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Embolization of a congenital arteriovenous malformation arising off the internal mammary artery

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ABSTRACT

Congenital arteriovenous malformations (AVM) of the internal mammary artery (IMA) are exceptionally rare. Patients with AVMs arising off the left IMA may present with continuous precordial murmurs and/or a pulsatile chest mass. AVMs in this location pose a risk of enlargement, rupture, infection, or high-output cardiac failure. The potential risks associated with AVMs warrant early therapeutic intervention. We describe a case of a congenital AVM originating from the left IMA, which was successfully embolized with *n*-butyl cyanoacrylate (NBCA) using a transcatheter arterial approach.

1. Introduction

Arteriovenous malformations (AVM) of the internal mammary artery (IMA) are exceptionally rare, primarily described in isolated case reports [1–4]. AVMs in the chest wall are most often attributed to iatrogenic causes, typically post-operative following median sternotomy, although a few traumatic and congenital etiologies have been described in the literature [1–4]. Patients may present with continuous precordial murmurs that may be confused clinically with a patent ductus arteriosus, particularly in cases of congenital IMA AVM [1,3]. Affected patients may also have associated pulsatile masses of the chest wall [2]. These AVMs pose risk of enlargement, rupture, infection, or high-output cardiac failure [1,4]. The potential risks associated with AVMs warrant early intervention of regardless of size [4,5]. In this report, we describe a case of a congenital AVM of the left internal mammary artery (LIMA) to left internal mammary vein (LIMV), which was embolized successfully using *n*-butyl cyanoacrylate (NBCA) via a transcatheter arterial approach.

2. Case report

A 9-year-old male with no prior medical or surgical history presented with a one-year history of a pulsatile soft tissue mass arising from the left anterior chest wall, immediately lateral to the sternum, which had gradually increased in size over time (Fig. 1). There was no antecedent trauma or procedural history. Clinically, the patient had no associated pain, skin breakdown, or episodes of bleeding from the area. A chest ultrasound was performed which revealed a vascular mass with arterial Doppler signal. Subsequent CT angiography to further delineate the lesion demonstrated an AVM in the left anterior chest wall arising from the LIMA and connecting directly to the LIMV (Fig. 2a). Given the

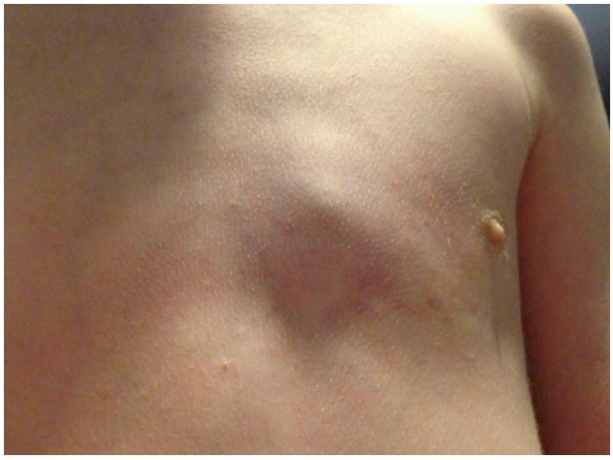

Fig. 1. 9 year old male presented to Interventional Radiology (IR) clinic with a pulsatile left chest wall mass.

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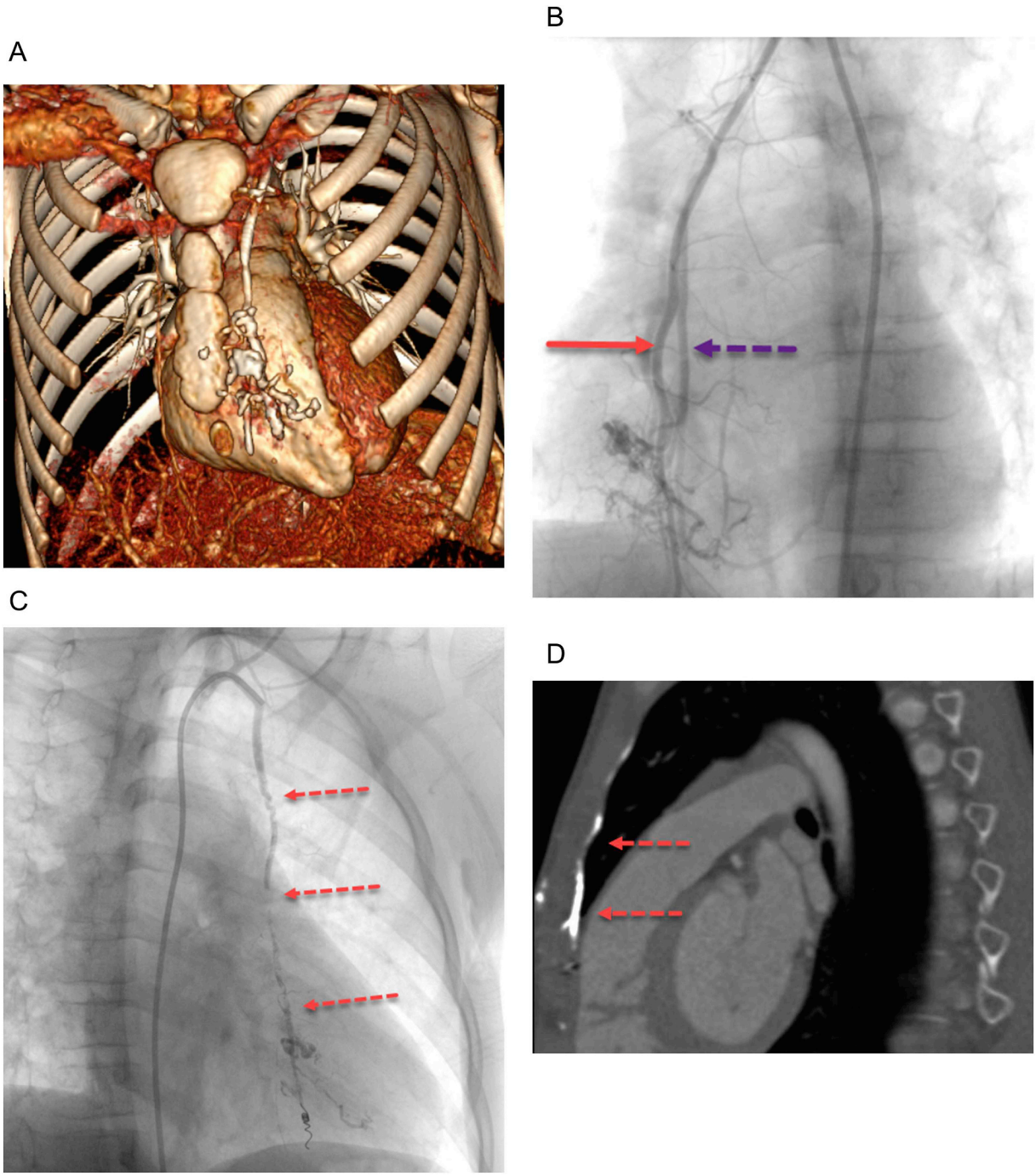

Fig. 2. a. Given the patient's constellation of history and physical exam findings, a CT scan was obtained which demonstrated an arteriovenous malformation (AVM) arising off the left internal mammary artery. A 3D rendered image of the CT scan delineates the extent of the AVM.
b. The patient was brought to the IR suite for angiogram and embolization. With a catheter placed in the left internal mammary artery, an angiogram was performed which confirmed the AVM arising off the left internal mammary artery (LIMA, red arrow) connecting to the left internal mammary vein (LIMV, dashed purple arrow).
c. The AVM was treated with nBCA glue mixed with Lipiodol in a 1:3 ratio which filled the LIMA and AVM nidus. Post-treatment angiogram via the left internal mammary artery demonstrates glue filling the LIMA (dashed red arrows) and no further filling of the AVM.
d. Follow-up CT obtained one month post procedure demonstrates nBCA glue filling the LIMA (dashed red arrows) and complete resolution of the AVM. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

natural history and inherent risks of untreated AVMs, the decision was made to treat the AVM using a transcatheter approach.

3. Procedural details

The risks, benefits and alternatives of the procedure were discussed with the family and informed consent was obtained. The procedure was performed under general anesthesia. The right common femoral artery was accessed using micropuncture technique under ultrasound guidance. A standard 0.035″ guidewire was then placed followed by a 5 French sheath. An aortogram was performed with a pigtail flush catheter positioned in the aorta. Next the left subclavian artery was selected. Digital subtracted angiogram (DSA) of the left upper extremity from the left subclavian artery revealed the AVM to be arising off the

left IMA with immediate filling of the left IMV (Fig. 2b). The left IMA was selected with a 2.4 French Progreat microcatheter (Terumo Interventional Systems, Somerset, NJ) and 0.018″ GT guidewire (Terumo Interventional Systems, Somerset, NJ). After careful evaluation of the DSA images the choice was made to use glue as an embolic agent. There were multiple small arterial feeders (< 1 mm) off the IMA feeding the AVM which precludes catheterization and embolization with coils. Glue was thus selected due to its ability to penetrate and embolize the several small arterial feeders of the AVM. The microwire and microcatheter were navigated past the AVM and a micronester 2 mm coil was placed to prevent any glue from migrating down into the abdomen. The AVM was then embolized using TRUFILL *n*-Butyl cyanoacrylate glue (Depuy Synthes, USA) and lipiodol mixed in a 1:3 ratio. Repeat angiogram following glue embolization was performed and showed no further filling of the AVM (Fig. 2c). All catheters, wires, and sheaths were removed and hemostasis achieved with manual pressure.

The patient tolerated the procedure and was discharged home the same day with anti-inflammatory and pain medications. A follow-up CT angiogram performed one month after the procedure revealed that the AVM was completely treated (Fig. 2d). The patient returned to IR clinic for follow-up at 1 month and 6 months after the procedure, which revealed the left chest wall pulsatile mass had resolved and there was no further precordial murmur.

4. Discussion

There are a few reports in the literature of congenital AVMs of the internal mammary vessels [1,4,6]. Congenital, traumatic, and iatrogenic causes are the primary etiologies described in the literature [1–4]. The patient in this case had no history of trauma, prior thoracic surgery, or other medical conditions, making a congenital origin the underlying etiology of his LIMA AVM. IMA AVMs typically present with continuous precordial and parasternal murmurs that are often associated with a pulsatile mass, which was the clinical presentation of our patient [1,2].

Given the rarity of these anomalies, there is a paucity of evidence regarding natural history and management of LIMA AVMs. In the few cases that have been published, a number of potential risks have been reported including AVM enlargement, rupture and subsequent hemorrhage, and increased risk of subacute bacterial endocarditis [1]. Although rare, the most concerning of the reported complications is high output cardiac failure secondary to the shunt physiology of IMA AVMs.

In this patient, there was an AVM connecting the IMA to the internal mammary vein, which drains into the azygous vein. Given the connection of a high pressure arterial system to a more central venous system, this patient was considered at risk for developing high output heart failure. Concerns for complications in this patient were amplified by the observation that the mass lesion had steadily increased in size over the course of one year.

Endovascular intervention with transcatheter embolization, rather than open surgical repair, is recommended for AVMs. Open surgical approaches for chest wall AVMs repair usually require sternotomy or thoracotomy incisions with high associated morbidity and surgical risks, whereas endovascular embolization is less invasive, with improved visualization under fluoroscopic guidance [2]. Overall transcatheter embolization techniques are widely considered safe, effective, and easy to perform [6,7]. It is essential to confirm continued efficacy of the intervention due to potential recanalization of arterial vessels. For initial post-procedural evaluation of treatment response we recommend cross-sectional imaging. For subsequent evaluation, especially in the pediatric population, ultrasound is recommended if feasible due to the lack of ionizing radiation.

In this case report we describe the utilization of transarterial catheterization technique to treat a LIMA AVM. Overall, the endovascular approach to treatment of the LIMA AVM in this patient was feasible and safe, while avoiding risks and morbidity associated with open surgical repair.

Conflict of interest

The authors declare that they have no conflict of interest.

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None.

References

[1] Gilard M, Mounayer C, Touiza A, Mansourati J, Jobic Y, Blanc JJ, et al. Congenital arteriovenous fistulas of the bilateral internal mammary vessels. Catheter Cardiovasc Interv 2000;50(2):234–7.
[2] Lee CY, Knight PA, Ling FS. Coil embolization of a symptomatic left internal mammary arteriovenous fistula. Catheter Cardiovasc Interv 2014;83(5):E174–7.
[3] Stafford RW, Kronenberg MW, Dunbar JD, Wooley CF. Continuous precordial murmurs due to internal mammary artery fistulas: including internal mammary to pulmonary artery fistulas. Am J Cardiol 1969;24(3):414–9.
[4] Glass I, Rowe R, Duckworth J. Congenital arteriovenous fistula between the left internal mammary artery and the ductus venosus: unusual cause of congestive heart failure in the newborn infant. Pediatrics 1960;26(4):604–10.
[5] Khunnawat CMS, Abela GS, Thakur RK. Unusual complications of coronary artery bypass graft surgery. Am J Cardiol 2006;98:1665–6.
[6] Song J, Kim YK, Kim SJ, Choi E-Y, Shim WS. An adult case of internal mammary arterio-venous fistula. Korean Circ J 2011;41(3):154–5.
[7] Lee SJ, Lee S, Kim KS, Cho HP, Shin DH, Choi SI, et al. Four cases of management of congenital coronary arteriovenous fistula. Korean Circ J 2002;32(2):163–9.