of the trigeminal and trochlear nerves and enters the cerebellomesencephalic fissure, where it originates several small arteries (pre-cerebellar arteries). Its main stem divides into two segments, commonly of the same size. One segment runs along the superolateral surface of the cerebellum (caudal extension) and the deeper segment supplies the vermis (rostral extension).

According to its position in relation to the structures along its course, this artery divides into four branches: anterior ponto-mesencephalic, lateral ponto-mesencephalic, cerebellomesencephalic and cortical segments^{14,15} (Figures 1, 5-7).

Anterior ponto-mesencephalic segment

This segment extends from the SCA origin, at the end of the basilar artery, often medially to the free edge of the tentorium cerebellum; then, it passes cranial nerves III, IV and V and runs to the anterolateral margin of the brainstem.

The pontomesencephalic junction is the point where the SCA bifurcation usually occurs. Bifurcation points other than this one act as reference to find a less common origin of the SCA^{16,17}. Bifurcations before the mesencephalon are associated with the supratentorial origin of the SCA and bifurcations before the pons with infratentorial origin.

The main stem of the SCA may send perforating branches, which can be direct or circumflex. The most common ramification arising from the main stem is the long circumflex branch. These perforating branches usually end at the tegument, at the junction of the superior and middle cerebellar peduncles, and in the interpeduncular fossa^{16,17}.

Lateral ponto-mesencephalic segment

The lateral ponto-mesencephalic segment begins after the trigeminal nerve arises at the pons. This segment arises from the anterolateral margin of the brainstem and runs to the anterior margin of the cerebellomesencephalic fissure. The basal vein and the posterior inferior cerebellar artery are near this segment, running above it^{18,19}.

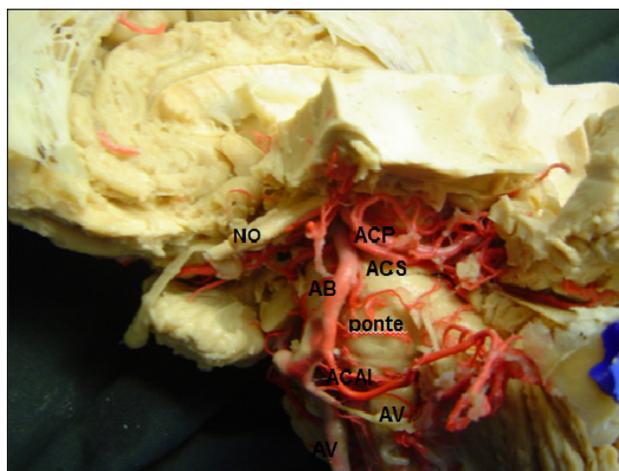


Figure 1. Lateral view of the arteries and posterior fossa. VA: vertebral artery; BA: basilar artery (with fenestration); AICA: anterior inferior cerebellar artery; ON: optic nerve; SCA: superior cerebellar artery; PCA: posterior cerebral artery.

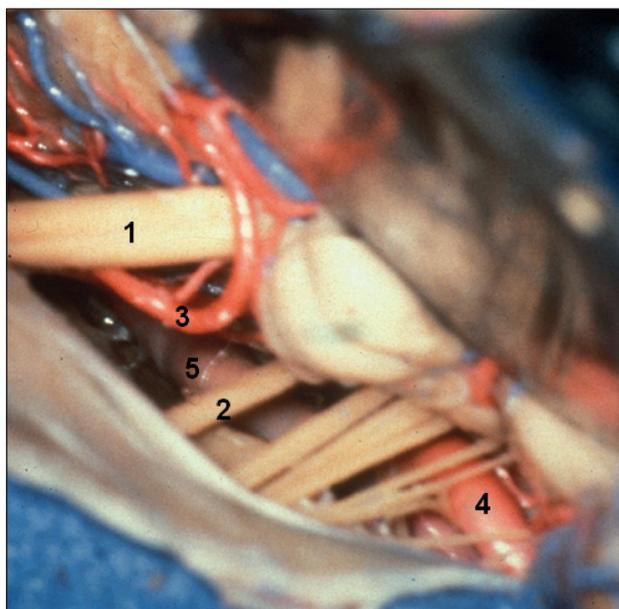


Figure 2. View of infratentorial arteries, using the suboccipital approach. (1) Complex of cranial nerves VII and VIII; (2) glossopharyngeal nerve; (3) anterior inferior cerebellar artery; (4) vertebral artery; (5) basilar artery.

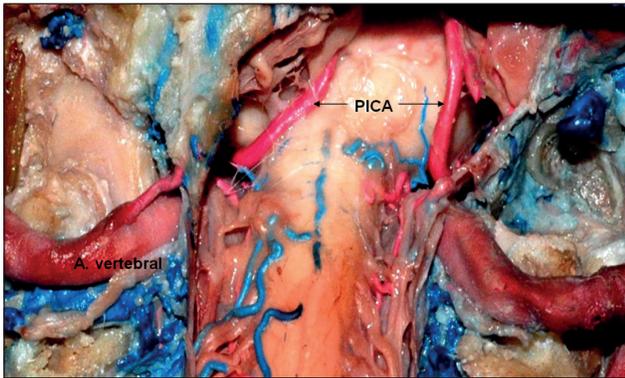


Figure 3. Posterior view of the vertebral arteries and the posterior inferior cerebellar artery.

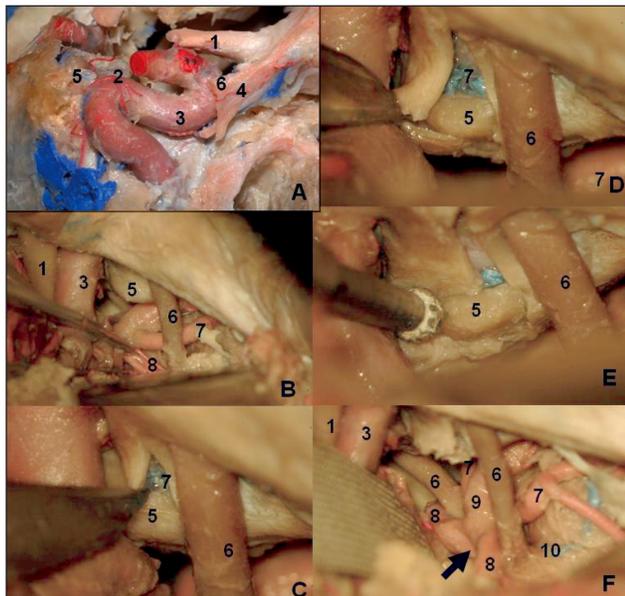


Figure 4. Microanatomic view of the transcavernous transsylvian approach steps to the top of basilar artery. (A) Relation of the meningohypophyseal trunk arising from the intracavernous portion of the internal carotid artery (2) with the posterior clinoid process (5); (B) the brain spatula retracts the right temporal lobe posteriorly (pretemporal access) to expose the basilar artery (after dissection of the arachnoid of basal cisterns); (C) opening in the oculomotor triangle (cavernous sinus roof) medially to the oculomotor nerve; (D) exposure of posterior clinoid; (E) posterior clinoid drilling; (F) exposure of the top of basilar artery (arrow) and its terminal branches: (1) optic nerve; (2) meningohypophyseal trunk; (3) internal carotid artery; (4) ophthalmic branch of trigeminal nerve; (5) posterior clinoid process; (6) oculomotor nerve; (7) superior cerebellar artery; (8) posterior cerebral artery; (9) basilar artery.

Half the cases present a contact zone of the SCA with the trigeminal nerve, extending 3 to 4 mm on the nerve surface, and that may be associated with trigeminal neuralgia. Just as the main stem, the rostral and caudal extensions also

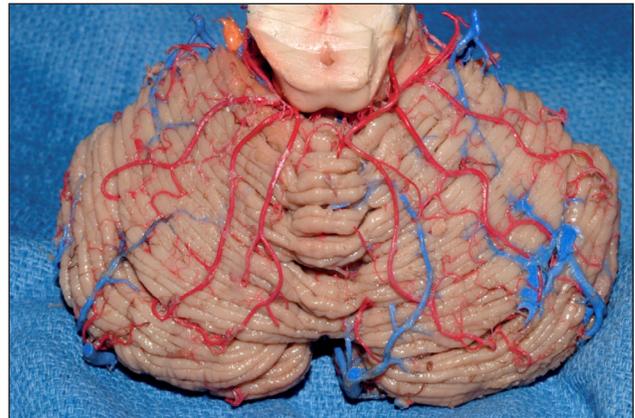


Figure 5. Branches of the superior cerebellar artery. This anatomic dissection shows superior cerebellar artery branches on the superior surface of the cerebellum.

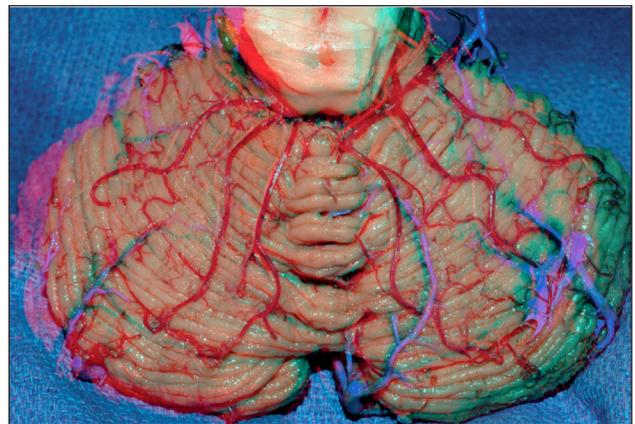


Figure 6. Stereoscopic view of superior cerebellar artery branches.

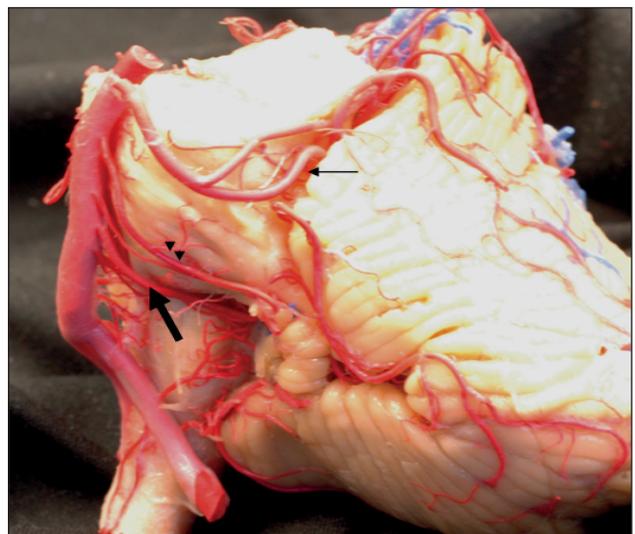


Figure 7. Anatomic part showing the basilar artery branches: superior cerebellar artery (arrow), anterior inferior cerebellar artery (arrow tips) and perforating and circumferential branches (thick arrow).

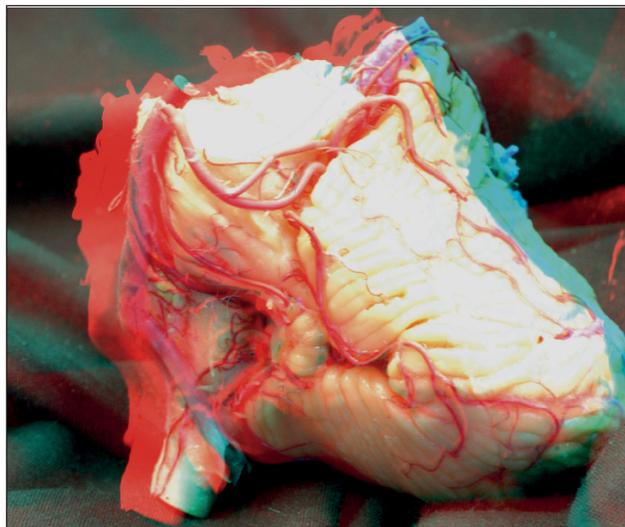


Figure 8. Stereoscopic view of the anatomic part showing the basilar artery branches.

send perforating branches, usually circumflex, which supply two main areas: the junction of the superior and middle peduncles and under the sulcus between the superior and inferior colliculi of the quadrigeminal lamina^{18,19}.

Cerebellomesencephalic segment

This is a tortuous portion of the artery that runs into the cerebellomesencephalic fissure. In this fissure, the SCA originates the “hemispheric branches”, of variable number, but on average presenting three ramifications: medial, intermediate and lateral. The medial ramification often arises from the rostral extension of the SCA and the lateral ramification from the caudal extension. These ramifications run to tentorial surface, where they divide into one to seven ramifications and end in the cerebellum tissue sheets^{20,21}.

The pre-cerebellar arteries arise from the hemispheric branches and originate two sections: the medial and lateral groups. The medial group is constituted of small arteries that run between the superior medullar velum and the central lobe, and the lateral group has arteries that run between the superior and middle peduncles and the central lobe lips. These arteries supply the area from the lateral cortex to the vermis, the deep cerebellar nuclei and the inferior colliculus^{20,21}.

Cortical segment

The cortical segment, the terminal portion of the SCA, includes the arteries that run across the cerebellar cortex, near the inferior surface of the tentorium cerebellum.

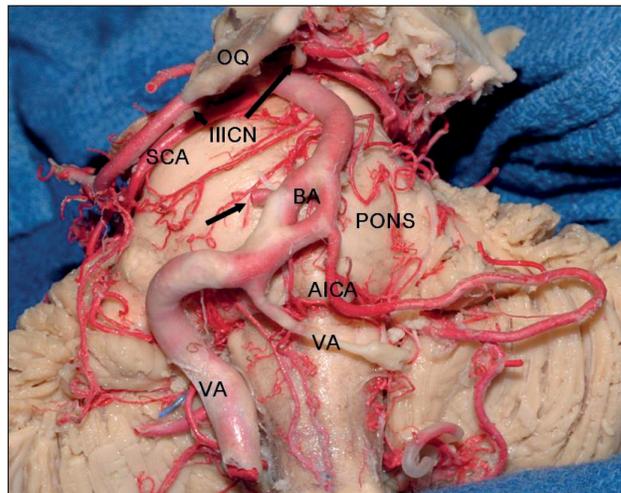


Figure 9. Anterior view of the brainstem showing the posterior fossa vascularization. VA: vertebral artery; BA: basilar artery (with fenestration); AICA: anterior inferior cerebellar artery; IICN: oculomotor nerve; SCA: superior cerebellar artery; OQ: optic chiasm.

This segment sends off cortical branches that supply the tentorial surface and the superior portion of the adjacent petrous surface²². These arteries most frequently originate three hemispheric branches (lateral, intermediate and medial) that supply, on their surface, the adjacent portions of the cerebellar hemispheres, towards the tentorium cerebellum; and two vermian arteries, one that runs along the midline and one towards the tentorial surface²². A marginal ramification is also common in half the individuals, which will supply part of the petrous surface, near the tentorial surface, and that arises from the lateral ponto-mesencephalic segment, towards the cortical surface²².

Anterior inferior cerebellar artery

AICA is a ramification that often arises from the lower half of the basilar artery, at the level of the bulbopontine sulcus. After it is originated, it remains close to the abducens nerve, running laterally to the bulbopontine sulcus and between the point of origin of the glossopharyngeal nerve (below) and the facial and vestibulocochlear nerve (above).

Some relations have been observed between AICA and the two nerves that run in the acoustic meatus. In this area, the artery bifurcates to form rostral and caudal extensions, just like the SCA. From this area, the artery runs to the posterior portion of the cerebellum, but it still sends off branches that will supply these nerves and arteries that irrigate the brainstem (the perforating arteries), as well as the other arteries that run in the foramina of Luschka (lateral foramina of the fourth ventricle) to supply the

choroid plexus. The artery runs to the cerebellopontine angle. From there, it runs to the floccule, in the middle cerebellar peduncle. After reaching the lateral face of the cerebellum, it runs through the horizontal cerebellar fissure (Figures 2 and 7).

Just as the SCA, AICA divides into four segments:

Anterior pontine segment

This is the segment that will originate AICA until an imaginary line that crosses the large axis of the inferior olive. Its right and left branches not always originate at the same level and it does not always arise as a single stem, as it may be a dual stem in some cases.

Lateral pontine segment

Its course starts at the end of the previous segment and ends at the floccule. The labyrinthine artery arises from this segment to supply the nerves that enter the internal acoustic meatus, just as the recurrent perforating arteries that supply the brainstem, and the subarcuate artery that runs to the subarcuate fossa. That's the point where the artery, after passing the facial and vestibulocochlear nerves, duplicates to form rostral and caudal extensions, in most hemispheres analyzed. In cases without such duplication, the bifurcation occurs before these nerves or the artery, which has single stem since it arises. However, even in these cases, the territorial distribution of the vessels is usually similar to the distribution of the arteries of single stem.

Flocculonodular segment

The flocculonodular segment runs from the floccule to the middle cerebellar peduncle. In this portion, the artery is already divided into two stems. The rostral extension in the floccules sends off branches to the foramen of the fourth ventricle roof (Luschka), and runs to the superior lip of the cerebellopontine fissure and to the petrous surface of the cerebellum. The caudal extensions enter the bulbocerebellar fissure and run to the cerebellar cortex below the floccule.

Cortical segment

The last portion of AICA, the cortical segment, runs from the cerebellar peduncle to the petrous surface of the cerebellum, where it is the main supplier. Its territory is of varied extension, and it may include only the floccule and adjacent portions or spread across most petrous surface, with its area boundaries overlying on the SCA territory (in

the lower portion of the petrous surface) and on the territory of the posterior inferior cerebellar artery (PICA), which supplies the lateral portion of the suboccipital surface. Due to such area overlying, the rostral and caudal extensions often anastomose with the SCA and PICA.

Several relations have been observed between AICA and the nerves that run across the internal acoustic meatus. The subarcuate cerebellar artery arises below the facial nerve and runs to the subarcuate fossa and towards the cerebellum, where it is the main supplier of the floccule. Another important aspect is the fact that the main suppliers of the internal ear organs are AICA ramifications, such as the labyrinthine artery, whose branching ends up originating the vestibular, cochlear and vestibulocochlear arteries, as they arrive at their corresponding destinations.

The subarcuate artery often arises from the labyrinthine artery, that is, it originates medially to the internal acoustic meatus, penetrates the dura mater that covers the subarcuate fossa and enters the subarcuate canal. It is important because it supplies the petrous bone in the region of semi-circular canals and it can be the pathway to disseminate, via subarcuate canal, infections to the meninges and petrosal sinus that come from the mastoid region.

Posterior inferior cerebellar artery

PICA is the most inconstant of the cerebellar arteries regarding its course and distribution area. It usually arises from the posterior or lateral margin of the vertebral artery, near the olive, and it is the largest branch of the vertebral artery (and rarely arising from the basilar artery). It may be originated below or above the magnum foramen, but in most cases (83% of the times), it begins above the magnum foramen.

It runs near the roots of low cranial nerves, first passing the hypoglossal nerve, above, below or through its roots, and then the glossopharyngeal, vagus and accessory nerves, usually located below or at the same level as this artery. Its course is much more tortuous than that of the other cerebellar arteries, as it runs to the cerebellar tonsils, bulbocerebellar sulcus, and from there, it spreads to the vermis and the suboccipital surface of the cerebellum (Figure 3).

Along its course, PICA divides into five segments, described below, and that may not always be present.

Anterior bulbar segment

The anterior bulbar segment begins where this artery arises, almost always at the vertebral artery. It is believed that this segment is present only if the artery arises

before the bulbus, and not if its origin is laterally to it. It usually occurs at PICA, whose origin is in the upper portion of the vertebral artery. When starting its course from the origin of this vessel, this part of the artery gets in contact with the roots of the hypoglossal nerve. From this point, this segment runs backwards and its anatomical limit is an imaginary line that passes the most prominent portion of the olive.

Lateral bulbar segment

The lateral bulbar segment is present in most arteries and runs from the point where the artery passes the most prominent portion of the olive to the emergency point of the roots of the glossopharyngeal, vagus and accessory nerves.

Tonsillar bulbar segment

This segment runs from the emergency point of cranial nerves IX, X and XI, in a posterior course, until the artery reaches the lower half of the tonsil. PICA usually bifurcates to form the medial (smaller) extension and the lateral (larger) extension in the lower portion of the tonsil, most commonly in the telovelotonsillar fissure.

The tonsillar bulbar segment and the telovelotonsillar segment (described below) often sends off branches through the foramen of the fourth ventricle roof (Luschka), which are important suppliers to the portions of the choroid plexus that are not supplied by the AICA branches. In the fourth ventricle, PICA also supplies the middle portion of its roof and the medial portion of the lateral recess.

A number of small arteries often arises from these three bulbar segments, called perforating arteries, of direct or circumflex type. They establish several anastomoses with one another, creating a plexus, and end up penetrating in the brainstem, thus playing an important role in bulbus irrigation.

Telovelotonsillar segment

The telovelotonsillar segment is known to be the most complex portion of PICA. It originates in the ascending portion, near the tonsil. Along its course, it can create a loop of rostrally convex curve (the cranial loop), of variable location, from the anterior to the superior margin and from the lateral end to the medial aspect of the inferior medullary velum. It penetrates the fissures between the vermis, tonsil and cerebellum and sends off branches that supply the choroid tela and the choroid plexus of the fourth ventricle.

If the artery is already bifurcated in this topography, the medial segment will reach the vermis, via vermian hemispheric fissure, and the lateral segment, running through the telovelotonsillar fissure to reach the hemisphere. The branches that run through the telovelotonsillar fissure send up penetrating ramifications, which will supply the dentate nucleus.

Cortical segment

The cortical segment starts after the artery exits the sulcus delimited by the vermis, tonsil and hemisphere. In its distribution across the cerebellum surface, the boundaries of its areas many times overlies on the SCA territory.

The medial stem, the smallest of PICA stems, often originates a group of cortical branches named vermian branches, where this part of the artery terminates. They arise from the vermian hemispheric fissure. Their main irrigation area is the vermis and one part of the adjacent hemisphere.

The lateral stem, the largest of PICA stems, will send off two groups of branches: the hemispheric and tonsillary branches. The hemispheric branches are almost always three ramifications. They arise from the vermian hemispheric fissure and supply the medial, intermediate and lateral segments of the suboccipital surface. This territory is often mixed with that of the SCA, but it is known as the most constant territory supplied by PICA.

Finally, the tonsillary branches, usually one or two, supply the tonsil. They are not always present, and in this case, the tonsil is supplied by adjacent hemispheric branches.

Discussion

Regarding the clinical and surgical aspects, the occlusion of the SCA is not common, but when it occurs, it causes very rich clinical scenarios. Symptoms include vomiting, sudden dizziness, failure to stand still and ambulate (this symptom is also present in occlusions of other cerebellar arteries), contralateral Horner's syndrome, nystagmus, contralateral loss of thermoanalgesia, contralateral hearing disorder²³⁻²⁵.

In the occlusion of this artery, survival and maintenance of cerebellar function will be dependent on the collateral flow, but unfortunately, this area is susceptible to reduced irrigation, as it is the limit between the irrigations supplied by the vertebral arteries and the basilar artery, and a limited flow in the ipsilateral vertebral artery, even without occlusion of the SCA, may lead to infarction of this area^{26,27}.

Several surgical pathways are provided to access the SCA. The first is the temporal craniotomy, with lifting of occipital and temporal lobe and incision in the tentorium cerebellum, enabling a supratentorial and subtemporal approach. This surgical technical can be used when the SCA exposure at its point of origin and in the first three segments is intended (anterior ponto-mesencephalic, lateral ponto-mesencephalic, cerebellomesencephalic segments)^{24,25}.

Another surgical access to the SCA is through the pterional craniotomy, used when it is located above the dorsal sella. However, if its point of origin is low, a petrous approach can be used. The lateral suboccipital craniotomy is used when the artery is in the cerebellomesencephalic fissure or near the trigeminal nerve^{28,29}.

In AICA, the most frequent disorder affecting this territory is the development of cerebellopontine angle tumors, mainly acoustic schwannomas, with rare aneurysms and malformations in this artery³⁰.

Due to its close relation with cranial nerves VII and VIII, a compression syndrome caused by AICA occlusion appears with facial paralysis, dizziness, deafness, nausea and vomiting, associated with ataxia and dyskinesia. Among these symptoms, dizziness is often the most important. In general, the symptoms occur suddenly, without loss of consciousness. Other connections between nerve nuclei also cause homolateral loss of facial thermoanalgesia (trigeminal nerve). Loss of thermoanalgesia is also seen in the contralateral half, due to partially debilitated fibers of the lateral spinothalamic tract³⁰.

It should be noted that, due to the high variability of AICA anatomy, combined with collateral circulation, if any, the symptoms are not always uniform in the patients. The surgical access to AICA depends on where the injury to be treated is located, following the directions below:

- lateral suboccipital access: used to treat injuries in meatal and post-meatal segments of AICA and regions below the trigeminal nerve and adjacent to the internal acoustic meatus.
- subtemporal access: used in cases of high AICA origin or medially to the trigeminal nerve.
- pre-sigmoid access: indicated for deep resections, located ahead of the brainstem.

An occlusive syndrome that affects PICA almost always runs with bulbus and cerebellum ischemia, and it is more common in the dorsal portion of the inferior olivary nucleus. It may cause many symptoms, as the roots of several cranial nerves (homolateral facial paresthesia, homolateral palatal drop, dysarthria and dysphonia, ataxia, dizziness, nystagmus, Horner's syndrome and vomiting) and

ascending nervous pathways of the brainstem (contralateral thermoalgesic sensory loss) are affected, characterizing the "lateral bulbar syndrome".

The most frequent occlusion is caused by rupture of the atherosclerotic plaque and subsequent thrombosis. Arterial occlusions that occur distally to the bulbar branches cause a similar syndrome to labyrinthitis, as the flocculonodular complex is affected, but in these cases, there are no findings resulting from brainstem injuries²⁷.

Conclusion

The anatomic study of infratentorial arteries, in the stereoscopic perspective, provides the surgeon with rich details of the microsurgical anatomy, considering that an anatomic region can be studied under different angles and according to the patient's surgical position. Stereoscopic prints are useful as they provide a perspective of depth of the documented anatomy. Studies of this type are essential, as they enable a more advanced level in the surgeon's learning curve before complex procedures are performed in the patients.

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Figuras estereoscópicas deverão ser vistas com auxílio de óculos 3D anaglíficos (vermelho/azul).