



Pulmonary cement embolism after augmentation of pedicle screws with bone cement

Marc RÖLLINGHOFF, Jan SIEWE, Peer EYSEL, Karl-Stefan DELANK

From the University of Cologne, Germany

The authors present the very rare complication of widespread pulmonary artery cement embolism after pedicle screw augmentation with bone cement for multilevel spine fusion. A 69-year-old woman with severe osteoporosis underwent a posterior T12S1 fusion because of lumbar scoliosis. After two months the superior pedicle screws loosened, and a revision spondylodesis T8L1 was performed with bone cement augmentation of the pedicle screws. Although cement leakage was seen paravertebrally, the patient was asymptomatic and reported distinct pain relief, so that no further investigations were initiated. Three months later, instability was identified in the adjacent superior segment. A CT-scan of the chest now revealed multiple pulmonary cement embolisms. Corpectomy T7 and extension spondylodesis T6T9 with an anterior single rod were performed. The pulmonary embolisms remained clinically silent and lung function was normal 18 months after surgery. The risk for cement embolism after pedicle screw augmentation has been established at 1/119 or 0.8%. After vertebroplasty and kyphoplasty it ranges from 3 to 23%. The existing literature offers no clear strategy for prevention or treatment of pulmonary cement embolism. The authors feel, as far as prevention is concerned, that creating a cavity by means of balloon distention before pedicle screw augmentation allows to inject the cement under lower pressure, so that the incidence of cement embolism might be reduced. Treatment options include, besides surgical removal in symptomatic embolism, heparin or warfarin treatment for 3 to 6 months.

Keywords : cement ; pulmonary artery embolism ; spine ; pedicle screw ; augmentation.

INTRODUCTION

Various forms of operative repair are used for osteoporotic, degenerative or traumatic conditions of the spine. One reason why the minimally invasive vertebroplasty was developed in the mid-1980s was the high loosening rate of pedicle screws (6,11, 18). With this technique, it became possible for the first time to stabilize vertebral body fractures via percutaneous transpedicular cementation. Similarly, the use of cemented pedicle screws appears reasonable (18,22) when posterior spondylodesis is performed on patients with reduced bone quality (osteoporosis), where screw stability might be insufficient (3,15). However, cementing techniques, particularly those used in percutaneous interventions, remain controversial. However, few serious complications have been reported to date after cement augmentation of pedicle screws.

-
- Marc Röllinghoff, MD, Orthopaedic resident.
 - Jan Siewe, MD, Orthopaedic resident.
 - Peer Eysel, MD, Professor of Orthopaedic Surgery.
 - Karl-Stefan Delank, MD, Professor of Orthopaedic Surgery.
Department of Orthopaedic and Trauma Surgery, University of Cologne, Germany.

Correspondence : Marc Röllinghoff, Department of Orthopaedic Surgery, University of Cologne, Joseph-Stelzmann str. 9, 50924 Cologne, Germany.

E-mail : marc.roellinghoff@gmx.de

© 2010, Acta Orthopædica Belgica.

CASE REPORT

A 69-year-old woman presented with chronic lumbar pain, pseudoradicular pain radiating to both legs and walking distance decreased to 400 meters. Radiographs showed a degenerative right convex lumbar scoliosis with a relative spinal stenosis L2L3 and L3L4. Osteoporosis, diagnosed by DEXA (Dual-Energy X-ray Absorptiometry), with a T-score of -3.5, had been treated for three years with alendronate, calcium and vitamin D. Single shot peridural anaesthesia and physiotherapy had remained ineffective. Posterior corrective spondylodesis from T12 to S1 was performed because of progression of the lumbar scoliosis. The patient was discharged without neurologic deficit and with sufficient pain relief.

Two months later she presented with increasing back pain and a walking distance decreased to 50 meters. Plain radiographs showed loosening of the T12 and L1 pedicle screws (AMT Inc., ART). Spondylodesis T8-L1 was now performed (fig 1) with CT-guided cannulated cemented pedicle screws (DePuy Spine Inc.). Postoperative radiographs revealed paravertebral cement leakage on the left (fig 1), but this was clinically silent and the patient reported distinct pain relief without dyspnoea, so that no need for intervention was seen.

Three months later, the patient required re-hospitalization due to instability of the superior adjacent segment T7T8 (fig 2). CT-scans of the thorax were now performed because aortic dissection was suspected on chest radiographs. There was cement leakage from the left pedicle screw T10 into the azygos vein, with multiple cement embolisms into the pulmonary arteries on both sides (fig 3). There was no evidence of aortic dissection. While the pulmonary embolisms remained clinically irrelevant and pulmonary function was normal, there was progressive instability of the spine with increasing kyphosis and spondylolisthesis T7. Therefore the level T7T8 was treated with nucleotomy, a titanium cage and fusion with allogenic cancellous bone grafts, while an anterior single-rod spondylodesis T6T9 was performed (fig 4). After surgery, the patient's complaints were moderately relieved. She was discharged with a polyethylene

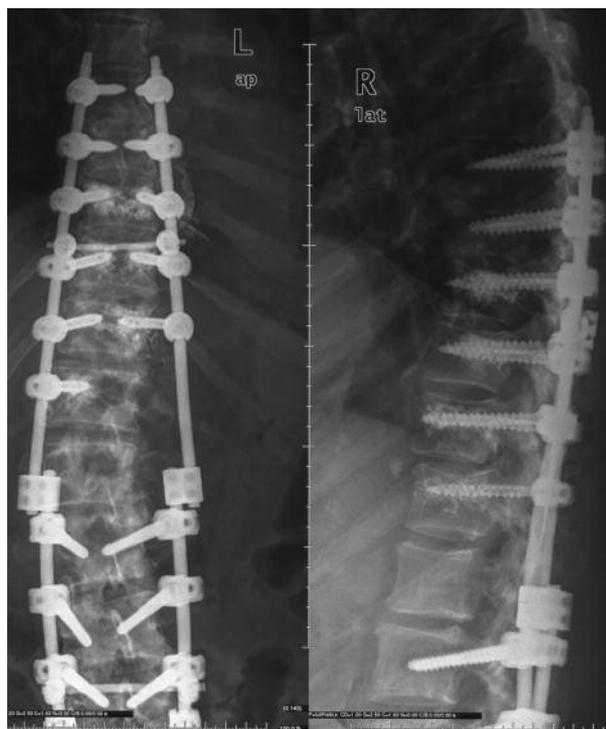


Fig. 1. — AP and lateral views of the thoracolumbar spine. The preexisting fusion T12S1 was extended to T8L1, by means of cannulated cemented pedicle screws. Paravertebral cement leakage on the left.

brace. Eighteen months later, the back pain, the pulmonary embolisms and the pulmonary function remained non-problematic.

DISCUSSION

Operative correction of lumbar scoliosis is still associated with a high complication rate (5). In high-grade osteoporosis a purely transpedicular approach will not always achieve sufficient screw stability (6,10,18), and the use of cemented pedicle screws therefore appears reasonable (18), all the more so as biomechanical studies have shown that the force required for screw avulsion may be doubled when polymethylmethacrylate (PMMA) bone cement is used as pedicle augmentation (3,6,21). Burval *et al* (3) performed biomechanical studies about pedicle augmentation on osteoporotic human cadaver spines using kyphoplasty and vertebroplasty techniques. They compared the effectiveness of

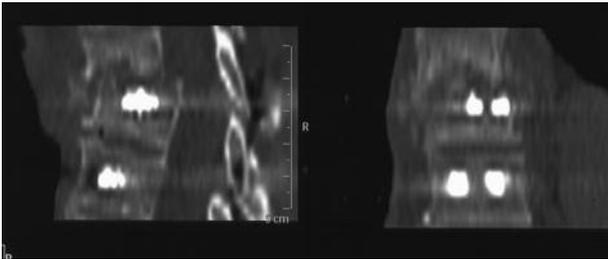


Fig. 2. — CT-scan of the thoracic spine, sagittal and coronal section : erosion of the adjacent endplates of T7 and T8. Anterior displacement of T7, on top of the fusion area.

the two techniques with each other and with a non-osteoporotic control group without augmentation. Both techniques were superior to the control group regarding resistance to screw avulsion, with kyphoplasty being more resistant than vertebroplasty.

Cement leakage into the surrounding tissues or paravertebral veins is a classical complication after vertebroplasty and kyphoplasty (12). Studies based on computed tomography have identified leakage in up to 90% after vertebroplasty (17) and in up to 37.5% after kyphoplasty (11). Leakage is usually secondary to premature injection of too liquid polymethylmethacrylate (PMMA), or to exaggerated pressure while injecting the material. In the majority of cases, cement leakage appears a harmless complication and requires no further treatment (4).

Most cement pulmonary embolisms are probably not detected because they induce no symptoms. In the existing literature cement embolism to the pulmonary arteries has been reported almost exclusively after vertebroplasty or kyphoplasty. Four studies have evaluated the risk of pulmonary embolism (1,7,8,14); all patients were screened with plain radiographs (1) or with computed tomography (14). The risk for cement embolism ranged from 3% to 23%.

To date, cement pulmonary embolism after pedicle augmentation with bone cement has been mentioned in only a few publications. In a series of 119 patients treated with bone cement augmentation of the pedicle, Frankel *et al* (9) identified one case of asymptomatic cement pulmonary embolus : a risk of 0.8%. Other reported complications include screw loosening despite augmentation and cement leakage through the pedicle wall (22).

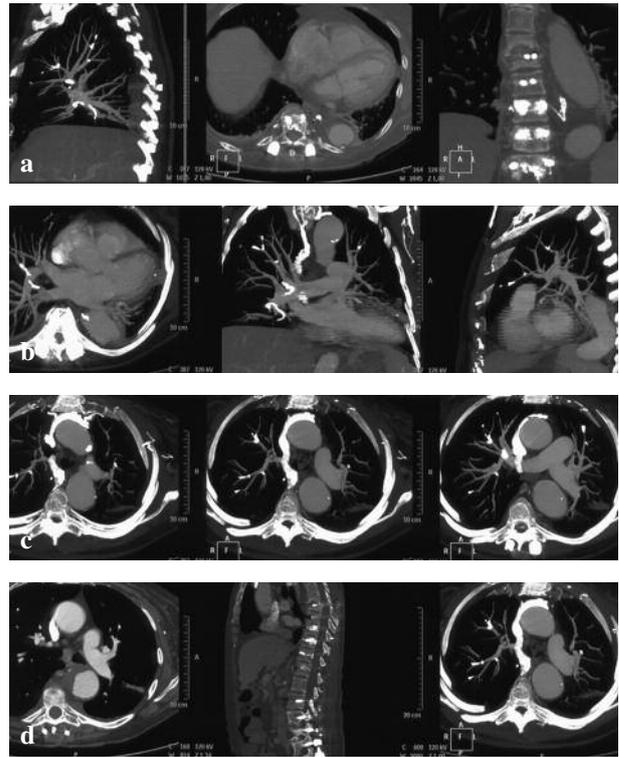


Fig. 3. — Sagittal, transverse, and coronal CT angiography of the chest. Cement embolisms in the epidural venous plexus and in the paravertebral veins at the levels T9 to T11, partially in the azygos vein, and in the outlets of the right superior, inferior and middle pulmonary lobe arteries. Erosion of the adjacent endplates T7-T8, indicating instability of T7 on top of the fusion mass. Atheromatosis of the abdominal aorta.

Temple *et al* (19) published a case report of catastrophic fat embolism following instrumentation with cement augmentation.

However, cement pulmonary embolisation can result in death. Pulmonary embolisms are grouped by clinical appearance : symptomatic or asymptomatic. Symptomatic cement embolisms are recognizable by the symptoms of dyspnoea/tachypnoea, tachycardia, cyanosis, chest pain, coughing, hemoptysis, dizziness, and/or sweating (2,13,16,20). Obviously it is much more difficult to diagnose asymptomatic cases.

In the current case, the paravertebral cement leaks remained clinically silent, while the patient reported distinct relief from pain, so that no further investigations were started. Only when a CT-scan

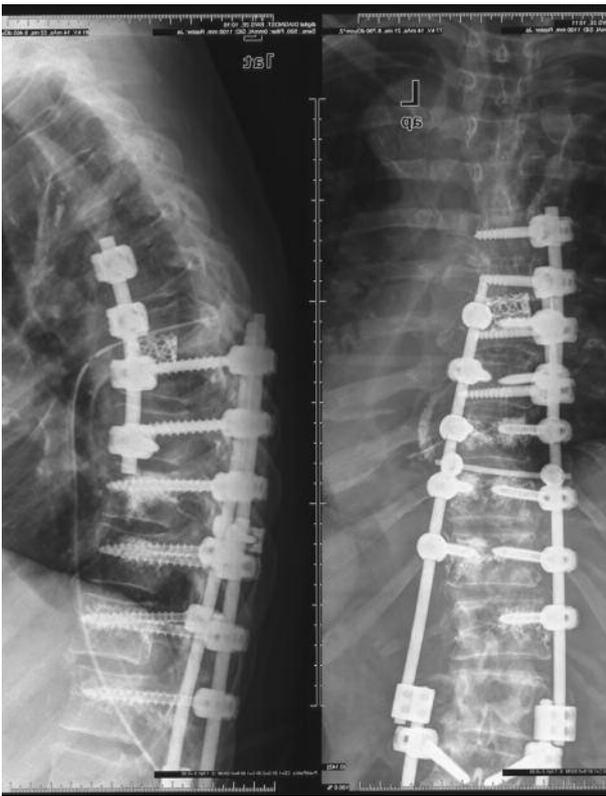


Fig. 4. — Lateral and AP radiographs of the thoracic spine : extension of the fusion area with an anterior single-rod system T6T9 ; corpectomy T7 and replacement with a titanium cage (ART, AMT Inc.).

was obtained, were multiple cement embolisms detected in the left and right pulmonary arteries. Computed tomography is the most effective modality for the diagnosis of pulmonary embolism, particularly since the multislice technique has become available. As the patient remained symptom free and lung function remained normal, no further therapy was initiated.

CONCLUSION

The literature offers no clear treatment strategy for pulmonary cement embolisms. There are no evidence-based studies enabling satisfactory statistical analysis. The authors feel, as far as prevention is concerned, that creating a cavity by means of balloon distention before pedicle screw augmentation

allows to inject the cement under lower pressure, so that the incidence of cement embolism might be reduced. Besides surgical removal in symptomatic embolism, treatment options include heparin or warfarin administration for 3 to 6 months (20).

REFERENCES

1. Anselmetti GC, Corgnier A, Debernardi F, Regge D. Treatment of painful compression vertebral fractures with vertebroplasty : results and complications. *Radiol Med (Torino)* 2005 ; 110 : 262-272.
2. Bernhard J, Heini PF, Villiger PM. Asymptomatic diffuse pulmonary embolism caused by acrylic cement : an unusual complication of percutaneous vertebroplasty. *Ann Rheum Dis* 2003 ; 62 : 85-86.
3. Burval DJ, McLain RF, Milks R, Inceoglu S. Primary pedicle screw augmentation in osteoporotic lumbar vertebrae : biomechanical analysis of pedicle fixation strength. *Spine* 2007 ; 32 :1077-1083.
4. Caudana R, Renzi BL, Ventura L *et al.* CT-guided percutaneous vertebroplasty : personal experience in the treatment of osteoporotic fractures and dorsolumbar metastases. *Radiol Med (Torino)* 2008 ; 113 : 114-133.
5. Cho KJ, Suk SI, Park SR *et al.* Complications in posterior fusion and instrumentation for degenerative lumbar scoliosis. *Spine* 2007 ; 32 : 2232-2237.
6. Cho KJ, Suk SI, Park SR *et al.* Short fusion versus long fusion for degenerative lumbar scoliosis. *Eur Spine J* 2008 ; 17 : 650-656.
7. Choe DH, Marom EM, Ahrar K, Truong MT, Madewell JE. Pulmonary embolism of polymethyl methacrylate during percutaneous vertebroplasty and kyphoplasty. *Am J Roentgenol* 2004 ; 183 : 1097-1102.
8. Duran C, Sirvanci M, Aydogan M *et al.* Pulmonary cement embolism : a complication of percutaneous vertebroplasty. *Acta Radiol* 2007 ; 48 : 854-859.
9. Frankel BM, Jones T, Wang C. Segmental polymethylmethacrylate-augmented pedicle screw fixation in patients with bone softening caused by osteoporosis and metastatic tumor involvement : a clinical evaluation. *Neurosurgery* 2007 ; 61 : 531-537.
10. Hasegawa K, Takahashi HE, Uchiyama S *et al.* An experimental study of a combination method using a pedicle screw and laminar hook for the osteoporotic spine. *Spine* 1997 ; 22 : 958-962.
11. Hauck S, Beisse R, Bühren V. Vertebroplasty and kyphoplasty in spinal trauma. *Eur J Trauma* 2005 ; 31 : 453-463.
12. Hodler J, Peck D, Gilula LA. Midterm outcome after vertebroplasty : predictive value of technical and patient-related factors. *Radiology* 2003 ; 227 : 662-668.
13. Jang JS, Lee SH, Jung SK. Pulmonary embolism of polymethylmethacrylate after percutaneous vertebroplasty : a report of three cases. *Spine* 2002 ; 27 : E416-E418.

14. **Kim YJ, Lee JW, Park KW *et al.*** Pulmonary cement embolism after percutaneous vertebroplasty in osteoporotic vertebral compression fractures : incidence, characteristics, and risk factors. *Radiology* 2009 ; 251 : 250-259.
15. **Linhardt O, Lüring C, Matussek J *et al.*** Stability of pedicle screws after kyphoplasty augmentation : an experimental study to compare transpedicular screw fixation in soft and cured kyphoplasty cement. *J Spinal Disord Tech* 2006 ; 19 : 87-91.
16. **Padovani B, Kasriel O, Brunner P, Peretti-Viton P.** Pulmonary embolism caused by acrylic cement : a rare complication of percutaneous vertebroplasty. *Am J Neuro-radiol* 1999 ; 20 : 375-377.
17. **Schmidt R, Cakir B, Mattes T *et al.*** Cement leakage during vertebroplasty : an underestimated problem ? *Eur Spine J* 2005 ; 14 : 466-473.
18. **Soshi S, Shiba R, Kondo H, Murota K.** An experimental study on transpedicular screw fixation in relation to osteoporosis of the lumbar spine. *Spine* 1991 ; 16 : 1335-1341.
19. **Temple JD, Ludwig SC, Ross WK *et al.*** Catastrophic fat embolism following augmentation of pedicle screws with bone cement : a case report. *J Bone Joint Surg* 2002 ; 84-A : 639-642.
20. **Tozzi P, Abdelmoumene Y, Corno AF *et al.*** Management of pulmonary embolism during acrylic vertebroplasty. *Ann Thorac Surg* 2002 ; 74 : 1706-1708.
21. **von Strempel A, Plitz W, Kühle J, Seidel T, Sukopp C.** [Biomechanical prerequisites for examining the stability of osteosynthesis procedures of the spine.] (in German). *Unfallchirurg* 1994 ; 97 : 343-346.
22. **Wuisman PI, Van Dijk M, Staal H, Van Royen BJ.** Augmentation of (pedicle) screws with calcium apatite cement in patients with severe progressive osteoporotic spinal deformities : an innovative technique. *Eur Spine J* 2000 ; 9 : 528-533.