

# Microanatomic Structure of Basillar Artery and its Perforators in Cadaver

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## ABSTRACT

**Objective:** The microsurgical anatomy of the posterior circulation is complex and variable. Surgeries performed close to this area are accepted to be highly risky due to important vascular and neural structures. In order to safely and securely treat pathologies in that area, understanding the microsurgical anatomy of the posterior circulation carries tremendous importance for neurosurgeons.

**Materials and Methods:** In order to reveal the characteristic of vertebrobasilar artery branches of people living in Turkey, we analyzed the arteries of 23 cadaveric brains (46 hemispheres) at the dissection laboratories of the Istanbul University Cerrahpaşa Medical Faculty Anatomy Department. The diameter of the vertebral artery, the fusion angle of vertebral arteries, the diameter of the basilar artery were examined.

**Results:** 13 vertebrobasilar junctions were located across the pontomedullary sulcus, 5 were located below the pontomedullary sulcus, and 5 were above the pontomedullary sulcus. The average diameter measured 5.11 mm, the smallest being 3 mm and the largest measuring 6 mm. Out of all analyzed basilar arteries, only one revealed a fenestration. All results were compared with previous studies and were found to be coherent.

**Conclusion:** Damage to the vertebral artery, basilar artery or any of their branches during surgery may stay asymptomatic. However, the damage may also result in cranial nerve paralysis or go as far as coma due to ischemia. Understanding the anatomy of that area well can minimize this risk of complications and further avoid them.

**Keywords:** Basillar artery, microsurgical anatomy, posterior circulation

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## INTRODUCTION

The posterior arterial circulation of the brain, a vital component of cerebral blood flow, is constituted by the vertebrobasilar system and its numerous branches.<sup>[1,2]</sup> This system plays a fundamental role in supplying blood to critical structures such as the medulla oblongata, pons, and mid-brain, which are essential for maintaining vital bodily functions, including respiration, cardiovascular regulation, and motor control.<sup>[2]</sup> The integrity of this system is paramount, as even minor disruptions can lead to severe neurological deficits or life-threatening conditions.<sup>[3,4]</sup>

Despite its critical importance, the microsurgical anatomy of the posterior circulation remains one of the most complex

and variable regions of the brain.<sup>[3,5]</sup> The intricate network of arteries, coupled with the close proximity to vital neural and vascular structures, makes surgical interventions in this area highly challenging. Even minor errors during surgical procedures can result in devastating outcomes such as ischemia, cranial nerve dysfunction, or even death. For this reason, a detailed and thorough understanding of this region is indispensable for neurosurgeons.<sup>[3,5,6]</sup>

One of the key challenges in posterior circulation surgery is addressing the significant anatomical variations commonly encountered in cerebral vascular structures. These variations, which may include differences in the branching patterns, diameters, and course of the arteries, can complicate



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both the diagnosis and surgical approach.<sup>[3,4,7]</sup> Accurate pre-operative knowledge of these variations is critical for minimizing risks and enhancing surgical outcomes.

In this study, we conducted an extensive examination of 23 human cadaveric brains to analyze the posterior vascular system in detail. Our primary focus was on the structure of the basilar artery and its perforators, given their pivotal role in supplying blood to the brainstem and cerebellum. By meticulously documenting and measuring these structures, we aimed to contribute valuable data to the existing body of literature. This study not only highlights common patterns but also underscores rare and clinically significant anatomical variations that neurosurgeons must consider during surgical planning.

By comparing our findings to existing definitions and classifications in the literature, we sought to provide an updated and comprehensive perspective on the microvascular anatomy of the posterior circulation. Our findings aim to support neurosurgeons in their efforts to safely and effectively manage pathologies in this anatomically and functionally complex region. This work underscores the critical importance of understanding the unique anatomy of each patient to tailor surgical approaches that maximize safety and efficacy.

## MATERIALS and METHODS

The article and its appendices, submitted to the Bakirköy Prof. Dr. Mazhar Osman Mental Health and Neurological Diseases Training and Research Hospital Ethics Committee with the file number 47773 on November 13, 2012, have been reviewed in accordance with the Regulations on Patient and Animal Rights, the Guidelines for Good Clinical Practice, and the Declaration of Helsinki, and have been approved by our Ethics Committee.

In order to reveal the characteristics of the vertebrobasilar artery branches of people living in Turkey, we analyzed the arteries of 23 cadaveric brains (46 hemispheres) at the dissection laboratories of the Anatomy Department. A mixture of 10% formaldehyde, 55% methanol, 15g sodium citrate, 15% glycerin, 5% phenol, 15% water, and 5ml eosin was injected into the arterial systems of the brains (with a pump) after being preserved in a formaldehyde pool for 6 months.

After injecting all vascular systems of the 23 brains, the brains were removed from the skull carefully using dissection methods, after lifting the calvarium. The brains, which were carefully removed from the skull, were placed in basins filled with formaldehyde-added fluid. The vertebrobasilar arteries were carefully examined after macroscopic dissection. Any brain showing pathologies was excluded from the study. After dissecting and

measuring the arteries, photographs of the field were obtained to document the vascular anatomy and variations.

The dissection commenced at the vertebral arteries, followed by the basilar artery and its branches, reaching the basilar bifurcation, and revealed the vasculature.

The following details were examined: the diameter of the vertebral artery (VA), the fusion angle of vertebral arteries, the diameter of the basilar artery, its length and structure, the distance between the vertebrobasilar junction to the pontomedullary sulcus and its position, the diameters of the Anterior Inferior Cerebellar Artery (AICA), Superior Cerebellar Artery (SCA), and Posterior Cerebral Artery (PCA), the distances between the AICA and vertebrobasilar junction, as well as the SCA and basilar bifurcation, and the count of rami pontis.

## RESULTS

### Vertebral Artery (VA)

The union of the right and left VA leads to the formation of the vertebrobasilar junction, which occurs at the pontomedullary sulcus. In our study, 13 vertebrobasilar junctions were located across the pontomedullary sulcus, 5 were located a minimum of 3.5 mm and a maximum of 18 mm (average 6.7 mm) below the pontomedullary sulcus, and another 5 were a minimum of 2 mm and a maximum of 7.5 mm (average of 3.78 mm) above the pontomedullary sulcus. Of the ones located below the sulcus, only one was relatively closer to the medulla spinalis, measuring a distance of 18 mm from the pontomedullary sulcus and 3 mm from the medulla spinalis.

The diameters of the vertebral arteries on the right measured 6 mm as the largest, 2.6 mm as the smallest, revealing an average of 3.81 mm, and on the left, the diameters measured 6 mm as the largest, 2.5 mm as the smallest, revealing an average of 4.62 mm (Table 1). Out of the VAs, 12 (52.6%) showed equal diameters, 6 (26%) revealed a larger diameter on the right side, and 5 (21.74%) showed a larger diameter on the left. No VA fenestrations or duplications were encountered. The smallest angle of fusion between the VAs was measured as 20°, the largest 85°, resulting in an average angle of 46.609° (Table 1).

### Basilar Artery

The junction of both vertebral arteries at the pontomedullary junction forms the origin of the basilar artery. It terminates after proceeding on the surface of the pons with the separation of both posterior inferior cerebellar arteries (PICA). The origins differed in several cases: 5 (21%) originated under the pontomedullary sulcus, another 5 (21%) originated above

**Table 1. Diameters of Vertebral Arteries (VA) and vertebral artery fusion angles**

Cadaver	Right VA diameter (mm)	Left VA diameter (mm)	VA fusion angle
1	4.5	4.5	30
2	4	4	40
3	3	5	35
4	3	3.6	50
5	4	4	40
6	3.5	3.5	45
7	6	4	20
8	5	5	45
9	2.6	2.6	50
10	3.9	3.9	70
11	3.9	3.9	40
12	4	3	55
13	3	6	60
14	5	5	65
15	3.5	3.5	37
16	5	3	40
17	3	2.5	85
18	3.5	3.5	50
19	4	4	35
20	4	3.5	50
21	3.5	4	40
22	4.5	4	45
23	4	4.5	45

Measurements include the largest, smallest, and average diameters of both right and left vertebral arteries, along with the smallest, largest, and average angles of vertebral artery fusion. Right VA Diameter (mm): Mean = 3.93, Median = 4.00, Std Dev = 0.81; Left VA Diameter (mm): Mean = 3.93, Median = 4.00, Std Dev = 0.82-; VA Fusion Angle: Mean = 46.61, Median = 45.00, Std Dev = 13.87

the sulcus, and 13 (58%) originated across the sulcus. The course of the basilar artery varied, as 14 (17%) deviated from the midline and 19 (83%) followed a straight course (Table 2).

The shortest basilar artery measured 24 mm, the longest measured 42 mm, resulting in an average length of 30.56 mm. The average diameter measured 5.11 mm, the smallest being 3 mm, and the largest measuring 6 mm (Table 2). Out of all analyzed basilar arteries, only one revealed a fenestration. No duplication was encountered. On the right side, we encountered 4–7 (average of 5) rami pontis separating from the basilar artery, and 3–8 (average of 4.78) on the left (Table 2). The basilar artery gives off large branches, such as the anterior inferior cerebellar artery, superior cerebellar artery, and posterior cerebral artery. In one case, the AICA

did not arise from the basilar artery; however, it gave rise to PICA from the right, which was concluded after examining the course of the artery.

### Anterior Inferior Cerebellar Artery (AICA)

The AICA is the first large branch of the basilar artery. Its distance to the vertebrobasilar junction measures a minimum of 3 mm, a maximum of 13 mm, resulting in an average of 8 mm on the right. On the left side, the distance measures at least 4 mm, at most 15 mm, which results in an average of 9.16 mm (Table 2). In around 6 (26.09%) cases, a single AICA was observed, whereas 14 (60.86%) showed double AICA, and 2 (8.69%) revealed triple AICA. Only one case (4.34%) revealed the absence of AICA.

The smallest diameter of the AICA measured 1 mm, the largest measured 2.5 mm, resulting in an average diameter of 1.39 mm on the right, whereas the left side presented the smallest diameter as 0.8 mm, the largest being 2 mm, resulting in an average diameter of 1.3 mm.

### Superior Cerebellar Artery (SCA)

The SCA is the most regular branch of the basilar artery. It mostly arises adjacent to the posterior cerebral artery. The distance from the right SCA to the basilar bifurcation measures at least 0.8 mm and at most 4.3 mm, resulting in an average of 2.38 mm. On the left, the least distance to the bifurcation was measured to be 0.8 mm as well, with the longest distance measuring 3.2 mm, resulting in an average of 2.31 mm (Table 2).

In 3 cases, right and left SCA duplications were encountered. The SCAs with duplication were different; however, the duplication was always unilateral. On the right, the smallest diameter of the SCA was measured as 0.8 mm and the largest 2 mm, resulting in an average of 1.3 mm. On the left, the smallest diameter was measured as 0.75 mm, with the largest measuring 2 mm, resulting in an average of 1.30 mm (Table 2). In one case, the left SCA came off the PCA instead of the basilar artery.

### Posterior Cerebral Artery (PCA)

The PCA arises from the basilar artery bifurcation and lies within the interpeduncular cistern, where it joins the posterior communicating artery. The diameter was at least 1.2 mm and at most 3.2 mm on the right, resulting in an average of 1.97 mm. On the left, the smallest diameter measured 1.2 mm, while the largest measured 3.2 mm, resulting in an average measurement of 1.93 mm (Table 2). On the left, one PCA showed to be giving off an SCA.

Table 2. Anatomical measurements and variations of the basillar artery and its main branches

Cadaver	BA diameter	BA length	BA Straight BA	Curved BA	Right R. pontis n	Left R. pontis n	Total R. pontis n	Right AICA-VBJ distance	Left AICA-VBJ distance	Right AICA diameter	Left AICA diameter	Right SCA-BT SCA distance	Left SCA-BT SCA distance	Right SCA diameter	Left SCA diameter	Right PCA diameter	Left PCA diameter
1	4.5	27	+		7	5	12	5	5	2.5	2	2.5	1.5	1.5	1.5	2.5	2
2	6	26	+		4	5	9	4-10 (2 AICA)	8	1	2	1.3	1.3	1.3	1.3	2	2
3	4	29	+		6	5	11	5	5		1.3	2.6	0.8	0.8	0.8	1.3	1.3
4	4	29	+		5	4	9	6	6	2	2	1.5		1.2		2	2
5	6	33	+		5	4	9	12	15	1.5	1.5	2	0.9	0.9	0.9	1.8	1.8
6	6	30	+		4	5	9	8	8	1.8	1.8	3	1.5	1.5	1.5	2	2
7	6	32	+		4	4	8	6	6	1.7	1.2	3	1.3	1.3	1.3	1.7	1.7
8	6.5	30		+	6	5	11	8	6	1		3.2	1	1.6	1	3.2	3.2
9	4	30	+		5	6	11	13	13	1.3	1.3	1.7	1	1	1	1.7	1.7
10	5	30	+		4	3	7	6	9	2	1.9	3.7	0.9	1.4	0.9	2.4	2.4
11	5	30		+	4	4	8	6	6	1.5		2.5	1.2	1.2	1.2	1.5	1.5
12	5	42		+	5	5	10					3	2	2	2	3	3
13	6	35	+		4	4	8		11.7		2	4.3	0.8	0.8	0.8	2.1	2.1
14	6	28	+		4	5	9	9	4	1.5	1	2.5	1.5	1.5	1.5	3	3
15	5	28	+		6	5	11	9	9	1	1	9	0.75	1	0.75	2	2
16	5	35		+	6	8	13		15		1	4	1	0.8	1.48	2	2
17	3	35	+		5	4	9	13	13	1.4	1	0.8	3	1.7	1.7	1.2	1.7
18	5	30	+		5	5	10	11	12	1	1	2	2.2	1.5	1.5	1.5	1.5
19	5	27	+		5	4	9	10	15-12 (2 AICA)	1.5	1.4	1.5	2.5	1.5	1.5	1.2	1.2
20	5	28	+		6	6	12	10	10		1.4	2.2	1.5	1.2	1.8	2.4	1.4
21	5	24		+	4	4	8	8	8	1	1	2	2.5	1	1	1.3	1.3
22	5	30	+	+	6	6	12	3	6	1	1	2	2	1.5	1.5	1.5	1.5
23	6	35	+	+	5	4	9	6	6	1.5	1.5	2.5	2	1.5	1.5	2	2

Included are measurements of basillar artery length and diameter, the number of pontine branches (rami pontis) on each side, distances of anterior inferior cerebellar artery (AICA) and superior cerebellar artery (SCA) from relevant anatomical landmarks, and recorded anatomical variations such as fenestrations, duplications, or absences. BA: Basillar artery; VBJ: Vertebrabasillar junction; BT: Basillar trunk; PCA: Posterior cerebral artery

## DISCUSSION

The anatomy of the vertebrobasilar system is complex. Surgeries in this area are performed for aneurysms, vascular pathologies like arteriovenous malformations, tumors (astrocytomas, medulloblastomas, ependymomas, hemangioblastomas, and meningiomas), and for revascularization.<sup>[1]</sup> Understanding the anatomy ensures secure operations and helps limit possible complications for better outcomes. The anatomy also plays a significant role in understanding the mechanism of vascular diseases like aneurysms.

The basilar artery is formed at the pontomedullary sulcus by the two vertebral arteries passing through the transverse foramina of the first 6 cervical vertebrae, entering the posterior fossa via the foramen magnum.<sup>[2]</sup> In some cases, the vertebral arteries may unite before or after the pontomedullary area.<sup>[3]</sup> In our study, we found 13 (58%) of the vertebrobasilar junctions to be across the pontomedullary sulcus, 5 (21%) situated below (approximately 6.7 mm), and another 5 (21%) situated above the sulcus (approx. 3.78 mm). One of the junctions, found below the sulcus, was closer to the medulla spinalis, being situated around 18 mm away from the pontomedullary sulcus and 3 mm from the medulla spinalis.

A study by Torche et al.<sup>[4]</sup> of 20 cadavers revealed the position of the vertebrobasilar junction to be across the pontomedullary sulcus in 10 (50%) cases, above the sulcus in 7 (35%) cases, and below the sulcus in 5 (21.74%) cases. The diameter of the VA was analyzed by Yasargil et al.<sup>[5]</sup> and resulted in measurements between 0.92 and 4.09 mm. The same study also revealed a dominance of the left side in 42%, of the right in 32%, and equal calibration in 26%.

Our findings are closest to the results obtained by Pai et al.<sup>[3]</sup> In their study, 53.3% of the VA diameters were equal, whereas 40% revealed a right dominance and 6.7% revealed a left dominance. Our study showed the diameters of the VA to be equal in 52.26%, whereas 26% were larger on the right and 21.74% had dominance of the left VA. The diameter of the VA carries clinical importance as VA aneurysms are most frequently observed on the dominant side.<sup>[4,6]</sup>

Of aneurysms found in the posterior circulation system, 6.5% are vertebrobasilar junction aneurysms. However, most commonly, VA aneurysms are situated on the PICA-VA junction, seen in 12.5% of cases. Anomalies such as duplication, fenestration, atresia, or the continuation of the VA as the basilar artery while the other VA runs as the posterior inferior cerebellar artery can be observed. However, we did not encounter any of the aforementioned anomalies. The VA fen-

estrating around a lower cranial nerve or being hypoplastic demonstrates a greater risk for the formation of aneurysms. Undoubtedly, knowing the anatomy of the VA well lowers the risk of damaging the vessel during surgery. Damage to the vessel may not cause any symptoms; however, it may also lead to complications such as Wallenberg syndrome (lateral medullary syndrome), coma, or death due to ischemia.

The basilar artery arises from the merging of both vertebral arteries at the pontomedullary sulcus and runs upwards through the prepontine cistern. The artery becomes more looped, gets longer, and shows a higher localization of the bifurcation as age increases.<sup>[5]</sup> In our study, we found a midline deviation of the basilar artery in 30%, while 70% revealed a straight course. However, Yasargil et al.<sup>[5]</sup> found the basilar artery to follow a straight course in 25%, whereas Grands et al.<sup>[6]</sup> revealed a straight course of the basilar artery in 74%. Numerous congenital anomalies of the basilar artery have been described. The basilar artery is formed during the 7<sup>th</sup> week of gestation as the primitive longitudinal neural arteries join. If this merge does not occur fully, fenestrations (partial or complete) may be seen.<sup>[7-10]</sup> Recently, another embryologic mechanism taking place in the 5<sup>th</sup> gestational week was found to be causing fenestrations. As persistent basivertebral anastomosis (transient bridging arteries) fail to diminish, they form vertebral or basilar artery fenestrations.<sup>[11]</sup>

Various studies have focused on this topic, with Yasargil et al.<sup>[5]</sup> revealing an occurrence of 1%. Takahashi et al.<sup>[1]</sup> examined 500 vertebral angiographies, revealing 3 cases with fenestrations. In our study, we found one (4.3%) basilar artery fenestration among 23 examined cadaveric brains. The fenestration of the basilar artery is most commonly observed at the vertebrobasilar junction. The focal defects of the tunica media of the fenestrated vessel may cause aneurysms.<sup>[12,13]</sup> The flow phenomenon at the proximal end of the fenestration, causing hemodynamic tension and increasing turbulence, may affect the formation of aneurysms.<sup>[14,15]</sup> These aneurysms are generally saccular and develop on the proximal part of the fenestration.<sup>[16-18]</sup> Understanding the complex anatomy of aneurysms and fenestrations is crucial. In order to avoid clipping a branch of the fenestrated vessel, preoperative investigation of the fenestration, apart from the aneurysm, can be helpful.<sup>[16]</sup>

A lateral suboccipital approach is advised, as aneurysms of the vertebrobasilar junction tend to lean forward.<sup>[15,16,19]</sup> Approaches such as presigmoid transpetrosal and suboccipital transcondylar also show favorable results, but they increase the risk of cerebrospinal fluid fistulas and lower cranial nerve paralysis (or palsy).<sup>[20]</sup> Other methods of treatment

include Guglielmi Detachable Coil embolization techniques.<sup>[17,21]</sup> Vertebrobasilar fenestrations are predisposing factors for vascular damage and ischemia.<sup>[11]</sup> The diameter of the basilar artery was measured in multiple studies. Our study revealed a diameter between 3 and 6 mm, resulting in an average measurement of 5.11 mm. In 1967, Wollschlager et al.<sup>[22]</sup> measured the diameters as well, showing a range between 2.7 and 4.3 mm, while Pai et al.<sup>[3]</sup> showed a diameter range of 3–7 mm in their study in 2007.

The length of the basilar artery changes with increasing age. In our study, we measured the length to be between 24 and 42 mm, resulting in an average measurement of 30.96 mm. The study conducted by Pai et al.<sup>[3]</sup> in 2007 revealed a length range between 24–35 mm, with an average of 24.9 mm. The basilar artery was observed to be giving off rami pontis alongside AICA, SCA, and PCA in our samples. However, Yasargil et al.<sup>[5]</sup> did not encounter any other long arteries arising proximal to the basilar artery in their series.

The basilar artery bifurcation is positioned at the pontomesencephalic junction. Our study showed 74% of the bifurcations to be at their expected normal location, while 26% were above the pontomesencephalic junction. However, none were located below the junction. Rhoton showed a normal position of the bifurcation in 72%, a location above the junction in 24%, and a location below the normal position in 4% in his study. For normally located basilar bifurcations, a transylvian approach is sufficient. However, when the bifurcation is located above the dorsum sellae, aneurysms in this area cause pressure on the 3<sup>rd</sup> ventricle after reaching the mammillary bodies and must be operated on using a subtemporal approach, as retraction of the brain will be needed.

In surgeries of aneurysms with the presence of lower basilar bifurcations, special attention must be paid to the upward running of the first segment of the PCA (P1), which may complicate reaching the neck of the aneurysm. In these cases, the use of fenestrated clips may be needed. Our study showed 4–7 rami ponti coming off the basilar artery trunk on the right and 3–8 on the left side. A complication occurring during basilar trunk aneurysm surgeries is the accidental clipping of small arteries, which then causes ischemic damage due to occlusion. Anatomical knowledge of this area is essential in order to minimize these complications.

### The AICA

The AICA may give up to 3 branches, but it may also be absent entirely. Yaşargil et al.<sup>[5]</sup> found the occurrence of one branch in 58%, double branches in 20%, three branches in 20%, and complete absence of AICA in 2% in their series. We found a

single branch of the AICA in six patients (26.09%), double branches in 14 patients (60.86%), and three branches in 8.69% in our cadaveric brains. We observed one case of complete absence of AICA in our study (4.34%). The distance between the AICA and the vertebrobasilar junction in our study was measured between 3 and 13 mm (average of 8 mm) on the right side, and 4 and 15 mm (average of 9 mm) on the left side. Maximo Torche et al.<sup>[4]</sup> measured an average distance of 9.6 mm in 1991. Yasargil et al.<sup>[5]</sup> showed 75% of the AICA to arise from the lower 1/3 of the basilar artery, 16% from the middle portion of the basilar artery, and 9% from the junction point of the VA and the basilar artery. We observed the AICA to arise from the lower portion of the basilar artery in 65.22%, whereas 34.78% arose from the mid 1/3 portion of the basilar artery.

The AICA can be reached via retrosigmoid, mid-fossa, translabyrinthine, supra- and infratentorial presigmoid (combined) approaches. Alongside other arteries, the AICA can be damaged during interventions for cerebellopontine corner tumors, rarely seen aneurysms originating from the AICA, brainstem masses, and mid-clival chordomas. Clinical symptoms include vertigo, vomiting, tinnitus, dysarthria, ipsilateral facial paresis, hearing loss, sensory disturbance in the trigeminal area, pain in the contralateral extremity and trunk, decreased temperature sensation, and ipsilateral hemiparesis. In order to avoid these complications, the anatomy of the AICA should be well understood by surgeons.

### The SCA

The SCA is the most consistent branch regarding the location of the basilar artery. It generally arises from the adjacent area of the basilar bifurcation, but may also rarely come off the PCA. Our study showed the average measured distance of 2.38 mm between the right SCA and the basilar bifurcation, whereas the left SCA was an average of 2.13 mm away from the bifurcation. Pai et al.<sup>[3]</sup> showed the right SCA to be 1.45 mm and the left SCA to be 1.33 mm away from the bifurcation in their study.

In our series, we found only one case in which the SCA came off the PCA. Wollschlager et al.<sup>[22]</sup> measured the diameter of the SCA to be 0.72–1.5 mm in their series, whereas Pai et al.<sup>[3]</sup> measured 0.5–2.5 mm in their study. We measured the diameter on the right side between 0.8 and 2 mm (average of 1.3 mm) and between 0.75 and 2 mm (average of 1.3 mm) on the left. The duplication of the SCA was described in the study of von Mitterwallner et al.<sup>[23]</sup> with an 8% occurrence on the right side and 13.3% on the left. Mani et al.<sup>[24]</sup> showed different results with a duplication rate of 28%. We encountered duplication of the SCA in 8.7% on the right and 13.04% on the left side.

The SCA can be damaged in surgical interventions for aneurysms (situated at the base or the apex of the SCA or PCA), tumors (tentorial incisura, cerebellopontine angle, clivus, upper cerebellar area), and trigeminal neuralgia (during dissection of the trigeminal nerve while decompressing), which may result in ischemia and infarctions. Postoperatively, the patient may experience headache, vomiting, dysarthria, ataxia of extremities and trunk, ipsilateral Horner syndrome, contralateral spinothalamic sensory deficit, upper motor neuron type facial paresis, and rarely, trochlear nerve paralysis.

### The PCA

The PCA arises from the basilar artery bifurcation, is located within the interpeduncular cistern, where it connects to the posterior communicating artery (PCoA) on the lateral aspect of the cistern. The PCA contains a total of 4 segments. However, in our study, we focused on the P1 segment only. The P1 segment begins at the commencement of the PCA and runs until the PCoA, where it terminates. The average diameter of the PCA was 1.93 mm on the right side and 1.97 mm on the left side in our samples. Wollschlager et al.<sup>[22]</sup> presented their diameter measurement results as 0.65–1.78 mm. We observed one SCA arising from the P1 segment in one case. The SCA can be damaged in surgeries for basilar roof aneurysms, PCA aneurysms, and suprasellar tumors. The result of this damage may be visual field defects, contralateral sensation loss and pain, deep sensory deficit, alexia, difficulty finding words and naming (anomic aphasia), Gerstmann syndrome, memory deficits, agitation, and delirium.<sup>[25,26]</sup>

### CONCLUSION

In our study, we evaluated the diameters and counts of the vertebral arteries, basilar arteries, AICA, SCA, and PCA, as well as the vertebral fusion angle, basilar artery length, count of rami pontis, the distance between the AICA and vertebrobasilar junction, the position of the vertebrobasilar bifurcation in regard to the lower border of the pons, the distance between the SCA and the basilar bifurcation, the location of the basilar bifurcation in regard to the upper border of the pons, and all variations of the branches. All results were compared with previous studies and were found to be coherent.

The results were evaluated considering the outcome of neurosurgical procedures. Damage to the VA, basilar artery, or any of their branches during surgery may remain asymptomatic. However, the damage may also result in cranial nerve paralysis or go as far as a coma due to ischemia. Understanding the anatomy of that area well can minimize the risk of complications and further avoid them.

### Disclosures

**Ethics Committee Approval:** The study was approved by the Bakirköy Prof. Dr. Mazhar Osman Mental Health and Neurological Diseases Training and Research Hospital Ethics Committee (No: 47773, Date: 13/11/2012).

**Informed Consent:** Informed consent was obtained from all participants.

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