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Case Report

Bone Cement Emboli after Arthroplasty: Is It Possible? A Case Report and Literature Review

Seyyed-Morteza Kazemi[1], Sohrab Keyhani[1], Mohammadreza Miniator Sajjadi[2], Ramin Etemadi[3,*], Seyyed-Mohsen Hosseininejad[4], Hoda Nouri[5]

[1] Professor, Department of Orthopedic Surgery, Bone Joint and Related Tissues Research Center, Akhtar Orthopedic Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Associate Professor, Department of Orthopedic Surgery, Teleghani Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3] Assistant Professor, Department of Orthopedic Surgery, 5th Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran
[4] Orthopedic Surgeon, Bone Joint and Related Tissues Research Center, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran; Joint, Bone, Connective tissue Rheumatology Research Center (JBCRC), Golestan University of Medical Sciences, Gorgan, Iran
[5] Cardiologist, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[*]Corresponding author: Ramin Etemadi; Department of Orthopedic Surgery, 5th Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran. Tel: +98-3113754467, Email: raminetemadi@ymail.com

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Abstract

Background: Polymethylmethacrylate (PMMA) has been extensively used as bone cement in orthopedic procedures. Pulmonary cement embolisms (PCEs) are supposed to originate from cement extravasation into the basivertebral veins before draining into the inferior vena cava and eventually becoming lodged in the pulmonary capillaries. Few cases of bone cement embolism have been reported. This study reported a case of pulmonary embolism (PE) after thoracolumbar fixation and kyphoplasty and reviewed the current literature.
Case Report: We presented an 81-year-old woman who had undergone thoracolumbar vertebroplasty three months before admission and became symptomatic due to PE after total knee arthroplasty (TKA).
Conclusion: This case illustrates that clinicians must be aware of the probable occurrence of respiratory distress syndrome in patients with a history of vertebroplasty.

Keywords: Bone Cement; Polymethylmethacrylate; Pulmonary Embolism; Knee Replacement Arthroplasty; Vertebroplasty

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Background

Polymethylmethacrylate (PMMA) has been extensively used as bone cement in orthopedic procedures (1). Adverse local, circulatory, and pulmonary events associated with vertebroplasty using PMMA bone cement and other spine surgeries have been reported (2-5).

Pulmonary cement embolism (PCE) has been recorded to occur rarely, varying from 4.6% to 23% of cases (6, 7). PCEs are believed to originate from cement extravasation into the basivertebral veins, which then drain into the inferior vena cava and ultimately become lodged in the pulmonary capillaries.

While the diagnosis of symptomatic PCE can be quickly confirmed by imaging, there are no standard guidelines on PCE management, and the treatment selection is often dependent on the severity of each case (8). Treatment options include anticoagulation, embolectomy, cardio-pulmonary resuscitation, and supportive care and observation. Anticoagulation is the elected treatment reported in most symptomatic cases (9), while asymptomatic cases are often treated conservatively with symptomatic management and close clinical observation (10).

We experienced a case of respiratory distress syndrome associated with pulmonary embolism (PE) in an adult woman who underwent total knee arthroplasty (TKA) three months after thoracolumbar fixation and kyphoplasty.

Case Report

An 81-year-old woman with severe right knee osteoarthritis and valgus alignment with a past medical history of recent thoracolumbar fixation and kyphoplasty was admitted for TKA. She had a history of hypertension and was receiving medical treatment. At the time of admission, her blood pressure (BP) was 140/85. Her high-resolution computed tomography (CT) did not show any coronavirus disease-2019 (COVID-19) lung involvement before admission. The laboratory tests demonstrated the following: hemoglobin (Hb) [hemoglobin 12.6 g/dl, Normal urinalysis, International Normalized Ratio (INR) 1.1], viral markers (negative), fasting blood sugar (FBS) (202, receiving insulin), and oxygen saturation by pulse oximetry (97%). The patient was operated on with cemented TKA (Figure 1).

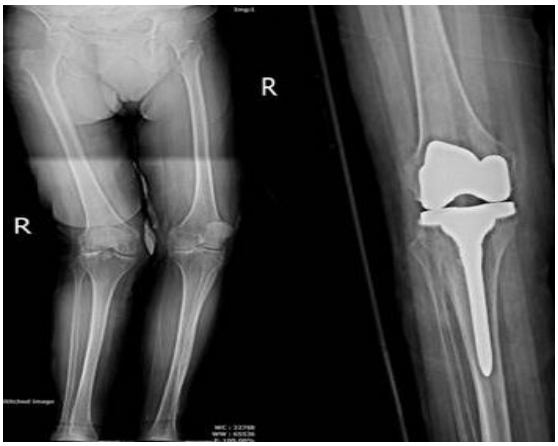

Figure 1. Preoperative and postoperative X-rays of the right knee

The surgery ended successfully and the patient was transferred to the recovery room and then to the intensive care unit (ICU) in stable condition.

Eight hours after the operation, she suddenly experienced shortness of breath, tachypnea, tachycardia, hypotension, hypoxemia, and a decreased level of consciousness. She exhibited the following: blood pressure (BP): 80/pulse, Hb (7.5, receiving 1 unit packed cell), creatine phosphokinase (CPK) (225), and creatine kinase-MB (CK-MB) (24). Electrocardiography showed non-specific changes. Based on clinical suspicion of PE, the patient received anticoagulation therapy. A heparin and norepinephrine drip and 5 L oxygen with a face mask (blood oxygen saturation with the mask was 96%) were started while waiting for more diagnostic documents.

The patient was transferred for echocardiography and spiral CT angiography (CTA) when she became hemodynamically stable. These modalities showed increased pulmonary arterial pressure and right ventricle enlargement, which are compatible with pulmonary thromboembolism (PTE). Diagnostic CTA also demonstrated a central feeling defect and linear density in the left pulmonary artery and interlobar branches with extension into the lingula and left lower lobe branches in favor of acute bone cement PE (Figure 2).

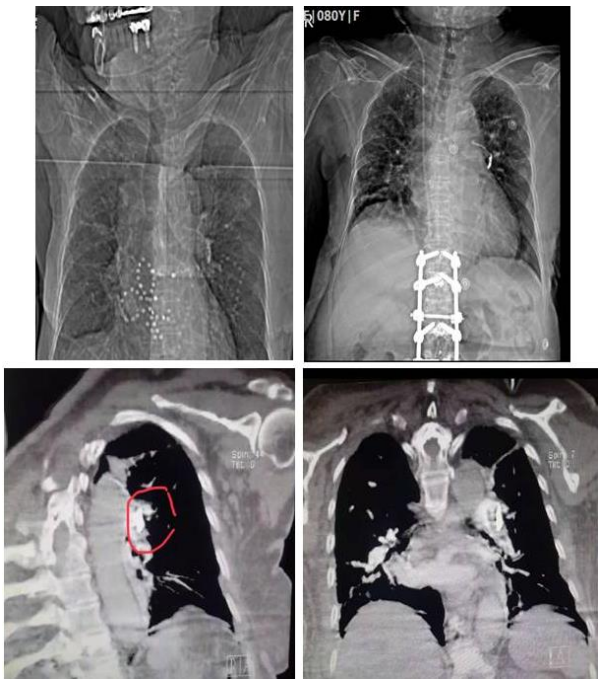

Figure 2. Computed tomography angiography (CTA) images illustrate linear density in the left pulmonary artery with extension to the interlobar branch and segmental left lower lobe in favor of acute pulmonary embolism (PE)

Discussion

PMMA bone cement prepared in a liquid methyl methacrylate monomer is widely used to anchor prostheses (3). Although incompletely understood, acute respiratory distress syndrome has been partly attributed to the formation of chemical microemboli, resulting in the activation of the inflammatory cascade to increase vascular endothelial permeability. The complement system may be activated in patients implanted with PMMA cement for a hip prosthesis (6).

The formation of anaphylactic toxins may cause direct cellular injury by increasing cell permeability by releasing histamine and platelet-activating factors and stimulating neutrophil adherence and superoxide production (7). In addition, the presence of the methyl methacrylate monomer in clinically relevant blood concentrations was cytotoxic to leukocytes and endothelial cells in vitro (8).

Cementing in hip arthroplasty has never been associated with cement embolism because the femoral medullary veins of cortical bones are small and not very distensible. In contrast, the leakage of bone cement into the circulation has been frequently observed in vertebroplasty (3).

The vertebral body is highly vascularized with intraosseous vertebral veins, making a freely communicating valveless network with paravertebral and extradural venous plexus (9). Because patients with cement embolisms can be completely asymptomatic, a routine chest X-ray after vertebroplasty is necessary (10). However, delayed presentations ranging from weeks to years have been reported. The emergency physician should consider bone cement embolization in the differential diagnosis in any patient with chest pain and shortness of breath that also has a history of pulmonary venous pressure (PVP) (9).

Symptomatic PCEs are relatively uncommon, and their management is controversial and generally based on the physician's preference (11). However, most reported cases of symptomatic PCEs are treated with anticoagulation (9).

PCE, as reported, occurs frequently during PVP. In contrast, PE caused by acrylic cement leakage associated with percutaneous kyphoplasty (PKP) has seldom been reported in detail; however, thromboembolism can be added to bone cement emboli (9). In the present case, the patient had a previous silent bone cement embolism that became symptomatic after TKA, and CTA showed the propagation of thrombosis near bone cement emboli.

Routine chest radiography, two-dimensional (2-D) echocardiography, and chest CT scan are suggested after each vertebroplasty to detect cardiac embolism and PEs. By finding such complications, future probable cardiopulmonary failures can be prevented or managed better (12).

Based on previous works of literature, cement embolisms usually do not result in clinically significant pulmonary arterial pressure (13). In cases of pulmonary arterial hypertension (PAH) induced by PCE and in high-risk patients, it is recommended that any intervention be planned by a multidisciplinary pulmonary hypertension team. It is also recommended that patients with PAH have an optimized treatment regimen before any non-emergency surgical interventions and continue this in the pre-, peri-, and post-operative periods without interruption. Monitoring patients with PAH should continue for at least 24 hours during the postoperative period (11).

If we had known the patient's history of PCE in the present case, we could have made a better evaluation of the presence of biologic acute PE before her elective TKA surgery. Generally, it is recommended to postpone elective surgeries for a minimum of two to four weeks from the acute PE event because of the high risk of recurrence in the first four weeks (14, 15).

Since the cement is an inorganic substance, using anticoagulants has the benefit of inhibiting biological clot formation on the outer surface of cement particles.

Decisions on the treatment method, use of thrombolytic agents or invasive embolectomy, and even duration of anticoagulation therapy should be made individually (16). The benefit of treatments with anticoagulants must be weighed against the risk of bleeding.

Based on the European Society of Cardiology's 2019 guidelines, extended oral anticoagulation of indefinite duration should be considered for patients experiencing their first episode of PE associated with a persistent risk factor like PCE, which was explained in the current case (class IIa level of evidence C) (17).

Our main limitation in carrying out this case study was the lack of access to some laboratory data and tests, including the pulmonary function test, which was conducted on a portable set-up and not documented in our central database system.

Conclusion

Based on this case and a review of the literature, few cases of bone cement embolism have been reported. Bone cement embolism could make patients symptomatic for weeks to years after vertebroplasty. Physicians should be aware of such complications in patients with a history of PVP or PKP. Based on previous studies, bone cement embolism has rarely occurred in arthroplasty. Further epidemiologic studies are needed to investigate the long-term complications of PCE to provide a comprehensive standard guideline for the management of patients with PCE.

Conflict of Interest

The authors declare no conflict of interest in this study.

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