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Is it Possible to Embolize the Hypoglossal branch of the Ascending Pharyngeal Artery without Complications?. A case series of Dural Arteriovenous Fistulae of the Craniocervical Junction

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ABSTRACT

The ascending pharyngeal artery is a branch of the external carotid artery that supplies many pharyngeal, posterior fossa, and cranial nerve structures. It has an important role in neurointerventional procedures; therefore knowledge of its anatomy, anastomosis, and hemodynamics is necessary to perform a safe embolization procedure. Complications of APA embolization have a wide range of possibilities from minor complications, including fever and facial pain, to major ones such as an accidental introduction of embolic material into the vertebrobasilar system. For years it has been considered that APA embolization can cause neurological deficit by supplying the lower cranial nerves, with this article we want to postulate the possibility that the APA is like as the Willis polygon in the craniocervical junction", because of its numerous anastomoses that help to supply bilaterally without generating neurological symptoms.

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Introduction

The ascending pharyngeal artery (APA) is a branch of the external carotid artery (ECA). This artery supplies the pharyngeal region, soft palate, odontoid apophysis, clivus bone, C1 and C2 nerve branches, cranial nerves, and posterior fossa meninges. Currently, there isn´t clear evidence about the possibility of embolizing the APA because there is a probability of a neurological deficit of the nerves that it supplies.

The aim of this paper, to present two case reports about arteriovenous fistulae of the posterior fossa by feeding arteries of the APA and vertebral artery. Also, it wants to show that APA can be embolized without neurological deficit by previous angiographic study, if found anastomoses between collateral branches of the APA, for this reason, it is postulated that APA has anastomoses that could mimic a Willis polygon, avoiding neurological deficit.

Case #1

Patient male, 45 years old, consulted to the emergency room for symptoms over the past 8 days consistent in headache with warning signs. Neurological exam normal. CT scan was performed with evidence of intraventricular hemorrhage (IVH). To complement the image studies, an MRI with angiography was done which showed intraventricular bleeding and a vascular anomalous malformation in the posterior fossa and craniocervical junction (Figure 1). For this reason, a cerebral arteriography was performed, which showed an dural arteriovenous fistula (DAVF) of the craniocervical junction with afferent arteries of the left hypoglossal branch of the APA and segment V3 of the left vertebral artery. Additionally, there was venous drainage from cortical veins of the posterior fossa and veins of the craniocervical junction (Figure 2).

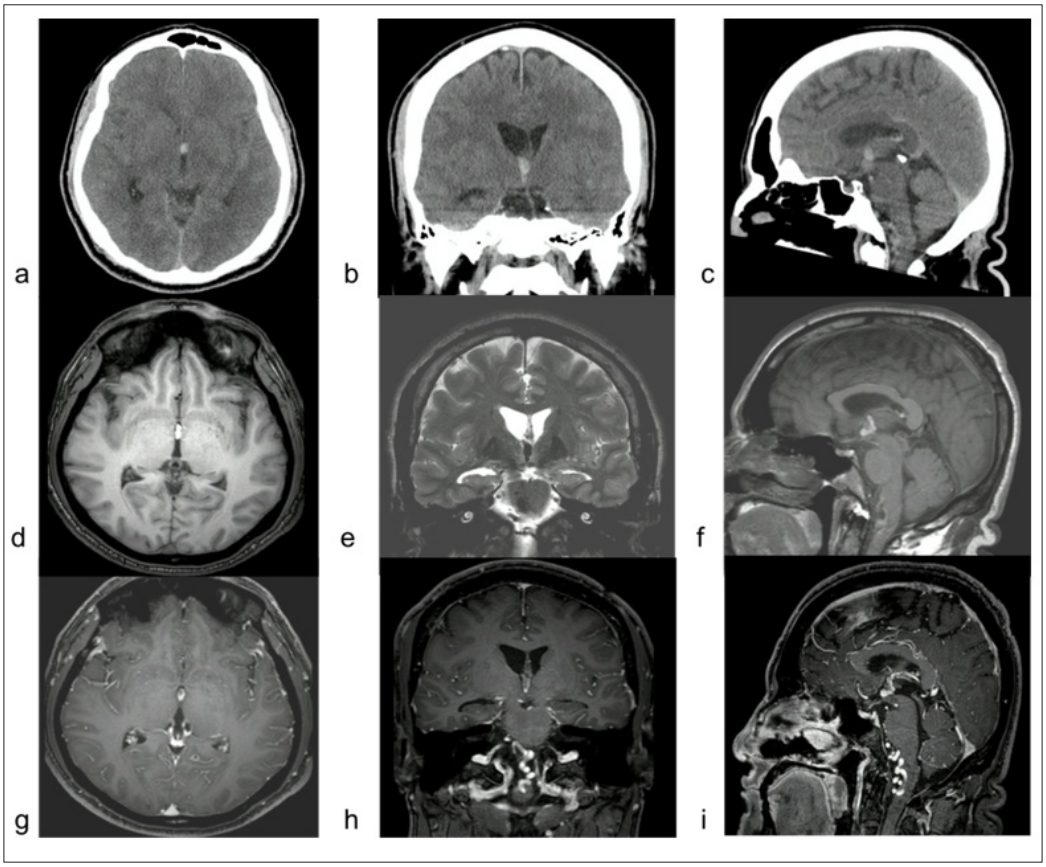

Figure 1: Brain CT scan and MRI simple and with gadolinium

CT scan in axial (a), coronal (b), and sagittal (c) views: hemorrhage through of the Monroe foramen and the third ventricle is observed. d-i: simple and contrasted MRI, it can see a sequence in T1 and T2, where there is early subacute hemorrhage in the Monroe foramen and the third ventricle, additionally, there is a vascular malformation in the craniocervical junction.

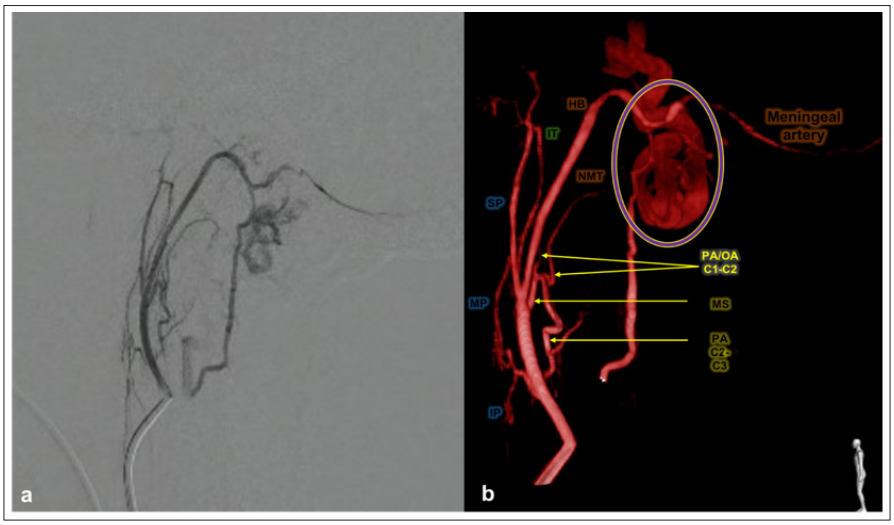

Figure 2: Cerebral arteriography with 3D reconstruction

a: normal acquisitions. b: 3D reconstruction of the feeding branches of the ascending pharyngeal artery with arteriovenous fistula. In this case, the cerebral arteriography was made with catheterization of the bilateral internal and external carotid arteries and bilateral vertebral arteries. There is an arteriovenous fistula with afferents of the left vertebral artery segment V3, and the ascending pharyngeal artery of the left neuromeningeal trunk in its branch hypoglossal, and venous drainage through veins of the craniocervical union (Purple circle). IP: Inferior Pharyngeal artery, MP: Middle Pharyngeal artery, SP: Superior Pharyngeal artery, IT: Inferior Trunk, NMT: Neuromeningeal trunk, HB: Hypoglossal branch, MS: Musculospinal artery, PA C2-C3: Prevertebral artery for C2-C3 vertebrae, PA/OA C1-C2: Prevertebral artery/Odontoid Arch for C1-C2 vertebrae

With this findings, it was decided to embolize the arteriovenous fistula. The procedure was realized during the same hospitalization. The procedure was done with general anesthesia, femoral punction with 6 French introductory, posteriorly, the Sofia´s catheter was introduced, and it was navigated until it lodged into the ECA. Then, a Sonic 1.2 microcatheter supported on hybrid microguide 0.007 was introduced and advanced until the branches of the left V3 vertebral artery were micro-catheterized, dimethyl sulfoxide and ethylene-vinyl alcohol copolymer-based liquid (Squid 12) was administered as an embolic agent. After that, the Sophia 5F guide catheter was exchanged due to poor stability when catheterizing the ECA; it was changed for Neuron Max 088 supported with a 260cm hydrophilic guide, and the neuromeningeal branch of the APA was microcatheterized. With a Sonic 1.5 microcatheter with the same hydrid microguide 0.007, it proceeded to the administration of embolizing liquid Squid 12 (total 1 ampoule) with adequate embolization of these afferences (Figure 3). There is residual fistula by arterial afferent of V4 and with a venous drainage of slow flow.

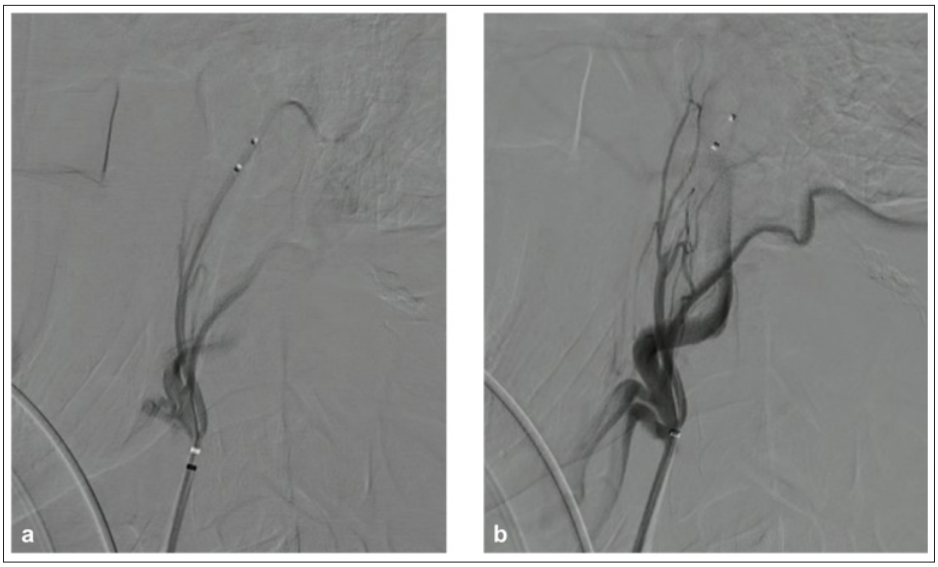

Figure 3: Preoperative and postoperative embolization of the ascending pharyngeal artery

a: preoperative embolization, the microcatheter is positioned into the neuromeningeal trunk of the APA. b: Post-embolization, when the neuromeningeal trunk was occluded for embolizing liquid Squid 12.

Case #2

A female patient, 54-yo, was examined extra-institutionally with subarachnoid hemorrhage (SAH) and IVH, she was in the ICU but recovered successfully, despite presenting mnesic faults. a cerebral arteriography was performed, which showed an arteriovenous fistula of the craniocervical junction with afferent arteries from the left hypoglossal branch of the APA and the meningeal posterior branch of the segments V3 and V4 of the left vertebral artery. Additionally, there was venous drainage thorugh the cervical and perimedullar veins. The arteriovenous fistula was embolized. The procedure was done with general anesthesia, femoral punction with 6 French introductory, posteriorly, the Envoy´s catheter was introduced, and then, it was navigated until it lodged into the posterior meningeal branch of the vertebral artery (segment V3), then, Apollo 1.2 microcatheter was supported on hybrid microguide 0.007, and it proceeded to administer dimethyl sulfoxide and ethylene-vinyl alcohol copolymer-based liquid (Squid 12) as an embolic agent. Following, Apollo´s microcatheter was repositioned in a meningeal branch of the V4 segment of the vertebral artery, however, during this maneuver, a thrombus into this segment was formed, we retired Apollo´s microcatheter and then, thrombus was migrated to the basilar artery. At this moment, it used a Solitaire stent to do thrombectomy with a good recanalization. Finally, the embolization of the hypoglossal branch of the APA left with the same embolic liquid was performed, at the end of the procedure, a fistula residue with the posterior meningeal branch of the V4 afferents was observed. The patient was discharged, and three months later was submitted to new embolization session for fistula residue, nevertheless, when we did cerebral arteriography, there wasn't a residue, probably was a spontaneous fistula thrombosis.

The patient had a good clinical evolution without lower cranial nerve deficit, and he was discharged. Fifteen days later, in the postoperative control, the patient was asymptomatic, without lower cranial nerve deficit.

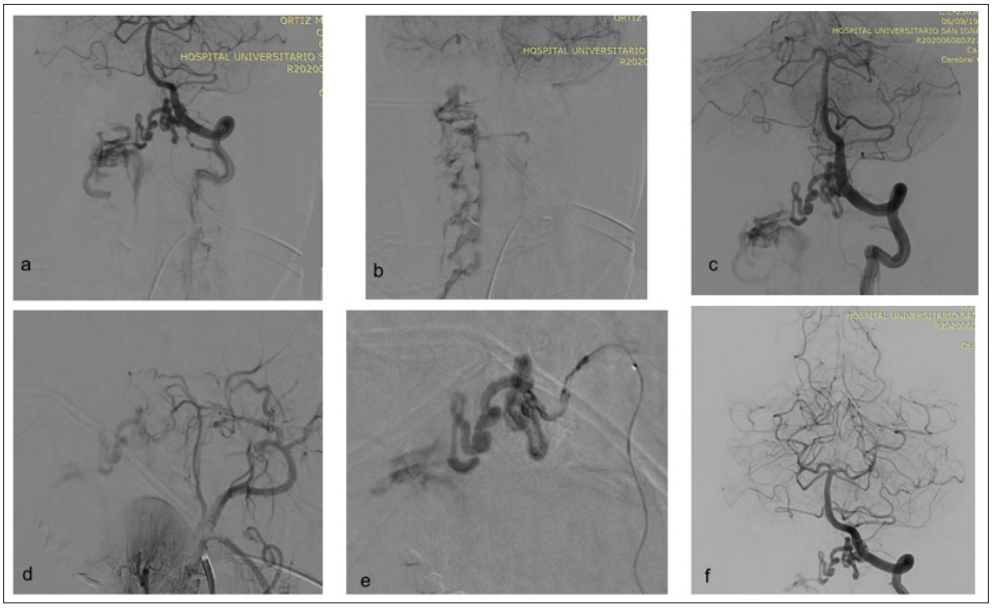

Figure 4: Arteriovenous fistula embolization

Image sequence of the embolization of the fistula described in case #2. In a. Branch of segment V3 of the left vertebral artery is observed. b. Drainage to cervical and perimedullary veins. c. An afferent branch of the fistula of segment V4 of the left vertebral artery is observed. d and e. The afferent branch of the hypoglossal branch of the neuromeningeal trunk of the APA is observed. f. The permeable vertebrobasilar system is visualized after the mechanical thrombectomy (TICI III).

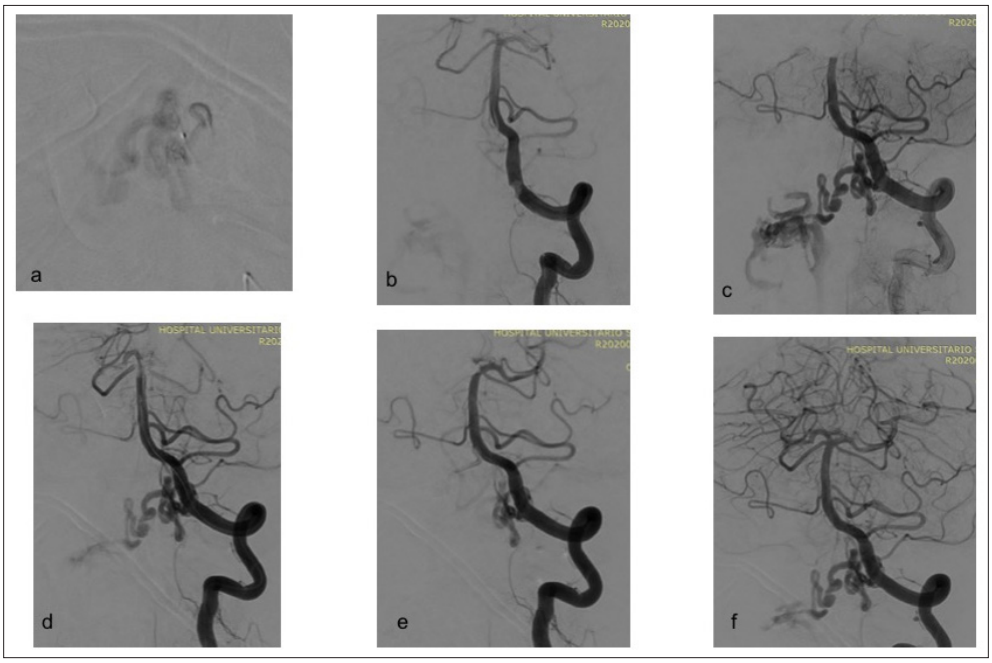

Figure 5: Mechanical thrombectomy due to intra-arterial intraoperative thrombus.

a. Microcatheterization of the meningeal branch of the V4 segment of the left vertebral artery. b. Exclusion of the arterial afferent to the fistula is evidenced by an acute intra-arterial thrombus in the ostium of this branch. c. The microcatheter is removed and subsequently, there is evidence of migration of the thrombus to the top of the basilar. Images d, e and f, show the passage of the Solitare catheter to perform the mechanical thrombectomy, showing adequate recanalization (TICI III) with an afferent meningeal branch of the V4 segment.

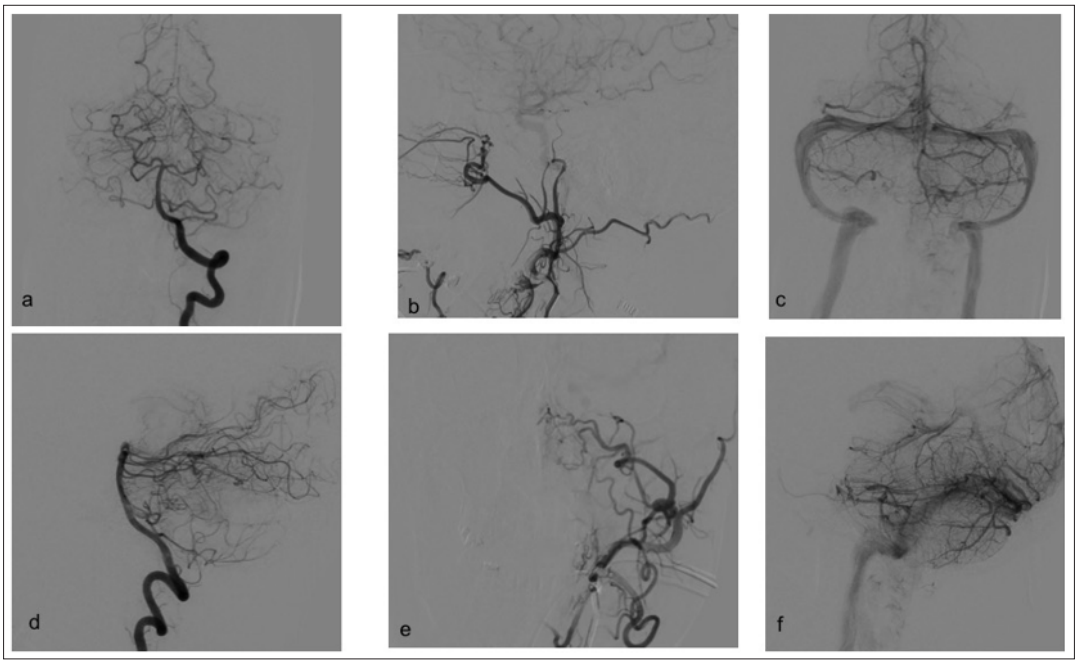

Figure 6: Angiographic control 3 months later

In these images, the control cerebral arteriography is visualized, where no residual arteriovenous fistula evidenced and the procedure is visualized, so it is assumed that the fistula, given the low arterial flow and slow venous flow, undergoes spontaneous thrombosis and total occlusion of the malformation.

Discussion

The DAVF is an abnormal shunting of blood between the arterial and venous system, without the normal capillary bed, which represents a source of resistance to blood flow; this is the reason why they are low-resistance, high-flow lesions [1]. They represent approximately 10-15% of all cerebral vascular malformations, the posterior fossa arteriovenous fistula involves most frequently the cavernous and transverse-sigmoid sinuses [2]. The craniocervical DAVf is a rare lesion, with an incidence of 1-2%, they are generated by an anomalous communication between a dural, pial o radicular artery and drains into a radicular vein between the foramen magnum and C2, presenting in 5 different types [3]. The foramen magnum FAV are also rare, accounting for approximately 2%, the arterial supply of these fistulas arises from the meningeal branches of the vertebral and ECA, its venous drainage is variable, divided into extradural veins, dural venous sinuses, and intradural veins, and it is related with two main forms of clinical presentation, intracranial when drainage takes place in ascending route into the venous sinus, and spinal that is descending drainage rout, with a slow and clinical picture of myelopathy [4].

The APA is a branch of the ECA, this artery supplies the pharyngeal region (including muscles and adjacent tissues), soft palate, odontoid apophysis, clivus bone, C1 and C2 branches, posterior fossa meninges and cranial nerves (VI-XII nerves) [5-7]. The APA is usually, the second smaller branch that exits the ECA, its ostium is in the posterior wall of the this artery. The ostium of the APA is cephalic and near of the origin of the occipital artery. The course was superior toward the posterior-lateral wall of the pharynx. The APA has several branches: pharyngeal branch, neuromeningeal trunk, inferior tympanic branch, muscle spinal branch, and prevertebral branch. These branches have anastomoses with the circulation of the ICA, ECA, and the same contralateral APA. The anastomoses frequently described are with maxillary internal artery, cavernous carotid artery, petrous carotid artery, vertebral artery, occipital artery (Figure 7) [6,8–11].

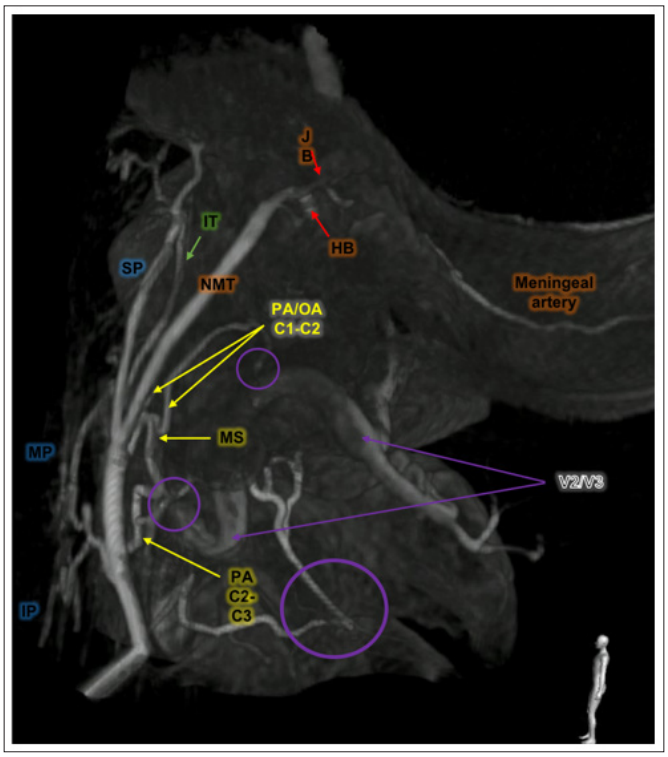

Figure 7: Anatomy of the ascending pharyngeal artery in 3D reconstruction

In this case, the patient debuted with an IVH secondary to an dural arteriovenous fistula (DAVf) of the craniocervical junction. In the literature, there are several reports about the clinical importance of the APA, some patients could debut with hemorrhage because of the arteriovenous malformations, dural fistulae into the cavernous

sinus, or transverse-sigmoid sinus [12-16]. It can also present as a SAH from rupture of a saccular aneurysm of the posterior clival meningeal branch of the ascending pharyngeal artery has been reported [17]. Added to this, the APA has shown to be important in cases of the carotid occlusion where it can act as collateral supply to certain arterial territories, as well, the APA is one the most important branches in the management of the pre-op embolization of tumors such as paragangliomas, juvenile nasoangiofibroma, skull base meningiomas, and other conditions, such as trauma and epistaxis [18-22]. Therefore, the APA is important in multiple clinical situations in which neurointerventionism management plays a central role, apart from the technical skills and embolization technique, a detailed knowledge of anatomy, anastomoses, and hemodynamics is mandatory for a safe embolization procedure in the ascending pharyngeal artery territory [23].

Complications of preoperative embolization vary [19,22,24,25]. Minor complications include fever and facial pain which are attributed to tumor ischemia and are usually transient. Major complications such as stroke may occur with the accidental introduction of embolic material into the vertebrobasilar system via the ECA or its anastomoses with the ICA, the embolization of the APA carries some risk of lower cranial nerve palsies because it supplies them or uses of particles that are too small thereby preventing meaningful anastomoses to them [16,21,25,26].

Currently, there is little evidence about the importance of the anastomoses of the APA, besides this, there aren´t anatomic and radiologic studies of this [8,11]. Sawlani et al., described in their case report, the importance of potential vascular anastomotic channels as a cause for ischemic complications during the embolization procedure. It also highlights the fact that dangerous anastomoses may only be visualized in the later phase of embolization probably due to changes in the hemodynamic pressure [23]. Likewise, Gross et al., reviewed the prevalence of APA supply to dAVFs and cases where it was a safe and effective pedicle for embolization treated transarterial via the APA, of the 267 endovascularly treated dAVFs, 68 had APA supply (25%), of this, there weren´t complications, including posttreatment cranial neuropathies or radiographic evidence of non-target embolization [14].

For that reason, it is frequently believed that if the APA is embolized there is the probability of deficit neurologic because of supply to the lower cranial nerves [8,27]. Taking into account this cases, it became clear that the anastomoses of the APA can supply ipsilateral and contralateral branches of the APA; including upper and lower branches. Therefore, the APA can be interpreted as a Willis polygon in the craniocervical junction, because its anastomoses from the inferior clivus until the upper cervical vertebrae, both anterior and posterior, including the odontoid arch, are able to share supply between them, which does not have neurological symptoms. It recommend performing 3D reconstructions, because in most cases they allow visualization of these anastomoses. In this case, the arteriography and 3D reconstructions of the patient showed these anastomoses between both APA, allowing for embolization without post-operative neurological deficit.

Conclusion

The APA is a very important artery for irrigating pharyngeal structures, as well as the craniocervical junction and even the posterior fossa meninges and cranial nerves. The anastomosis of the APA can supply ipsilateral and contralateral; becoming the Willis polygon of the craniocervical junction. For this reason, it is recommended to perform 3D reconstructions and arteriography in order to avoid neurological deficit after embolization and thus be one of the most promising treatments in the field of neurointervensionism.

Disclosures

The authors do not have any disclosures.

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