

Concrete proof of Murphy's law: a case report of intracardiac cement embolization

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Background

The literature describing the complications following kyphoplasty is limited. This case report is a reminder that novel therapeutic strategies can be associated with unexpected complications.

Case summary

A 61-year-old woman with rheumatoid arthritis and degenerative lumbar disc disease underwent open posterior instrumented fusion with bilateral open L2 vertebroplasty elsewhere. A month after discharge, she presented to our institution with acute chest pain and dyspnoea. A subsequent gated cardiac computed tomography (CT) angiogram showed three distinct cardiopulmonary emboli. One of the cement fragments had perforated the inferior wall of the right ventricle close to the base of the posterior tricuspid valve leaflet with a moderate circumferential pericardial effusion. Operative extraction of multiple cement emboli as well as repair of the tricuspid valve was pursued. Postoperative echocardiogram showed trivial tricuspid regurgitation after repair. The patient had an uneventful postoperative course and was discharged from the hospital on postoperative Day 5.

Discussion

Cement embolization following kyphoplasty can be associated with serious complications such as vascular injury, hypoxaemia, pulmonary artery obstruction, and cardiac perforation. Clinicians must maintain a high index of suspicion as cement embolism may not always present acutely.

Keywords

Case report • Embolization • Cardiac • Tricuspid • Kyphoplasty • Perforation

ESC Curriculum

2.1 Imaging modalities • 2.4 Cardiac computed tomography • 2.3 Cardiac magnetic resonance • 4.5 Tricuspid regurgitation

Learning points

- Cement embolization following kyphoplasty, although considered to be rare, can be associated with serious complications such as vascular injury, hypoxaemia, pulmonary artery obstruction, and cardiac perforation.
- Complications of cement embolization do not always present acutely.
- Clinically, a high level of suspicion is needed for cement embolism in order to prevent catastrophic complications.

Introduction

Cement embolization following kyphoplasty has been reported with an incidence of 2.1–30% and can be associated with serious complications

such as vascular injury, pulmonary artery obstruction, and cardiac perforation.¹ We present a case of multiple intracardiac and pulmonary artery emboli that required surgical extraction along with tricuspid valve repair. The route followed by the cement emboli was likely from the

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paravertebral veins through the inferior vena cava and into the right atrium, finally traversing the tricuspid valve before lodging into the right ventricle (RV) as well as the branch pulmonary arteries.

Timeline

Time	Event
Day 1	Open posterior instrumented fusion with bilateral open L2 vertebroplasty was performed elsewhere. Postoperative X-ray showed intracardiac lobulated, hyperdense mass. Computed tomography (CT) confirmed diagnosis of bone cement embolization. Remained asymptomatic and was dismissed on apixaban
Day 30	Acute chest pain and dyspnoea prompted hospital admission. Computed tomography showed that one of the cement fragments had perforated the inferior wall of the RV in close proximity to the base of the posterior tricuspid valve leaflet with a moderate circumferential pericardial effusion). Coronary angiogram performed pre-operatively demonstrated this sharp, spear-like fragment was in close proximity to the distal right coronary artery
Day 31	Operative extraction of multiple cement emboli was pursued. Intra-operative transoesophageal echocardiography (TEE) showed a large cement fragment across the tricuspid valve and mild regurgitation. All known cement fragments were removed, except for one within the right pulmonary artery
Day 36	The patient had an uneventful postoperative course and was discharged from the hospital on postoperative Day 5

Case presentation

A 61-year-old woman with rheumatoid arthritis and degenerative lumbar disc disease with previous anterior–posterior lumbar fusion underwent open posterior instrumented fusion with bilateral open L2 vertebroplasty elsewhere. Following surgery, a routine postoperative X-ray demonstrated an intracardiac lobulated, hyperdense mass (Figure 1). On further evaluation by non-gated chest CT, the diagnosis of bone cement embolization was confirmed by multiple radio-dense masses in both pulmonary artery branches and the RV (Figure 2). A transthoracic echocardiogram revealed a small pericardial effusion with an echodense mass measuring 2.0 × 0.9 cm along the ventricular aspect of the tricuspid valve with moderate tricuspid regurgitation. The mass was entangled in the tricuspid chordae and tethered to the ventricular septum. The atrial septum was intact. Given that she was asymptomatic, hospital discharge with close outpatient follow-up was pursued. Discharge medications included apixaban, presumably initiated to prevent thrombosis. One-month post-discharge, she presented to our institution with acute chest pain and dyspnoea. A subsequent gated cardiac CT angiogram showed three distinct cardiopulmonary emboli. One of the cement fragments had perforated the inferior wall of the RV close to the base of the posterior tricuspid valve leaflet with a moderate circumferential pericardial effusion (Figure 2). Coronary angiogram performed pre-operatively demonstrated this sharp, spear-like fragment was in close proximity to the distal right coronary artery.

Operative extraction of multiple cement emboli was pursued. Intra-operative TEE showed a large cement fragment across the tricuspid

valve and mild regurgitation (Figure 3). After a median sternotomy and pericardiectomy, 500 mL of frank blood was evacuated from the pericardial sac. A cement fragment perforating the inferior aspect of the RV was visualized near the distal right coronary artery. This fragment had resulted in partial laceration of the inferior vena cava. Cardiopulmonary bypass was established with ascending aortic and bicaval venous cannulation. An oblique right atriotomy was made and the cement mass adjacent to the tricuspid valve as well as the fragment perforating the RV wall was removed (Figures 4 and 5). Rupture of one of the tricuspid valve chordae was identified. This was corrected with interrupted polypropylene sutures and an annuloplasty ring (26 mm Carbomedics) was placed. A cement fragment was also removed from the left pulmonary artery. The fragment in the right pulmonary artery was unable to be located and retrieved. Postoperative TEE showed trivial tricuspid regurgitation after repair. The patient had an uneventful postoperative course and was discharged on postoperative Day 5.

Discussion

Vertebroplasty involves the injection of polymethylmethacrylate (PMMA) into the compressed vertebral body for mechanical stabilization. Cement embolization to the heart and pulmonary circulation is a well-known complication following vertebroplasty with an incidence of 2.1–30%.¹ In a cohort of 244 patients during 313 vertebroplasty sessions, the incidence of small asymptomatic cement pulmonary emboli was 9.4%.¹ The size of the embolus appears uncorrelated to outcomes, since even small emboli may be lethal if embolization results in cardiac perforation.¹

Symptoms associated with cement emboli are highly variable and the presentation may be acute, subacute, or chronic.² The most feared outcomes are cardiac perforation, acute valvular injury, and paradoxical cerebral embolism. Early detection and prompt management are paramount, despite the absence of clinical symptoms in many cases. Identification of a patent foramen ovale or atrial septal defect is important, as either may facilitate paradoxical embolism.² Conservative medical therapy, percutaneous techniques (snaring the embolus and placement of an inferior vena cava filter), and surgical retrieval have been previously described. Medical management with anticoagulation should ideally be reserved for small and peripheral emboli that are asymptomatic. In cases of cardiac perforation, therapeutic anticoagulation has the potential to worsen outcomes due to promotion of haemopericardium, such as in this case. Percutaneous retrieval of these foreign bodies may be challenging and result in fragmentation with further distal embolization. Surgery is indicated in patients with haemopericardium, overt RV perforation, or haemodynamic compromise due to obstruction of major pulmonary vessels.³

Cardiac embolization of PMMA following vertebroplasty has been reported in the literature, however, the large volume of embolic burden and the unusual sharp, blade-like configuration of the emboli in our case presented a uniquely challenging situation. This resulted in progressive complications of RV perforation and haemopericardium with early tamponade physiology. Any delay in surgical intervention could have led to life-threatening complications including, overt cardiac tamponade, coronary laceration, or cardiac arrhythmias. This case underscores the importance of closely monitoring patients following vertebroplasty, with prompt treatment of any intracardiac cement emboli, given the potential for complications and rapid deterioration. This case also illustrates the role of multimodality cardiac imaging in diagnosing and monitoring such complications. Computed tomography provides high spatial resolution for localization of emboli and determining the relationship to surrounding structures. Transthoracic echocardiography or TEE allows valve characterization, haemodynamic evaluation, and assessment of pericardial tamponade. 3D TEE produces images with spatial resolution that is superior to 3D TTE. Furthermore, 3D TEE can be performed intra-operatively, providing views akin to a 'surgical view', thereby facilitating procedural guidance. Given the unique emboli geometry and

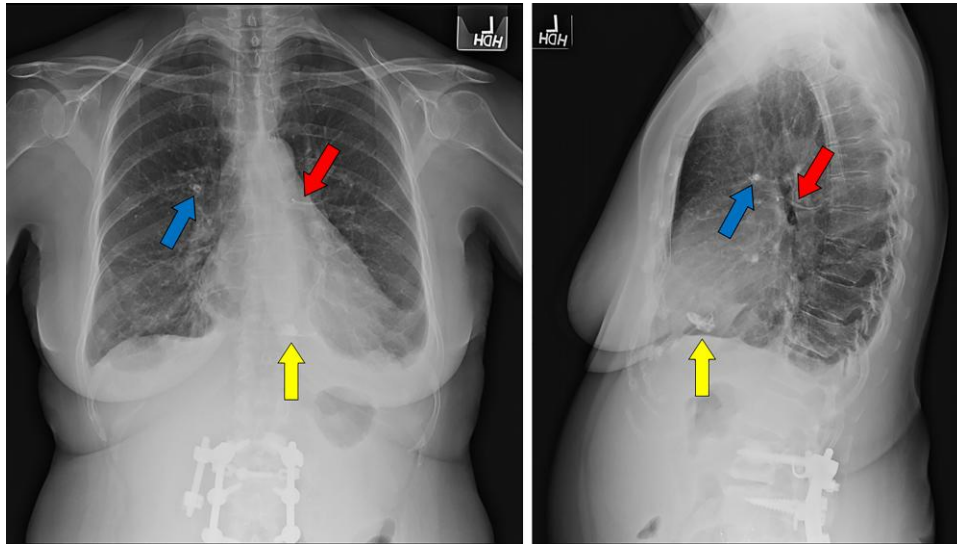


Figure 1 Chest X-ray (pulmonary artery and lateral) demonstrating three embolized cement fragments: the bulkiest mass was present in the region of the tricuspid valve apparatus (yellow arrows), a slender shard-like embolus in the left pulmonary artery (red arrows), and globular mass within the right pulmonary artery (blue arrow).

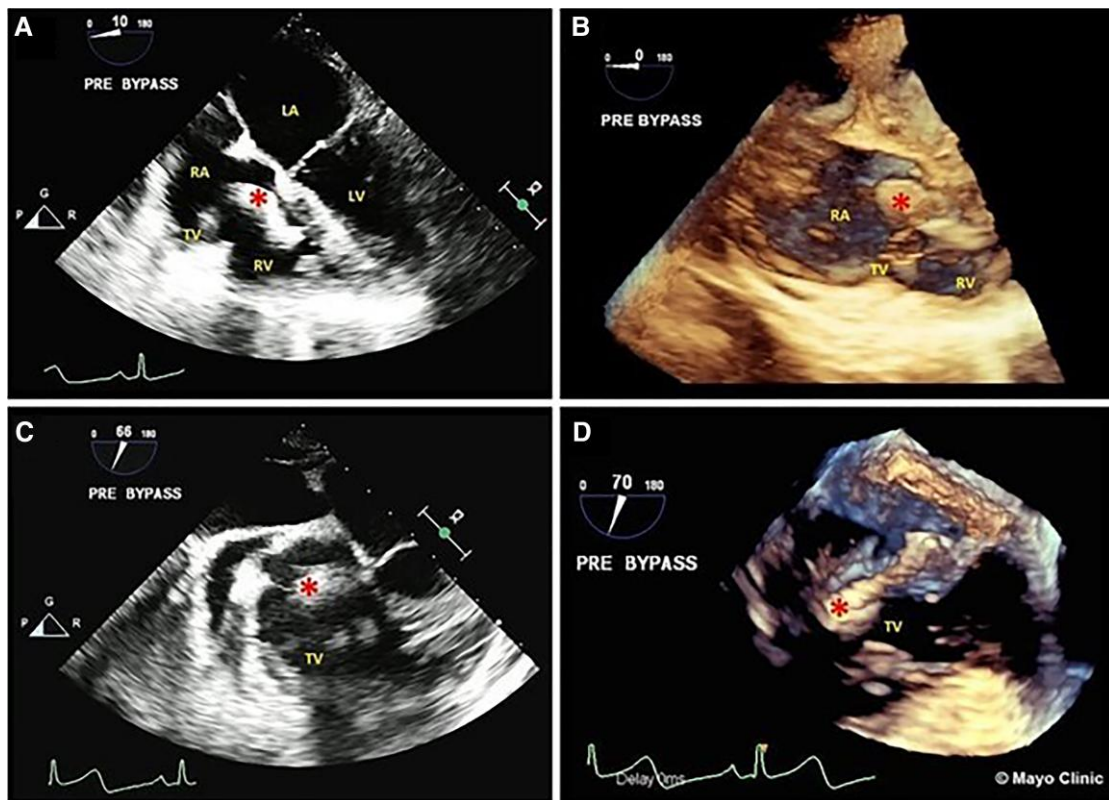


Figure 2 Computed tomography chest demonstrating three discrete embolized cement fragments. One embolic fragment (yellow arrow) formed a perforating mass entangled in tricuspid valve apparatus (A) and perforated the right ventricle free wall, coursing in close proximity to the distal right coronary artery (B), with gross specimen demonstrated in Figure 3. A second embolic fragment (C, red arrow) was a sliver-like shard lodged in the left pulmonary artery, with gross specimen demonstrated in Figure 3. A third embolic fragment, within the right pulmonary artery (D, blue arrow), was not removed at the time of surgery. LV, left ventricle; MPA, main pulmonary artery; RCA, right coronary artery; RV, right ventricle; TV, tricuspid valve.

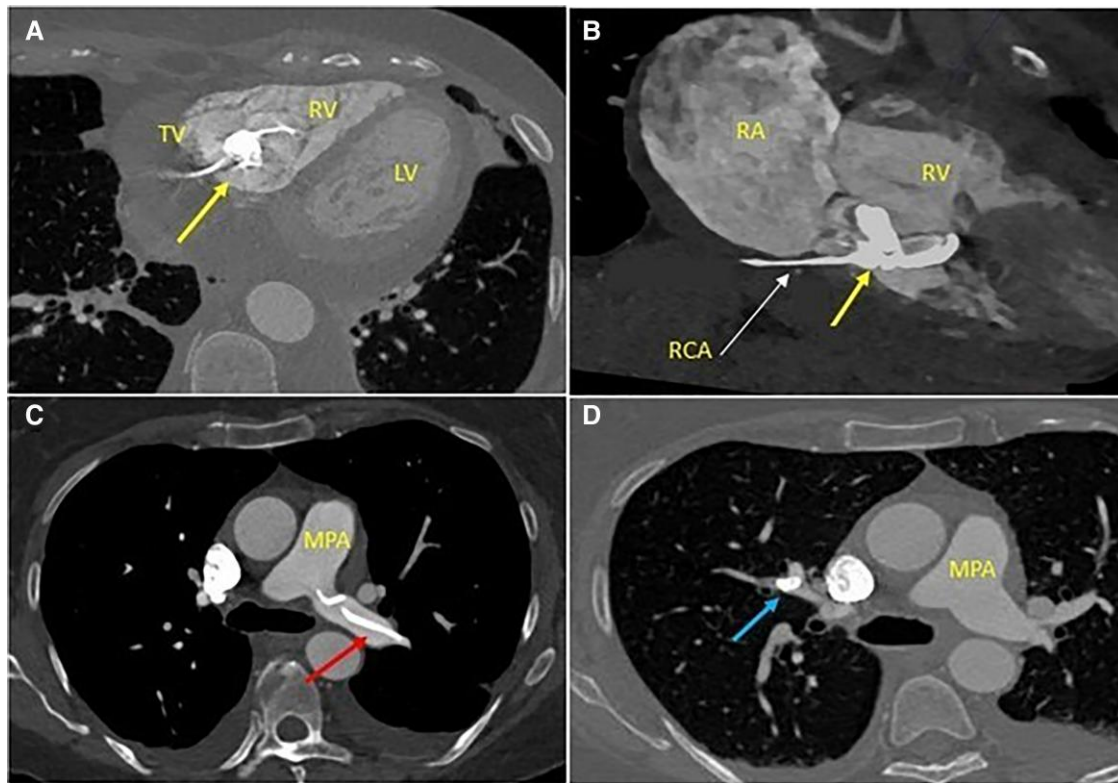


Figure 3 Transoesophageal echocardiogram demonstrating the intracardiac embolic fragment (*) entangled in the tricuspid valve apparatus in the 2D four-chamber view (A), 3D four-chamber view (B), 2D short axis view of tricuspid valve (C), and 3D short axis view of tricuspid valve (D). LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle; TV, tricuspid valve.

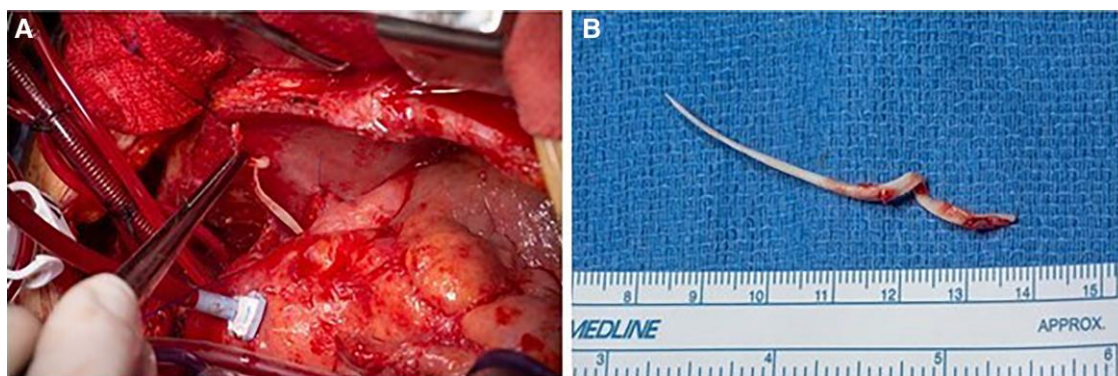


Figure 4 Intracardiac embolic fragment entangled in tricuspid subvalvular apparatus (A). Surgically extracted cement embolus (B) demonstrates a sharp, blade-like fragment (*) that had perforated the right ventricle.

complex interaction with cardiac tissues, 3D intra-operative guidance was particularly helpful in this case for identifying the emboli.

Several strategies have been described to decrease the incidence of cement emboli. Polymethylmethacrylate is an inert material which reaches 90% of its tensile strength within an hour of injection and is the material of choice for vertebroplasty due to its intrinsic properties. Pathophysiology of PMMA embolism is likely related to insufficient polymerization and absorption of this unpolymerized material into

the venous circulation of the peri-vertebral region. Rapid injection of PMMA while still in the liquid state might also play a role in the aetiology of this complication.² Use of a pre-injection venogram and injection of sclerosing agents into the vertebral body before vertebroplasty have been suggested to reduce the incidence of embolization. Other recommendations include reducing the amount of cement used, mixing PMMA with barium or tungsten for opacification, and use of high-resolution fluoroscopy to facilitate early detection of extrasosseous

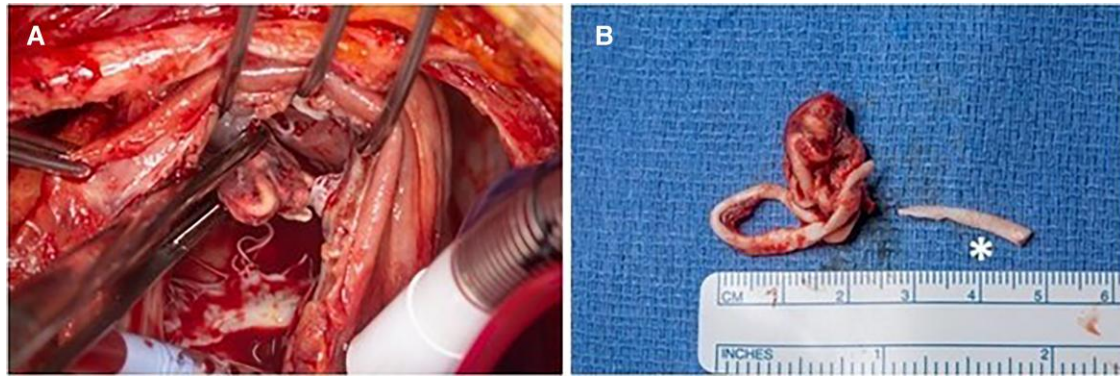


Figure 5 Long, needle-like embolized fragment extracted from left pulmonary artery (A). Surgically extracted cement embolus (B) demonstrates a sliver-like shard that was lodged in the left pulmonary artery.

cement leakage.⁴ It is important that patients routinely undergo chest imaging after the procedure.⁵

The literature on describing this complication is limited with no high-level evidence to guide management. Published outcomes are likely distorted by publication bias with a higher likelihood of publication of successful percutaneous or surgical cement retrieval. This case report is a reminder that novel therapeutic strategies can be associated with unexpected complications. We recommend that anticoagulation be continued for at least 3 months following emboli retrieval, especially with the suspicion of missing fragments, as in this case. This should ideally be accompanied by routine follow-up with repeat imaging.

Clinicians must maintain a high index of suspicion as cement embolism may not present acutely. It is critical to promptly treat intracardiac emboli as soon as the diagnosis is made, in order to avoid potentially lethal complications of arrhythmia, perforation, tamponade, and acute valvar dysfunction. Management of this complication should be individualized, by taking into account the location, size, orientation, and haemodynamic consequences of the emboli.

Lead author biography



Krithika Ramaprabhu finished her residency in cardiothoracic surgery in India and moved to the US for fellowship in Adult cardiac surgery. She is currently a robotic cardiac surgical fellow at the Mayo Clinic, Rochester. Her interests include robotic cardiac surgery, mitral valve repair, and coronary surgery and taking these to a global level and making them affordable for all.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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Data availability

The data used to support the findings are included within this article.

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