Surgical revascularization in the presence of a preserved primitive carotid-basilar communication

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Anomalous arteries that connect the anterior and posterior cranial arterial systems are unusual variants that can severely alter normal patterns of cerebral blood flow. Persistent trigeminal, hypoglossal, otic, and proatlantal arteries have been described. This report illustrates the technical aspects of carotid endarterectomy with an ipsilateral preserved primitive carotid-basilar communication. Identification of the internal carotid and hypoglossal arteries, maintenance of cerebral perfusion, arteriotomy closure, preoperative imaging, the use of shunts, and reconstruction strategy are discussed. Preoperative angiography and detailed, individualized surgical strategy should be used to ensure a successful endarterectomy in patients with preserved primitive carotid-basilar communications. (J Vasc Surg 2005;41:1066-9.)

Anomalous communications between the anterior and posterior cranial circulation are well-recognized variants that can impact extracranial reconstructive vascular surgery.1 Four derivatives of the primitive neurovasculature have been encountered (Fig 1).2 These communications supply blood to the longitudinal vessels at the base of the hindbrain from the more anterior internal carotid system in the early (4- to 5-mm) embryo.1 The arteries are named for the nerves with which they are associated. Later in development (7- to 12-mm, or 7-week embryo), the two dorsal longitudinal-neural arteries fuse to become the basilar artery, while the trigeminal, otic, and hypoglossal arteries involute. The proatlantal arteries remain functional until the vertebral arteries mature to supply the basilar system.3 Persistence of these vessels during development leads not only to anomalous flow between the intra and/or extra cranial anterior and posterior systems, but can suppress the development of normal vasculature, further altering the anatomy of the blood supply to the brain.

Persistent hypoglossal arteries are the second most frequently encountered remnant, with an incidence as high as 0.02% to 0.26%.1,4,5 The hypoglossal artery originates from the internal carotid artery (ICA) at the C1-3 vertebral level and courses dorsally and laterally toward the hypoglossal nerve and then through the anterior condyloid foramen (hypoglossal canal).1,4,6 Within the cranium, the hypoglossal artery joins the basilar artery.

The clinical significance of this communication must be appreciated during revascularization to prevent ischemia. We report a patient with a persistent hypoglossal artery requiring carotid endarterectomy with emphasis on the technical challenges of managing revascularization in this setting.

CASE REPORT

Preoperative evaluation. A 55-year-old hypertensive woman presented with an asymptomatic, self-audible left
neck bruit. A carotid duplex ultrasound scan performed at another hospital revealed an 80% to 99% stenosis of the left ICA and no other significant abnormalities. We performed contrast arteriography to confirm these findings. A 75% left ICA stenosis was demonstrated, and a hypoglossal artery originating at the level of the second cervical vertebrae was also identified (Figs 2 and 3). The left vertebral artery was absent and the right vertebral artery was hypoplastic.

**Operative technique.** A longitudinal arteriotomy was extended from the left common carotid artery (CCA) onto...
the left ICA (Fig 4). Nonpulsatile back bleeding was noted from both the hypoglossal artery and the left ICA. A Javid (Bard Inc, Tempe, Ariz) shunt was then placed to supply temporary flow from the CCA to the ICA. Once the CCA-to-ICA shunt was opened, pulsatile back bleeding was noted from the hypoglossal artery. The endarterectomy included eversion of the external carotid artery and hypoglossal artery to generate plaques with feathered endpoints from these branches. A Dacron (DuPont, Wilmington, Del) patch was fashioned and used to close our arteriotomy (Fig 4).

A carotid duplex ultrasound scan performed 1 month later revealed a 40% to 60% stenosis of the hypoglossal artery. This finding prompted further investigation with computed tomography arteriography (CTA), which demonstrated a 20% stenosis of the distal left ICA, a 25% stenosis at the proximal hypoglossal artery, and a 39% stenosis of the CCA near the proximal extent of our arteriotomy.

DISCUSSION

The first challenge in performing this carotid endarterectomy involved obtaining adequate preoperative imaging. Preserved communications between the carotid and basilar systems are often associated with altered patterns of blood flow to the brain. Unilateral or bilateral vertebral artery hypoplasia has been noted in 46% of patients with preserved type I proatlantal arteries, and was almost uniformly noted in the presence of a preserved hypoglossal artery. The posterior circulation receives its blood supply primarily from the preserved carotid-basilar communication, so the ipsilateral CCA supplies the entire region. These considerations underscore the importance of adequate imaging before revascularization to help ensure adequate cerebral perfusion during revascularization, which is one reason why we previously performed angiography before all carotid endarterectomies.

The second challenge involved identifying the left ICA and the hypoglossal artery during dissection. The preoperative angiogram (Fig 2) guided this decision. The hypoglossal artery course was posterior and lateral compared with the ICA. This was consistent with our intraoperative findings (Fig 4). The external carotid artery was identified by its location and the presence of the superior thyroid branch.

Maintenance of cerebral perfusion was our third challenge. Arteriographic right-sided contrast injection did not enhance the left middle cerebral artery or posterior circulatory system (Fig 3). The absence of vertebral artery flow bilaterally suggested that the entire vertebrobasilar system

![Fig 4. Intraoperative pictures demonstrate (A) a preserved hypoglossal artery (arrow) and (B) patch repair after carotid endarterectomy extending from the common carotid artery (CCA) onto the internal carotid artery. ECA, external carotid artery.](image-url)
and most of the left hemisphere were dependent on inflow from the left CCA. Intraoperatively, the lack of back bleeding from the left ICA and the hypoglossal artery confirmed the anticipated lack of collateral flow to the entire hemisphere after left CCA clamping.

Once the CCA-to-distal ICA shunt was opened, pulsatile back bleeding was noted from the hypoglossal artery. In our unpublished experience, this corresponds with a stump pressure of 50 mm, and a lack of such bleeding is interpreted as an indication for shunting. Either the ipsilateral posterior communicating artery was patent or leptomeningeal perforators supplied collateral anterior-to-vertebrobasilar flow.

If poor back bleeding from the hypoglossal artery had been noted despite the CCA-to-ICA shunt, we would have placed a Y-shaped shunt, fashioned with a multiple perfusion set (Medtronic Inc, Minneapolis, Minn) or dual intraluminal balloon shunts (Pruitt-Inahara, LeMaitre Vascular Inc, Burlington, Mass) with individual inflow provided to both the ICA and hypoglossal artery to ensure perfusion of the anterior and vertebrobasilar systems during clamping.8,9 Electroencephalographic or xenon perfusion monitoring are excellent adjuncts that could be used to provide more detailed documentation of adequate cerebral perfusion.

Our final challenge was the closure of the arteriotomy. We used a Dacron (DuPont, Wilmington, Del) patch, which crossed from the CCA to the proximal ICA (Fig 4). Our arteriotomy did not extend into the hypoglossal artery, nor did our patch. A postoperative duplex scan revealed a moderate stenosis at the origin of the hypoglossal artery, and CTA demonstrated a mild stenosis in the same location. Either residual plaque or narrowing secondary to compromise of the CCA and its branch vessels from our patch repair could be the cause of this stenosis. Perhaps our arteriotomy should have been Y-shaped extending into the hypoglossal artery to ensure technically optimal endpoints. Such details are critical in this type of revascularization to ensure optimal outcomes. Also, the use of intraoperative ultrasound may have identified this stenosis and allowed intraoperative repair. Reconstruction would then require the use of a Y-shaped patch to prevent additional narrowing of both the ICA and hypoglossal artery origin.

In conclusion, atherosclerotic stenosis of the extracranial arteries in the presence of a preserved hypoglossal artery presented significant technical complexity for the performance of an uncomplicated carotid endarterectomy. Preoperative angiography and detailed, individualized surgical strategy were use to maintain cerebral perfusion. The need for shunting should be anticipated for patients with this anatomy. Extensive Y-shaped arteriotomy and patch closure should be considered to avoid recurrent stenosis.

REFERENCES

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CORRECTION

Regarding the front cover, the second and last short titles in the bulleted list are incorrect. The following are the correct titles:

Open vs Endo AAA Repair in NSQIP Private Hospitals
Diagnostic MRA vs Arteriography for Renal Artery Stenosis