Acute Myocardial Infarction/Thrombectomy

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KEYWORDS

• Thrombectomy • Cardiogenic shock • Acute myocardial infarction • Culprit lesion

KEY POINTS

- Although the benefits of routine upfront thrombectomy are uncertain, aspiration may be necessary in bailout situations.
- Recent randomized trials suggest complete revascularization should be considered during the index hospitalization for ST-segment myocardial infarction.
- Few data support the use of intra-aortic balloon pump in acute myocardial infarction complicated by shock; newer devices may offer essential hemodynamic support in select cases.

THROMBECTOMY

The histopathologic hallmark of acute myocardial infarction (AMI) is plaque rupture and attendant thrombus formation, which can either be occlusive (leading to ST-elevation MI [STEMI]) or partially occlusive (unstable angina or non-STEMI). The goal of thrombectomy during AMI is to debulk intraluminal thrombus to prevent its downstream embolization and to improve flow and visualization (Fig. 1). Theoretically, this should enhance myocardial perfusion and facilitate procedural success. In fact, observational studies associate high thrombus burden with worse outcomes and higher stent thrombosis rates.[1]

Early trials supported this concept and even demonstrated a mortality advantage to upfront routine thrombectomy in STEMI. However, later evidence and a large randomized controlled trial published in 2015 have dimmed enthusiasm. Despite these recent data, a full discussion of thrombectomy and available devices is warranted, because interventionalists need familiarity with them for use, at minimum, as a bailout adjunct to AMI cases where heavy thrombus burden forestalls successful achievement of thrombolysis in MI (TIMI) grade 3 flow.

Mechanical Thrombectomy

Mechanical thrombectomy devices use moving, machine-driven parts to macerate and aspirate clot. Although they succeed at debulking large-volume thrombus, the evidence supporting their routine use is lacking. Previous devices included the Transluminal Extraction Catheter (InterVentional Technologies, Inc., San Diego, CA) and X-Sizer (eV3, White Bear Lake, MN). Currently, the only Food and Drug Administration (FDA)-approved mechanical thrombectomy device for AMI, Angiojet (Boston Scientific, Marlborough, MA), uses rheolytic thrombectomy (RT) to break up and remove thrombus. The 6F catheter–compatible system is intended for use in vessels larger than 2 mm in diameter with angiographic evidence of thrombus. High-velocity saline jets in the device's nose-cone fire into the diseased region, physically tearing the thrombus apart and creating a low-pressure vacuum via the Venturi-Bernoulli effect to aspirate debris (Fig. 2).

Angiojet was approved in 1999 based on a saphenous vein graft study (VEGAS-2) that demonstrated superiority to intragraft urokinase infusion.[2] It was later studied in two larger randomized trials (AiMI [AngioJet Rheolytic Thrombectomy in Patients Undergoing Primary

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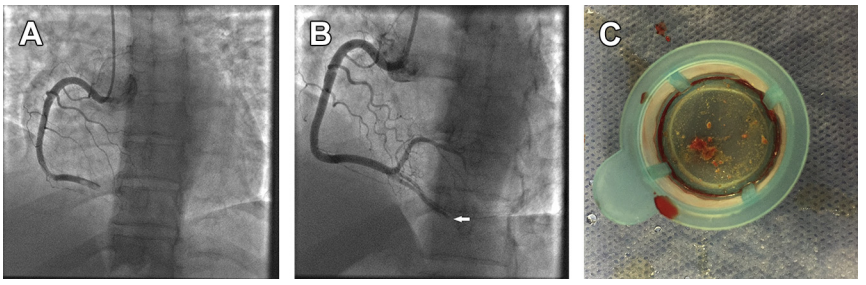

Fig. 1. Acute thrombotic occlusion of right coronary artery before (*A*) and after thrombectomy (*B*). Residual, distal thrombus (*arrow*) could not be recovered. (*C*) Thrombus retrieved using manual aspiration thrombectomy. (*Courtesy of* Jonathan Soverow, MD, MPH, Columbia-Presbyterian Hospital, New York, NY.)

Angioplasty for Acute Myocardial Infarction] and JETSTENT [AngioJet Rheolytic Thrombectomy Before Direct Infarct Artery Stenting in Patients Undergoing Primary PCI for Acute Myocardial Infarction]), which raised concerns about the device's safe use in the setting of AMI.

The AiMI trial randomized 480 patients presenting within 12 hours with STEMI by electrocardiogram (EKG) criteria to RT versus percutaneous coronary intervention (PCI) alone.[3] Of note, visible thrombus was not required for enrollment. Patients with high-risk features, such as cardiogenic shock, ejection fraction less than 35%, and recent stroke, were excluded. The primary end point, infarct size as measured by sestamibi imaging at 14 to 28 days, was higher in the RT group. There were no differences in tissue myocardial perfusion blush or ST-segment resolution. In addition, 30-day major adverse cardiac event (MACE) was higher in the RT group (6.7% vs 1.7%; $P = .01$), driven primarily by higher mortality rates (4.6% vs 0.8%; $P = .02$). Only around 20% of patients had moderate-high thrombus burden at baseline, but use of RT in this subset did not reduce infarct size compared with PCI alone. Nearly 60% of patients in the RT group had upfront temporary pacing wires placed. In their discussion, the study investigators highlighted that introduction of the device into the artery takes longer and may embolize debris. In addition, the study itself was not powered to detect differences in mortality, which had an extremely low rate in the PCI-alone group (0.8%) at 1 month and became nonsignificant at 6 months (5.8% vs 2.1%; $P = .06$).

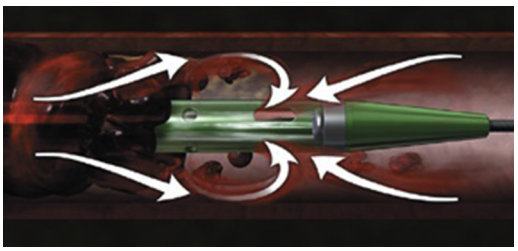

Fig. 2. Angiojet mechanical thrombectomy system. High-pressure saline jets create a vacuum effect that allows maceration and aspiration of large-volume thrombus. (Image provided *courtesy of* Boston Scientific. © 2016 Boston Scientific Corporation or its affiliates. All rights reserved.)

The JETSTENT trial attempted to redress these outcomes by refocusing the target population.[4] The JETSTENT trial randomized 501 patients with STEMI in a greater than 2.5-mm vessel and with visible thrombus to RT versus direct stenting. Moreover, in contrast to AiMI, the JETSTENT protocol required the device be activated before crossing the lesion. Although ST-segment resolution, 6-month MACE (11.2% vs 19.4%; $P = .011$), and 12-month event-free survival rates (85.2% vs 75.0%; $P = .009$) were improved with Angiojet, there was no difference again in infarct size. These results may emphasize the need for stricter patient selection, suggesting that those most likely to benefit have significant thrombus burden in larger diameter vessels, and the need to turn on the device before advancing through the lesion. Of note, temporary pacemaker was rarely needed (0.7%) despite prior experience suggesting high rates of bradycardia with the use of AngioJet.

Another mechanical thrombectomy device, the X-Sizer, received FDA approval for PCI and was evaluated in AMI, but is not currently available in most markets. The X-Sizer was a dual-lumen over-the-wire device that used a motorized, helical cutter to dislodge thrombus paired with an aspiration port attached to a vacuum. The X AMINE ST trial (X-Sizer in AMI for Negligible Embolization and Optimal ST Resolution) randomized 201 patients with STEMI and TIMI 0 to 1 grade flow to X-Sizer thrombectomy versus PCI alone.[5] Use of the device was associated with improved ST-segment resolution and a reduction in the occurrence of distal embolization, but without significant differences in TIMI