

Life-threatening intracardiac cement embolisms after percutaneous kyphoplasty: a case report and literature review

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Chunneng Huang 

Abstract

Background: Percutaneous kyphoplasty is a popular technique in the treatment of osteoporotic vertebral fractures, but intracardiac cement embolism can be a life-threatening complication.

Case presentation: The authors present a case involving a patient who developed dyspnea and chest tightness after percutaneous kyphoplasty. Echocardiography and chest computed tomography confirmed several foreign bodies in the right atrium and pulmonary arteries causing cardiac perforation and pericardial tamponade. Conservative treatment was administered, and the patient died of respiratory and heart failure.

Conclusions: The present case highlights that surgical removal may be the first-choice treatment for symptomatic intracardiac cement embolism.

Keywords

Intracardiac cement embolism, pulmonary embolism, percutaneous kyphoplasty, osteoporotic vertebral compression fracture, conservative treatment, case report

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Introduction

Percutaneous kyphoplasty and vertebroplasty are minimally invasive surgical techniques that are widely used to treat osteoporotic vertebral compression fractures and spinal metastases.^{1,2} However, percutaneous kyphoplasty is associated

Department of Orthopedics, Affiliated Hangzhou First People's Hospital, Zhejiang University School of Medicine

Corresponding author:

Chunneng Huang, Department of Orthopedics, Affiliated Hangzhou First People's Hospital, Zhejiang University School of Medicine, 261 Huansha Road, Hangzhou, Zhejiang Province 310006, China.

Email: hcnzju@zju.edu.cn



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with multiple complications due to leakage of polymethylmethacrylate (PMMA) cement into the perivertebral venous system. The rate of venous cement embolism complications reportedly ranges from 2.1% to 26.0%.^{3,4} The cement first enters the heart chambers and may further migrate into the pulmonary arteries, which can cause life-threatening complications. We herein report a case of post-kyphoplasty intracardiac and pulmonary cement embolisms that caused cardiac perforation and pericardial tamponade, resulting in severe cardiopulmonary complications.

Case report

A woman in her early 80s was hospitalized because of persistent severe back pain. One month earlier, she had experienced an accidental fall. The patient was 155 cm tall, weighed 62 kg, and had a body mass index of 25.8 kg/m². She had a history of hypertension. Radiography and magnetic resonance imaging confirmed a compression fracture of the L4 and L5 vertebral bodies. The T-value measured by dual-energy X-ray absorptiometry was -3.3, which indicated osteoporosis of the lumbar spine. Percutaneous kyphoplasty was performed via a unilateral transpedicular approach with a 13-gauge needle under local anesthesia. Using fluoroscopic guidance, the prepared cement was injected into the L4 and L5 vertebral bodies, and the injected cement volume reached approximately 4.0 mL for each vertebra. No extravasation of bone cement was observed on either anteroposterior or lateral fluoroscopy. The patient's back pain was soon relieved, and she was discharged from the hospital 3 days after surgery.

Two months later, the patient developed dyspnea and chest tightness. No signs of myocardial ischemia were found on an electrocardiogram, and a heart murmur was auscultated during the physical examination.

Laboratory tests showed remarkably elevated D-dimer and myocardial enzyme concentrations. Transthoracic echocardiography showed a foreign body with calcium density in the right atrium (Figure 1). Therefore, we suspected that the patient had developed an intracardiac embolism. Chest computed tomography confirmed the existence of foreign bodies in the right atrium with perforation of the atrial wall, causing pericardial tamponade. Several high-density materials in the left pulmonary artery and right lower lobe pulmonary artery were also observed (Figure 2).

After obtaining the patient's consent for treatment, she was promptly treated with low-molecular-weight heparin and oxygen. Urgent pericardial drainage was performed with aspiration of 300 mL of bloody fluid. The patient's blood oxygen saturation decreased to 83%, and she was treated with respiratory support. Cardiology specialists were consulted immediately, and the treatment options were discussed. We decided to perform open surgery to remove the cement emboli from the right atrium and pulmonary artery. However, the patient refused surgical removal. Five days after admission, the patient developed atrial fibrillation and pneumonia that was



Figure 1. Echocardiographic finding of a linear foreign body in the right atrium (dotted line; length = 73 mm).

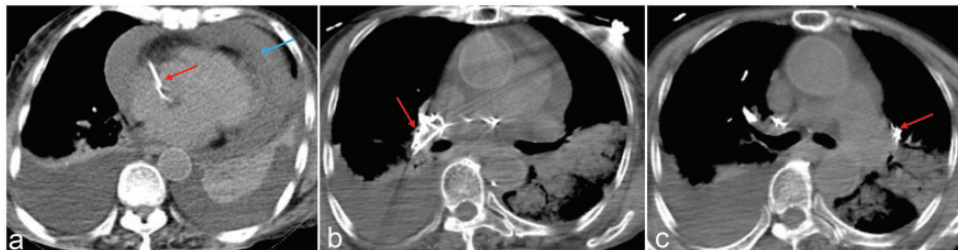


Figure 2. Images of intracardiac and pulmonary cement embolism. (a) Computed tomography showed high-density foreign bodies in the right atrium (red arrow) resulting in pericardial tamponade (blue arrow) and (b, c) Cement embolisms were present in the left pulmonary artery and right lower lobe pulmonary artery (red arrow).

unresponsive to antibiotic therapy. She died of cardiac and respiratory failure 7 days after admission. The reporting of this study conforms to the CARE guidelines.⁵

Discussion

Kyphoplasty is a technique that involves the injection of PMMA bone cement into the compressed vertebral body to mechanically stabilize the fracture. Reported complications of kyphoplasty include infection, adjacent level fracture, central canal stenosis, and pulmonary embolism.⁶ Among the various complications, cement leakage is relatively common. It may cause local complications such as central canal stenosis and systemic complications including pulmonary embolism and intracardiac embolism. The rate of venous cement embolism as a complication of kyphoplasty is reportedly as high as 65%.⁷ The bone cement enters the right heart chambers and may further migrate into the pulmonary arteries. PMMA is a foreign object and cannot be absorbed by the human body. Because of its irregular shape and porous surface, PMMA is considered potentially thrombogenic.⁸ In most patients, the cement pieces are small and scattered, and the embolisms can be clinically insignificant. In some patients, however, the embolisms may change the

hemodynamic status and lead to fatal consequences.⁹

Intracardiac embolism of bone cement secondary to vertebroplasty and kyphoplasty is a potentially serious complication. The reported incidence of intracardiac embolism is 3.9%.¹⁰ The most common symptoms of intracardiac embolism are chest pain and dyspnea. The onset of symptoms may be days, months, or even years after surgery. Most bone cement is located in the right atrium and right ventricle. However, several reports have described penetration of the heart wall by the cement, resulting in cardiac perforation,^{9,11,12} whereas involvement of the tricuspid valve can result in tricuspid regurgitation.^{13–16} In the present case, we presumed that the PMMA had stayed in the right atrium after the procedure. As the heart continued to beat, the PMMA eventually penetrated the right atrial wall and caused pericardial tamponade.

In terms of treatment, most reported cases of symptomatic intracardiac embolism were treated with open surgery (Table 1), especially in patients with tricuspid valve injury and cardiac perforation. Percutaneous retrieval is an alternative minimally invasive procedure to remove the cement, but potential complications such as further thrombus fragmentation and distal embolization need to be fully recognized.¹⁷

Table 1. Literature review of intracardiac embolism due to kyphoplasty or vertebroplasty.

Authors and year	Patient age (years), sex	Procedure	Surgical level	Time of event	Symptoms	Location of embolus	Cardiac complications	Interventions	Outcomes
Song et al. (2020) ¹³	79, Female	Kyphoplasty	L5	3 weeks	Chest pain with chest tightness	RV, RPA	Tricuspid regurgitation	Open surgery	Uneventful recovery
Amáiz-García et al. (2014) ²⁰	71, Female	Vertebroplasty	L1	–	Acute respiratory distress	RV, RPA	–	Open surgery	Uneventful recovery
Braiteh and Row (2009) ²¹	51, Female	Vertebroplasty	L3	5 months	Chest pain	RA, RV	–	Percutaneous retrieval	–
Cadeddu et al. (2009) ²²	68, Female	Vertebroplasty	T12, L2	2 years	None	RA, RV	–	Unsuccessful percutaneous retrieval	–
Caynak et al. (2009) ²³	64, Female	Vertebroplasty	T4–T9	2 months	Progressive dyspnea	RA, RPA, LPA	Pericardial tamponade	Open surgery	Uneventful recovery
Duijvelshoff et al. (2019) ¹⁴	69, Female	Kyphoplasty	T12, L1	7 years	None	RV	Tricuspid regurgitation	Open surgery	Total atrioventricular block
Gosev et al. (2013) ²⁴	58, Female	Kyphoplasty	T12, T11, L1	10 days	Chest pain, dyspnea	RV, RPA	Pericardial effusion	Open surgery	–
Kim et al. (2005) ¹¹	66, Female	Vertebroplasty	T8	7 days	Chest pain	RA, RV	Cardiac perforation	Open surgery	–
Lee et al. (2010) ²⁵	78, Female	Vertebroplasty	T8	6 years	Progressive dyspnea	RA, RV	–	Anticoagulation therapy	–
Lim et al. (2007) ²⁶	55, Female	Vertebroplasty	L2	5 years	Mild dyspnea	RA, RV	–	Open surgery	Uneventful recovery
Lim et al. (2008) ¹²	59, Female	Vertebroplasty	T12, L1	2 months	Chest pain, dyspnea	RV	Multiple cardiac perforation	Open surgery	Continuous lower back pain
Llanos et al. (2013) ²⁷	68, Female	Vertebroplasty	L3	2 months	Chest pain, dyspnea	RA, LPA	–	Open surgery	Uneventful recovery
Moon et al. (2013) ²⁸	86, Female	Vertebroplasty	L3, L4	5 years	Chest pain, fever	RV	Pericardial effusion	Open surgery	Uneventful recovery
Pannirselvam and Hee (2014) ¹⁸	52, Female	Vertebroplasty	T10, T11, L2	9 months	Syncope	RA	–	Anticoagulation therapy	Uneventful recovery
Son et al. (2008) ¹⁵	65, Female	Vertebroplasty	L1, L2	10 months	Chest pain and tightness	RA, RV	Cardiac perforation, tricuspid regurgitation	Open surgery	Uneventful recovery

(continued)

Table 1. Continued.

Authors and year	Patient age (years), sex	Procedure	Surgical level	Time of event	Symptoms	Location of embolus	Cardiac complications	Interventions	Outcomes
Tran et al. (2013) ⁹	68, Female	Kyphoplasty	L3, L4	1 day	Chest pain, dyspnea	RV	Pericardial tamponade	Percutaneous retrieval	Uneventful recovery
Wang et al. (2021) ¹⁶	53, Female	Vertebroplasty	L3, L4	15 months	Chest pain	RA, RV	Tricuspid regurgitation	Open surgery	Uneventful recovery

RA, right atrium; RV, right ventricle; LPA, left pulmonary artery; RPA, right pulmonary artery.

Few reports have addressed conservative treatment for intracardiac embolism of bone cement. Pannirselvam and Hee¹⁸ described a patient who presented with syncope after vertebroplasty. Echocardiography showed a 2.8-cm foreign body in the right atrium. The patient was treated with anticoagulation therapy and had no further symptoms, including syncope; thus, there was no need for additional interventions. Liang et al.¹⁹ suggested that cardiopulmonary embolism should be managed by conservative treatment under close monitoring. In patients who develop mild clinical manifestations with a stable hemodynamic status, conservative treatment including anticoagulation, continuous low-flow oxygen inhalation, and antibiotics can be an option.

There are no clear criteria for how severe an intracardiac cement embolism must be before surgery is required. Hatzantonis et al.¹⁷ suggested that surgical removal should be considered for patients with symptomatic intracardiac embolism. The decision about whether to attempt percutaneous retrieval or open surgery should be based on careful consideration of a number of clinical issues, including the precise location and size of the embolism and the presence of any cardiac complications.

Conclusion

Intracardiac cement embolism following percutaneous kyphoplasty is a rare but life-threatening complication. Surgical removal may be the first-choice treatment for symptomatic intracardiac embolism.

Author contributions

Huang Chunneng drafted and edited the manuscript.

Declaration of conflicting interests

The author declares that there is no conflict of interest.

Ethical statement

All patient details have been de-identified. Verbal consent for publication was obtained from the patient's son, and the consent for publication was approved by the Institutional Review Board of Hangzhou First People's Hospital.

Data availability statement

This is a case report of one patient. To protect the patient's privacy and respect her confidentiality, none of the raw data are available in any public repository. The original reports, laboratory studies, imaging studies, and clinical records are retained as per normal procedure within the medical records of our hospital.

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ORCID iD

Chunneng Huang  <https://orcid.org/0000-0003-2433-8068>

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