Stenting in the Remnant of the Third Aortic Arch in a Case of Post-Irradiation Occluded Internal Carotid Artery

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Summary

Collateral networks between the external carotid artery and internal carotid arteries become crucial for cerebral perfusion after occlusion of internal carotid arteries. We report the first case of a patient who received percutaneous transluminal angioplasty and stenting in a collateral vessel between the external and internal carotid artery for treatment of radiation induced severe stenosis of the internal carotid artery in the context of a contralateral internal carotid artery occlusion.

Introduction

The incidence of carotid stenosis and occlusion appears higher among patients who have undergone radiation therapy for head and neck malignancies¹⁻⁴. The latent period ranges from two to 18 years according to the type of malignancy and overall radiation dose¹. Not only hemodynamic insufficiency but also thromboembolic material from carotid stumps or injured arterial walls can cause stroke in patients with prior neck irradiation^{1,4,5}. Endovascular treatment is usually preferred to surgical intervention for the reduction of neurological deficits because of local adhesion and fibrosis change after radiation². We present the unique case of a patient who underwent successful stenting of an anomalous external to internal carotid collateral for the treatment of severe radiation-induced internal carotid stenosis.

Clinical History

A 58-year-old man was diagnosed with a transglottic carcinoma (stage T2N1Mo) of the right-side anterior commissure. He completed concurrent chemo-radiation therapy 17 months ago, and was regularly followed up in our oncology outpatient department. His previous medical history revealed hypertension and coronary artery disease with medical management. He was referred to our department because he complained of dizziness and blurred vision, and a computer tomography scan of the neck taken during a regular follow-up visit showed occlusion of the right ICA, and long segmental 85% stenosis of the left ICA. Considering the high risk of future stroke^{2,4}, he was admitted for stenting.

Digital subtraction angiography disclosed total occlusion of the right proximal ICA. The right distal ICA is supplied by the right posterior cerebral artery via the right posterior communicating artery. The hypoplastic left proximal ICA had 80% stenosis. The distal left cervical ICA was connected to the left external carotid artery by a collateral (Figure 1). Concurrent 60% stenosis of the left proximal external carotid artery was also noted (Figure 2). The degree of stenosis was assessed through angiography according to the European Carotid Surgical trial criteria. Bilateral anterior cerebral arteries, middle cerebral arteries and the vertebro-basilar system were within normal limits. The patient was premedicated with aspirin and plavix, and systemic heparinization

Figure 1 Anterior-posterior (A) and lateral views (B) of the left common carotid angiogram: the ICA (black arrow) is stenotic. The proximal external carotid artery (white arrow) as well as the pharyngeal-occipital complex is also stenotic. The collateral branch (black arrowhead) from the external carotid artery extends posteriorly and laterally to the ICA at the level of inter-C1 and C2 vertebral body space (white asterisk). The inferior tympanic artery (white dashed arrow), the superior pharyngeal (black dashed arrow), and the musculospinal branch (white arrowhead) of the ascending pharyngeal artery, as well as the musculocutaneous branch of the occipital artery (black asterisk), are also shown.

kept active partial thromboplastin time at at least two times above the normal value. Percutaneous transluminal angioplasty was performed with a Maverick catheter (Boston Scientific Fremont, CA, USA) sized at 2.5×20 mm, following which a carotid Wallstent (Boston Scientific Fremont, CA, USA) sized at 7×40 mm was placed into the left external carotid artery, with control angiography showing excellent results (Figure 3). The patient tolerated the procedure well, and his symptoms resolved within one week. The follow-up CT angiography showed patency of the stent.

Discussion

Carotid artery stenosis is a late complication of radiotherapy for malignancies of the head

and neck region^{5,6}. Routine Doppler ultrasound or CTA for screening is recommended after radiotherapy¹. Post-radiation endarterectomy is challenging because of the difficulty of dissection due to extensive fibrosis and vessel wall fragility after obliteration of the vasa vasorum². When compared to endarterectomy, carotid artery stenting has shown a high success rate, and comparable immediate complication rate^{2,7}.

There are several possible explanations for the observed collateral branch in our cases. The cervical portion of the ICA is the dorsal aorta between the second and third aortic arch phylogenetically. The external carotid artery is derived from the ventral aorta. The extracranial anastomosis between the cervical ICA and ECA are embryonically derived from proatlantal type II, proatlantal type I and hypoglossal

Figure 2 Volume rendering of the rotational angiogram of the left common carotid artery shows the occipital artery (dashed arrow) takes off at the middle portion of the collateral branch from the pharyngeal-occipital complex. It is also treated as the aberrant ICA in this case.

Figure 3 Lateral view of the left common carotid angiogram 3 months after stenting shows mild restenosis in the proximal external carotid artery (black arrow). The internal carotid artery (white arrow) is more atretic. The ascending pharyngeal artery (black arrowhead) is more evident due to augmented blood flow in the external carotid artery. The occipital artery (white arrowhead) is slightly stenotic.

Figure 4 A) Axial view of CT angiography of the neck in this patient shows the internal carotid artery is not laterally deviated, and patency of the foramen. B) Post-contrast coronal plane of CT of the neck in this patient shows that this collateral is extracranially located.

artery, caudally to cranially. The proatlantal artery type I and type II correspond to the first and the second cervical segmental arteries respectively⁸. The collateral branch could not be a remnant of either of these two arteries because they arise from the origin of the ICA, not the external carotid artery. The hypoglossal artery is the artery of the third branchial arch, and it arises at the origin of the third aortic arch from the ventral aorta, eventually developing as the ascending pharyngeal artery. On the other hand, it is not uncommon for the ascending pharyngeal artery and the occipital artery to share a common trunk due to their proximity to the origins of the proatlantal type I artery and the hypoglossal artery during embryological development⁹. This may explain the orifice of the occipital artery from the pharyngo-occipital trunk in our case.

The other anatomical variations of the cervical ICA include fenestration, duplication, or aberrant course development^{10,11}. In cases involving fenestration, there is no discrepancy between the two components of the common trunk. In cases involving duplications, the accessory channel originates at the bifurcation and ascends in the same cervical space. Then it enters the middle ear to join the classic internal carotid, starting near the origin of this artery and extends to its petrous portion, also involving the first two segments. The upper limit of the fenestration corresponds to the embryonic origin of the stapedia artery within the carotid canal, following a short course over the promontorium. It corresponds to the tympanic

branch of the ascending pharyngeal artery and anastomoses with the remnant of the hyoid artery. However, in our case, the anastomotic channel is located extracranially (Figure 4). Neither fenestration nor duplication applies to our case⁸. In conclusion, this collateral might be the remnant of third aortic arch due to the proximities of the orifices of the occipital artery and ascending pharyngeal artery.

Stenting in the external carotid arteries in patients with occluded internal carotid arteries has shown satisfactory initial results^{12,13}. No stent migrations or fractures have been reported in spite of the vicinity of the stent position to the pharyngeal and facial muscles¹⁴. However, further assessments will be required before long-term results are available.

Conclusion

Patients presenting with occluded internal carotid arteries and stenotic external carotid arteries constitute a challenging task since endarterectomy is unfavorable in post-irradiation patients. Comprehensive knowledge of collateral networks and congenital variations between external and internal carotid arteries is essential to treat the stenotic segments endovascularly. In this case of radiation induced carotid stenosis, a rare embryologic carotid anomaly, the remnant of the third aortic arch became a large external to internal carotid artery collateral and permitted stenting the external carotid artery to improve internal carotid flow.

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