Endovascular management of saccular extracranial internal carotid artery aneurysm using transcervical carotid approach and flow reversal

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ABSTRACT

Transcervical endovascular management of saccular aneurysms of the extracranial internal carotid artery is an evolving treatment option. We report our experience during two decades in managing such a complex vascular scenario. Patients in this case series were symptomatic and had Eagle syndrome (elongated styloid processes in two cases and a calcified stylohyoid ligament in one case). All patients underwent endovascular stenting for expanding extracranial internal carotid artery saccular aneurysm using self-expandable covered stent grafts reinforced with a self-expanding nitinol stent. The approach was transcervical in all cases with cerebral protection by manual flow reversal. (J Vasc Surg Cases and Innovative Techniques 2019;5:273-7.)

Keywords: Endovascular; Internal carotid; Saccular aneurysm; Flow reversal; Transcervical

There is a dearth of large series to define the safest, most efficient approach in managing extracranial internal carotid artery (ICA) saccular aneurysms.[1] Reported 30-day mortality rate and stroke rate are 4.67% and 6.67%, respectively, with conservative management. However, with intervention, the rates drop substantially to 1.91% and 5.16%.[2] Consent for publication of their data was obtained from all patients included in this case series.

METHODS

Between 2002 and 2018, >12,000 patients were referred to our tertiary vascular services with carotid artery disease, of whom 813 (6.7%) had carotid intervention. Three (0.4%) patients presented with symptomatic ICA saccular aneurysm. All patients underwent intervention and had preoperative computed tomography angiography (CTA), duplex ultrasound marking, and 150 mg of clopidogrel 16 hours before the intervention.

All three patients had an ICA saccular aneurysm of Attigah type I[3] (Figs 1-3). In all cases, there was no history of infection, and inflammatory marker levels were normal. The likely etiology was mechanical, specifically Eagle syndrome.[4-7] Two patients had elongated styloid processes, longer than 3 cm (Figs 2 and 3), whereas the other patient had a calcified stylohyoid ligament[8] (Fig 1).

TECHNIQUE

All cases in this series were done in vascular theater under general anesthesia with transcervical approach and manual flow reversal under induced systolic hypertension. Cerebral perfusion was monitored using the INVOS system (Medtronic, Minneapolis, Minn), which provides a continuous noninvasive measurement of cerebral oxygen saturation. Intraoperatively, patients received 5000 units of heparin intravenously, and activated clotting time was measured to ensure a value above 250 seconds. All patients had postoperative CTA of the carotid artery and were observed every 6 months with duplex ultrasound scan.

Transcervical access was achieved through a transverse incision 15 mm above the clavicle between both heads of the sternocleidomastoid muscle. A 7F sheath was inserted, after controlling the common carotid artery with a Vessel-Clude (Medica Europe BV, Oss, The Netherlands). Cerebral protection was done through reversal of flow, which was achieved by clamping of the common carotid artery and application of negative pressure by connecting a VacLok (Merit Medical, Jordan, Utah) syringe to the 7F sheath (Fig 4). The flow reversal vacuum was created only during steps in the procedure that are associated with increased risk of embolization, namely, lesion crossing and covered stent deployment.[9,10]

All stent diameters were sized 1 mm larger than the maximum diameter of the ICA into which they were deployed. We used a Viabahn stent graft (W. L. Gore & Associates, Flagstaff, Ariz). In cases of excessive tortuosity and to overcome external mechanical forces, the Viabahn was reinforced by deploying an Xact tapered stent (Abbott Vascular, Abbott Park, Ill) within the Viabahn to

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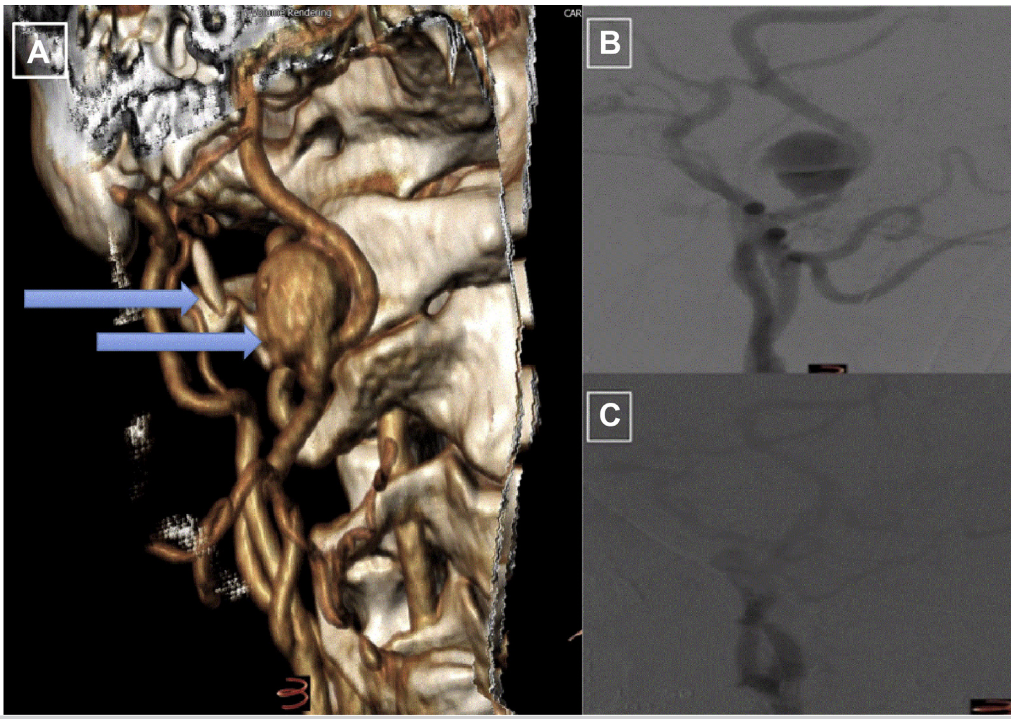

Fig 1. A 68-year-old man presented with crescendo transient ischemic attacks. Computed tomography angiography (CTA) showed a 16-mm right internal carotid artery (ICA) saccular aneurysm. **A,** Three-dimensional reconstruction of preoperative CTA image demonstrating calcified stylohyoid ligament and associated aneurysm (*arrows*). **B,** Intraoperative image before stent deployment. **C,** Intraoperative image after stent deployment (Viabahn, 6 mm × 5 cm [W. L. Gore & Associates, Flagstaff, Ariz]; Xact carotid tapered stent, 8/6 × 40 mm [Abbott Vascular, Abbott Park, Ill]).

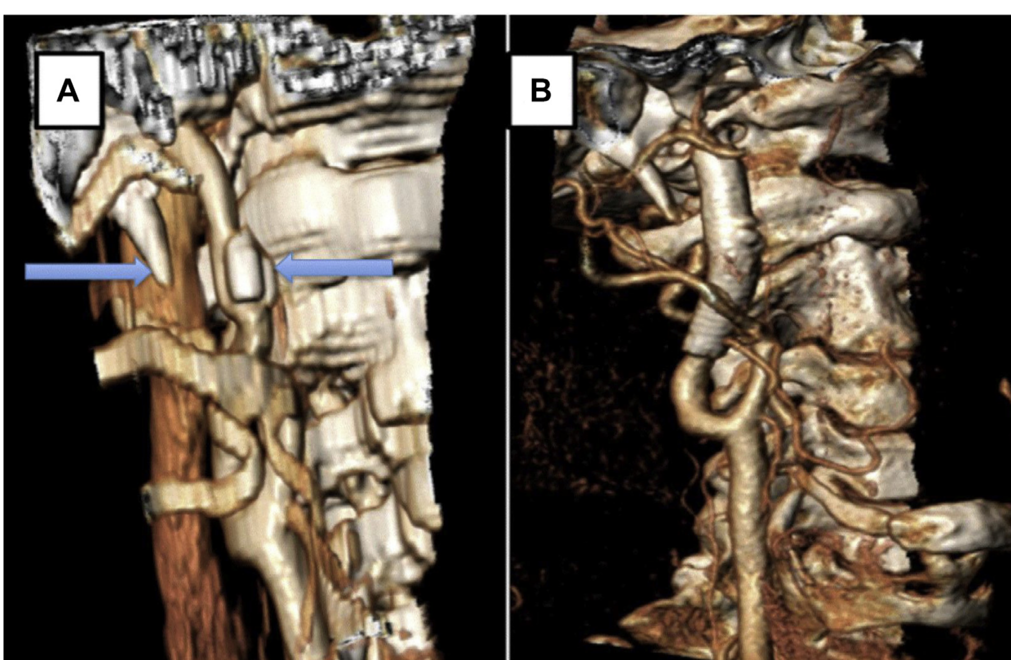

Fig 2. A 66-year-old man presented with a right cerebrovascular accident. Computed tomography angiography (CTA) showed an 11-mm right internal carotid artery (ICA) aneurysm and elongated styloid process (*arrows*). **A,** Three-dimensional reconstruction of preoperative CTA image. **B,** Three-dimensional reconstruction of post-operative CTA image (Viabahn, 7 mm × 5 cm [W. L. Gore & Associates, Flagstaff, Ariz]; Xact carotid tapered stent, 9/7 × 40 mm [Abbott Vascular, Abbott Park, Ill]).

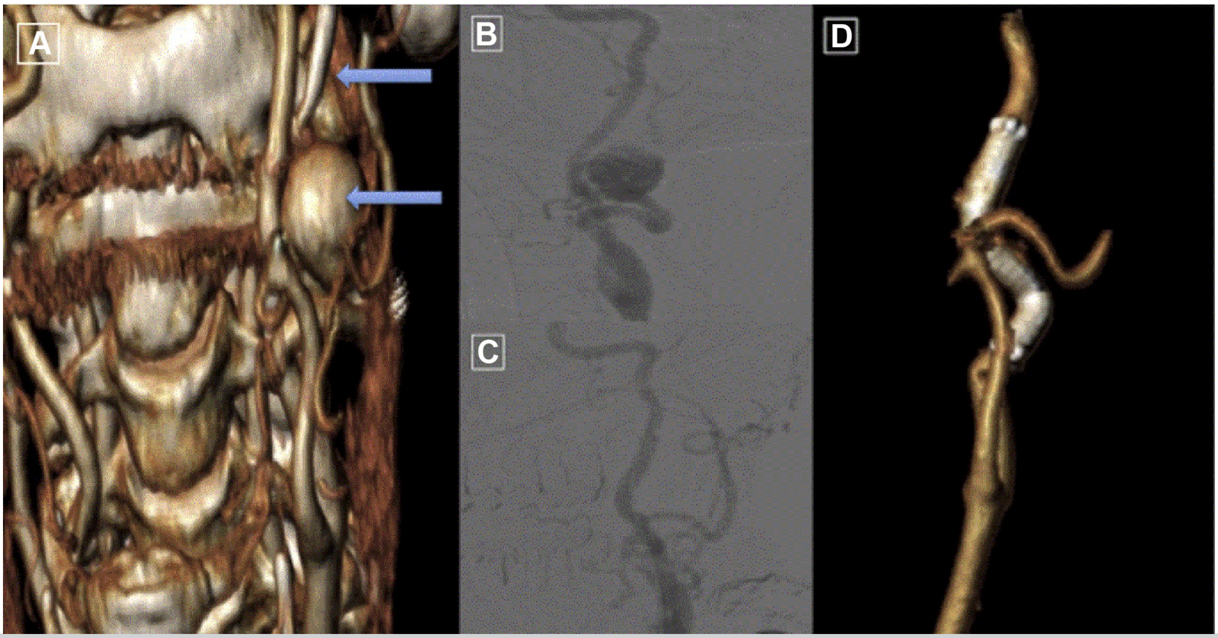

Fig 3. A 79-year-old woman with a 17-mm left internal carotid artery (ICA) saccular aneurysm discovered on computed tomography for follow-up after aortic valve replacement and slurred speech. **A,** Three-dimensional reconstruction of preoperative computed tomography angiography (CTA) image demonstrating elongated styloid process and associated ICA aneurysm (*arrows*). **B,** Intraoperative image before stent deployment. **C,** Intraoperative image after stent deployment (Viabahn, 5 mm × 5 cm [W. L. Gore & Associates, Flagstaff, Ariz]; Xact carotid tapered stent, 8/6 × 40 mm [Abbott Vascular, Abbott Park, Ill]). **D,** Three-dimensional reconstruction of postoperative CTA image.

add more radial force to the proximal part because of ICA tortuosity. Completion angiography was performed with emphasis on the M1, A1 area and flow through the stent. All patients were discharged home on direct oral anticoagulation with clopidogrel for 6 months, then clopidogrel indefinitely.[11-13]

Case 1. A 68-old-man with a 50-pack-year history of smoking presented to the emergency department with a 1-day history of two episodes of left arm and leg weakness lasting <1 hour on both occasions. On examination, no residual neurologic deficit was found. At the time of presentation, he had been taking aspirin 300 mg daily for cardiac comorbidities.

Computed tomography of the brain showed acute ischemia in the right parietal lobe. CTA showed a 1.6-cm saccular aneurysm of the right extracranial ICA. Deployment of a 6- × 5-mm Viabahn stent was successful, followed by placement of an 8/6×40-mm Xact stent inside the Viabahn. Completion angiography showed complete exclusion of the aneurysm with normal flow through the stents. The patient recovered well postoperatively, with no recurrence of symptoms. Follow-up CTA showed patent stents with fully thrombosed aneurysm (Fig 1).

Case 2. A 66-year-old man was under yearly active surveillance for right ICA aneurysm since 2009. He was taking rivaroxaban 20 mg daily and had significant comorbidities, including hypertension, atrial fibrillation, left atrial appendage, myocardial infarction with percutaneous coronary stents in 2009, left hemispheric cerebral stroke in 2010, and seizures since then. The carotid CTA examination revealed right extracranial ICA saccular aneurysm at the level of C2 and level of the mandible and demonstrated size increase from 0.8 to 1.1 cm. The patient had three attacks of right amaurosis fugax despite oral anticoagulation. The case was discussed at the multidisciplinary meeting, and it was agreed that the patient should undergo right ICA stenting to seal the orifice of the aneurysm. The postoperative period was uneventful with good recovery. Six weeks later, CTA of the carotid artery confirmed patency of the stent and complete exclusion of the aneurysm with full sac thrombosis. At 3-year follow-up, the patient was asymptomatic, and duplex ultrasound revealed a patent right ICA stent with complete aneurysm exclusion (Fig 2).

Case 3. A 79-year-old woman had a background history of nonvalvular atrial fibrillation, diabetes mellitus, aortic valve replacement 3 years previously, and documented 60% stenosis in the right ICA. She was taking 10 mg of rivaroxaban daily. The patient was complaining of left-sided neck pain and intermittent slurred speech. Carotid duplex ultrasound documented left ICA aneurysm. The patient underwent CTA, which showed a 1.8-cm saccular aneurysm of the left extracranial ICA

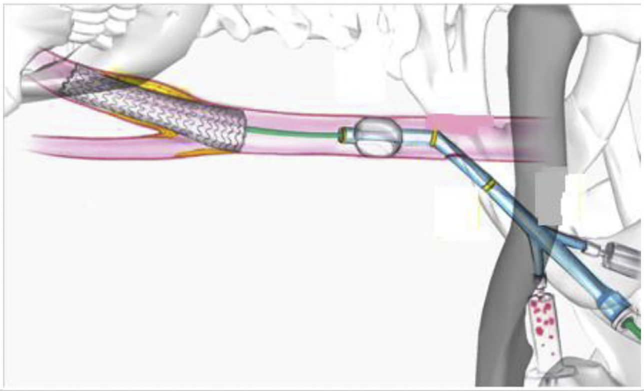

Fig 4. Flow reversal and cervical access system. This system connects a VacLok (Merit Medical, Jordan, Utah) syringe to a 7F introducer sheath. The flow reversal afforded by the syringe mechanism is not continuous. It is performed only during critical steps of the procedure, that is, lesion crossing, stent deployment, and balloon angioplasty. On each occasion the vacuum is generated, the syringe is filled and emboli are visible within the collected blood. Unlike continuous flow reversal systems, the VacLok system creates a vacuum only on deployment of the stent or during balloon angioplasty. This blood is not injected back into the patient as no more than 100 mL is collected during the course of the procedure.

(Fig 3, *A*). Deployment of a 5- × 50-mm Viabahn stent was successful. Completion angiography showed complete exclusion of the aneurysm with normal flow through the stent (Fig 3, *B* and *C*). The patient's recovery was uneventful. Follow-up CTA at 18 months showed a patent stent with fully thrombosed aneurysm (Fig 1, *D*).

DISCUSSION

Selection of treatment options largely depends on aneurysm anatomy, including size and length.[14] Evidence about best treatment is scarce owing to the rarity of disease and publication bias.[15] Treatment of the extracranial carotid artery aneurysm is necessary in most cases because of the high risk of fatal complications related to embolization and local compression.[15] Conservative management is associated with a 71% mortality rate,[4] and ligation carries catastrophic consequences.

Extracranial carotid artery aneurysms account for 0.4% to 1% of all arterial aneurysms and about 4% of peripheral artery aneurysms.[16,17] Any segment of the common carotid artery, external carotid artery, and ICA can be affected, although the ICA is most commonly involved.[18,19]

Our findings in this case series concur with those of Bartoli et al[20] that nontraumatic saccular aneurysms of the extracranial ICA are rare and represent <1% of all indications for revascularization of the ICA. Our approach agrees with that of Angiletta et al[21] that endovascular therapy should always be considered in managing Attigah type I aneurysms located in the mid-distal ICA. Like other authors,[22,23] we found that endovascular stenting of extracranial ICA aneurysms was associated with few procedure-related complications and a short recovery time.

With contemporary perioperative mortality results similar for open and endovascular repair, endovascular repair remains an effective alternative method for treatment of extracranial ICA aneurysm, especially for higher lesions with avoidance of cranial nerve injuries.[2,24] We used Viabahn endograft because of its extreme flexibility and conformability to the vessel configuration during head and neck movements. One of the limitations of the endovascular approach is the embolization risk.[20] We believe that endovascular exclusion with the Viabahn stent is an efficient and safe procedure despite the anatomic difficulty. The transcervical access decreases the risk of embolization from excessive manipulation of the arch compared with the femoral approach.[25] This has been studied using diffusion-weighted magnetic resonance imaging, and the transcervical access is particularly useful in combination with flow reversal in vulnerable patients, such as elderly and symptomatic patients.[26]

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