Carotid artery replacement with superficial femoral artery in a patient with recurrent radiation-induced carotid artery stenosis

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ABSTRACT

A 58-year-old man presented with a right hemispheric transient ischemic attack from recurrent common carotid artery (CCA) in-stent restenosis. He had undergone prior neck radiation for carcinoma of the right tonsil and subsequent right carotid endarterectomy (10 years prior) and right CCA stenting (5 years prior), all for symptomatic radiation-induced stenosis. We performed CCA reconstruction using a transposed superficial femoral artery and pectoralis major myocutaneous flap coverage. Early stenosis of the proximal graft required angioplasty and stent grafting. However, at 1.5 years postoperatively, he has no further issues and a patent graft. This case highlights the options available for complex radiation-induced lesions of the carotid vessels. (J Vasc Surg Cases Innov Tech 2024;10:101488.)

Keywords: Carotid artery stenosis; Carotid artery stenting; Carotid endarterectomy; Radiation; Superficial femoral artery graft

The risk of developing carotid artery stenosis is higher for patients with prior radiation to the neck than for the general population.[1] Radiation-induced carotid artery stenosis (RICAS) differs from atherosclerotic disease in terms of both the pathological characteristics and the distribution pattern.[2] The choice of treatment modality must balance between the risks of stroke, wound healing, and nerve injuries due to a hostile neck anatomy. We report a case of recurrent RICAS managed by carotid artery replacement using a superficial femoral artery (SFA) graft. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 58-year-old man with hypertension, hyperlipidemia, type 2 diabetes mellitus, and a 75 pack-year smoking history presented to the clinic in 2021 with a history of transient weakness on the left side. His medical history was significant for squamous cell carcinoma of the right tonsil requiring modified radical neck dissection and postoperative radiation therapy (7000 cGy) in 2005. He developed symptomatic right carotid artery stenosis (70%) from RICAS for which he underwent carotid endarterectomy (CEA) at an outside facility in 2010 complicated by hypoglossal nerve injury. Five years later, in 2015, he presented with recurrent symptomatic multifocal severe stenosis of the right common carotid artery (CCA). Magnetic resonance imaging of the brain at this time revealed several foci of ischemic changes in the right posterior frontal white matter. He was treated with transfemoral right CCA stenting with distal embolic protection (10-mm × 37-mm Wallstent; Boston Scientific Corp) with an excellent result. Postoperatively, the patient received atorvastatin and dual antiplatelet (aspirin and clopidogrel) therapy, which was changed to single antiplatelet (aspirin) therapy after 3 months. During ultrasound surveillance, he developed a recurrent asymptomatic significant in-stent stenosis in 2019 (peak systolic velocity, 381 cm/s), which was managed medically by restarting clopidogrel, in addition to aspirin.

In 2021, he presented with a transient ischemic attack from critical stenosis (peak systolic velocity, 460 cm/s) of the right CCA stent (Fig 1). After discussing various treatment modalities with the patient (medical management vs redo angioplasty and stenting vs carotid reconstruction), we proceeded with carotid reconstruction. Preoperative vein mapping revealed a small great saphenous vein (2-3 mm). His SFA was 6 mm and free of disease and thought to be the optimal conduit. Due to the prior neck dissection and limited soft tissue coverage with radiation changes, a pectoralis major myocutaneous flap was planned for soft tissue coverage after the carotid reconstruction. Under general anesthesia, a partial sternotomy was performed to expose the innominate artery for proximal control (Fig 2, *A*). Following this, the right SFA was harvested and used as a conduit and was replaced using an 8-mm ringed polytetrafluoroethylene graft. Subsequently, under electroencephalographic monitoring, neck dissection was performed, and the CCA lesion was isolated. Before clamping, a therapeutic dose of heparin (10 IU/kg) was given, and the mean arterial pressure was increased by 10 mm Hg above the baseline. Next, the CCA was opened after clamping proximally at the origin, and the stent was explanted (Fig 2, *B*). The SFA conduit was transposed and sewn from the carotid

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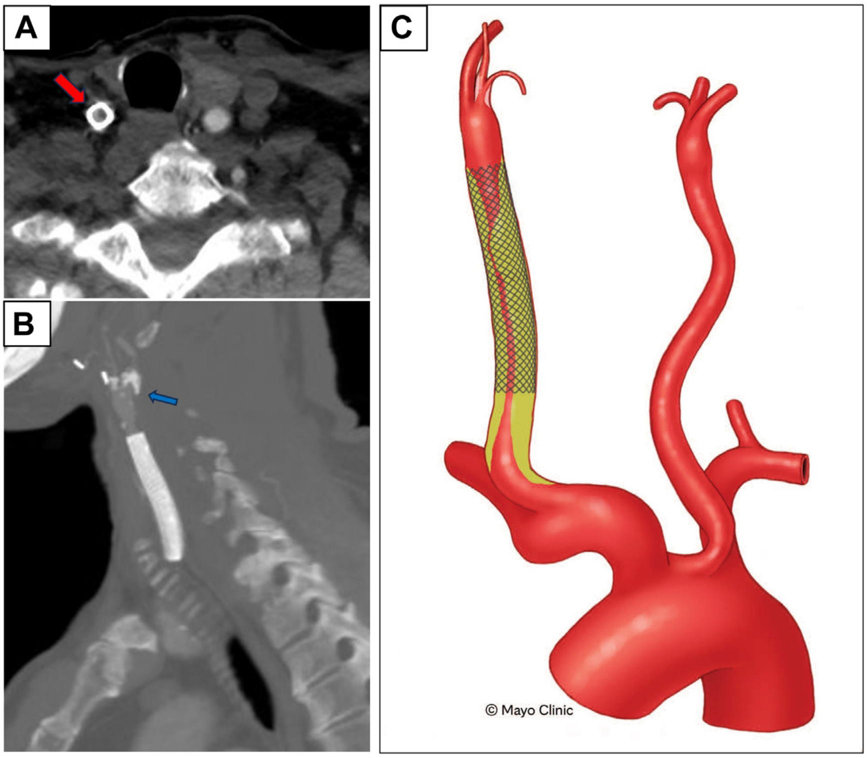

Fig 1. A, Axial section showing near complete occlusion of the right common carotid artery stent (*red arrow*). **B,** Sagittal section showing right common carotid artery stent and calcified plaque near a carotid bifurcation in the proximal external carotid artery and internal carotid artery. **C,** Illustration demonstrating critical in-stent stenosis of the right common carotid artery stent.

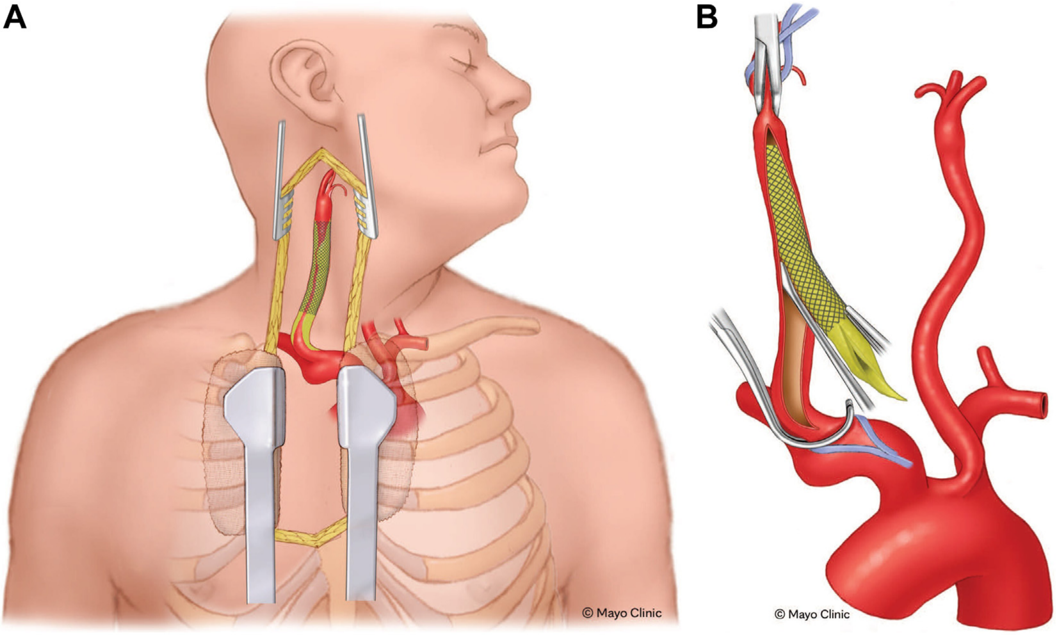

Fig 2. A, Illustration showing exposure of the innominate artery with partial sternotomy and exposure of the carotid artery on the right side of the neck. **B,** Arteriotomy and stent explantation.

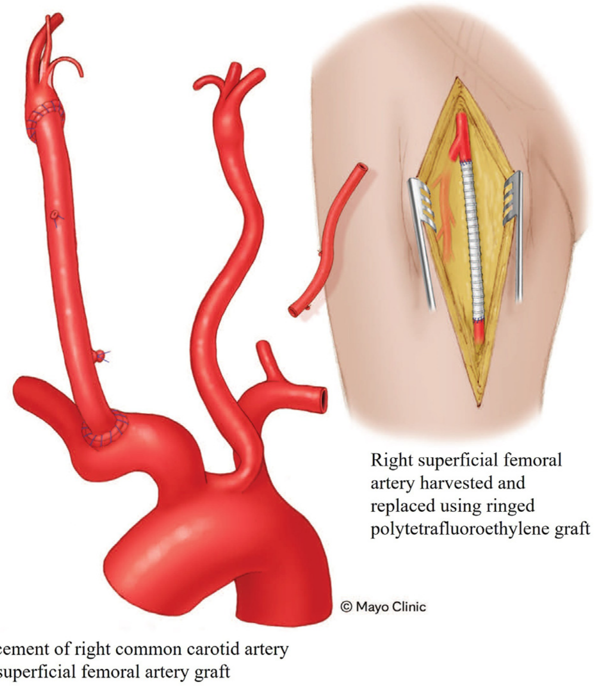

Fig 3. Right superficial femoral artery (SFA) as a conduit for right common carotid artery reconstruction and replacement of the SFA using a ringed polytetrafluoroethylene graft.

artery origin on the innominate artery to the carotid bulb as an interposition graft using 6-0 Prolene suture in a continuous fashion (Fig 3). Finally, a 7-cm × 5-cm pectoralis skin paddle based on the thoracoacromial artery was designed to include the pectoralis major muscle. The flap was then rotated 180° into the neck defect, and the muscle was sewn to the remnant of the sternocleidomastoid muscle (Fig 4). The chest incision was closed primarily over the drain. The cerebral ischemic time during the procedure was <30 minutes, and no electroencephalographic changes were observed throughout. His postoperative course was uneventful, and the patient was discharged with aspirin and statin therapy.

At 2 months of follow-up, he again developed transient left arm weakness. Magnetic resonance imaging of the brain showed new infarcts in the right frontoparietal cortex. On evaluation, there was critical stenosis at the proximal anastomotic site of the SFA graft. Angioplasty and stent grafting (6-mm × 22-mm iCast; Getinge Group) of the bypass graft was done (Fig 5). At 1.5 years of follow-up, the patient is doing well with no complaints. Both the carotid reconstruction and the polytetrafluoroethylene graft were patent without any stenosis. At this time, he developed symptomatic significant stenosis of the left internal carotid artery, which was managed by angioplasty and stenting (8 × 29 mm Wallstent; Boston Scientific Corp).

DISCUSSION

Previously published studies reported an incidence of carotid stenosis of 18% to 38% for patients following cervical radiation compared with 2% to 8% in the general population.[3,4] The interval between radiation exposure and subsequent carotid artery intervention ranged from 3 to 19 years.[2] In our case, the patient developed symptoms of carotid stenosis and underwent the first intervention (CEA) 5 years after the radiation exposure. Choosing an optimal treatment strategy for treating RICAS is challenging. Although CEA is the gold standard for atherosclerotic carotid artery stenosis, it is associated with higher rates of cranial nerve injuries and wound healing complications when performed in a radiated field due to tissue fibrosis. Carotid artery stenting can be considered as an alternative, because it is not associated with cranial nerve injuries. However, this should be balanced against the risks of stroke and restenosis, which are higher compared with the risks after CEA.[5]

In the present case, initial management of symptomatic RICAS was with CEA. This was complicated by hypoglossal nerve injury. The rate of nerve injuries associated with CEAs in radiated fields varies from 3% to 4.5%.[1,6] However, the rate can be as high as 28% in patients with a history of prior radical neck dissection.[7] Our patient had both of these risk factors. Although carotid stenting might reduce the risk of cranial nerve injury, other outcomes can be inferior to those with CEA. In a meta-analysis by Zhang et al,[2] carotid artery stenting for RICAS was associated with a higher risk of stroke (3.8% vs 0.2%) and restenosis (13.9% vs 6.3%) compared with CEA. The choices for managing in-stent stenosis due to RICAS are limited. Among the options considered, we believed carotid reconstruction was the most appropriate. Redo carotid artery stenting was not considered in this case due to the increased risk of stroke and embolization due to the near complete, long-segment in-stent stenosis. Although the great saphenous vein is often the first-line conduit, it was not thought to be usable in this case. Other venous conduits, such as the basilic, cephalic, or superficial femoral veins, are an option. However, in our experience with arterial reconstruction in high-risk fields, the SFA has shown excellent outcomes. In addition, a pectoralis major myocutaneous flap was used for wound closure given the limited availability of soft tissue. Both techniques have been previously described. Jacobs et al[8] in 1994 reported the first use of the SFA for carotid artery reconstruction in patients with head and neck malignancies. Carotid artery reconstruction with pectoralis major myocutaneous flap coverage has been reported as a safe and durable option to prevent wound complications when operating on a previously radiated field or to treat graft infections.[9]

Carotid artery reconstruction after radiation or prior surgery remains challenging. Guerra et al[10] reported the outcomes of carotid artery bypass in patients with hostile neck anatomy (prior radiation or surgery). They reported a 30-day rate of stroke and hypoglossal nerve injury in patients with hostile neck anatomy of 12% and 16%,

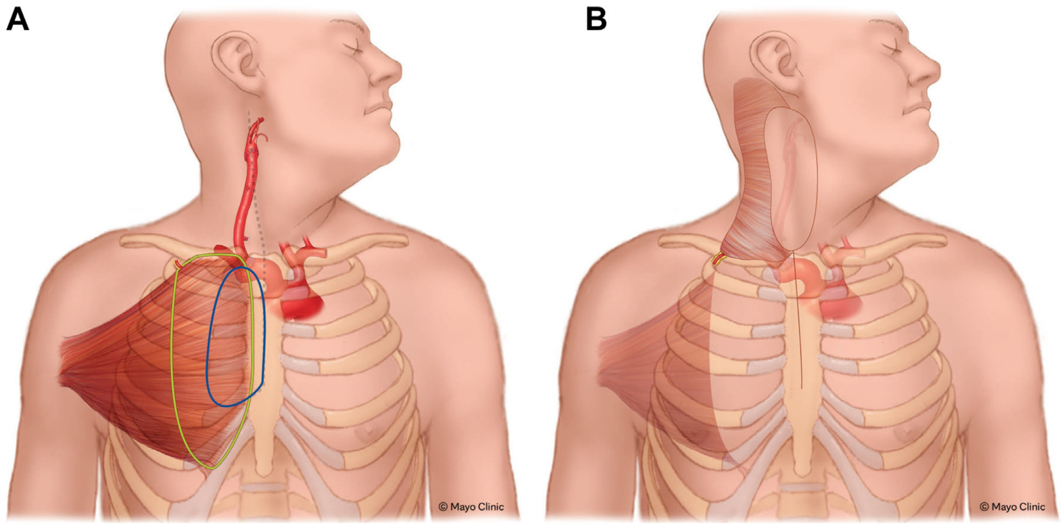

Fig 4. A, Harvesting a pectoralis major myocutaneous flap based on the thoracoacromial artery (*blue arrow*), skin paddle (*outlined in blue*), and muscle flap (*outlined in green*). **B,** The flap was rotated 180° and used to cover the neck wound.

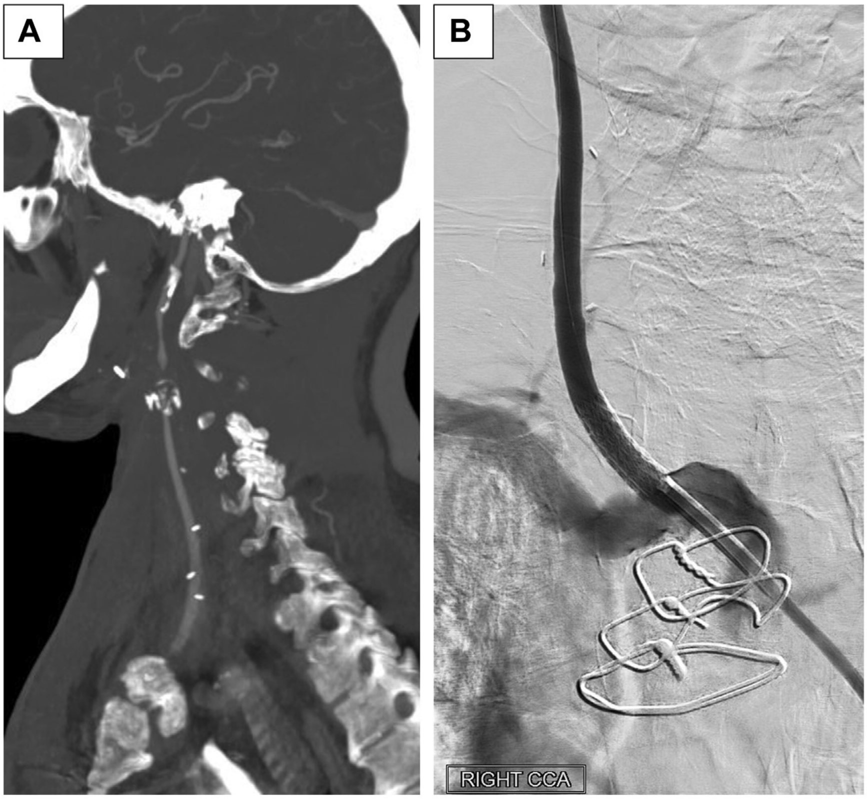

Fig 5. A, Sagittal section showing critical stenosis at proximal anastomotic site of superficial femoral artery bypass graft. **B,** Completion angiogram after bypass graft angioplasty and stent placement.

respectively.[10] These results should alert providers of the high-risk nature of these reconstructions. Although a small series, at 3 years of follow-up, the primary patency was 100%.[10] In our case, the patient did not experience any 30-day postoperative events but developed symptomatic recurrent stenosis at 2 months after reconstruction. Owing to the short-segment stenosis of the bypass segment, we managed it with angioplasty and stent grafting. The main limitation of this case report is the short follow-up, because the patient had developed recurrent stenosis in the past. However, at 1.5 years of follow-up, the patient is doing well without any symptomatic or imaging recurrence. This reinforces the need for diligent surveillance and follow-up.

CONCLUSIONS

Recurrent in-stent stenosis and radiation-induced injury of the carotid artery are complex case scenarios. These can be managed safely by stent explantation and reconstruction using autologous and synthetic conduits. Choosing an optimal technique based on the patient's anatomy and risk of stroke and multidisciplinary coordination are paramount for good long-term outcomes.

DISCLOSURES

None.

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