

2017.11.21 Review

顎動脈を中心に

Anatomy of External carotid artery for “TAE”

- EC IC anastomoses -

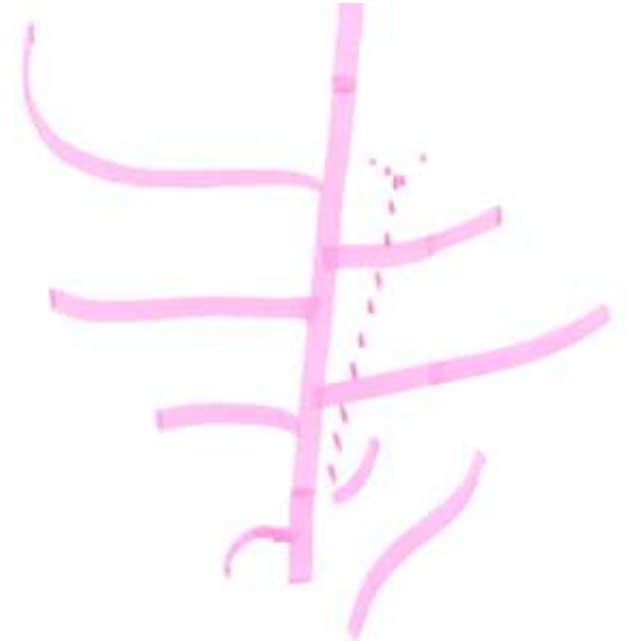
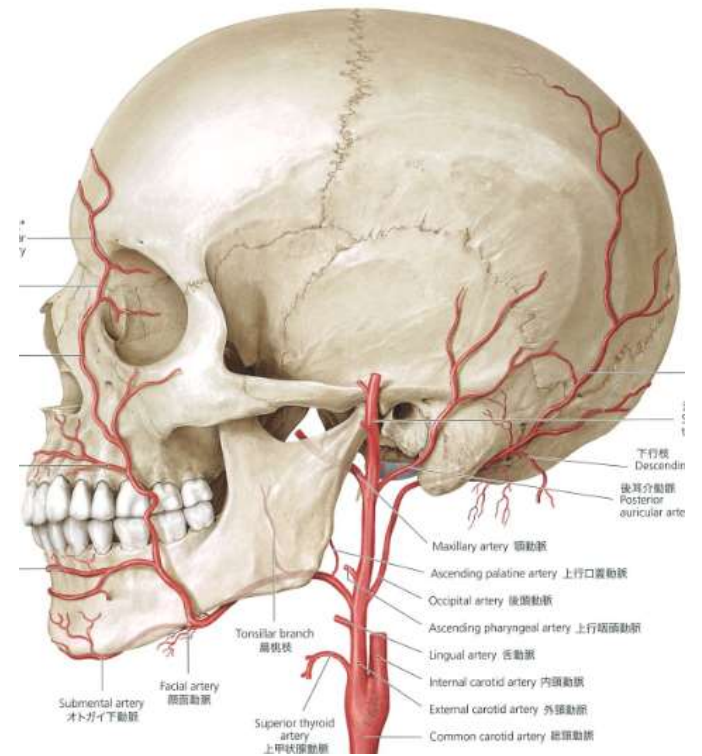
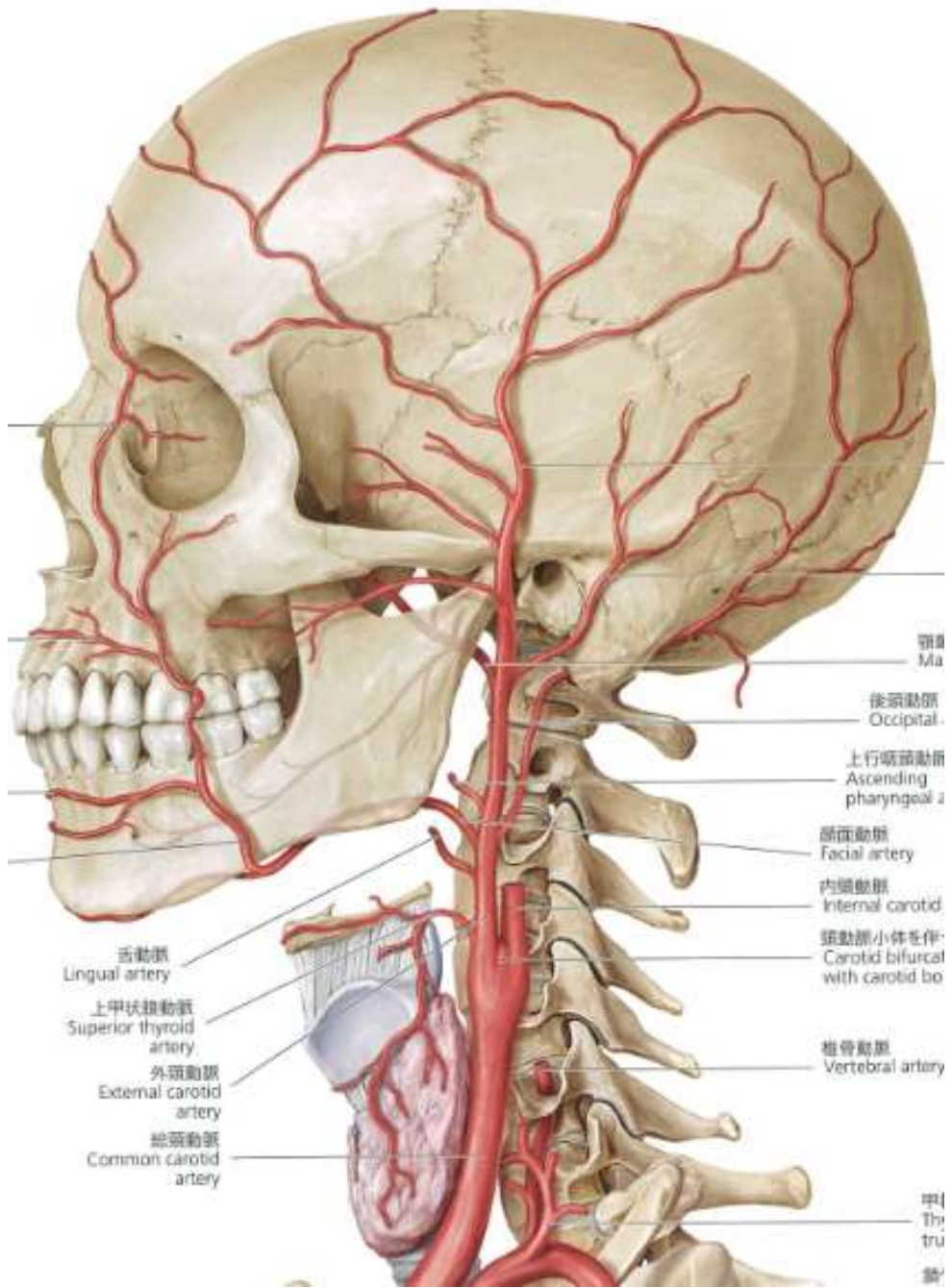
- Supply to the Cranial nerves -

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*Increasingly more important, mainly for transarterial endovascular treatment of dural arteriovenous fistulas, treatment of epistaxis, and preoperative embolization of head and neck tumors to decrease surgical blood loss.*

*We have to be kept in mind while doing the embolization procedures to avoid possible major complications such as embolic stroke or cranial nerve palsies.*



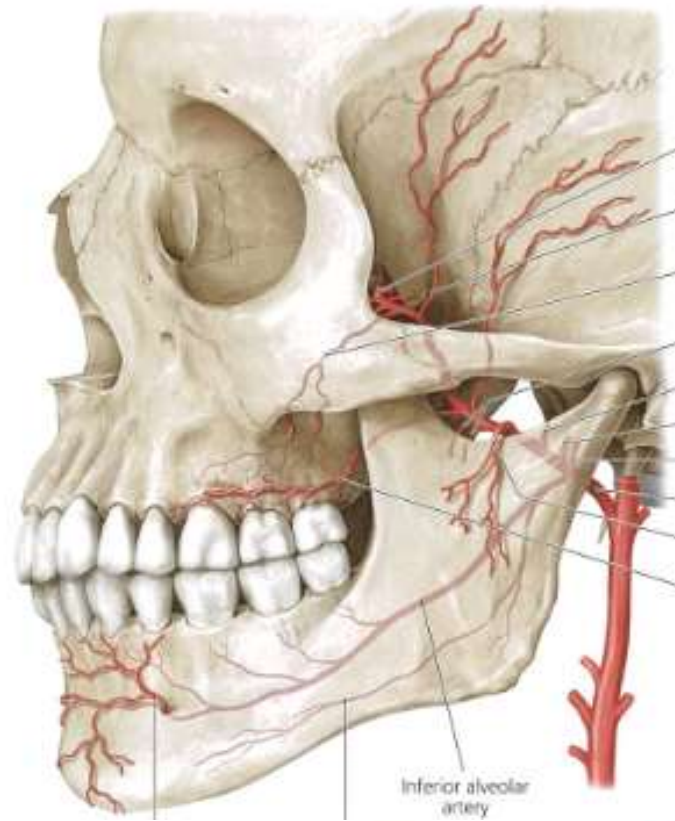


IMA : segment分類

1<sup>st</sup> segment *mandibular segment*

2<sup>nd</sup> segment *zygomatic segment*

3<sup>rd</sup> segment *pterygopalatine segment*



IMA : *Djindjian*らの分類

1. *Ascending br.* (→ cranial, intracranial) AMA, MMA, ATA
2. *Ascending br.* (→ extracranial) ADTA, PDTA
3. *Descending br.* IDA, PA etc.
4. *Anterior br.* PSDA, IOA, DPA etc.
5. *Recurrent br.* A of FR, Vidian a. (Pterygoid canal a.), Pharyngeal a.
6. *Terminal br.* Sphenopalatine a.



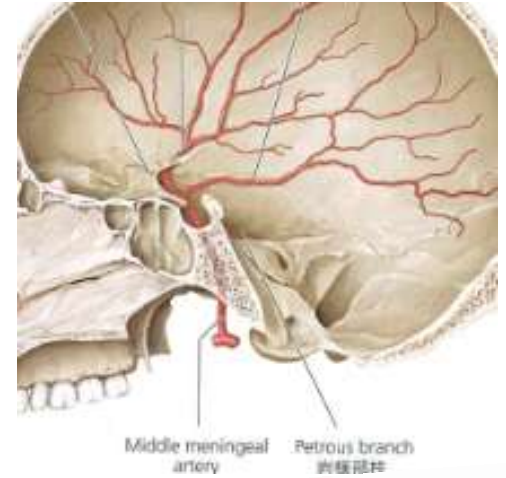


# middle meningeal artery :

1. foramen spinosum から頭蓋内に入り、petrosal br. と posterior cavernous sinus br. を分岐

petrosal br.      **arterial arcade**      → 顔面神経への vasa nervosum  
 stylomastoid a. ( from OA or PAA)

posterior cavernous sinus br. は三叉神経節への vasa nervosum



2. petrosquamous suture に沿って、petrosquamous br.を分岐

lateral clival a. ( from MHT)      mastoid br. ( from OA)      ←  
**EC IC anastomoses**      **arterial arcade**  
 petrosquamous br.      jugular br. ( from ascending pha a.)

3. MMA temporal segment を越えて posterior convexity br. の分岐のもう一方が anterior br.

meningolacrimal a. ( from anterior br.)      ←  
**EC IC anastomoses**  
 lacrimal a. ( from ophthalmic a.)



※ lacrimal variant : 眼窩内 lacrimal a. と superficial recurrent meningeal a. (from anterior br.) が吻合

※ meningolacrimal variant : meningo-ophthalmic a. ( from anterior br.) を介して吻合

※ meningolacrimal variant : lacrimal a. は Hyrtl's canal を通り眼窩内へ

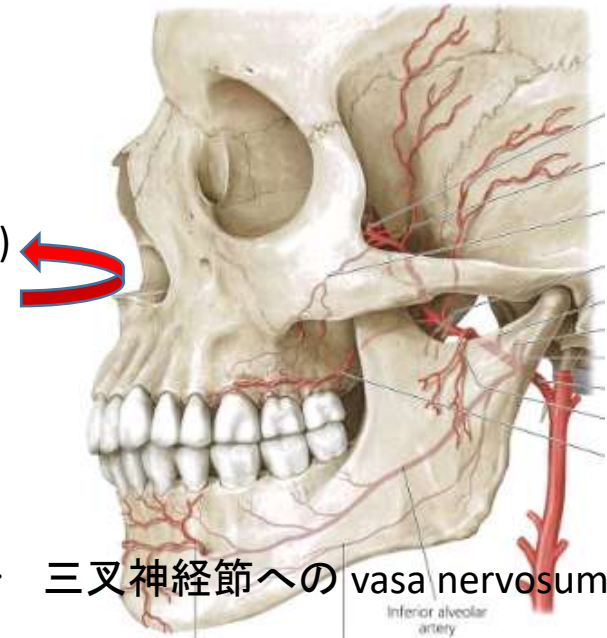
accessory meningeal artery : ※ 一般にMMAと共通幹形成

1. anterior br. , posterior br. に分岐

↪ Vidian a. ( from Recurrent br. or ICA) anterior br. ( from AMA) ↪  
EC IC anastomoses arterial arcade  
pharyngeal br. ( from ascending pha. a.)

2. posterior br. は foramen ovale, foramen Vesalius から頭蓋内へ

↪ ILT, MHT ( from ICA) posterior br. ( from AMA) ↪ → 三叉神経節への vasa nervosum  
EC IC anastomoses arterial arcade  
posterior cavernous sinus br. ( from MMA)



deep temporal artery :

1. anterior deep temporal a. はzygomatico-temporal foramen を介して眼窩内へ

↪ anterior deep temporal a. lacrimal a. ↪  
EC IC anastomoses arterial arcade  
lateral palpebral a. ( from ophthalmic a.)

外側後鼻枝  
Lateral posterior  
nasal arteries

中側後鼻枝  
Posterior septal  
branches

sphenopalatine artery : ※ Hardy

↪ posterior septal a. ↪  
EC IC anastomoses arterial arcade  
ethmoidal a.



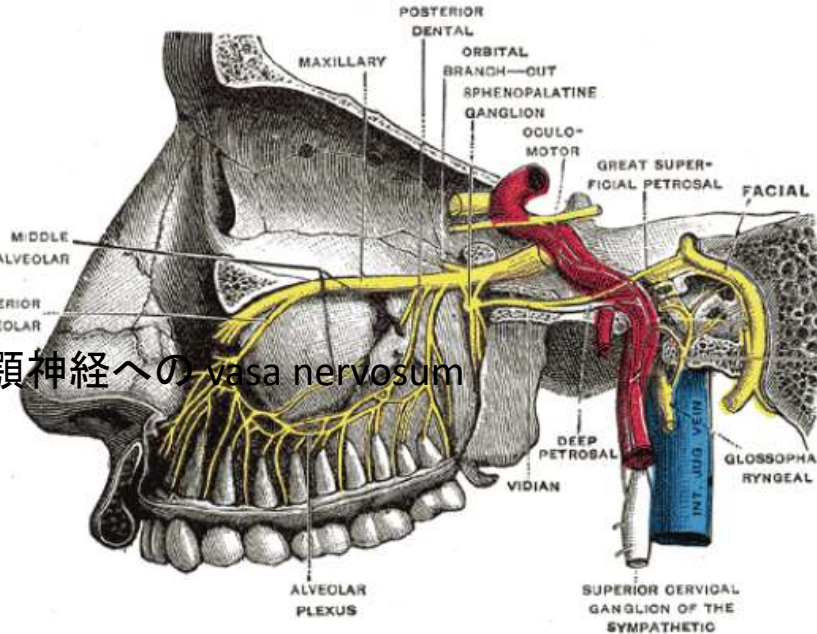
# Recurrent branches

## Artery of Foramen Rotundum :

1. foramen rotundum を介して頭蓋内へ



→ 上顎神経への vasa nervosum



## Vidian artery ( Pterygoid canal a. ) :

1. Pterygoid canal を介して鼻腔/咽頭腔へ



→ 翼突管神経への vasa nervosum

## Pharyngeal artery :

1. pterygovaginal canal を介して鼻腔/咽頭腔へ



※ foramen の同定は Rotational DSA が必須

※ foramen の位置を足掛かりに走行で判別

REVIEW ARTICLE

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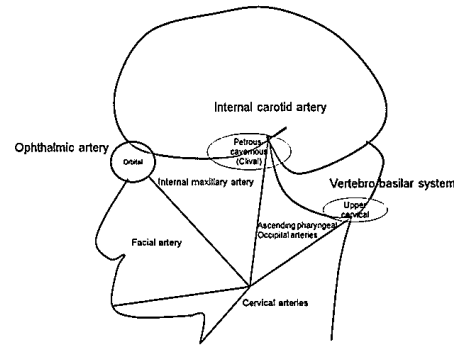


# Dangerous Extracranial–Intracranial Anastomoses and Supply to the Cranial Nerves: Vessels the Neurointerventionalist Needs to Know

**SUMMARY:** Transarterial embolization in the external carotid artery (ECA) territory has a major role in the endovascular management of epistaxis, skull base tumors, and dural arteriovenous fistulas. Knowledge of the potential anastomotic routes, identification of the cranial nerve supply from the ECA, and the proper choice of embolic material are crucial to help the interventionalist avoid neurologic complications during the procedure. Three regions along the skull base constitute potential anastomotic routes between the extracranial and intracranial arteries: the orbital, the petrocavernous, and the upper cervical regions. Branches of the internal maxillary artery have anastomoses with the ophthalmic artery and petrocavernous internal carotid artery (ICA), whereas the branches of the ascending pharyngeal artery are connected to the petrocavernous ICA. Branches of both the ascending pharyngeal artery and the occipital artery have anastomoses with the vertebral artery. To avoid cranial nerve palsy, one must have knowledge of the supply to the lower cranial nerves: The petrous branch of the middle meningeal artery and the stylomastoid branch of the posterior auricular artery form the facial arcade as the major supply to the facial nerve, and the neuromeningeal trunk of the ascending pharyngeal artery supplies the lower cranial nerves (CN IX–XII).

In the last 20 years, the role of embolization of the external carotid artery (ECA) territory has become increasingly more important, mainly for transarterial endovascular treatment of dural arteriovenous fistulas,<sup>1,2</sup> treatment of epistaxis, and preoperative embolization of head and neck tumors to decrease surgical blood loss.<sup>3–6</sup> However, because embryologic and phylogenetic development closely links the ECAs to the intracranial arteries, there are certain common anastomotic routes that have to be kept in mind while doing the embolization procedures to avoid possible major complications such as embolic stroke or cranial nerve palsies.<sup>7</sup> Most of these anastomotic channels follow the cranial nerves along the neural foramen. Although they may not be visualized on routine (ie, global) catheter angiographies, they are always present and will therefore necessarily open under the following circumstances: 1) with increased intra-arterial pressure (eg, during embolization procedures or superselective injections<sup>8</sup>), 2) in the presence of high-flow shunts as a consequence of the “sump effect,” or 3) as collateral routes when occlusions of the major intracranial arteries occur.<sup>9–12</sup>

The functional vascular anatomy concept, as introduced by Lasjaunias et al<sup>7</sup> and Berenstein et al in 1983,<sup>13</sup> analyzes the arterial anatomy of the head and neck by their territories, which include the internal maxillary, linguofacial, pharyngo-occipital, thyroïdal, cervical, internal carotid, and vertebral territories. The adjacent territories have inter-relationships and will function as potential vascular collaterals in case of vascular occlusion. There are 3 regions within these territories (Fig 1) that serve as the major extracranial–intracranial anastomotic pathways:



**Fig 1.** Diagram of the functional vascular anatomy of the head and neck with the 3 major extracranial–intracranial anastomotic pathway regions: the orbital, petrous-cavernous-clival, and upper cervical regions.

- 1) The orbital region via the ophthalmic artery that is the interface between the internal maxillary and internal carotid territories.
- 2) The petrous-cavernous region via the inferolateral trunk (ILT), the petrous branches of the internal carotid artery (ICA), and the meningohypophyseal trunk to the carotid artery.
- 3) The upper cervical region via the ascending pharyngeal, the occipital, and the ascending and deep cervical arteries to the vertebral artery.

The major extracranial and intracranial anastomoses are summarized in Table 1.

### Orbital Region (anastomoses to the ophthalmic artery)

The most important risk when embolizing within this region is occlusion of the central retinal artery, which results in blindness of the patient. Infrequently, embolic stroke can also occur through retrograde filling of the ICA. Because the central retinal artery typically originates with or close to the posterior

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**Table 1: Summary of the major extra- and intracranial anastomoses**

Major artery	Extracranial		Intracranial	
	Location	Branch	Branch	Artery
Internal maxillary artery	Proximal	MMA	Orbital branches, anterior branch (anterior falcine artery)	Ophthalmic artery
			Cavernous branches	ILT
	Distal	AMA	Petrous branch	CN VII supply
			Artery of foramen ovale	ILT
Superficial temporal artery	Proximal	AMA	Artery of foramen ovale	Petrous ICA
	Distal	Vidian artery		ILT
	Distal	Artery of foramen rotundum		Ophthalmic artery
	Distal	Anterior deep temporal artery		Ophthalmic artery
Ascending pharyngeal artery	Pharyngeal trunk	Superior pharyngeal artery	Supraorbital branch	Ophthalmic artery
Posterior auricular-occipital artery	Neuromeningeal trunk	Odontoid arch Hypoglossal and jugular branch	Carotid branch (foramen lacerum)	Lateral clival artery
				Vertebral artery (C1)
				Meningohypophyseal trunk of ICA CN VII supply
Occipital artery	Muscular branches			Vertebral artery (C1-C2)
Ascending and deep cervical arteries				Vertebral artery (C3-C7)

**Note:**—MMA indicates middle meningeal artery; AMA, accessory meningeal artery; ILT, inferolateral trunk; ICA, internal carotid artery; CN, cranial nerve.

**Table 2: Summary of the branches of the ophthalmic artery and their anastomoses to the ECA**

Ophthalmic Artery Branch	Origin of the Ophthalmic Branch	ECA Branch
Proximal lacrimal artery (main branch)	Second portion of OA	MMA (through superior orbital fissure)
Distal lacrimal artery (inferior branch)	Second portion of OA	Anterior deep temporal artery and infraorbital artery (IMA)
Anterior ethmoidal arteries	Third portion of OA	Septal arteries: sphenopalatine artery (IMA), MMA
Posterior ethmoidal arteries	Second or third portion of OA	Sphenopalatine artery, greater palatine artery (IMA), MMA
Supraorbital artery	Third portion of OA	STA
Dorsal nasal artery	Terminal branch of OA	Angular termination of FA, infraorbital artery

**Note:**—OA indicates ophthalmic artery; ECA, external carotid artery; IMA, internal maxillary artery; STA, superficial temporal artery; FA, facial artery.

**Table 4: Summary of the cranial nerve supply**

Cranial Nerve	Location	Arterial supply
III, IV	Cisternal	Mesencephalic perforators (common trunk for CN III)
	Cavernous sinus	CN III: ILT only; CN IV: marginal artery of the tentorium cerebelli (meningohypophyseal trunk) + ILT
VI	Superior orbital fissure	Anteromedial branch of ILT
	Cisternal	
	Dorsum sella	Jugular branch of AscPhA, medial branch of lateral clival artery, meningohypophyseal trunk
V	Cavernous sinus	ILT
	Superior orbital fissure	Anteromedial branch of ILT
	Cisternal	Basilar vestige of trigeminal artery (between SCA and AICA)
	Meckel cave	Lateral artery of trigeminal ganglion, cavernous branch of MMA, carotid branch of AscPhA, ILT
V2	Foramen rotundum	Artery of foramen rotundum
V3	Foramen ovale	Posteromedial branch
VII, VIII	Cisternal + IAC	Internal auditory artery
	Ganglionic ganglion	Petrosal branch of MMA, stylomastoid branch of posterior auricular/occipital artery
IX, X	Cisternal, jugular foramen	Jugular branch of neuromeningeal trunk
XI	Spinal root	C3 segmental branch
	Cranial root	Jugular branch of neuromeningeal trunk
XII	Cisternal hypoglossal canal	Hypoglossal branch of neuromeningeal trunk

**Note:**—AscPhA indicates ascending pharyngeal artery; SCA, superior cerebellar artery; IAC, internal auditory canal; AICA, anterior inferior cerebellar artery; VA, vertebral artery.