

# Saltzman Type III Persistent Trigeminal Artery: A Case Report and Review of Medical Literature

## Case Report

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### Abstract

The trigeminal artery belongs to a series of embryonic transient arteries referred to as persistent carotid-vertebrobasilar anastomosis. Since its anatomical discovery in the mid-nineteenth century and its first angiographic observation about a century later, many case reports of persistence of the trigeminal artery after birth and into adult life have been published, most of them being fortuitous angiographic discoveries. In this paper, we describe a new case of trigeminal artery we discovered during a gross anatomy course, and review its anatomical, epidemiological, and pathogenic features in the medical literature.

**Keywords:** Brain vascularisation; Persistent carotid-vertebrobasilar anastomosis; Trigeminal artery; Amyotrophic lateral sclerosis

### Abbreviations

AICA: Anterior Inferior Cerebellar Artery; BA: Basilar Artery; ECA: External Carotid Artery; HA: Hypoglossal Artery; ICArA: Internal Carotid Artery; ICerA: Intersegmental Cervical Artery; PA: Proatlantal Artery; PCA: Posterior Cerebral Artery; PCoA: Posterior Communicating Artery; PICA: Posterior Inferior Cerebellar Artery; SCA: Superior Cerebellar Artery; TA: Trigeminal Artery

### Introduction

The discovery of persistent carotid-vertebrobasilar anastomosis dates back to 1844 in gross anatomy and to 1950 in angiography [1,2]. Since that time, five different types of persistent carotid-vertebrobasilar anastomosis have been described: the Trigeminal Artery (TA), Hypoglossal Artery (HA), Otic Artery (OA), Proatlantal Artery (PA), and Intersegmental Cervical Arteries (ICerA) (Table 1) [3]. Over 400 observations of persistent TA were published before 1982, but reports of TA found during gross anatomy dissection courses are very scarce [4,5]. We describe in this paper a new case to

be added to those previously well documented, and discuss its place in our current knowledge of its features: Saltzman type, correlations with the classical epidemiological data and associated pathologies [6-12].

**Table 1:** First published observations of the five types of persistent carotid-vertebrobasilar anastomosis.

Artery	First case report
Trigeminal artery	Quain, 1844 [1]
Otic artery	Kempe and Smith, 1969 (?) [6]
Hypoglossal artery	Batujeff, 1889 [7]
<b>Proatlantal artery</b>	
Type 1 (arises from the ICA)	Gottschau, 1885 [8]
Type 2 (arises from the ECA)	Lucarelli and De Ferrari, 1960 [9]
<b>Cervical intersegmental artery</b>	
First	Pinstein and Gerald, 1976 [10]
Second	Flynn, 1968 [11]
Third	Parkinson et al., 1979 (?) [12]

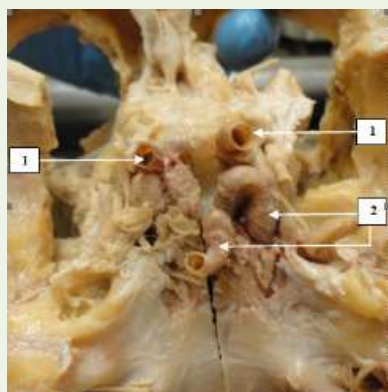
### Embryology of the cerebral vascular system

The embryological development of the vascular cerebral system begins very early, before the closure of the neural groove, and achieves its adult configuration at the 40 mm/52 days embryonic stage [13,14]. Both arterial systems supplying the encephalon, that is the bilateral ventral carotid axis and the dorsal longitudinal neural channels (the fusion of which giving rise to the basilar artery), are temporarily interconnected by more or less symmetrical anastomosis. In rostrocaudal order, these anastomoses are the trigeminal, otic, hypoglossal, proatlantal, and intersegmental cervical arteries. They appear at the 4-5 mm/29 days embryonic stage and persist for approximately 1 week [15]. The three pre-segmental arteries (TA, OA and HA) regress when the posterior communicating artery develops, while the PA does not completely disappear, a segment of it being incorporated into V3 segment of the vertebral artery and part of the occipital artery [16]. However, some of them may persist after birth and into adult life: the TA is the most common one and represents about 85% of all persistent carotid-basilar anastomosis, the OA is by far the rarest one [17,18]. Exceptional observations of two different persistent anastomosis in the same patient have also been published: TA and OA, TA and HA [19,20].

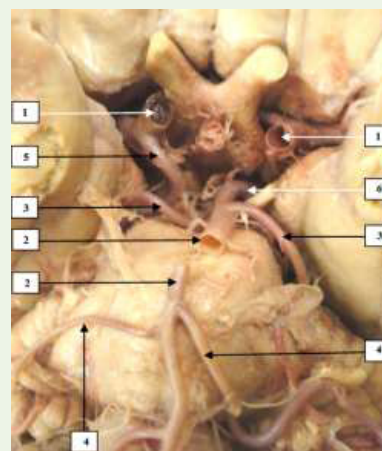
### Case Report

A new case of TA was found in the anatomy laboratory of the University of Quebec at Trois-Rivieres during a gross anatomy course intended for Montreal Medical Faculty otorhinolaryngologists (Figure 1). This artery was found during the dissection of a 72-year old woman who had died of amyotrophic lateral sclerosis, and had no other documented neurological medical history.

The TA was 4 millimeters in diameter. It arised from the C4-C5 junction of the right Internal Carotid Artery (ICA), and joined the Basilar Artery (BA) between the Superior Cerebellar Artery (SCA) and the Anterior Inferior Cerebellar Artery (AICA). The caudal segment of the BA was hypoplastic. The TA supplied both SCA and the left Posterior Cerebral Artery (PCA). The first segment of the right PCA was absent; its distal segment was totally supplied by a thick right posterior communicating artery (PCoA). The left PCoA was present but hypoplastic (Figure 2).



**Figure 1:** Internal surface of the base of the skull-1: internal carotid artery. 2: trigeminal artery.



**Figure 2:** Ventral aspect of the brain stem; the trigeminal artery has been removed, it joined the basilar artery just above its hypoplastic caudal segment-1: internal carotid artery. 2: basilar artery. 3: superior cerebellar artery. 4: anterior inferior cerebellar artery. 5: right posterior communicating artery supplying the ipsilateral posterior cerebral artery. 6: left posterior cerebral artery.

Saltzman's classification differentiates 3 types of TA [21]. Type I is characterized by the fact that all branches of the vertebrobasilar complex (both CSA and PCA) are injected via the TA, the ipsilateral PCoA being absent or hypoplastic. In Type II, the TA supplies both SCA, each PCoA supplying the ipsilateral PCA. In Type III, one PCA is supplied by the ipsilateral PCoA, the other PCA and both SCA being injected by the TA. Our case report therefore belongs to Saltzman type III TA. Subtypes III a, b and c have been described when the TA supplies directly the SCA, AICA or PICA, respectively; unfortunately, the dissection of the specimen was too far ahead to make it possible to know which subtype it matches [22].

### Epidemiological features of the persistent trigeminal artery

The reported prevalence of TA may vary, due to differences in the imaging modalities employed, from 0.1% to 0.63% [23,24]. It may be observed on either side, bilateral reports being exceptional [25]. Some studies could not find any statistical significant difference between male and female, though women were much more concerned than men in the 160 case reports we compiled (103 women / 57 men) [26].

### Associated pathologies

We could find over 30 different pathologies related to or at least associated with a persistent TA in the medical literature. These pathologies are mainly of neurological (peripheral and central), tumoral, or vascular (other than cerebral) natures:

**Peripheral nervous system:** Cranial nerve symptomatology associated with a persistent TA may concern the optic nerve [amaurosis], the oculomotor nerve [palsy], the trigeminal nerve [trigeminal neuralgia], the abducens nerve [paresis], the cochleovestibular nerve [neurinoma; intermittent vertigo]. A recurrent Horner syndrome has also been found in association with a persistent TA [27-35].

**Central nervous system:** Ischaemic lesions, intracranial aneurisms, carotid-cavernous fistula [36-38].

**Tumors:** Intrasellar chordoma, pituitary adenoma [39,40].

**Vascular anomalies (others than cerebral):** Anatomical variant of the superior thyroid artery, aortic arch vessel anomalies [41,42].

Though amyotrophic lateral sclerosis is known to affect lower motor neurons in the brain stem, the association of a persistent TA and amyotrophic lateral sclerosis is in all likelihood to be regarded as coincidental: we could not find any publication pointing out a putative link between them [43]. However, we think it pertinent to publish a new case of persistent trigeminal artery discovered during a gross anatomy course.

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