Asymptomatic Non-Bifurcating Carotid Artery A Case Report and Literature Review

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SUMMARY – *Vascular anomalies of the carotid vessels are rare and pose a challenge in diagnostic radiology. With the widespread use of non-invasive vascular imaging techniques, such as CT and MR angiography, understanding the natural variation and congenital anomalies that can occur is becoming increasingly important. Here, we describe a case of a very rare anatomical variant: a non-bifurcating left carotid artery, and perform a concise review of the literature and knowledge available on this interesting anatomical variant.*

Introduction

An 80-year-old man presented to the Emergency Department at our institution with sudden onset of confusion and vertigo.

There were no focal neurological symptoms, aside from a subtle right inferior quadrantanopsia.

The remainder of the cranial nerve examination was unremarkable, and muscle tone, bulk and power were normal in all limbs.

His medical history was non-contributory. Given the constellation of symptoms, there were concerns of a posterior circulation stroke.

A non-contrast scan and a CT angiogram demonstrated a thromboembolic occlusion of the left posterior cerebral artery at the P2 level, in keeping with the patient's clinical symptoms.

The symptoms resolved without intervention. However, an incidental finding of a non-bifurcating left carotid artery was made.

We present the radiologic findings of this rare anatomic variant, where the external carotid artery branches directly arise from a single unbranched carotid artery.

In addition, we conducted a review of the current literature, summarizing the anatomic, radiologic and clinical implications.

Abbreviations

CCA = common carotid artery;
ICA = internal carotid artery;
ECA = external carotid artery;
StyA = superior thyroid artery;
APA = ascending pharyngeal artery;
LA = lingual artery;

FA = facial artery;
OA = occipital artery;
PAA = posterior auricular artery;
MA = maxillary artery;
STpA = superficial temporal artery.

Radiologic Findings

Figure 1 A-C) CT angiograms demonstrating the normal bifurcation of the right CCA (arrow) as it ascends superiorly. The left carotid artery (arrowhead) does not bifurcate in the neck and is continuous with the intracranial segment of the ICA. There is hypoplasia of the left non-bifurcating carotid artery relative to the contralateral side, and branches off the non-bifurcating carotid artery can be observed (C, arrowhead).

← Figure 2 CT angiogram demonstrating the supraclinoid segments of the right ICA (arrow) and the non-bifurcating left carotid artery (arrowhead). Note the hypoplasia of the left non-bifurcating carotid relative to the contralateral ICA.

↓ Figure 3 3D CT angiogram reconstruction. A) Lateral view of the normal right CCA, ICA and ECA with associated branches seen. B) Lateral and anterior-posterior (C) views of the non-bifurcating left carotid artery. Due to dental amalgamate, there was streak artifact and segments of the left OA and PAA could not be reconstructed adequately. The dashed lines are intended to represent the missing segments that are faintly seen in the source images.

Discussion

Classically, the common carotid artery (CCA) most commonly bifurcates into the internal carotid artery (ICA) and the external carotid artery (ECA) between the levels of the C3 and C5 vertebral bodies. However, this bifurcation may occur as caudal as the T3 vertebral body level^{1,2} or as cranial as the level of the C1 vertebral body³. The proximal main trunk of the ECA gives off branches that constitute the superior thyroid artery (STyA), ascending pharyngeal artery (APA), lingual artery (LA), facial artery (FA), and occipital artery (OA). The distal main trunk of the ECA subsequently supplies the posterior auricular artery (PAA) and terminates as the maxillary artery (MA) and superficial temporal artery (STp). The embryological development of the ECA is a complex process. Via hemodynamically induced remodeling, the third aortic arch gives rise to the common carotid artery, the cervical aspect of the internal carotid artery (the intracranial component of the internal carotid stems from the dorsal aorta) and the external carotid artery. Concomitantly, remnants of the first and second aortic arches form the ventral pharyngeal and stapediaal arteries, which anastomose with the developing ECA, and develop into the known branches of the ECA^{4,5}.

There are two major hypotheses accounting for the rare anomaly in our case report: agenesis of the proximal aspect of the ICA with anastomosis of the distal ECA to the distal ICA, as proposed by Nishizawa et al.⁶. Seidel⁷, on the other hand, described a patient in which there was agenesis of the ECA with an arterial stump at the level of the expected bifurcation, with all ECA branches arising from the ICA.

In the current case, the left carotid artery failed to bifurcate and a single artery ascends, supplying all normal branches of the ECA, continuing cephalad in the typical cervical, petrous, cavernous and supraclinoid course of the ICA. In the absence of an arterial stump at the expected level of the bifurcation, maldevelopment of the third aortic arch and proximal ICA agenesis appear to be the more plausible hypothesis. The proximal ECA and the distal ICA then anastomose to produce the vascular pattern observed. A similar description was by given Morimoto et al. Additionally, the hypoplasia of the entire carotid canal relative to the normal contralateral side in our patient further supports the notion of maldevelopment of the third aortic arch with proximal ICA agenesis,

given that the diameter of the non-bifurcating artery is more similar to that of the contralateral ECA as opposed to the ICA.

Our review of the literature identified ten case reports⁸⁻¹⁷ and one small retrospective study¹⁸ documenting this vascular anomaly. It is unclear when the first description of a similar anomaly dates back to, but it appears that in 1821, Allan Barns described a case of single carotid vessel without any appreciable bifurcation on cadaveric dissection, and with the vessels that typically arise from the ECA originating from the ICA¹⁹. In 1965, Seidel⁷ provided the first radiological description of a non-bifurcating carotid. However, the term "non-bifurcating carotid artery" would only later be proposed and coined by Marimoto et al.⁸ in 1990, in a case report depicting a left-sided non-bifurcating cervical artery giving rise to all of the branches of the ECA and continuing distally as the ICA.

One of the case reports¹⁵ described three separate patients. With the patient described in our case report, a small sample size of 13 patients exists. Eight of the 13 (62%) patients were male, and ten of the 13 (77%) cases described consisted of a left-sided non-bifurcating carotid artery.

Uchino et al.¹⁸ retrospectively reviewed 2866 non-contrast MR angiograms and identified six cases of a non-bifurcating carotid artery, indicating an incidence of 0.21% in a Japanese cohort. The authors state that the incidence of non-bifurcating carotids was more prevalent than previously thought and comparable to the incidence of persistent trigeminal artery, the most common type of carotid anomaly documented to date²⁰. The authors also analyzed the pooled patient data for their six cases and case reports they identified in the literature, reporting no predominance for laterality or sex. However, the authors' inclusion criterion for a non-bifurcating carotid was 'at least two branches of the ECA arising separately from the cervical carotid artery with no physiological dilatation of the origin of the ICA'. This has the potential to result in an inflated prevalence rate, as such a broad definition would, for example, include the normal variants in which the STy, APA and OA originate from the cervical segment of the ICA²¹⁻²⁵ and do not represent true non-bifurcating carotid arteries.

The clinical implications of a non-bifurcating carotid are undetermined, although the majority of the case reports discussing this entity appear to be based on incidental findings. Three

of the case reports^{9,12,16} describe patients with high-grade carotid stenosis. However, the presence of carotid stenosis in patients lacking an appreciable bifurcation, which is generally regarded as a major culprit in the development of carotid plaques, illustrates the multifac-

torial nature of plaque formation. Additionally, as vascular imaging techniques become more widespread, knowledge of rare vascular anomalies is increasingly important to ensure adequate and correct diagnoses are made, especially in acute and intraprocedural settings.

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