Aberrant left vertebral artery transposition and concomitant carotid-subclavian bypass for treatment of acute intramural hematoma with thoracic endovascular aortic repair

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Aberrant left vertebral artery (LVA) origin off the aortic arch is an uncommon anatomic variant. Treatment of the thoracic aortic pathology that necessitates its coverage has not been described. We present a patient with an acute intramural hematoma with a dominant LVA originating from the aortic arch. A LVA-to-carotid artery transposition with shunt placement, carotid-to-subclavian bypass, and thoracic endovascular aortic repair were performed. The patient recovered uneventfully, without any evidence of stroke. This case study shows that aberrant left vertebral anatomy presents a unique and interesting challenge and that vertebral shunt techniques during revascularization can be performed without stroke. (J Vasc Surg 2016;■:1-5.)

Aberrant vertebral artery origin off the left-sided aortic arch is an uncommon anatomic variant seen in ~2% to 6% of the population.[1,2] The most common variation is a left vertebral artery (LVA) originating between the left common carotid artery (CCA) and left subclavian artery (LSCA).[1] These variants are usually of no clinical significance except when encountered when treating cerebrovascular or thoracic aortic pathology.[3,4] We present an interesting case of an acute intramural hematoma (IMH) necessitating coverage of the aberrant dominant LVA and its surgical management. The patient consented to this presentation.

CASE REPORT

A 61-year-old male engineer presented to his primary care physician with hypertensive crisis with systolic blood pressures >200 mm Hg. He had a medical history of untreated hypertension. He complained of chest pain. Results of the electrocardiogram and troponin analysis were consistent with a non-ST segment elevation myocardial infarction, and cardiac catheterization demonstrated extensive coronary artery disease.

The patient was transferred to our institution for evaluation for coronary revascularization. On arrival, his systolic blood pressures were 150 to 180 mm Hg with no chest pain. Physical examination was unremarkable, with equal palpable pulses in all extremities. An echocardiogram demonstrated a normal ejection fraction at 50%. A chest computed tomography revealed a large IMH spanning the distal aortic arch and descending aorta with two penetrating aortic ulcers just distal to the takeoff of the LSCA (Fig 1). In addition, his aberrant arch anatomy was noted, comprising a bovine arch and LVA directly off the arch proximal to the origin of the LSCA. Given these findings, the patient was evaluated for repair of the IMH and penetrating aortic ulcers before coronary revascularization.

A preoperative computed tomography angiogram of the neck and brain to evaluate the cerebral circulation (Fig 2) demonstrated a dominant LVA from its anomalous origin terminating in the basilar artery without any posterior communicating arteries to complete the circle of Willis. The right vertebral artery was severely atretic at its origin and absent in the posterior cerebral circulation (Fig 2, *a-c*). After multidisciplinary discussion, thoracic endovascular aortic repair (TEVAR) before coronary artery bypass grafting (CABG) was favored.

A staged approach was planned with a vertebral artery transposition with a shunt to preserve posterior circulation flow, followed by carotid-to-subclavian bypass with polytetrafluoroethylene to preserve the left internal mammary artery (LIMA) as the conduit for subsequent CABG, and then TEVAR. This was deemed to offer the least morbidity because aortic clamping during CABG could result in retrograde propagation of the IMH and a fatal myocardial infarction.

A left cervical incision over the anterior border of the sternocleidomastoid was performed to expose the CCA. The LVA was identified more medially and posterior in the neck. A longitudinal arteriotomy was made in the LVA, and a Pruitt F3 shunt (LeMaitre Vascular, Burlington, Mass) was inserted into the proximal and distal LVA (Fig 3, *a*). The balloons of the Pruitt F3 shunt were gently inflated to secure it in place.

The anastomosis was then performed in an end-to-side fashion using a parachute-suturing technique of posterior-to-medial and anterior-to-lateral vertebral-to-carotid wall, respectively, until ~90% of the anastomosis was completed to allow for maintenance of the shunt until flow could be restored. The shunt was then removed, the proximal LVA was ligated to allow for the final sutures placed in the anastomosis, and the parachuted-sutures were cinched and tied. The proximal end of the vertebral artery was oversewn. This minimized ischemic time to <2 minutes (Fig 3, *b*).

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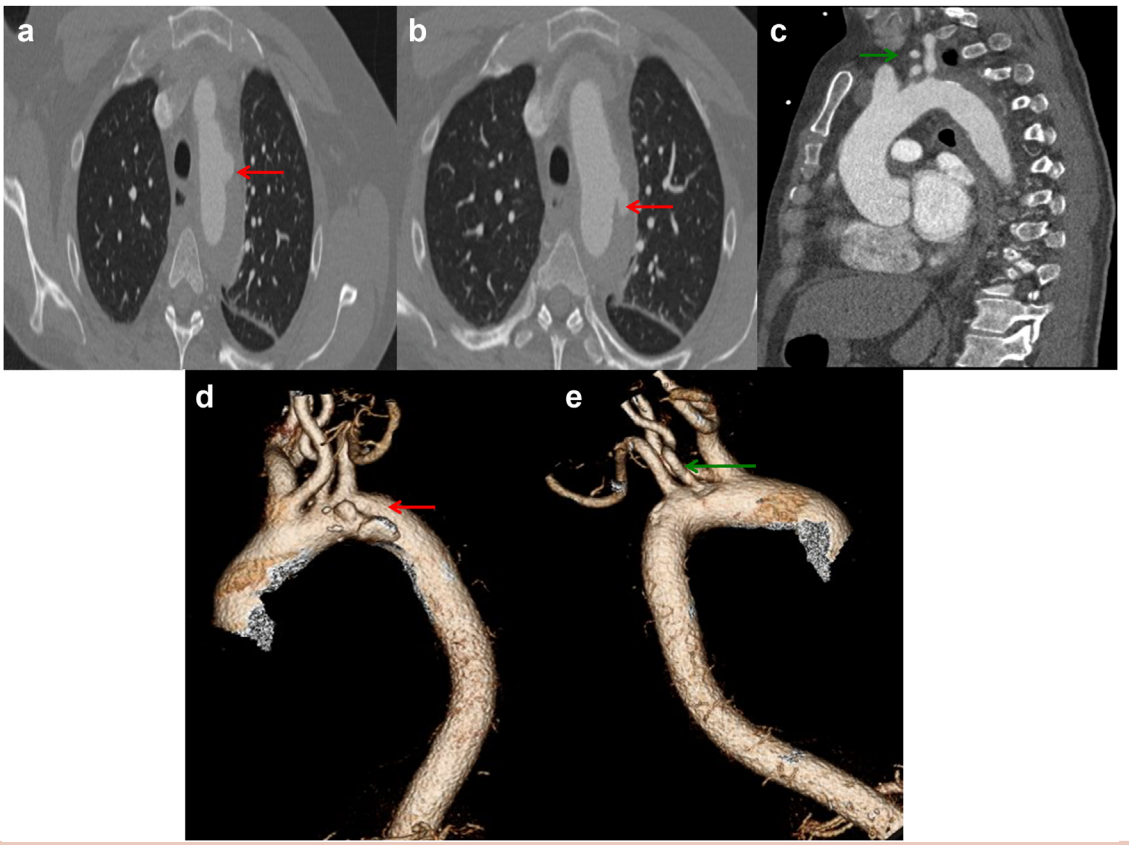

Fig 1. a, b, and **d,** Computed tomography angiogram of the thoracic aorta demonstrates two penetrating aortic ulcers (*red arrows*) and surrounding type B intramural hematoma (IMH). **c,** Dominant left vertebral artery (LVA) arising from the aortic arch between the common bovine trunk and the left subclavian artery (LSCA). **e,** Posterior view three-dimensional reconstruction. The *green arrows* in **c** and **e** indicate the LSCA.

A supraclavicular incision was performed to expose the LSCA. The LSCA-polytetrafluoroethylene anastomosis was performed first, then the CCA was clamped distal to the vertebral artery transposition, and an end-to-side anastomosis was performed (Fig 3, *b*). Standard TEVAR with a Gore conformable (C)-TAG (W. L. Gore & Associates, Flagstaff, Ariz) endograft was performed next through percutaneous bilateral groin access.

A completion angiogram demonstrated no evidence of endoleak as well as brisk flow through the grafts and cervical vessels (Fig 3, *c*). Recovery was uneventful, with no stroke. The patient underwent single-vessel CABG with a LIMA to the left anterior descending artery 2 weeks later. At the 1-year follow-up, he had no further symptoms, with a widely patent vertebral artery and carotid-subclavian bypass (Fig 3, *d* and *e*).

DISCUSSION

An aberrant LVA is an uncommon aortic arch anomaly present in ~2.4% to 5.8% of the population.[5] The aorta develops during the third week of gestation from a dorsal and ventral aortic bud that gives rise to six paired branchial arch arteries.[2] The regression of the right dorsal aortic root and right ductus arteriosus leaves the normal left aortic arch, and any deviation from this results in arch anatomy variation. The most common variants include bovine anatomy with a common brachiocephalic trunk, which occurs in 10% to 22%, coarctation of the aorta in 5% to 7%, and an LVA arising from the arch in 2% to 6% of the population.[6,7] This aberrant LVA typically arises between the left CCA and the LSCA, as seen in this patient.

This variant becomes especially important when treating thoracic aortic disease. In this patient with a dominant LVA and no posterior communicating arteries to complete his circle of Willis, revascularization of the LVA was critical in maintaining posterior cerebral perfusion. However, there are currently no reports in the literature of an association between LVA dominance and an incomplete circle of Willis, making this the first reported case. Given the rarity of this occurrence, there is a dearth of literature on the best way to manage these anomalies.

Because the LVA arises off the LSCA in most cases, with ~40% of thoracic aortic pathology treated by TEVAR necessitating its coverage, this may allow for extrapolation of criteria in deciding when to revascularize the anomalous vertebral artery.[8] Surgical options for