Bone cement embolism penetrating both the aorta and the right atrium after percutaneous vertebroplasty: Thermal rather than mechanical injury?

Chung Shik Shin, MD, Min Woo Kim, MD, Jun Hui Go, MD, Jeong Moon Lee, MD, and Jong Bum Choi, MD, Jeonju and Iksan, Republic of Korea

Percutaneous vertebroplasty (PVP) has been used to treat lumbar compression fractures for more than 30 years. The polymethyl methacrylate bone cement used in this procedure can reach temperatures of 70 °C or greater. Migration of the cement embolism into the venous system is common but usually asymptomatic. These embolisms are rod-shaped because of venous flow dynamics and settle in the right atrium, right ventricle, and pulmonary artery, with a rare risk of thromboembolism. Aortic perforation caused by a bone cement embolism may be thermal rather than mechanical injury.

CENTRAL MESSAGE

Bone cement embolism penetrated both the right atrial and aortic walls.

Aortic perforation caused by a bone cement embolism may be thermal rather than mechanical injury.

CLINICAL SUMMARY

The patient visited our emergency department and registered a systolic pressure of 70 mm Hg. Eighteen hours earlier in a different facility, she had undergone PVP for repair of the second lumbar vertebra compression fracture. During her time at the previous hospital, she had experienced sudden onset of shock with a systolic pressure of 60 mm Hg for 15 minutes. An enhanced computed tomography scan of the chest showed hemopericardium with a dense strand in the right atrium and several thin strands in the pulmonary artery. In our emergency department, systolic blood pressure increased to 90 mm Hg with percutaneous pericardial catheter drainage and transfusion of two units of fresh-frozen plasma. The drained blood was reddish, suggesting arterial bleeding.

Emergent exploration was performed through a median sternotomy. After removal of the pericardial hematoma, systolic blood pressure increased to 90 mm Hg with percutaneous pericardial catheter drainage and transfusion of two units of fresh-frozen plasma. The drained blood was reddish, suggesting arterial bleeding.
We did not use cardiopulmonary bypass because of her poor respiratory function, so that several thin emboli in the pulmonary artery were not removed, which we considered clinically insignificant. The patient was discharged home 10th day postoperatively with apixaban because of atrial fibrillation.

**DISCUSSION**

The incidence of cardiac perforation as a complication of PVP is very low, and the cardiac symptoms commonly arise days to months after the procedure rather than periprocedurally. Most cardiac perforations occurred in the right atrium and ventricle. However, in our case, perforations were found in both the right atrial wall and the aorta facing the right atrial wall. The leading cause of cardiac tamponade and hypotension in this case was aortic bleeding. The cement fragment was rod-shaped and easily fractured with a light index-finger force. The cement stick was too fragile to penetrate even the right atrial wall with mechanical force. Thus, it was incomprehensible that the weak cement stick could penetrate the thicker and more rigid aortic wall in the short period after the patient had undergone PVP. We found no literature on aortic injury due to bone cement embolism. When the bone cement is injected into the vertebra, its temperature of more than 70°C can be maintained in the bloodstream, which is 36.5°C, during migration to the right atrium or ventricle. A rod-shaped embolus could puncture the right atrium or ventricle by mechanical force if both ends extend across the limited atrial and ventricular spaces during cardiac cycles. For punctures of the aorta, however, a thermal effect should be considered as a potential mechanism of injury. Given the thickness and rigidity of the aorta, we infer that a thermal effect allowed the cement embolism to puncture the aortic wall and right atrium in this case.

**References**

1. Wegener B, Zolyniak N, Güleçiyüz MF, Büttner A, von Schulze Pellengahr C, Schaffer V, et al. Heat distribution of polymerisation temperature of bone cement on the spinal canal during vertebroplasty. *Int Orthop.* 2012;36:1025-30.
2. Shridhar P, Chen Y, Khalil R, Plakseychuk A, Cho SK, Tillman B, et al. A review of PMMA bone cement and intra-cardiac embolism. *Materials (Basel).* 2016;9:821.
3. Kollmann D, Hoetzenecker K, Prosch H, Ankersmit H, Aigner C, Taghavi S, et al. Removal of a large cement embolus from the right pulmonary artery 4 years after kyphoplasty: consideration of thrombogenicity. *J Thorac Cardiovasc Surg.* 2012;143:e22-4.
4. Son KH, Chung JH, Sun K, Son HS. Cardiac perforation and tricuspid regurgitation as a complication of percutaneous vertebroplasty. *Eur J Cardiothorac Surg.* 2008;33:508-9.
5. Hong SW, Oh TH, Jeon JM, Lee YS, Kim KT. Cardiac perforation caused by cements as a complication of cement augmented pedicle screw fixation using the fenestrated pedicle screw: a case report. *Korean J Neurotrauma.* 2020;16:337-42.