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Vertebroplasty: Case Report**

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*AJNR Am J Neuroradiol* 2002, 23 (5) 868-870

<http://www.ajnr.org/content/23/5/868>

This information is current as  
of July 19, 2025.

## Case Report

# Paradoxical Cerebral Arterial Embolization of Cement during Intraoperative Vertebroplasty: Case Report

Rebecca Scroop, Joseph Eskridge, and Gavin W. Britz

**Summary:** Paradoxical cerebral embolism of cement occurred in a 78-year-old woman after cement-assisted transpedicular spinal fixation surgery. Multiple pulmonary emboli of polymethylmethacrylate precipitated pulmonary hypertension and right-to-left shunting into the systemic circulation through a patent foramen ovale. This rare complication occurred because of failure to recognize venous migration of cement during the procedure and the injection of multiple levels in one setting. Although this was an open procedure, the technical aspects were the same as for vertebroplasty and the precautions should be applied to percutaneous vertebroplasty.

Acrylic cement (polymethylmethacrylate [PMMA]) is commonly used to provide increased prosthetic fixation by conforming to macroscopic irregularities in the target bone. Most commonly, PMMA is used for peripheral fixation of orthopaedic hardware, such as in hip or knee arthroplasty. Percutaneous vertebroplasty involves injection of PMMA into a diseased vertebral body for pain relief and partial bone remodeling (1).

Pulmonary emboli of PMMA and fat are known to occur after both procedures but with uncertain frequency and are usually asymptomatic (2–4). Even more rarely, cerebral arterial emboli have been reported to occur in association with peripheral PMMA-assisted arthroplasty (5). We report a case of paradoxical cerebral embolization during intraoperative transpedicular PMMA injection.

## Case Report

A 78-year-old woman was hospitalized for revision of thoracolumbar hardware because of increasing back pain. She had undergone posterior segmental hardware placement from T11–L2 after an L1 crush fracture 8 months previously. Recently obtained radiographs confirmed failure of the hardware with retraction of pedicle screws at three levels.

The old hardware was removed, and posterior segmental fusion from T4 to L4 was performed using Synthes titanium USS implants. The bone was osteoporotic, and it was elected to

use PMMA to assist fixation of the pedicular screws at T4 through L4 with transpedicular cement injection. The cement consisted of simplex powder, 1.2 g of tobramycin, and 6 g of sterile barium sulfate, which was mixed with PMMA liquid acrylic to a toothpaste consistency and injected via an 11-gauge needle. The needle tip was positioned in the mid third of the vertebral body, close to midline. Approximately 1 cc of cement was injected bilaterally at each of the 13 levels. At the T3 and L5 levels, no screws were placed but transpedicular cement was used to improve bone strength. Fluoroscopic monitoring was used intermittently by the operator during the procedure, and at no time was there concern recorded of significant extravasation of cement into the venous system.

Toward the end of the operative procedure, the patient became hypotensive with elevation in pulmonary arterial pressure to 60 mmHg and her oxygenation status declined to a PaO<sub>2</sub> of 50. After the patient's condition was stabilized, a radiograph of the chest was obtained and revealed multiple PMMA emboli (Fig 1B). CT of the chest confirmed pulmonary emboli (Fig 2B) and the presence of PMMA within the paravertebral and epidural veins (Fig 2A and B). During the recovery phase from the general anesthetic, it was noted that the patient was hemiparetic on the right side. CT of the head revealed a left-sided middle cerebral artery territory acute infarct and a hyperattenuated focus within the left middle cerebral artery consistent with PMMA (Fig 3A). Several other emboli were seen within more peripheral cerebral vessels (Fig 3B), which were clinically silent. An echocardiogram was obtained and confirmed right heart dilation, elevated pulmonary arterial pressure, and a patent foramen ovale.

The patient was not anticoagulated because of the recent surgery, and the patient's respiratory status slowly improved after a period of 10 days with assisted ventilation. The patient remained hemiparetic with a moderate expressive dysphasia at the 3-month follow-up examination.

## Discussion

Transpedicular injection of PMMA performed with vertebroplasty is frequently associated with leaking into the external vertebral venous plexuses. From there, cement could migrate into the inferior vena cava and result in pulmonary emboli. If the needle tip is positioned within the basivertebral venous plexus, cement injection may result in more extensive leakage into the venous system and then into the lungs.

In the majority of cases, leakage is asymptomatic and the leakage occurs because of the fluid consistency of the PMMA at the time of injection. For this reason, real-time monitoring during injection and adequate opacification of the PMMA are required. If venous filling is noted, repositioning of the needle or temporary cessation of PMMA injection to allow polymerization is suggested. Although most pulmonary

Received June 28, 2001; accepted after revision October 16.

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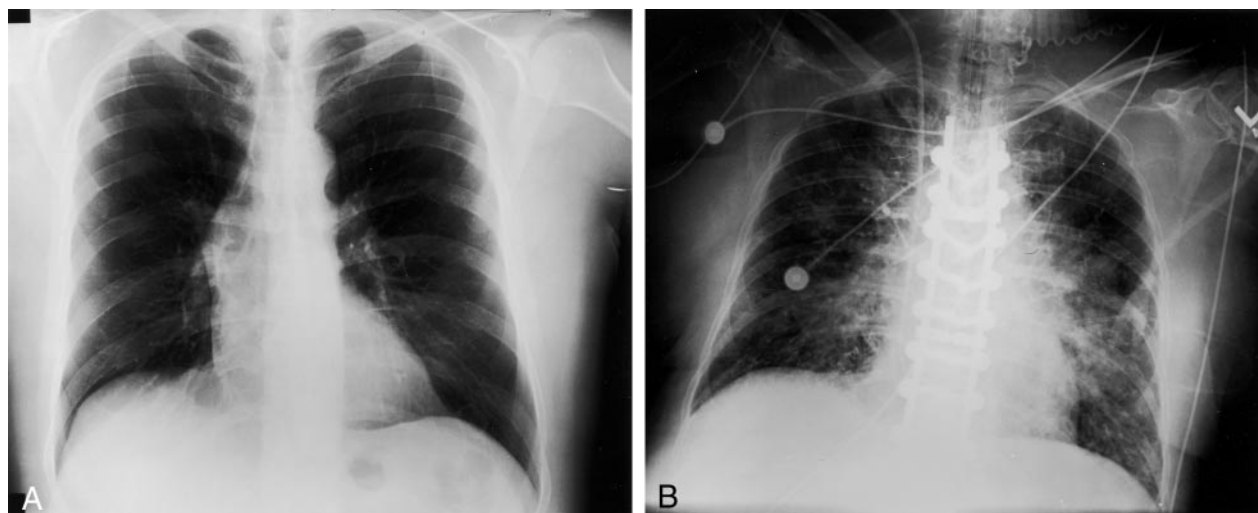


FIG 1. Pre- and postoperative radiographs of the chest.

A, Normal anteroposterior preoperative radiograph of the chest.

B, Anteroposterior postoperative radiograph of the chest shows numerous emboli of cement throughout the lungs.

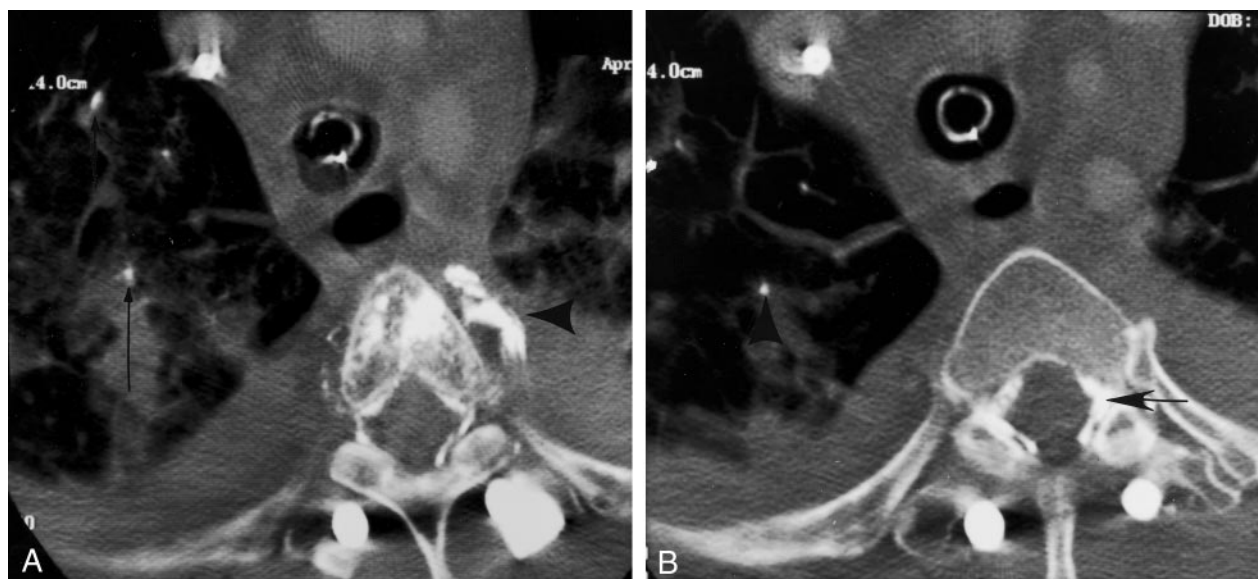


FIG 2. CT scans confirm pulmonary emboli.

A, CT scan obtained through the level of T4 shows cement within the paravertebral veins (arrowhead) and small emboli of cement within the lungs (arrows).

B, CT scan obtained at the T5 level shows cement in the epidural veins (arrow) and pulmonary emboli (arrowhead).

emboli from PMMA are asymptomatic, clinically significant disease has been reported (2).

Cerebral emboli have been reported to occur after PMMA- and non-PMMA-assisted arthroplasty and have been attributed to fat emboli resulting from raised intramedullary pressure during reaming and cementation (6, 7). When systemic emboli are seen, they have been attributed to paradoxical embolism via a patent foramen ovale (8). Transpulmonary passage of small emboli, both fat and air, has recently been shown in experimental models, suggesting that microemboli in the lungs may undergo embolization into the systemic circulation (5). In our case, cerebral embolism occurred via a patent foramen ovale. Multiple pulmonary emboli of PMMA were apparent on

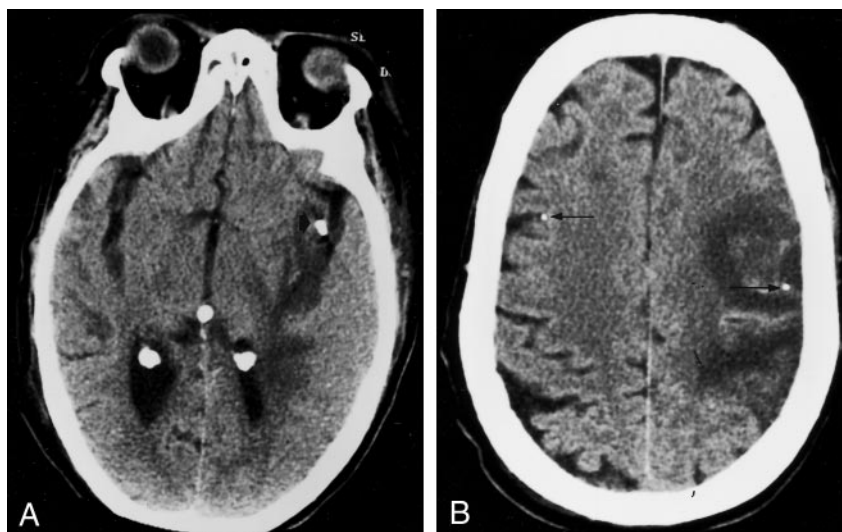
a postoperative CT scan of the chest. The resultant elevation in right heart pressure caused paradoxical emboli of PMMA via a patent foramen ovale into the systemic circulation.

Although this was an open procedure, cement was injected in much the same way as for percutaneous vertebroplasty, with transpedicular placement of an 11-gauge needle into the vertebral body. Therefore, the complications from this procedure could potentially occur with vertebroplasty. Symptomatic embolization in this case was thought to have resulted from two factors: venous leakage of cement that was not appreciated even with fluoroscopic monitoring and injection of multiple levels in one setting. The former is well established as good practice for vertebroplasty.

FIG 3. CT scans of the head.

A, Unenhanced CT scan of the head shows an embolus of cement within the left middle cerebral artery and early ischemic changes.

B, CT scan of the same patient, obtained at a more superior level, shows other emboli in more peripheral branches (arrows).



The value of obtaining a vertebrogram before injection of cement is controversial and should not preclude real-time monitoring (2). The properties of iodinated contrast material differ significantly from those of PMMA. Inevitably, venous extravasation occurs, and residual vertebral opacification may interfere with visibility of PMMA. This has resulted in a shift in practice, with obtaining a vertebrogram no longer being standard (9, 10). The consistency and opacification of the cement were not thought to have contributed significantly to the complications experienced.

Assuming that venous extravasation and pulmonary emboli can and probably do occur to some degree in association with clinically uncomplicated vertebroplasty, it is prudent to limit the levels treated at a single setting. In this case, a total of 15 levels were treated with transpedicular PMMA and resulted in significantly raised pulmonary pressures. Although not based on experimental or hard clinical evidence, we recommend that in patients without underlying pulmonary disease, a maximum of three levels be treated in a single setting, even with good fluoroscopic monitoring. Unlike this case, vertebroplasty does not require general anesthesia, and it is our practice to use local anesthesia and neurolept sedation that allows early detection of any changes in the clinical condition of the patient (11).

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## Erratum

Article **The Sphenoparietal Sinus of Breschet: Does It Exist? An Anatomic Study** AJNR 25:112–120, January 2004. The sentence on page 112, paragraph 1 which reads “Cruveilhier observed that book II, plate 3 could not be found or confirmed and does not correspond to Breschet’s atlas (1).” should read “The reference given by Cruveilhier, that is ‘book II, plate3’ could not be found or confirmed, and does not correspond to Breschet’s atlas (1).”

A misspelling of oligodendrogliomas occurs in the title of the article **Glial Tumor Grading and Outcome Prediction Using Dynamic Spin-Echo MR Susceptibility Mapping Compared with Conventional Contrast-Enhanced MR: Confounding Effect of Elevated rCBV of Oligodendroglimoas** AJNR 25:214–221, February 2004. The correct title should be **Glial Tumor Grading and Outcome Prediction Using Dynamic Spin-Echo MR Susceptibility Mapping Compared with Conventional Contrast-Enhanced MR: Confounding Effect of Elevated rCBV of Oligodendrogliomas**.

The authors and their affiliations are incorrectly listed in the article **Noninvasive MR Cisternography with Fluid-Attenuated Inversion Recovery and 100% Supplemental O<sub>2</sub> in the Evaluation of Neurocysticercosis**, AJNR 25:295–297, February 2004. The authors and their respective affiliations should be listed as:

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Re: Retraction Request: AJNR 23: 868–870, May 2002

Dear Editor:

We request that the manuscript entitled, “Paradoxical Cerebral Arterial Embolization of Cement During Intraoperative Vertebroplasty: Case Report,” published in the American Journal of Neuroradiology in May 2002 be retracted. We have discovered several factual errors that we believe warrant its retraction from publication.

We apologize for this inconvenience; however, we believe the integrity of the scientific literature requires the requested action.

Respectfully Submitted,

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The above request for retraction has been reviewed and concurred with by the following University of Washington School of Medicine representatives:

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