

Case Report

Intracardiac leakage of cement during artificial femoral head replacement: a case report and review

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Abstract: Bone cement leakage from the femoral medullary cavity is a rare complication following hip replacement. Currently, there are no reports of bone cement leakage into the heart. Here, we report an 81-year-old female patient with right femoral neck fracture. A thorough preoperative examination showed that bone cement had leaked into the heart during right femoral head replacement, leading to the death of the patient that night. Postoperative cardiac ultrasound showed that bone cement entered the vascular system through the femoral medullary cavity and subsequently entered the heart. Extreme deterioration in the patient's condition resulted in death that night. Unfortunately, the patient's family abandoned the idea of surgical removal of foreign bodies, leading to inevitable death. This case emphasizes the risk of clinical manifestations of cardiac embolism of bone cement after artificial femoral head replacement, suggesting that the risk of such embolism might be underestimated. We propose routine real-time C-arm X-ray guidance and injection of an appropriate amount of bone cement to prevent serious cardiopulmonary failure.

Keywords: Femoral neck fracture, hip hemiarthroplasty, bone cement leakage, intracardiac embolism

Introduction

In an aging society, femoral neck fractures are becoming more common in the elderly [1]. Artificial femoral head replacement is the most effective treatment for femoral neck fractures [2]. Bone cement plays an important role in hemiarthroplasty [3-5], but complications, such as cement leakage into the blood vessels reaching the heart, lungs, and cerebral circulation, are common. However, it is exceptionally rare for bone cement to leak into the heart [6, 7]. We encountered the following case of bone cement leakage into the heart.

Case report

An 81-year-old female patient fell two days prior, and the pain worsened during home recuperation, prompting her to come to our hospital. An X-ray revealed a right femoral neck fracture. She had a history of hypertension, chronic emphysema, and heart disease for 5, 10, and 8 years, respectively. No specific diagnosis or

treatment had been provided, and other examinations did not reveal any notable abnormalities. The surgical operation was performed 3 days after admission. At 14:00, the patient received oxygen inhalation after entering the room. Right internal jugular vein puncture and catheterization were performed, and L2-3 combined spinal and epidural anesthesia was administered in the left lateral position. After lying down, the patient reported no obvious discomfort, and vital signs remained stable. The anesthesia was effective, and the left lateral (surgical) position was assumed. The surgery commenced at 15:00. Throughout the procedure, the patient's vital signs remained stable, with blood pressure (BP) ranging from 125-140/65-75 mmHg, heart rate (HR) at 75-90 beats/min, and oxygen saturation (SPO₂) at 99-100%. During the operation, about 1 minute after bone cement implantation at 15:31, the patient suddenly experienced a loss of consciousness, accompanied by a significant decrease in BP to 64/34 mmHg, HR to 49

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Figure 1. Bedside echocardiography showed the cardiac dynamic results. A. A large foreign body was visible in the right atrium (red arrow); B. Emboli caused ineffective contractions of the right atrium; C. Some clumps could cross the tricuspid valve and enter the right ventricle.

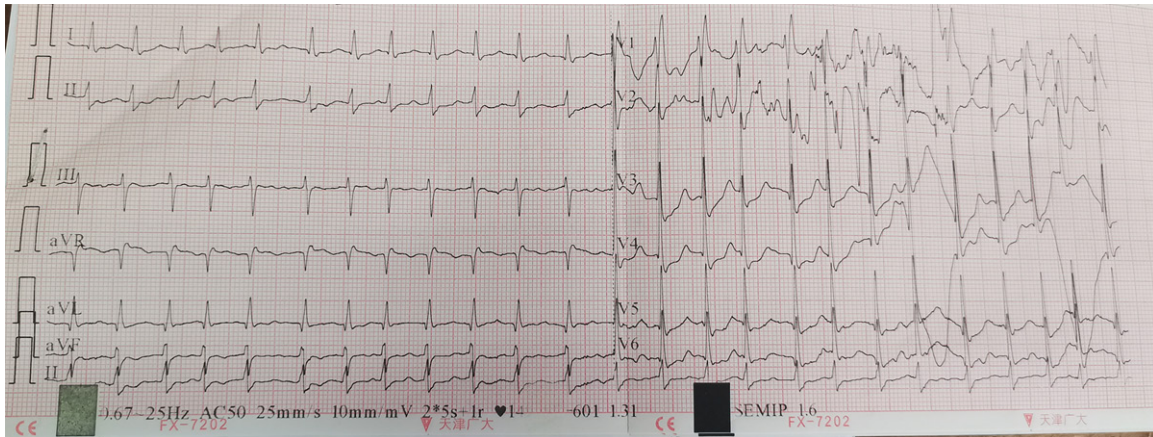


Figure 2. Electrocardiogram showed the cardiac results: 1. atrial fibrillation with a rapid ventricular rate, 2. complete right bundle branch block, 3. ST segment changes, and 4. QT interval prolongation.

beats/min, and SPO_2 to 81%. Despite intravenous administration of 10 mg ephedrine and 20 μg epinephrine, the response was unsatisfactory. The patient was immediately placed in the supine position, chest compressions were initiated, and tracheal intubation was performed as the patient's heartbeat had ceased. At 15:46, skin suturing was completed. The maintenance of the norepinephrine micropump (8 mg/36 ml NS, 3 mg/h), adrenaline administration at specific intervals (a total of 5 mg), and intravenous infusion of 150 mL sodium bicarbonate were performed. The patient's heartbeat continuously recovered until 16:17. She was sent to the ICU at 16:50, and continued to receive sedation, ventilator support, mild hypothermia treatment to reduce oxygen consumption and protect brain cells, nutritional support for myocardial treatment of ischemia and hypoxia injury, and symptomatic support treatment, including sodium bicarbonate correction for acid imbalance. Simultaneously, the patient's bedside echocardiography showed a large foreign body in the right atrium, with some

clumps crossing the tricuspid valve and entering the right ventricle (**Figure 1** and [Supplementary Video, IMG_2677](#)). The electrocardiogram indicated: 1. atrial fibrillation with a rapid ventricular rate, 2. complete right bundle branch block, 3. ST segment changes, and 4. QT interval prolongation (**Figure 2**). Therefore, we suspected that the patient might have had a cardiac embolism. The patient's family refused any invasive treatment techniques. At 19:30, the patient was in a deep coma and needed large doses of vasoactive drugs to maintain stability. After 21:00, the patient's BP was 55-60/35-38 mmHg, and SPO_2 levels could not be detected. The patient was in a state of shock that was difficult to improve, and her condition was critical. The family chose to discharge the patient after a medical consultation, and she passed away on the night she returned home.

Discussion

Intracardiac bone cement embolization is a rare complication associated with hip replace-

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ment surgery. Cement leakage can occur through small veins into the venous system, further migrating to the right side of the heart and pulmonary artery. In most cases, cement leakage is considered to be a subclinical problem. However, in some cases, cement leaks can be fatal. We reviewed the literature and found 26 cases of intracardiac bone cement embolization (**Table 1**). The main manifestations of cardiac embolism are perforation, pericardial tamponade, or pericardial perforation, which can cause chest pain and dyspnea [8-12] and occur during or after surgery. Pannirselvam et al. [13] reported that one patient presented with syncope in the ninth month after vertebroplasty. Transesophageal echocardiography revealed a mass with a size of 2.8 cm at the outlet of the inferior vena cava in the right atrium. The patient was treated with prophylactic anticoagulants for the emboli, and symptoms improved.

The occurrence of cement emboli at different locations has different effects on the cardiac function of patients. For example, case studies of echocardiography in patients with embolus-related right ventricular complications revealed moderate to severe pericardial effusion [14-16] or hemopericardium [9, 10, 17]. Park et al. [15] hypothesized that cement deposits in the right atrium and ventricle of a 66-year-old female patient were attributable to the injection of very low-viscosity acrylic cement into the vertebral body that subsequently flowed into the right ventricle, resulting in acute pericarditis. Kim et al. reported on an embolus in a patient undergoing vertebroplasty of the right atrium and ventricle. The echocardiogram showed an overall decline in cardiac function, poor systolic function (27%), impaired diastolic functioning in the left ventricle, and moderate to severe tricuspid reflux [12]. One case reported difficulty in breathing and heart-related problems more than 5 years later; it was revealed that bone cement leakage had occurred from the mouth into the right atrium and right ventricle [18]. Two patients experienced left and right pulmonary trunk and right ventricular embolism. Though the patients reported no discomfort and stable vital signs, conservative treatment was chosen [19, 20]. Most of the remaining patients needed open heart surgery. Intracardiac cement embolism mostly occurred during or after percutaneous vertebroplasty, and

the incidence of intracardiac cement embolism after percutaneous vertebroplasty was only 3.9% [11].

All the leakage of cement into the inferior vena cava resulted in a pulmonary embolism [21]. Reducing bone cement leakage, especially towards the inferior vena cava, can reduce the incidence of bone cement cardiac embolism. Unclear display screens in C-shaped arm line machines, use of low-viscosity cement, and excessive injection of bone cement increase the risk of bone cement leakage [14, 22]. Bone cement injection under the fluoroscopic guidance of a C-arm machine with real-time and clear display screen is very helpful for reducing bone cement leakage. Immediate cessation of bone cement injection is crucial in the event of a leakage. Alternatively, a gelatin sponge can be placed through the working sleeve, and prompt repositioning of the sleeve can be considered [23]. In this case, bone cement injection occurred without real-time guidance from the C-arm X-ray machine, resulting in bone cement leakage, an essential factor in this complication. In addition, the injection of a total of about 50 mL of bone cement was a secondary complicating factor.

There is no consensus on the best treatment for cement leakage-induced cardiac embolism. Non-surgical treatment includes symptomatic treatment and oral anticoagulant therapy for 3 to 6 months, and surgical treatment includes percutaneous embolectomy (especially for right atrial emboli) and open cardiac embolectomy [22]. Asymptomatic patients are often treated with anticoagulants such as warfarin or low-molecular-weight heparin [24]. In symptomatic patients, the emboli in the right atrium are usually removed using a percutaneous catheter. In patients with right ventricular involvement or perforation, surgical removal is required, while open surgery is required to remove large right ventricular emboli, even in the absence of symptoms.

During surgery, our patient experienced an immediate decrease in blood oxygen saturation, unclear consciousness, a significant decrease in BP and heart rate, and cessation of spontaneous breathing, after which the heart-beat stopped. In addition, the cardiac ultrasound showed a huge foreign body in the right

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Table 1. Patients' characteristics of the cement embolus, method of the treatment and the outcome

Case no.	Age/sex	Surgery	Embolus	Symptoms	Treatment	Outcome	Paper
1	62/f	Kyphoplasty	Right ventricle	Chest pain	Thoracotomy	Recovery	Prokop et al. [8]
2	84/f	Vertebroplasty	Cement leakage from t10 to l2	Weakness, numbness, and pain in both legs	Removed intradural cement completely	Recovery	Baek et al. [25]
3	52/f	Vertebroplasty	Right atrium	Syncope	Anticoagulation	Recovery	Pannirselvam et al. [13]
4	73/f	Vertebroplasty	Right atrium, right ventricle, right pulmonary artery	Asymptomatic	Thoracotomy	Recovery	Dash et al. [26]
5	55/f	Vertebroplasty	Right atrium, right ventricle	Dyspnea and edema	Thoracotomy	Recovery	Lim et al. [18]
6	71/f	Vertebroplasty	Right ventricle, right pulmonary artery	Acute respiratory distress	Thoracotomy	Recovery	Arnaiz-garcia et al. [27]
7	64/f	Vertebroplasty	Right atrium, right pulmonary artery, left pulmonary artery	Progressive dyspnea	Thoracotomy	Recovery	Caynak et al. [28]
8	-/f	Vertebroplasty	Right ventricle	Worsening dyspnea	Thoracotomy	Death	Lee et al. [14]
9	71/m	Vertebroplasty	Right atrium	Chest pain, epigastric pain, diaphoresis, syncope	Percutaneous retrieval	Recovery	Mattis et al. [9]
10	66/f	Vertebroplasty	Right atrium, right ventricle	Pleuritic chest pain	Thoracotomy	Recovery	Park et al. [15]
11	65/f	Vertebroplasty	Right atrium, right ventricle	Chest pain and collapse	Thoracotomy	Recovery	Son et al. [10]
12	71/m	Vertebroplasty	Right atrium	Chest pain	Percutaneous retrieval	Recovery	Grifka et al. [11]
13	74/f	Kyphoplasty	Right ventricle, right pulmonary artery	Right-sided chest pain, nausea	Thoracotomy	Recovery	Farahvar et al. [16]
14	58/f	Kyphoplasty	Right ventricle, right pulmonary artery	Chest pain, shortness of breath	Thoracotomy	Recovery	Gosev et al. [29]
15	75/f	Vertebroplasty	Right atrium, right ventricle	Dyspnea	Thoracotomy	Recovery	Kim et al. [12]
16	66/f	Vertebroplasty	Right atrium, right ventricle	Chest pain	Thoracotomy	Recovery	Kim et al. [17]
17	86/f	Vertebroplasty	Right atrium, right ventricle	Chest pain and fever	Thoracotomy	Recovery	Moon et al. [30]
18	68/f	Kyphoplasty	Right ventricle	Chest pain and dyspnea, cardiac shock	Thoracotomy and percutaneous retrieval	Recovery	Tran et al. [31]
19	85/f	Vertebroplasty	Right atrium	Hypotension	Percutaneous retrieval	Recovery	Bose et al. [32]
20	51/f	Vertebroplasty	Right atrium, right ventricle	Chest pain and palpitation	Percutaneous retrieval	Recovery	Braitheh et al. [33]
21	70/f	Kyphoplasty and vertebroplasty	Right atrium, right ventricle	Chest tightness	Thoracotomy	Recovery	Sun et al. [19]
22	61/f	Vertebroplasty	Right ventricle	Chest pain and dyspnea	Thoracotomy	Recovery	Krithika et al. [20]
23	-/f	Vertebroplasty	Right atrium, right ventricle	Unconscious	Thoracotomy	Recovery	Yin et al. [34]
24	56/m	Kyphoplasty	Right atrium	Dyspnea and right-sided chest pain	Thoracotomy	Recovery	Weininger et al. [35]
25	57/f	Vertebroplasty	Right atrium	Left-sided chest pain	Anticoagulation	Recovery	Hatzantonis et al. [24]
26	28/m	Kyphoplasty and vertebroplasty	Right ventricle	Chest pain	Thoracotomy	Recovery	Audat et al. [36]

ventricle, and our patient's vital signs were extremely unstable. Therefore, we should have performed a thoracotomy as soon as possible. Unfortunately, the patient's family opted not to pursue the surgical removal of foreign bodies, leading to the inevitable outcome of death.

This represents the first reported case of cardiogenic embolism resulting as a complication of hemiarthroplasty. Thus, cement can lead to cardiac embolism after solidifying from a paste during injection.

Conclusions

This case emphasizes the risk of clinical manifestations of cardiac embolism of bone cement after artificial femoral head replacement, suggesting that the risk of such embolism might be underestimated. We propose routine real-time C-arm X-ray guidance and inject an appropriate amount of bone cement to prevent serious cardiopulmonary failures. When bone cement is used, symptoms such as dyspnea, chest pain, and decreased oxygen saturation should raise suspicion of cardiac embolism, prompting immediate bedside echocardiography. A suspected cardiac embolism is a serious condition that demands prompt intervention, including open heart surgery, to save the patient's life.

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Disclosure of conflict of interest

None.

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