Treatment of a symptomatic intrathoracic internal carotid artery

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ABSTRACT

Intrathoracic common carotid artery bifurcations are an anatomic anomaly with such rarity that only six cases have been reported to date. The true incidence of and preferred treatment options for a diseased intrathoracic common carotid artery bifurcation or internal carotid artery (ICA) have not been clearly described. This case report describes a 72-year-old man who experienced a postoperative right hemispheric stoke after an aortic valve replacement, radiofrequency maze procedure, and left atrial appendage clip. Postoperative cerebrovascular evaluation revealed a severely diseased intrathoracic ICA that was treated by ligation of the diseased proximal ICA and transposition of the distal ICA to the disease-free external carotid artery. The patient provided written consent to present the history, data, and images in this manuscript. (J Vasc Surg Cases and Innovative Techniques 2017;3:171-4.)

CASE REPORT

A 72-year-old man presented with symptomatic aortic stenosis and proximal atrial fibrillation. Preoperative evaluation confirmed no clinical evidence of carotid bruits and normal blood pressure of the upper extremities, severe symptomatic aortic valvular stenosis, proximal atrial fibrillation, and normal findings on coronary angiography. The patient was consented and taken to the operating room for right internal jugular venous access, intraoperative epiaortic ultrasound examination, aortic valve replacement, radiofrequency maze procedure, and left atrial appendage clip. Immediately after postoperative extubation, the patient demonstrated evidence of a right hemispheric stroke. Although a stroke from his most recent surgical intervention was likely possible, a full stroke workup including cerebrovascular imaging with duplex ultrasound suggested that the velocities of the right carotid artery were within normal range. Concurrently, ultrasound imaging suggested an anatomic anomaly at the level where the carotid bulb normally lies. Computed tomography angiography (CTA) and magnetic resonance angiography (MRA) analysis of the head and neck confirmed the anomaly as an intrathoracic carotid bulb bifurcation with a severely diseased internal carotid artery (ICA) and a normal-appearing external carotid artery (ECA; Fig 1, *A*). Furthermore, CTA and MRA confirmed that there was no aortic arch, innominate artery, or subclavian artery disease present (Fig 1, *A*). After an uneventful 1-month postoperative cardiac surgery recovery with minimal neurologic deficits remaining from his initial postoperative stroke, the patient returned for treatment of his symptomatic right aberrant diseased ICA.

To date, no standardized treatments have been published for a rare aberrant, symptomatic right carotid artery. Consequently, treatment of this rare symptomatic ICA was pursued following a novel, unconventional surgical treatment plan. Preoperative CTA and MRA findings presented anatomic options that would allow us to safely perform a transposition of the distal ICA with a normal-appearing antegrade-flowing ECA origination from the intrathoracic bulb while ligating the diseased proximal ICA. A standard right-sided neck incision was performed; the ICA and ECA were exposed and brought under routine vascular exposure (Fig 1, *B*). After standard heparinization and appropriate ICA and ECA vascular control, the ICA was divided just distal to where the ICA became normal caliber and free of disease. There was excellent retrograde ICA flow; the diseased proximal ICA was ligated at approximately the C4 level. A lateral posterior arteriotomy was made in the ECA, and an end-to-side anastomosis was created between the ICA and ECA (Fig 2, *A*). After hemostatic anastomosis, routine flushing and deairing were performed, followed by re-establishment of cervical-cerebral blood flow. Intraoperative Doppler analysis confirmed excellent distal ICA diastolic flow. Heparin was reversed in the standard fashion, all wound layers were closed, and the patient was awoken from anesthesia with no neurologic sequel. The patient had an uneventful postoperative recovery and was discharged home on postoperative day 2.

Postoperative head and neck CTA revealed excellent flow in the common carotid artery (CCA), ECA, ICA-ECA anastomosis, and distal ICA (Fig 2, *B*). Further postoperative evaluation consisted of carotid duplex ultrasound imaging of the surgical repair (Fig 3), demonstrating a peak systolic velocity of 0.6 m/s and an end-diastolic velocity of 0.22 m/s, consistent with normal distal ICA flow.

DISCUSSION

The standard surgical carotid endarterectomy for atherosclerotic ICA disease is a complex procedure that

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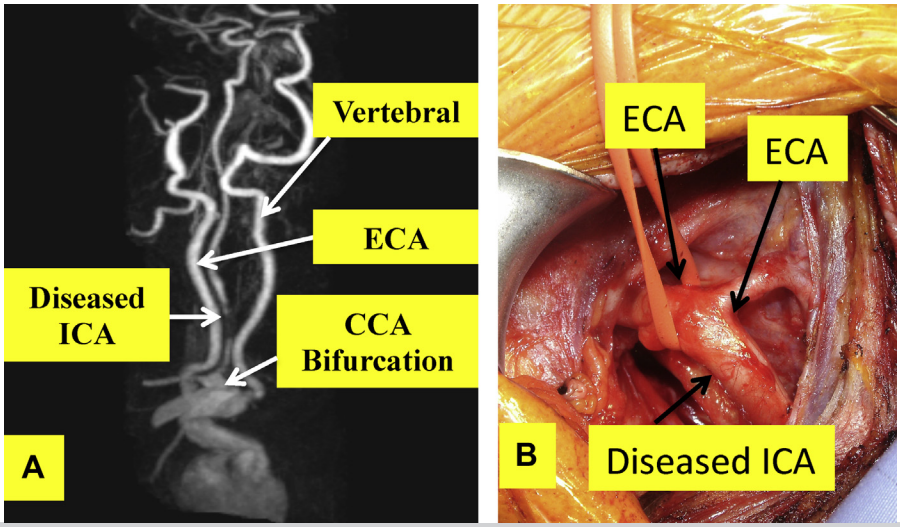

Fig 1. A, Magnetic resonance angiography (MRA) image shows the preoperative intrathoracic carotid bifurcation and the severely diseased internal carotid artery (*ICA*). **B,** Intraoperative photograph shows the diseased ICA before bypass and disease-free external carotid artery (*ECA*). *CCA*, Common carotid artery.

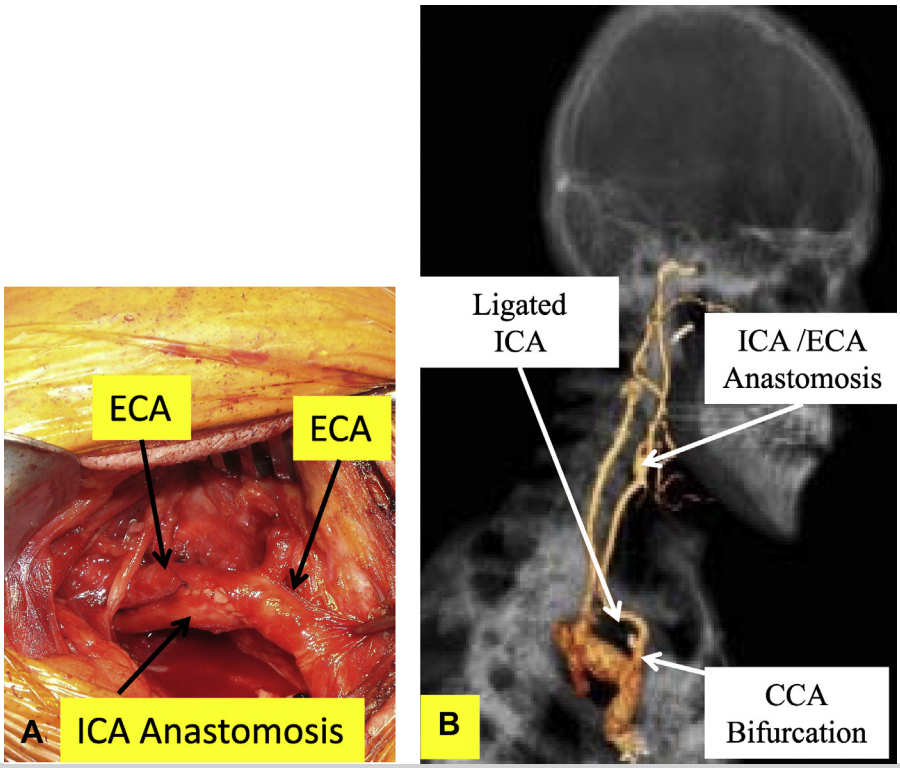

Fig 2. A, Intraoperative photograph showing the internal carotid artery (*ICA*) to external carotid artery (*ECA*) bypass. **B,** Three-dimensional computed tomography angiography (CTA) detailing the ICA to ECA bypass and ligation of the proximal diseased ICA. *CCA*, Common carotid artery.

requires a full understanding of all normal and potentially anomalous neck anatomy.[1-5] Variability of the right CCA bifurcation occurring below the cervical vertebra is an infrequent occurrence. Clinical reports suggest that the level at which the CCA bifurcates is most common at vertebral levels C3 to C5. Variability of the CCA bifurcation can be found as high as C1 and as low as the thoracic inlet, with anatomic data demonstrating frequencies of high, normal, and low bifurcation locations as 31.2%, 57.5%, and 11.3%, respectively.[5,6]

Selection of patients for surgical, endovascular, or medical management for cerebrovascular disease has

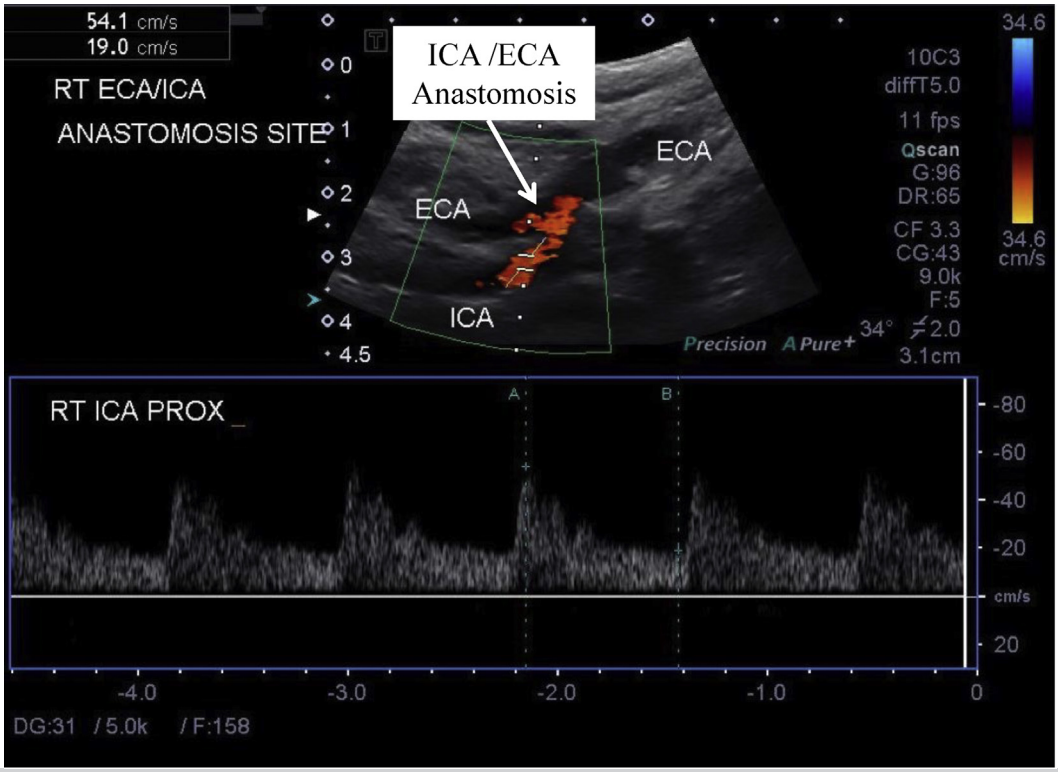

Fig 3. Carotid duplex ultrasound shows the internal carotid artery (*ICA*) bypass to the external carotid artery (*ECA*) with normal ICA velocities.

been clearly outlined in a multidisciplinary consensus statement.[7,8] Absolute and relative contraindications to endovascular therapy for cerebrovascular disease have been well established.[8] A number of surgical and endovascular treatment options were considered in the treatment of this patient's diseased carotid anatomic anomaly.

We present a patient with an exceptionally long and heavily diseased ICA originating within the chest at approximately T3, which then became normal in caliber around C3-C4. The ECA appeared normal with minimal disease on preoperative evaluation. These anatomic arrangements presented an opportunity to re-establish distal ICA flow by performing an ICA to ECA transposition with ligation of the diseased proximal ICA. This report describes a case in which we thought that a conventional surgical or endovascular approach would be difficult, with an increased risk of further intraoperative stroke. Intrathoracic carotid bifurcations present a challenging situation in performing a satisfactory, durable, and safe endarterectomy. The anatomic anomalies of the CCA, particularly the variance of the level at which the CCA bifurcation occurs, play a significant factor in the diagnosis, planning, and treatment of carotid arterial disease.

CONCLUSIONS

Carotid endarterectomy procedures are complicated and meticulous, requiring superior understanding of head and neck anatomy. Adding variance into an already anatomically complex region of the body can present considerable challenges.[4] Normal anatomic position of the CCA bifurcation takes place at the level of C3 to C5, nearest the body of the hyoid bone and the superior border of thyroid cartilage.[4-6] Consequently, bifurcations of the CCA as low as the T3-T4 level are an extremely rare anatomic occurrence, providing extensive interest in the clinical, diagnostic, radiologic, and treatment options.[1,4] This case report offers an unconventional surgical treatment option that may serve to reduce intraoperative embolic sources while re-establishing normal distal ICA flow. The durability of this procedure is yet to be determined; yearly duplex ultrasound analyses are recommended. Two years after the procedure, the patient remains neurologically asymptomatic and continues to demonstrate normal duplex ultrasound velocities.

REFERENCES

1. Acar M, Ulusoy M, Zararsiz I, Efe D. Anatomical variations in the branching of human aortic arch. Biomed Res 2013;24:531-5.
2. Gailloud P, Murphy KJ, Rigamonti D. Bilateral thoracic bifurcation of the common carotid artery associated with Klippel-Feil anomaly. Am J Neuroradiol 2000;21:941-4.
3. Gomez CK, Arnuk OJ. Intrathoracic bifurcation of the right common carotid artery. BMJ Case Rep 2013.

4. Lo A, Oehley M, Bartlett A, Adams D, Blyth P, Al-Ali S. Anatomical variations of the common carotid artery bifurcation. ANZ J Surg 2006;76:970-2.
5. Uzun L, Kokten N, Kilicaslan A, Tasel B, Tayyar Kalcioglu M, Tekin M. Bilateral lower cervical bifurcation of the common carotid artery. Case Rep Otolaryngol 2013;2013:894804.
6. Bakheit MA, Al Gahtani FM. Low bifurcation of the common carotid arteries: an anatomical and radiological study. East Mediterr Health J 2013;19:S227-8.
7. Moore WS, Barnett HJ, Beeb HG, Bernstein EF, Brener BJ, Brott T, et al. Guidelines for carotid endarterectomy: a multidisciplinary consensus statement from the Ad Hoc Committee, American Heart Association. Circulation 1995;91:566-76.
8. Roubin GS, Iyer S, Halkin A, Vitek J, Brennan C. Realizing the potential of carotid artery stenting proposed paradigms for patient selection and procedural technique. Circulation 2006;113:2021-30.

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