Duplication of the Extracranial Internal Carotid Artery

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Summary: We describe a case of duplication of the left internal carotid artery from a point 1 cm distal to the origin to the proximal petrous segment where the vessel reunites. Duplication and fenestration of the internal carotid artery are discussed. A review of embryologic development is presented. Identification of these entities is important, especially in patients who require surgical intervention involving the internal carotid artery.

Index terms: Arteries, carotid, internal; Arteries, abnormalities and anomalies

Duplication of the extracranial internal carotid artery is rare (1), as is fenestration (2, 3). The term *fenestration* is used for areas in an artery of short focal division of the lumen; longer segments involving a large portion of the artery are termed *duplications*. We encountered a patient who had duplication of the extracranial internal carotid artery and report our findings with digital subtraction angiography.

Case Report

A 46-year-old man with squamous cell carcinoma of the right side of the neck was evaluated with digital subtraction angiography before treatment. The procedure was performed with injections of the aortic arch and selective injection of the common carotid artery. There was duplication of the left extracranial internal carotid artery from 1 cm above the bifurcation to its entrance into the petrous bone (Fig 1). Both lumina of the duplication were of equal caliber, and each was approximately 50% of the caliber of the contralateral internal carotid artery. The two segments of the duplication had a parallel course.

Discussion

There are several reports of duplication and fenestration of intracranial vessels including the vertebral arteries (4, 5), middle (5–9) and anterior cerebral arteries (5, 10), and supraclinoid portion of the internal carotid artery (11, 12). Duplication of the extracranial portion of the internal carotid artery seems to be uncommon.

The relationship between fenestration and duplication is unclear. Previously they have been discussed as a single entity (3). However, there seem to be several differences. Two of three reported extracranial internal carotid artery fenestrations were associated with aneurysms (2, 3) of the anterior and right middle cerebral arteries, respectively. This has not been seen with duplications (1). In reported cases of duplication, the entire extracranial portions of the internal carotid arteries were involved (1–3). Three cases of fenestration involved small segments of the extracranial internal carotid artery at the level of C1-2. Embryologically, duplication and fenestration probably represent separate entities (3).

The anatomic development of the vessels in the neck results in bilateral single vertebral and common carotid arteries. Superiorly, the carotid artery divides into single external and internal carotid arteries. Embryologically, during the fourth and fifth weeks of gestation the six aortic arches develop. These connect the most distal portion of the truncus arteriosus (the aortic sac) with the dorsal aorta. All the arches do not exist simultaneously; some form while others regress (Fig 2). The first and second arches degenerate to a large extent; the maxillary artery is the remnant of the first aortic arch and the hyoid and stapedial arteries are remnants of the second. The third aortic arch develops into the proximal portion of the internal carotid artery. A portion of the dorsal aorta between the third and fourth arches (the carotid duct) then regresses (Fig 3). The fourth arch persists as the aortic arch (usually on the left) and the brachiocephalic artery. The fifth arch is never well developed and degenerates. The sixth arch will de-

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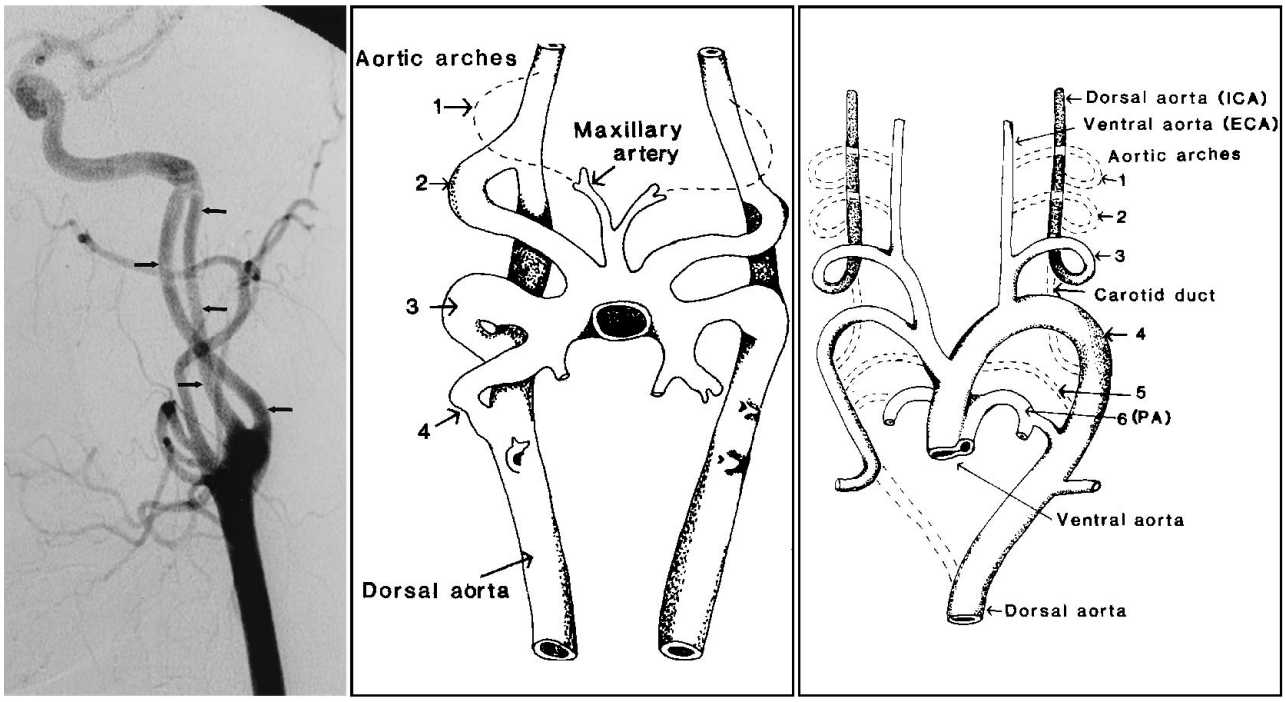

Fig 1. Digital subtraction angiogram shows duplication (*arrows*) of the left internal carotid artery just distal to the bifurcation extending to the proximal petrous portion.

Fig 2. Schematic of development at approximately 4- to 5-mm embryo stage shows regression of the first arch and formation of the fourth arch.

Fig 3. Schematic of nearly complete development of the great vessels. *Broken lines* represent portions that have regressed. *ICA* indicates internal carotid artery; *ECA*, external carotid artery; and *PA*, pulmonary arch.

velop into the pulmonary arch. The external carotid artery origin and the common carotid artery are formed from a persistent segment of the ventral aorta. The intracranial portion of the internal carotid artery is formed by a portion of the dorsal aorta (Fig 3) (13–16).

In our patient, there was duplication of the internal carotid artery from the bifurcation to the skull base, where the two vessels reunite. It can be postulated that the duplication was in the third aortic arch, and reunion occurs at the arch's termination in the dorsal aorta. The third aortic arch is formed by multiple channels in the early stage (4 to 5 mm) (14). If two channels persist instead of the usual single channel, two arches, and subsequently two internal carotid arteries, would form.

Embryologically, the formation of fenestration is different from duplication. It has been suggested that a fenestration is formed by the persistence of the cranial portion of the carotid duct (10), and not the development of an abnormal third arch.

In conclusion, duplication of the extracranial internal carotid artery is rare, but it is significant in the event of neck surgery (17). If a grafting procedure had been necessary, or if the tumor had occurred on the same side as the duplication and only one lumen was affected by the tumor, knowledge of this variant would have been important to the surgeon.

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