A 58-year-old woman was referred to our center for further workup and treatment of a probable polymethylmethacrylate (PMMA) embolism to the right ventricle (RV) and right pulmonary artery. The patient’s medical history included hypertension, hypothyroidism, hyperlipidemia, and anxiety. She developed lower back pain ≈1 month before admission and was diagnosed with multiple compression fractures. Ten days before admission, the patient underwent percutaneous kyphoplasty of the T11, T12, and L1 vertebral bodies. A biopsy during that procedure revealed multiple myeloma as the underlying cause of the fractures. No vascular abnormalities were noticed at that time. A day before transfer she was readmitted with chest pain and shortness of breath. She was noted to have diffuse ST segment elevations on her ECG and mildly elevated cardiac troponin. Coronary angiography did not show evidence of obstructive coronary disease. However, fluoroscopy during coronary angiography showed foreign material in the RV and the pulmonary artery (Figure 1 and online-only Data Supplement Movie I). A computed tomography demonstrated foreign material in the RV and the pulmonary artery with a free wall perforation (Figure 2 and online-only Data Supplement Movie II). On arrival to our institution, an echocardiogram showed a hyperechogenic rod-like structure 5 to 6 cm long embedded in the RV free wall with a moderate pericardial effusion (Figure 3 and online-only Data Supplement Movie III). Endovascular retrieval of the cement fragments was considered, but given the expectation that the embolic material, PMMA cement, would not be pliable enough to allow catheter-based retrieval, the consensus decision was to approach removal surgically. The patient was taken to the operating room. After opening the pericardium, 200 mL of old blood and clot were evacuated. On further inspection, a white colored spear-shaped foreign body penetrating the acute margin of the RV was found with the piece of it penetrating into the...
diaphragm (Figure 4 and online-only Data Supplement Movie IV). After cardiopulmonary bypass initiation and opening of the right atrium, the foreign body 6 cm in length entangled in the tricuspid valve anterior leaflet cords was removed from the right ventricular cavity (Figure 5 and online-only Data Supplement Movie V). The RV was then repaired with pledgeted 4-0 Prolene suture. Another foreign V-shaped body was retrieved through the right pulmonary artery from the right upper and middle lobe pulmonary artery branches (Figure 6). On uneventful cardiopulmonary bypass termination, the bilateral reactive plural effusions were evacuated. The patient was extubated 1 hour after surgery and was transferred to the step-down unit on the first postoperative day.

Percutaneous vertebroplasty and kyphoplasty have become an increasingly common technique for treatment of vertebral compression fractures since its introduction in the late 1980s. Percutaneous kyphoplasty involves creation of a balloon cavity in the vertebral body before injection of PMMA cement to enable a lower pressure deployment and thereby reduce the risk of embolism. Embolism of the PMMA cement is frequently associated with these procedures, occurring in ≤26% of patients in some reports.1,2 The PMMA cement likely enters the venous system through the iliolumbar or epidural veins and migrates centrally to the right heart chambers and pulmonary arteries. On some occasions, migration of larger cement fragments can be seen on fluoroscopy during the procedure. However, patients are frequently asymptomatic, and many cement emboli are found incidentally on subsequent imaging.2

Figure 3. Echocardiogram of the right ventricle showing a hyperechogenic polymethylmethacrylate fragment (arrow) imbedded in the right ventricular free wall.

Figure 4. Polymethylmethacrylate fragment penetrating the acute margin of the right ventricle (arrow).

Figure 5. Polymethylmethacrylate fragment 6 cm in length removed from the right ventricular cavity.

Figure 6. V-shaped polymethylmethacrylate fragment in the right upper and lower lobe pulmonary artery branches.
Several points are worth considering in this case. Our patient presented with signs and symptoms of pericarditis caused by the protruded RV fragment. We believe that the RV perforation occurred when the hardened cement fragment in the ventricle was pushed through the free wall by the tricuspid valve annulus during cardiac systole. She did develop a moderate pericardial effusion that fortunately did not progress to cause cardiac tamponade. RV perforation has been described previously with management by surgical retrieval of the PMMA cement fragments and repair of the ventricle. Endovascular retrieval of a cement fragment embolus in the pulmonary artery without RV damage has also been reported. In that case, a rounded cement piece was maneuvered from the pulmonary artery to the femoral vein, where it was retrieved via a surgical cutdown. Although we considered an endovascular approach, the long linear and V-shaped pieces could not be retrieved easily without risk of further fragmentation and embolization or entanglement in the tricuspid valve apparatus, and, importantly, percutaneous repair of the RV puncture site would not be feasible.

Small cement emboli typically do not cause symptoms and appear to remain inert over the long term, so routine postprocedure imaging has not been advocated. Nonetheless, cement embolization and cardiac vascular perforation should be considered in patients presenting with chest pain after percutaneous kyphoplasty.

Written consent for the publication was obtained from the patient.

Disclosures
None.

References
Right Ventricular Perforation and Pulmonary Embolism With Polymethylmethacrylate Cement After Percutaneous Kyphoplasty
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