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IMAGES IN INTERVENTION

# Embolization of Cardiac Arteriovenous Malformation With Onyx

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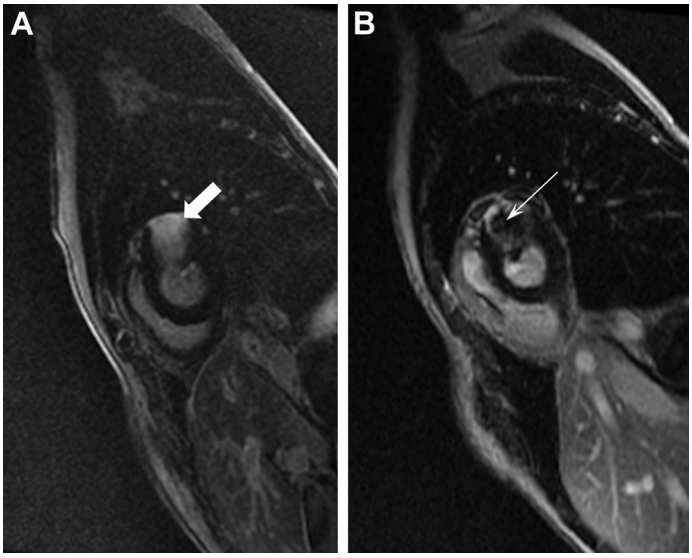
A 30-year-old woman with worsening heart failure (New York Heart Association functional class III) was found to have an ~3-cm arteriovenous malformation (AVM) in the anteriolateral left ventricle wall (**Figure 1A**), supplied by obtuse marginal (OM) branches (**Figure 2A**, Online Video 1). OM1 was embolized at the level of the aneurysm. More proximal coil placement was not performed to avoid infarcting normal myocardium. Supply from a small branch of the larger OM2 was not embolized given its small size. The procedure failed because of new collateralization from this branch and recanalization around the coils in OM1 (**Figure 2B**, Online Video 2), and the patient's clinical status did not improve. Eight weeks later, the AVM was embolized with Onyx (Covidien, Mansfield, Massachusetts) using a triaxial system consisting of a 6-F extra back-up 3.5 guiding catheter (Medtronic, Minneapolis, Minnesota), 0.38 distal access intermediate catheter (Concentric Medical, Fremont, California), and an Echelon-10 microcatheter (Covidien). Embolization from OM1 (proximal to previously placed coils) failed to penetrate the AVM, whereas embolization from the OM2 branch inferior to the AVM completely casted the AVM (**Figure 2C**, Online Video 3), resulting in an angiographic cure (**Figure 2C**, Online Video 4). Follow-up cardiac magnetic resonance imaging confirmed shrinkage of the AVM with no residual flow (**Figure 1B**). The patient's symptoms resolved, and during 43 months of follow-up, no recurrence was observed clinically or by serial echocardiograms and cardiac magnetic resonance imaging.

Cardiac AVMs are exceedingly rare and can have fatal outcomes secondary to intractable heart failure or arrhythmias (1,2). Onyx is a liquid embolic agent different from prior cyanoacrylate-based "glues" and has been successfully used in brain AVMs (3). Onyx

**FIGURE 1 MRI Scan of the Heart Before and After Embolization of the AVM With the Onyx Liquid Embolization System**




The vertical short-axis images of the tumor were obtained using the steady-state free procession technique. **(A)** Initial scan showing an ~3-cm intramyocardial mass in the anterior wall extending to the anterolateral wall and protruding into the left ventricular cavity **(thick arrow)**. **(B)** Diminished overall enhancement and central nonenhancement of the AVM status post-embolization with Onyx **(thin arrow)**. AVM = arteriovenous malformation; MRI = magnetic resonance imaging.

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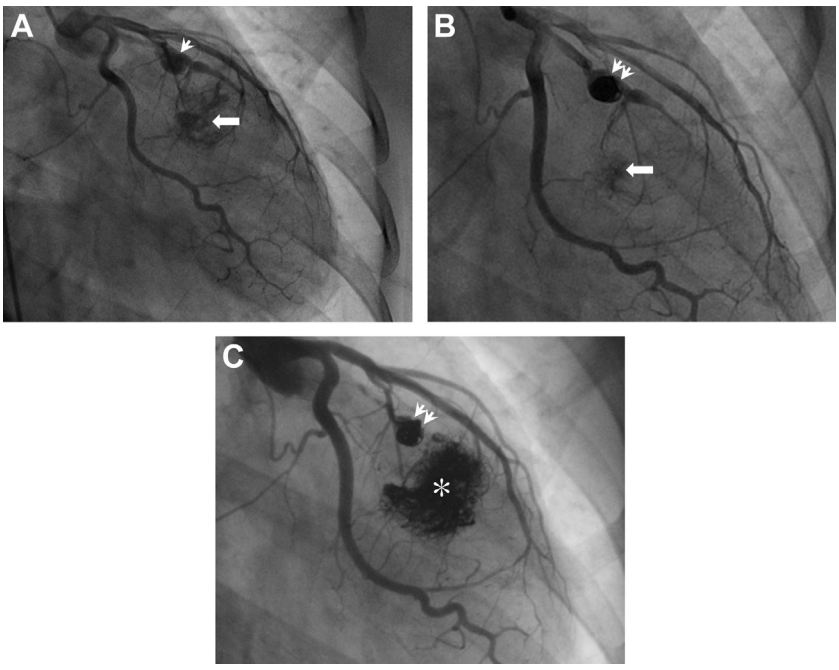
**FIGURE 2 Coronary Angiogram**




**(A)** Initial coronary angiogram shows aneurysmal dilation of the left circumflex artery **(single arrowhead)**, with the obtuse marginal (OM) branch vessels supplying the highly vascular intramyocardial arteriovenous malformation (AVM) **(thick arrow)**. The majority of blood supply comes from OM1 and some blush from a more inferiorly located branch of OM2 (Online Video 1). **(B)** After mechanical embolization **(double arrowheads in B and C)** with 2 each of 5/2- and 6/2-mm Tornado coils (Cook Medical, Bloomington, Indiana), a residual blush **(thick arrow)** can be noted as a result of recanalization around the coils in OM1 and collateralization through the branch of OM2 (Online Video 2). **(C)** Embolization with 5-ml Onyx (Online Video 3) fills up the AVM to its core **(asterisk)**, and no flow to the AVM is noted (Online Video 4).

allows slow, controlled embolization, with multiple interrupted injections finding new AVM compartments, and has much less adherence to catheter tips, even when casted. To our knowledge, this is the first successful percutaneous treatment of a cardiac AVM using the Onyx embolization system.

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**KEY WORDS** cardiac arteriovenous malformation, liquid embolization, Onyx

**APPENDIX** For supplemental videos and their legends, please see the online version of this article.