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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Polymer Emboli Complicating Transcatheter Aortic Valve Implantation

A Case Report

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ABSTRACT

Hydrophilic polymers are frequently used as surface coatings in modern intravascular technologies. We hereby present a case of a patient who underwent transcatheter aortic valve implantation that was complicated with foot gangrene and mesenteric ischemia, necessitating emergency enterectomy. Histologic examination revealed hydrophilic polymer emboli as the culprit of these complications. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2022;4:543–548)

HISTORY OF PRESENTATION

A 92-year-old Bahraini woman was admitted to our cardiac center with acute pulmonary edema and presyncope. Her initial blood pressure was 80/44 mm Hg (mean arterial pressure 55 mm Hg) with sinus tachycardia (115 beats/min). Physical examination revealed bilateral basal crackles with a crescendo-decrescendo ejection systolic murmur over the aortic area radiating to both carotids.

LEARNING OBJECTIVES

- To recognize that hydrophilic polymer coating delamination from vascular device surfaces is associated with significant morbidity and mortality.
- To be aware that polymer embolism is now a well-documented iatrogenic event ascribed to catheterization and other vascular procedures.
- Additional device-specific studies incorporating various clinical scenarios are required to better understand the impact of polymer emboli.

PAST MEDICAL HISTORY

The patient's previous medical history included systemic hypertension and type 2 diabetes. No other relevant medical history.

DIFFERENTIAL DIAGNOSIS

Post transcatheter aortic valve implantation (TAVI) embolic phenomena have generally been attributed to air, septic, thrombotic, atheromatous (cholesterol embolization syndrome), or other foreign body embolism. Polymer embolism should be included in the differential of unanticipated post-procedural ischemic complications, even if intravascular devices appear intact or are properly placed during the procedure.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

HPE = hydrophilic polymer emboli

TAVI = transcatheter aortic valve implantation

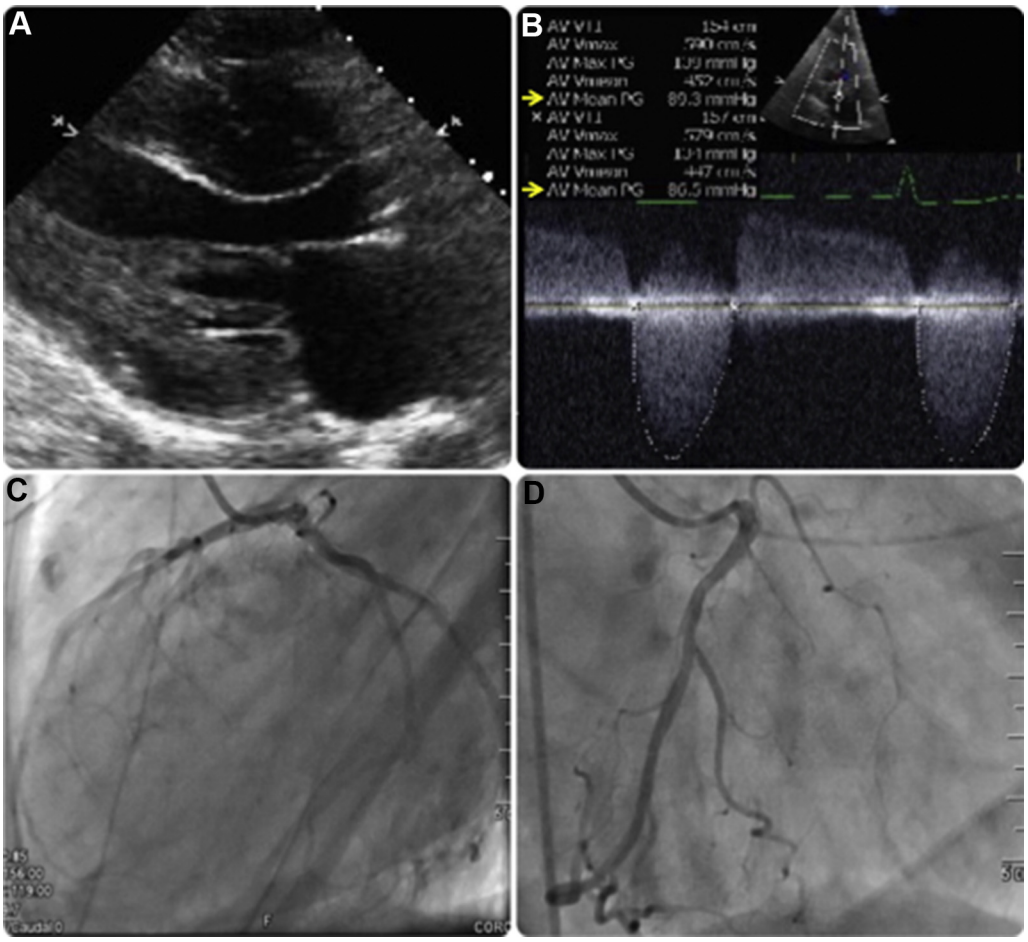
INVESTIGATIONS

The patient's electrocardiogram showed QRS voltage criteria for left ventricular hypertrophy, which was confirmed with a transthoracic echocardiogram that showed an ejection fraction of 55% and a heavily calcified aortic valve with critical aortic stenosis (aortic valve area 0.3 cm^2 and peak/mean transvalvular gradient 139/89 mm Hg) (Figures 1A and 1B). Baseline creatinine was 105 mmol/L (reference range 44-88 mmol/L); hence, we performed a coronary angiogram with minimal contrast (20 mL only) to rule out underlying coronary artery disease in view of the patient's multiple risk factors and troponinemia. Coronary angiogram revealed calcifications but no flow-limiting disease in the coronary arteries (Figures 1C and 1D).

MANAGEMENT

Owing to the patient's ongoing unstable hemodynamic parameters in the presence of normal ejection fraction, an emergency heart team was consulted and agreed (by consensus) to proceed with emergency TAVI as the primary treatment strategy, as she was deemed at high risk of surgical aortic valve replacement, and to rescue the patient from refractory

FIGURE 1 Severe Aortic Stenosis With Normal Coronaries



(A and B) Transthoracic echocardiogram shows left ventricular hypertrophy and calcified aortic valve with critical aortic stenosis (mean transvalvular gradient = 89 mm Hg). **(C and D)** Coronary angiogram shows no obstructive lesions in proximal coronary arteries.

cardiogenic shock. In light of the patient's critical condition, and because there was no time to perform a TAVI computed tomography scan for further evaluation, the patient's family agreed to emergency TAVI (with the intention to minimize contrast use). A 7-F PreludePRO sheath (Merit Medical Systems, Inc) was placed in the left femoral artery. Aortic diameters were measured using transesophageal echocardiogram and a 6-F pigtail catheter for aortography (Cordis Corporation). A 5-F temporary cardiac pacemaker lead (Biotronik Inc) was positioned in the right ventricular apex from the 6-F PreludePRO sheath (Merit Medical Systems, Inc) in the left femoral vein. After this step, the suitability of the peripheral vessels for the TAVI procedure was confirmed with peripheral angiography. Because there was no absolute anatomic contraindication, emergent TAVI was performed with a 14-F eSheath (Edwards Lifesciences) (**Figure 2**) and successful deployment of a 23-mm Edwards Sapien-3 valve (Edwards Lifesciences) (**Figure 3**). At the end of the procedure, 2 Perclose ProGlide closure devices (Abbott Vascular) were placed in the common femoral artery and facilitated rapid hemostasis.

On day 3 post procedure, the patient developed severe abdominal pain, acute kidney injury, and blue discoloration of the left foot (**Figure 4**). Computed tomography abdominal scan with oral and intravenous contrast showed complete thrombosis of the distal third of the superior mesenteric artery, with extensive pneumatosis intestinalis and gas in the mesenteric branches of the superior mesenteric vein and splenic vein; complete thrombosis of the distal half of the right renal artery, with no enhancement of almost the entire right kidney; and extensive calcification of the aorta and bilateral iliac arteries (**Figure 5**). She underwent emergency exploratory laparotomy, in which the entire gangrenous bowel was resected (**Figure 6**). After 48 hours, she underwent follow-up exploratory laparotomy where a side-to-side colo-jejunal anastomosis was performed. Biopsies of the gut and the gangrenous left foot were consistent with typical findings of hydrophilic polymer emboli (HPE) (**Figure 7**).

DISCUSSION

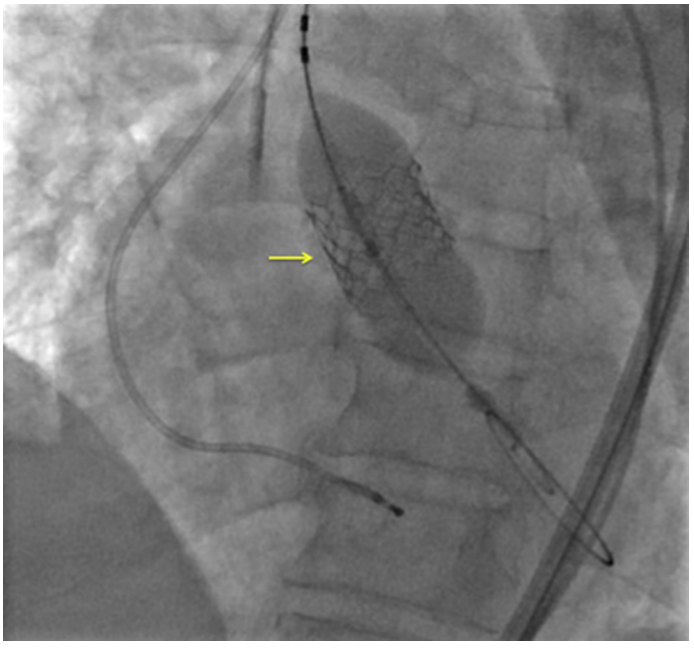
Over the past 3 decades, interventional cardiologists have increasingly adopted lubricated, hydrophilic polymer-coated devices to access and treat a wider range of clinical presentations. This technology has greatly contributed to the accessibility of larger-diameter catheter procedures, such as transcatheter aortic valve replacement; however, one of the drawbacks of lubricated polymer coatings is the separation of the polymer coat during an interventional procedure.[1]

Polymer coating embolisms are difficult to detect in the clinical setting. The only known methods to confirm the presence of hydrophilic polymers are postmortem analysis of the vasculature; targeted

FIGURE 2 A 14-F Vascular Catheter Introduction Set

Reproduced with permission from Edwards Lifesciences.

FIGURE 3 Emergent Transcatheter Aortic Valve Implantation

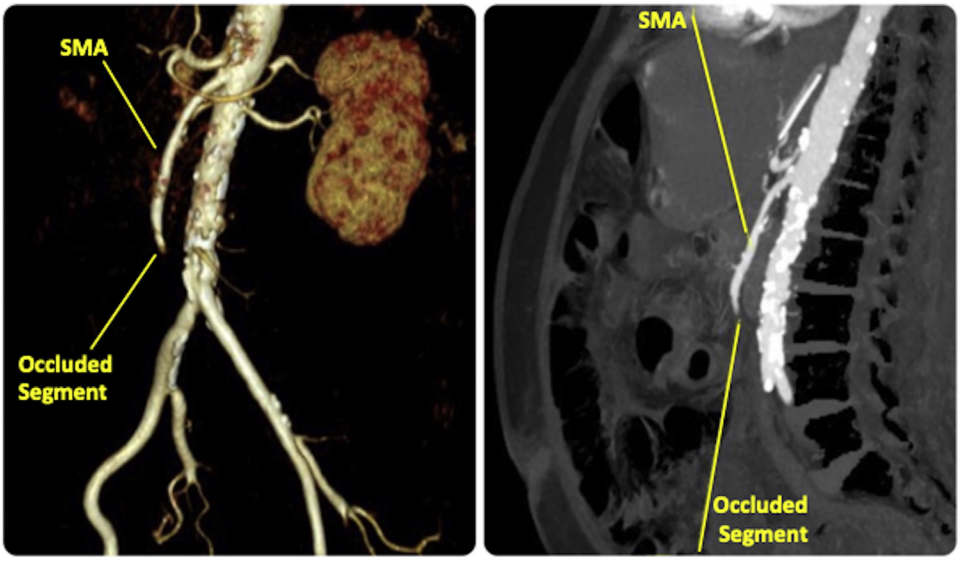


Successful deployment of a 23-mm transcatheter heart valve.

FIGURE 4 **Ischemic Left Foot**

Dorsal and plantar aspects of the patient's left foot on day 3 after transcatheter aortic valve implantation demonstrates gangrene involving the entire plantar aspect and proximal and distal regions of digits 1 to 5, with scattered petechiae seen on the dorsal aspect.

FIGURE 5 **Computed Tomography Abdominal Scan**



Computed tomography showed complete thrombosis of the distal third of the superior mesenteric artery (SMA), with extensive pneumatosis intestinalis and extensive calcification of the aorta.

tissue biopsy; and evaluation of explanted organs, resected tumors or tissues, and aspirated thrombus or atherosclerotic debris.[2]

Nevertheless, polymer coating emboli have been affiliated with a range of adverse clinical sequelae. They are detected microscopically as nonpolarizable, nonrefractile, lamellated (either basophilic, eosinophilic, or colorless) elements occluding small and medium-sized vessels and they are often associated with ischemia, infarction, or hemorrhage.[3,4]

Nowadays, larger sheaths are used in several catheter interventions, such as TAVI and endovascular aortic repair. In our patient, the highly calcified aorta and iliac arteries suggest a higher probability of "scraping" or "peeling" of the polymer coating on the 14-F sheath. Furthermore, exposing devices to pulsatile blood or saline during preparation for longer procedures allows the coating to potentially degrade in vivo and detach. In their experiment, Stanley et al[5] reported avulsion of the hydrophilic coating from the sheath when incubated in 0.9% saline for as little as 15 minutes. Over 60 minutes, even more of the coating was shed from the surface of the catheter.[4,5]

Specific management guidelines for the treatment of HPE do not exist; treatment relies mainly on conservative approaches and further interventions based on the patient's clinical status and target polymer site.[5] Scattered case reports document some success in using steroids and immunomodulatory and antiplatelet therapies in the treatment of HPE, but the potential adverse risks of such treatments should be considered.[5] In our case, surgical resection was warranted as a lifesaving procedure in the setting of gangrenous bowel and to debride necrotic wounds.

FOLLOW-UP

The postoperative period was complicated with acute kidney injury and shock liver. Fortunately, she responded to medical treatment and supportive care with full recovery, and was discharged with only dry gangrene in her left foot. She planned for conservative management with potential partial amputation of her left foot once her general condition improved with rehabilitation programs.

FIGURE 6 Mesenteric Ischemia

Emergency exploratory laparotomy shows patchy segments of acute gangrene involving the small bowel.

CONCLUSIONS

The elusive nature of polymer emboli and their diverse clinical sequelae with the potential for multiorgan involvement highlight the need for safer devices and attention to particulate testing of the devices on the market. Clinicians and pathologists should be aware of the degradative histologic appearances of HPE in view of its subtle nature. Patients may recover from HPE complications with conservative management.

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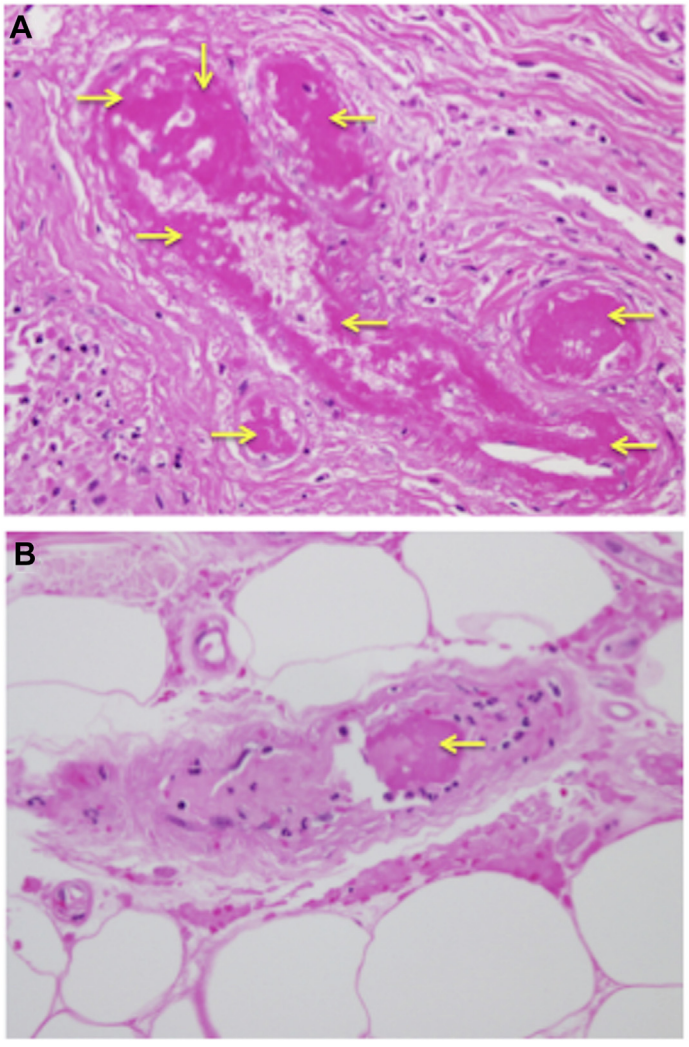
FIGURE 7 Hydrophilic Polymer Emboli



Photomicrographs of the blood vessels of the small intestine **(A)** and the skin **(B)**. The small blood vessels are occluded by micro emboli along with aggregates of lamellated, nonrefractile, granular eosinophilic foreign material **(yellow arrows)**. Some of the blood vessels show foreign body histiocytic reaction. Hematoxylin and eosin-stained slides, ×400 original magnification.

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KEY WORDS aortic valve, complication, valve replacement