Hybrid repair of tandem high-grade innominate and carotid artery stenosis in an asymptomatic male

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ABSTRACT

Tandem atherosclerotic lesions of the innominate artery (IA) and internal carotid artery (ICA) are challenging and represent an inherent risk of cerebrovascular accident. Treating asymptomatic patients is controversial; therefore, it is critical to minimize the risk of a cerebrovascular accident if repair is undertaken. An asymptomatic 78-year-old man with a chronically occluded left ICA and tandem stenoses of the IA and right ICA underwent a hybrid intervention with stenting of the IA lesion and right ICA endarterectomy. The intra- and postoperative course was successful, without any signs of neurological sequelae. Sixteen months later, the patient remained asymptomatic, with patent reconstructions. (J Vasc Surg Cases Innov Tech 2024;10:101487.)

Keywords: Carotid endarterectomy; Endovascular repair; High-grade carotid stenosis; Neurologic protection; Supra-aortic occlusive disease

Concomitant high-grade innominate artery (IA) and internal carotid artery (ICA) stenoses are uncommon, with an incidence of <5%.[1] Current evidence supports treating symptomatic "tandem" proximal IA and ICA lesions with a hybrid approach of carotid endarterectomy (CEA) and retrograde IA balloon angioplasty and stenting.[2] This technique, described >2 decades ago, has demonstrated lower death and stroke rates than open repair.[3] Nonetheless, there is controversy regarding the treatment of asymptomatic patients.[4] We present a case of an asymptomatic patient with tandem proximal IA and right ICA atherosclerotic lesions and occlusion of the contralateral left ICA who underwent successful hybrid repair without neurological complications. The patient consented to publication.

CASE REPORT

An asymptomatic, physically active, 78-year-old man was found to have lower blood pressure in his right arm than in his left, with a gradient of 60 mm Hg. His relevant medical history included 20 pack-years of smoking, obesity (body mass index, 31 kg/m^2), hypertension, hyperlipidemia, and atrial flutter treated with warfarin. He denied a history of transient ischemic attack, stroke, coronary artery disease, upper or lower limb exertional discomfort, diabetes mellitus, or a family history of cardiovascular diseases. His physical examination revealed a right cervical bruit and weakly palpable right upper extremity pulses compared with the contralateral side. His femoral and popliteal pulses were normal and symmetrical.

Computed tomography angiography of the neck (Fig 1) revealed 95% stenosis of the right IA and occlusion of the left ICA with distal reconstitution. The right ICA had 80% to 90% stenosis at the carotid bifurcation. Both vertebral arteries (VAs) were patent. Bilateral carotid ultrasound revealed diffuse dampening in the right carotid system waveforms with low velocities in the common carotid artery (CCA; peak systolic, 35 cm/s), consistent with high-grade stenosis of the IA. A Doppler ultrasound evaluation (Fig 2) showed elevated velocities in the proximal ICA, consistent with ≥50% to 69% stenosis by velocity criteria (peak systolic, 166 cm/s; end diastolic, 118 cm/s), and bidirectional right VA flow, suggesting a steal phenomenon, possibly associated with remote episodes of dizziness reported by the patient in retrospect.

After thoroughly discussing the risks and alternatives, surgical intervention was deemed beneficial for the patient. A brain and neck magnetic resonance angiogram confirmed adequate supply of the left anterior intracranial circulation through the external carotid artery, ICA collateral vessels, and a complete circle of Willis. A pharmacological stress echocardiogram and chest radiograph did not show abnormalities, and electrocardiography evidenced the known atrial flutter. The patient was scheduled for open right CEA with retrograde stenting of the IA stenosis, using electroencephalography (EEG) for neuromonitoring.

Fig 3 illustrates the operative steps. First, standard exposure of the right carotid bifurcation and circumferential dissection of a 5-cm segment of the right CCA was conducted via a longitudinal neck incision. Second, brachial access was obtained through a 3-cm incision on the medial aspect of the right arm, and a 45-cm, 8F sheath was advanced into the mid-axillary artery.

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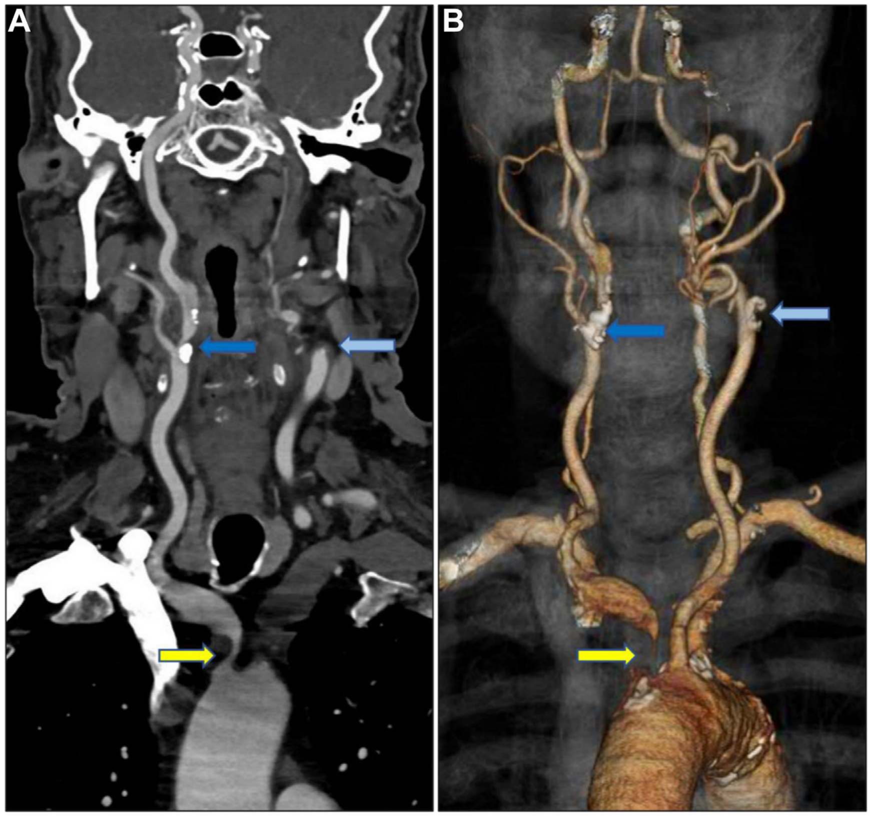

Fig 1. Preoperative computed tomography angiogram demonstrating noncalcified innominate artery (IA) high-grade stenosis (*yellow arrow*), right internal carotid artery (ICA) high-grade stenosis (*dark blue arrow*), and left ICA occlusion (*light blue arrow*). **A,** Reformatted coronal view. **B,** Three-dimensional reconstruction.

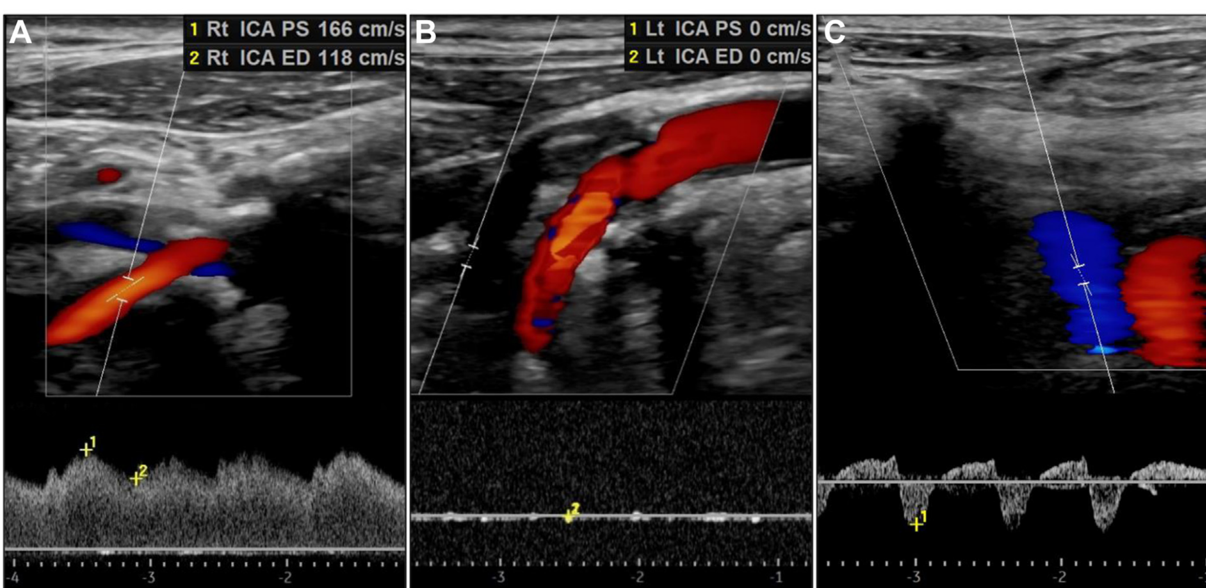

Fig 2. Preoperative carotid ultrasound showing dampened waveforms in the right internal carotid artery (ICA) and elevated velocities in the proximal ICA, consistent with 50% to 60% stenosis (**A**), absent flow in the left ICA (**B**), and bidirectional flow in the right vertebral artery (VA; **C**).

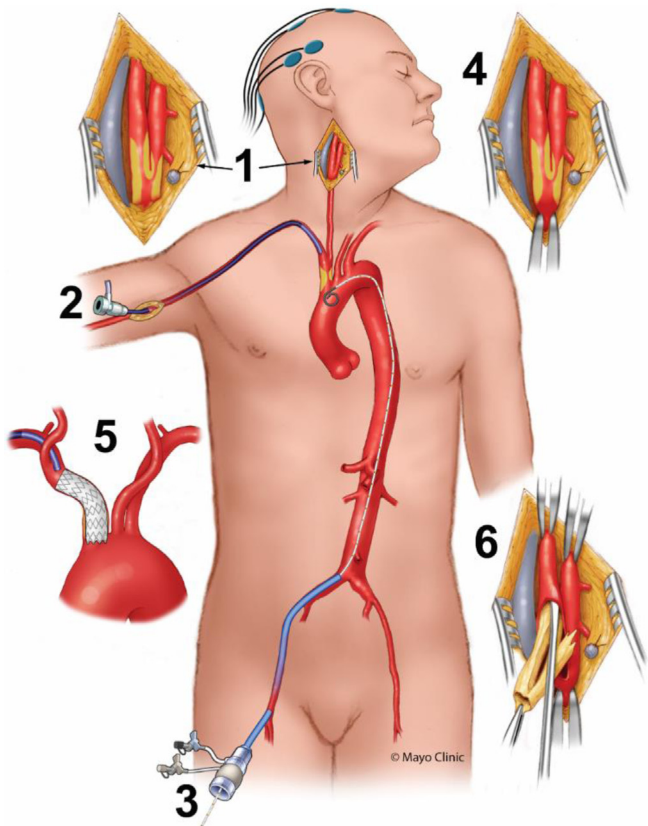

Fig 3. Diagrammatic representation of procedural steps. *1,* Standard right carotid bifurcation exposure; *2,* brachial access obtention and 8F sheath advancement into the mid-axillary artery; *3,* insertion of pigtail flush catheter into the ascending aorta via percutaneous right common femoral access; *4,* clamping of the mid-right common carotid artery (CCA) with an atraumatic vascular clamp; *5,* deployment of an 11-mm × 39-mm Viabahn stent across the innominate artery (IA) stenosis, with post-dilation to 14 mm; and *6,* CCA and internal carotid artery (ICA) endarterectomy with primary closure.

Third, for contrast injection, a pigtail flush catheter was introduced into the ascending aorta via percutaneous right common femoral access. Fourth, the mid-right CCA was occluded with an atraumatic vascular clamp to protect from distal embolization with flow cessation, and the IA lesion was crossed. Fifth, an 11-mm × 39-mm Viabahn VBX covered stent (W.L. Gore & Associates) was deployed across the IA stenosis and dilated to 14 mm. Aortography confirmed patency of the stent and both VAs, with no signs of dissection, and the right distal ICA was clamped in preparation for CEA. Finally, a high-grade, preocclusive calcified plaque was removed from the bulb and proximal ICA through longitudinal arteriotomy. The proximal and distal end points were secured with tacking sutures. Primary closure was feasible due to the artery's generous size.

After restoring flow to the external carotid artery, the ICA clamp was released, resulting in a strong, palpable pulse with a biphasic low-resistance Doppler signal. No EEG changes occurred during the procedure. Completion angiography revealed a widely patent IA, VAs, and right ICA without residual stenosis (Fig 4). The left ICA was chronically occluded. The incisions were closed, and the patient was extubated in the operating room without immediate neurological complications. After an uneventful postoperative course, the patient was discharged on chronic warfarin therapy and aspirin on day 2. At 16 months of follow-up, he remained asymptomatic, denied further episodes of dizziness, reported feeling more energized, and had bilateral palpable and symmetrical upper extremity pulses. Computed tomography angiography showed a widely patent IA stent with increased flow to the VA, a right patent ICA, and a chronically occluded left ICA (Fig 5).

DISCUSSION

Intervening in asymptomatic patients with supra-aortic atherosclerotic tandem disease is a topic of debate, but it could be appropriate after a thorough risk/benefit assessment. This patient's complex radiographic findings of multilevel occlusive disease, combined with his multiple cardiovascular risk factors, would likely have led to worsening stenosis and progression to occlusion if left untreated. Although natural history data are lacking, multivessel tandem disease suggests a significant atherosclerotic disease burden,[3] placing patients at moderate to high risk of stroke and global cerebral

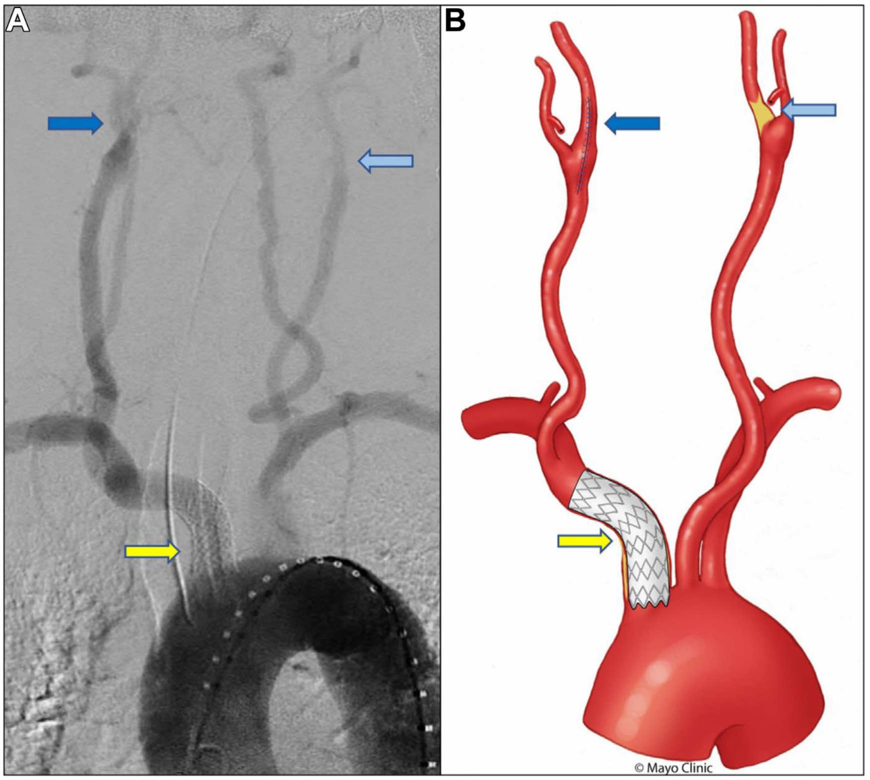

Fig 4. A, Intraoperative aortography demonstrating a widely patent innominate artery (IA) stent (*yellow arrow*) and right internal carotid artery (ICA) after endarterectomy (*dark blue arrow*), and a chronically occluded left ICA (*light blue arrow*). **B,** Diagrammatic representation.

hypoperfusion, particularly with unilateral brain flow dependence.

Atherosclerotic tandem lesions of the IA and ICA are rare and challenging. A systematic review reported a 30-day stroke and death rate of 3.3% for hybrid repair and 7% for open repair.[3] However, there is real-world evidence of a comparable 30-day risk of stroke or death between both techniques.[5] Clouse et al.[4] reported an elevated risk (11.1%) of perioperative stroke in asymptomatic patients undergoing hybrid repair, suggesting that intervention in asymptomatic patients should be avoided. The current guidelines favor a hybrid approach with IA retrograde stenting and ipsilateral CEA instead of open great vessel reconstruction in symptomatic patients.[6]

To ensure maximum neurological protection, a meticulous procedure is crucial. This involves distal CCA and proximal ICA dissection for surgical outflow control, followed by brachial access for IA stenting. Distal clamping before retrograde IA stenting prevents embolization to the brain.[7] Some experts recommend placement of a contralateral ICA embolic protection filter due to the risk of bilateral brain embolization.[8] The CCA is clamped after aortography confirmation, and aortography is repeated after stent deployment to confirm patency and the absence of dissection. Finally, CEA is performed with tacking sutures for technical success. Maintaining a careful surgical step order and EEG monitoring will minimize the risk of neurological damage.

Several technical alternatives were considered for the present patient. Some studies have linked temporary vascular shunts to higher morbidity and no reduction in perioperative cerebrovascular accident risk.[9,10] Therefore, our practice favors selective shunting based on intraoperative EEG changes, even with a raised systolic blood pressure (100 mm Hg) after distal clamping to enhance collateral flow. Retrograde transcarotid IA stenting has demonstrated safety and efficacy.[7] However, a transbrachial approach offers an ergonomically favorable option despite a theoretical risk of embolization when crossing the VAs. A transfemoral approach is technically feasible but could present challenges for distal cerebral protection and stent deployment accuracy due to the longer distance to the IA and the aortic arch angles involved.[11]

CONCLUSIONS

Asymptomatic tandem occlusive disease of the IA and ipsilateral ICA with contralateral ICA occlusion is an atypical presentation of multilevel atherosclerotic disease. Hybrid repair with transbrachial retrograde IA stenting and ipsilateral ICA endarterectomy can be a safe

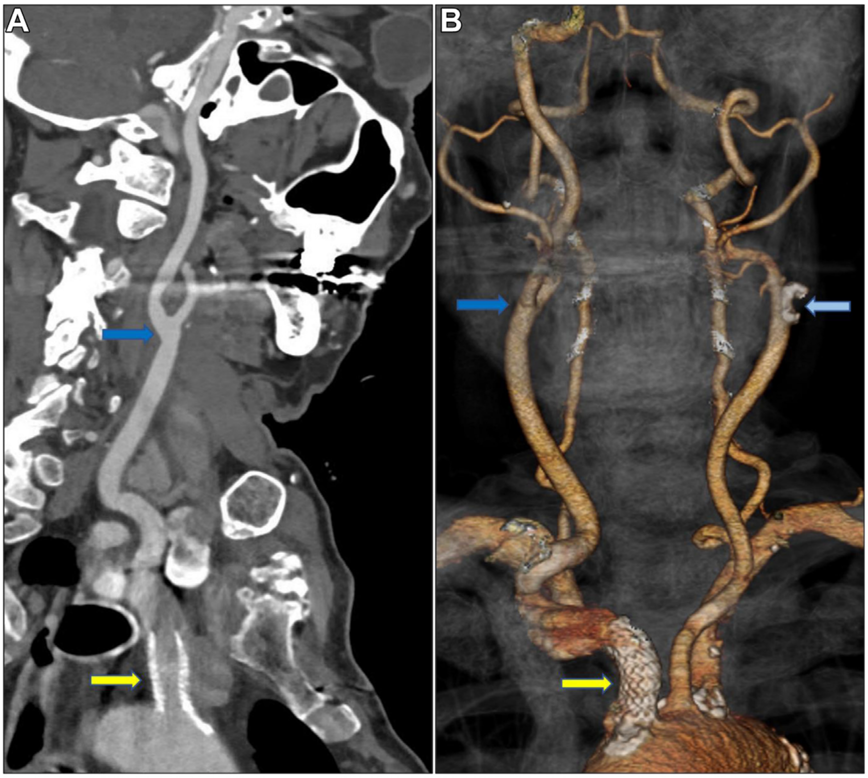

Fig 5. Computed tomography angiogram at 16 months of follow-up showing patency of the innominate artery (IA) stent (*yellow arrow*) and right internal carotid artery (ICA) after endarterectomy (*dark blue arrow*) and a chronically occluded left ICA (*light blue arrow*). **A,** Sagittal view. **B,** Three-dimensional reconstruction.

treatment option for selected asymptomatic patients with a high risk of stroke. A cautious surgical technique with distal carotid clamping for flow cessation before IA stenting can decrease the risk of intraprocedural cerebrovascular accidents.

DISCLOSURES

None.

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