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Recurrent aortic dissection in a patient with an actin mutation treated with a laser-fenestrated aortic arch stent-graft

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Abstract

A 58-year-old African-American female, who had previously undergone a valve-sparing aortic root replacement for a type A dissection, represented 2 months later with a new focal dissection and aneurysm with intramural hematoma just distal to the origin of the left subclavian artery. Since no landing zone distal to the subclavian artery existed, the patient underwent TEVAR with laser fenestration-aided stent-graft placement in the left subclavian artery. The patient recovered without complication, and 52 months later is doing well with normal renal function and ambulatory status.

Introduction

Metachronous aortic aneurysms and dissections are rare. Individuals with connective tissue disorders and anomalous arch anatomy appear to be susceptible.¹ As endovascular techniques continue to evolve, these patients can now be treated with advanced endovascular technologies. Herein, the case of a woman with a bovine arch and history of prior cardiovascular surgery for a type A dissection who returned 2 months later with a new descending thoracic aortic aneurysm and type B dissection is presented. She underwent successful thoracic endovascular aortic repair (TEVAR) with an arch endograft into zone 1 with laser fenestration and stent-graft placement within the left subclavian artery. Consent was obtained for publication.

Case Report

A 58-year-old African American female with a history significant for a bovine aortic arch, hypertension, severe obesity, and 2 first-degree relatives with aortic dissections originally

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pre-sented with an ascending aortic aneurysm and acute type A dissection with intramural hematoma, extending from the aortic root to the iliac arteries. In addition, a 4.8-cm juxtarenal abdominal aortic aneurysm (AAA) was noted. She was taken emergently to the operating room for a valve-sparing aortic root replacement with a Dacron interposition graft. She recovered without complication.

The patient represented 2 months later with new-onset chest pain and hoarseness. Cross-sectional imaging demonstrated a new descending thoracic aortic aneurysm with a focal dissection just distal to the left subclavian artery (Figure 1). The bovine branch vessels and the left subclavian artery were spared from the dissection, and the arch zone 1 territory measured 2.4 cm (Figure 2). As there was no landing zone distal to the subclavian artery, a carotid to subclavian bypass in tandem with TEVAR was entertained. However, due to the patient's body habitus, a custom laser-fenestrated aortic arch graft was performed.

Access was obtained via left brachial and right femoral artery cutdowns. A lumbar drain was used. Intraoperative aortography demonstrated a large, irregular thoracic aneurysm with a focal dissection along the greater curve of the arch. The lumen measured 4.6 cm. The left subclavian artery was widely patent and measured 7 mm proximally. The primary endograft was a 32 mm 32 mm × 129 cm Valiant device deployed via the right common femoral artery from takeoff of the bovine arch zone 1 to the proximal descending aorta. This was extended with a 36 mm × 36 mm × 117 cm Valiant graft distally.

The pigtail from the arm was exchanged over a wire for the laser fiber, and a Morpheus tip-deflecting catheter was used to direct the laser fiber. A fenestration was made in the graft, and a 0.014 wire was passed through the fenestration into the ascending aorta. The fenestration was balloon dilated with a 4-mm balloon, and then an 8 mm × 38 mm iCast covered stent was deployed through the fenestration and was flared using a 10-mm balloon. Completion aortography demonstrated a patent bovine arch and left subclavian artery with antegrade flow into the left vertebral artery and the left internal mammary artery (Figure 3). There was no endoleak. The patient recovered without complication and was discharged on postoperative day 5.

Genetic testing was performed based on her history. A 12-gene thoracic aortic aneurysm and dissection panel detected a novel variant in the smooth muscle alpha-actin (ACTA2) gene classified as a novel disease-causing mutation (c.1 A>G; p.Met1).

She was doing well and after 6 months returned for surveillance ultrasound of her AAA, which showed an increase in the diameter. Elective, open repair was performed 2 months later. She tolerated the operation well and was discharged on post-operative day 6. She has since been doing well with serial follow-up for over 52 months with normal renal function and normal ambulatory status (Figures 4 and 5).

Discussion

Recurrent dissections are extremely rare and only typically seen in patients with connective tissue disorders.²⁻⁴ A recent study by Isselbacher et al showed that among 3624 patients with initial dissection, just 5% developed another dissection, and of those with recurrent

dissections, more than 21% had Marfan syndrome.⁴ While this patient does not have the clinical or molecular diagnosis of Marfan syndrome, she was found to have a disease-causing mutation in the ACTA2 gene. ACTA2 encodes for the actin isoform present in aortic smooth muscle, and mutations in this gene are associated with familial thoracic aortic aneurysm and/or dissection disorder.^{5,6} Disease-causing mutations in the ACTA2 gene are the most common cause of nonsyndromic hereditary thoracic aortic aneurysm and dissection, accounting for up to 21% of cases.⁷ Unlike connective tissue disorders like Marfan and Loeys-Dietz syndrome, patients with ACTA2 mutations usually have no physical manifestations of disease, so they unfortunately may not be recognized until an aortic event occurs in the patient or a family member.⁸ Importantly, it has been recommended that patients identified with an ACTA2 mutation undergo elective surgical repair when the aortic root or arch reaches a maximal diameter of 4.5 cm.⁸

Some genotype–phenotype correlations are available for patients with ACTA2 gene mutations. Patients with disease-causing ACTA2 mutations have a 76% risk of dissection or aneurysm repair by the time they reach 85 years, with type A dissections more common than type B (54% vs 21%).⁹ Some ACTA2 gene mutations affecting specific amino acid residues (eg, R258) have been associated with higher risks of aortic dissection/repair and other systemic diseases like premature coronary artery disease, ischemic stroke, and moyamoya disease.¹⁰ The specific disease-causing ACTA2 gene mutation found in this patient has not been previously reported in the literature. This variant was predicted to be disease-causing by the laboratory as it alters the start codon of the ACTA2 gene (ie, the first amino acid), and protein translation may be pre-vented entirely or an abnormal protein may be produced using an alternate methionine residue.

The presence of the bovine arch not only added to the complexity of the case but may have also contributed in predisposing the patient to aortic pathology. A higher prevalence of aneurysms and dissections has been reported in patients with bovine anatomy compared with the normal population.¹¹ It has been hypothesized that altered blood flow could be the culprit for the susceptibility to dissection, in addition to underlying genetic alterations in these patients.¹²

In situ radiofrequency laser fenestration is not a new concept. However, its utility in an emergent scenario is relatively novel. Redlinger et al. published a series of 22 emergent TEVARs with concomitant left subclavian artery laser fenestration; primary patency was 100% at mid-term follow-up, and no major complications were observed.¹³ At our institution, we have experienced similar results and now use laser fenestration routinely, especially in situations with complex anatomical considerations. As technology improves and arch grafts evolve, laser fenestration may serve a lesser role in the treatment of patients with poor landing zones and inadequate aneurysm necks.

Conclusion

This is the case of a 58-year-old woman with a bovine arch and history of prior type A dissection repair who returned 2 months later with a new descending thoracic aortic aneurysm and associated type B dissection. She was successfully treated using an arch graft

with laser fenestration and stent-graft of the left subclavian artery. Elective repair of a growing juxtarenal AAA was also performed in the interval, and follow-up for over 52 months shows her to be doing well with normal kidney function and ambulatory status. Subsequent genetic testing showed her to carry a mutation in the ACTA2 gene, highlighting the importance of serial clinical follow-up in these patients and their at-risk family members, as they can be susceptible to developing recurrent aneurysms and dissections along their native aorta.

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Figure 1.

Computed tomography angiography (CTA) of the aorta. Inset (A) is 1 month status post repair of the ascending aneurysm and dissection. There is no aneurysm of the proximal descending thoracic aorta. Inset (B) demonstrates CTA taken 2 months later with development of a new aneurysm with penetrating atherosclerotic ulcer and focal dissection.

Figure 2. Computed tomography angiography (CTA) of the proximal landing zone at the time of representation with new focal dissection distal to the left subclavian artery. The arch vessels are spared from the dissection and the zone 1 territory of the arch measures 2.4 cm.

Figure 3.
Intraoperative completion aortography after thoracic endovascular aortic repair (TEVAR) and laser fenestration of the left subclavian artery.

Figure 4.
Follow-up 3-dimensional volume-rendered computed tomography angiography (CTA) of the aorta at 5 years.

Figure 5.
Computed tomography at 52-month follow-up.