CASE REPORT

Pulmonary Embolism Caused by Cement Leakage after Percutaneous Kyphoplasty: a Case Report

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Introduction

Both percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) involve injection of polymethyl-methacrylate (PMMA) cement into diseased vertebral bodies to stabilize fractures. These procedures can give patients significant pain relief; however, PVP has a statistically higher risk of cement leakage than does PKP¹. Cement pulmonary embolism reportedly occurs frequently during PVP^{2,3}. In contrast, pulmonary embolism caused by acrylic cement leakage associated with PKP has seldom been reported in detail. The present case is a patient who developed pulmonary embolism after PKP for multiple osteoporotic vertebral compression fractures (MOVCFs).

Case Report

A 63-year-old woman with persistent, severe back pain was diagnosed as having MOVCF. After confirming that her laboratory data were within normal limits, plans to perform PKP were made. This procedure was performed under local anesthesia via a unilateral transpedicular approach under lateral and anteroposterior fluoroscopic guidance. A balloon filled with iohexol was expanded gradually to compress the cancellous bone and lift the endplate, after which PMMA cement mixed with barium or tungsten was prepared at room temperature (20°C) and injected into the affected vertebra 3 min after mixing. During the fluoroscopically guided procedure, extravasates were observed posterior to the T₇ vertebral body and anterior to the T₁₂ vertebral body. Injecting was immediately stopped and restarted one minute later, after which the procedure was resumed. Eventually, 4 mL, 3 mL and 4 mL cement were injected into T₇, T₈ and T₁₂ vertebral bodies, respectively. All vital signs were stable during the procedure.

Eight hours after the procedure, the patient complained of pain in her right lower chest, tachypnea and tachycardia.

Arterial blood gas analysis showed a pH of 7.404, PaO₂ of 64.2 mm Hg and a PaCO₂ of 41.2 mm Hg. A laboratory test showed a blood D-dimer concentration of 1.3 mg/L and her electrocardiogram was normal. A routine chest radiograph (Fig. 1) revealed multiple tubular opacities corresponding to the courses of blood vessels, mainly in the inferior lobe of the right lung, which suggested pulmonary embolism presumably caused by the bone cement used during PKP. A lateral radiograph showed cement extravasates posterior to the T₇ vertebral body and anterior to the T₁₂ vertebral body (Fig. 2). A CT scan of the chest showed several deposits of high-contrast cement in the pulmonary arteries of the right lower lobes and some high-density intraluminal cement outlining the external vertebral venous plexus at the level of the T₇ vertebral body (Fig. 3). Multi-slice spiral CT pulmonary angiography confirmed the presence of multiple, linear hyperdensities within the pulmonary arteries (Fig. 4).

In response to the diagnosis of pulmonary embolism caused by acrylic cement, high-dose heparin (5000 U/12 h) was begun immediately and oxygen administered via a nasal cannula at 2 L/min. The patient responded favorably two days later, with relief of pain, and resolution of dyspnea and tachycardia. Fifteen days after PKP, the patient's condition appeared to be stable, except for a continuous slight pain in the right lower chest. The patient was discharged and prescribed oral anticoagulants for 6 months. Three months later radiography showed that the cement emboli appeared unchanged. However, the patient denied any respiratory or chest-related symptoms.

Discussion

Percutaneous kyphoplasty is a new technique that was developed based on PVP in order to overcome the shortcoming of high cement leakage rates¹. Several articles have

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Fig. 1 Chest radiograph revealing multiple tubular opacities corresponding to the courses of blood vessels, mainly in the inferior lobe of the right lung.

reported the complication of pulmonary embolism caused directly by cement leakage during the procedure of PVP²⁻⁴; however, this complication is relatively rare in PKP. In the procedure of PKP, an inflatable balloon is inserted into the vertebral body by either a transpedicular or extrapedicular route in order to compress the cancellous bone and create a cavity in the vertebra before injecting PMMA. Creation of a cavity allows the cement to be injected at a much lower pressure and in a more viscous phase than is possible in standard PVP, which probably explains why PKP has a significantly lower cement leakage rate than does PVP^{5,6}.

The volume of PMMA injected into the vertebrae is correlates closely with the occurrence of cement leakage. In a study by Ren *et al.* the mean injected cement volume was more in the cement leakage group (5.34 mL) than in the no cement leakage group (4.17 mL)⁷, which confirms a positive correlation between the volume of injected cement and the complication rate. Some experts have concluded that overfilling the vertebral body is one of the major factors that facilitates cement migration into the venous system⁸. In our case, volumes of 4 mL, 3 mL and 4 mL were injected into T₇, T₈ and T₁₂ vertebral bodies, respectively, and pulmonary embolism occurred. We therefore concluded that, in MOVCF patients, the mean injected cement volume should be strictly controlled.

Fig. 2 Lateral radiograph of chest showing extravasation of cement posterior to the T₇ vertebral body and anterior to the T₁₂ vertebral body.

In an *in vitro* study, Weisskopf *et al.* used a pressure sensor and detected significantly lower intravertebral pressure during PKP than during PVP cement injection⁹. However, during PKP they recorded a relative increase in the

Fig. 3 Chest CT image disclosing several deposits of high-contrast material in the pulmonary arteries of the right lower lobes of the lung.

Fig. 4 Multi-slice spiral CT pulmonary angiography confirming the presence of multiple, linear hyperdensities within the pulmonary arteries.

intravertebral pressure during the final stage of stabilization, when the injected volume had exceeded the capacity of the preformed cavity. Baroud *et al.* reported a strong relationship between uniformity of filling pattern, the elapsed time after mixing of the cement and viscosity. They found that they could considerably reduce the incidence of leakage by controlling the timing of the injection according to cement viscosity¹⁰. Therefore, we prefer to inject the PMMA at a high-viscosity to achieve a stable and uniform pattern of cement flow into the vertebrae. This prevents venous extravasation and, to some extent, decreases the incidence of pulmonary embolism. Yang and Wang concluded that applying the procedure of PKP to too many vertebrae of MOVCF patients during a single procedure significantly increased cardiovascular toxicity and the possibility of cement pulmonary embolism. They therefore recommend injecting no more than three vertebrae at a time¹¹.

Pulmonary cement embolism may cause inflammatory reactions and an increase in capillary permeability; such a reaction in the lungs may lead to acute respiratory distress¹². In addition, it may cause a persistent increase in pulmonary arterial pressure, which release of vasoactive mediators may intensify¹³. Because pulmonary cement embolism can cause increasingly severe cardiopulmonary deterioration in the long term, routine chest radiographs should be taken immediately in patients with chest pain, tachypnea and tachycardia to ascertain whether pulmonary cement embolism is the cause and to take the necessary remedial measures. Fortunately, in our patient, the volume of leakage was small and the harmful reaction mild; thus we were able to successfully manage her with conservative medical treatment.

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