Title

Bone cement embolism into the right heart

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Glossary of Abbreviations

Methylmethacrylate (MMA), computed tomography (CT)

Central Message

Bone cement embolization is a well-documented complication of percutaneous vertebroplasty. Cardiac embolization is not an infrequent condition that may sometimes require surgical intervention

Central picture legend

Intracardiac embolization of bone cement into the right heart
Introduction

Percutaneous vertebroplasty with the use of bone cement is a widely performed minimally invasive orthopedic procedure for treating osteolytic vertebral metastases and osteoporotic vertebral fractures. One of the main complications associated with percutaneous bone cement injection was cement leakage, either into the paravertebral tissue, or less frequently, into the peri-vertebral venous plexus, which may result in embolization into the right heart or pulmonary vasculature. In this report, we present a case of intracardiac bone cement embolism after percutaneous vertebroplasty.

Case Report

This is a 76 year-old female with a history of osteoporotic vertebral compression fracture, for which she had received percutaneous vertebroplasty of the L3-5 vertebra with methylmethacrylate (MMA) two months prior to presentation (supplementary figure 1). The patient had been experiencing intermittent chest tightness and dyspnea since the procedure, so she presented to the cardiology clinic for evaluation. An echocardiogram showed an echogenic mass within the right atrium/ventricle (Figure 1a), as well as the presence of moderate tricuspid insufficiency. Chest X-ray (Figure 1b) and computed tomography (CT) (Figure 1c) also revealed a linear-shaped hyper-attenuated lesion extending from the right atrium into the right ventricle. Fragments of hyper-attenuated lesions were also seen in the branches of the right pulmonary artery.
In light of her recent surgical history, bone cement cardiac embolism was suspected. Upon admission, physical examination was unremarkable except for a grade II systolic murmur at the right lower sternal border. Subsequent surgical extraction of the cement was successfully performed through a median sternotomy under cardiopulmonary bypass. Upon right atriotomy, it was noted that the bone cement was densely adhered to the tricuspid valve leaflet (supplementary video), and tricuspid valve replacement was required due to irreparable leaflet damage (Figure 2). The patient was admitted to the intensive care unit for post-operative monitoring and was subsequently transferred to the general ward the next day. In accordance with the institutional policy of the Institutional Review Board (IRB) or equivalent ethics committee of the National Taiwan University Hospital, the IRB committee of the National Taiwan University waived the need for IRB approval and patient informed consent for case report of a single patient, as long as the article does not contain any patient identifiable information.

**Discussion**

Bone cement leakage and embolization is a well-documented complication of percutaneous vertebroplasty with a reported incidence of 4.6% (1, 2). Potential risk
factors for cement embolisms include osteoporotic or osteolytic fracture, injection of cement in large amount & under high injection pressure etc. (3). Though higher injection pressure has generally been considered as a risk factor (4, 5), there is currently lack of evidence to suggest at what injection pressure increases risk of cement embolization. The injection pressure is affected by multiple factors, including the technique & equipment used for injection, viscosity of the cement prior to injection, site of injection, severity & etiology of the fracture etc. (6). In our case, the amount of injected cement was unknown. However, in a retrospective study by Hsieh et al., the author reported an increased risk of pulmonary embolism with >7c.c of injected cement compared to <3.5c.c (0.9% vs. 0%, p<0.01) (7). However, there have been reports of cement embolism with injected volume as little as 1.5c.c (8). This can again be explained by the fact that the occurrence of cement leakage & subsequent embolization is multi-factorial, and risk assessment should be individualized.

Our patient’s symptoms developed insidiously over the course of weeks, but for the majority of patients with cement embolization, they remained asymptomatic. For those with symptoms, the onset was highly variable. While some patients developed dyspnea & chest pain immediately after cement injection, there were cases where patients developed symptoms months or even years after the procedure (9). For cases with no symptom, small & peripherally located cement emboli, it can be
managed conservatively with anti-coagulants, whereas some patients may require surgery, including those with tricuspid valve dysfunction, right ventricular perforation and large pulmonary embolism causing hemodynamic instability (10). Previous literatures have reported the retrieval of right atrial cement fragments through percutaneous approach, however, there is a potential risk of causing further fragmentation and distal embolization, as well as causing valvular injury (11).

Therefore, the optimal interventional should be individualized based on the size / location of the bone cement, presence of valvular or ventricular injury and extent of the embolization, as well as the risk of the procedure and its associated complications.

**Conclusions**

Bone cement embolization is a well-documented complication of percutaneous vertebroplasty with MMA, and disease manifestation may vary considerably depending on the size / location / associated valvular dysfunction etc. Post-operative surveillance with chest X ray have been proposed by some experts, though its sensitivity may be limited when compared to CT or echocardiography. Most important of all, clinicians should keep in mind that cardiac embolization is not an infrequent condition that may sometimes require surgical intervention.
References


neurological deficit and pulmonary cement embolism after percutaneous vertebroplasty.


**Figure Legends**

**Figure 1.** 1a: Echocardiography showed the presence of a echogenic linear mass within the right atrium & ventricle of the heart. 1b: A linear hyper-attenuated lesion was found on the chest x ray. 1c: Computed tomography also clearly demonstrated that there was a radio-opaque mass extending from the right atrium into the right ventricle.

**Figure 2.** The embolized bone cement was successfully extracted. The cement was densely adhered to the tricuspid valve leaflet.

**Supplementary figure 1.** Computed tomography image showing bone cement in the lumbar vertebra (L3-L5).

**Supplementary figure 2.** Computed tomography image showing small fragment of bone cement within branch of the right pulmonary artery (white arrow).

**Video Legend**

**Supplementary video.** The bone cement was retrieved under partial cardiopulmonary bypass. Upon right atriotomy, a string-shape cement was seen adhered to the tricuspid valve, and was subsequently removed carefully with Debakey forceps.
Surgical Approach

✓ Median sternotomy

✓ Cardiopulmonary bypass setting: SVC/IVC venous cannulation (bicaval snares) → Ascending aorta, normothermia, beating heart

✓ Right atriotomy

✓ Extraction of bone cement with DeBakey forceps

✓ Excised destructed tricuspid valve, followed by implantation of a 27mm Mosaic bioprosthetic valve

✓ Closed the RA atriotomy & de-air