Surgical removal of extravasated epidural and neuroforaminal polymethylmethacrylate after percutaneous vertebroplasty in the thoracic spine

Chang-Chin Wu · Mu-Hung Lin · Shu-Hua Yang ·
Po-Quang Chen · Tiffany Ting-Fang Shih

Received: 10 May 2006 / Revised: 18 July 2006 / Accepted: 20 September 2006 / Published online: 20 October 2006
© Springer-Verlag 2006

Abstract Although extravasations of polymethylmethacrylate during percutaneous vertebroplasty are usually of little clinical consequence, surgical decompression is occasionally required if resultant neurologic deficits are severe. Surgical removal of epidural polymethylmethacrylate is usually necessary to achieve good neurologic recovery. Because mobilizing the squeezed spinal cord in a compromised canal can cause further deterioration, attempts to remove epidural polymethylmethacrylate in the thoracic region need special consideration. A 66-year-old man had incomplete paraparesis and radicular pain on the chest wall after percutaneous vertebroplasty for osteoporotic compression fracture of T7. Radiological studies revealed polymethylmethacrylate extravasations into the right lateral aspect of spinal canal that caused marked encroachment of the thecal sac and right neuroforamina. Progressive neurologic deficit and poor responses to medical managements were observed; therefore, surgical decompression was performed 4 months later.

After laminectomy and removal of facet joints and T7 pedicle on the affected side, extravasated polymethylmethacrylate posterior and anterior to the thecal sac was completely removed without retracting the dura mater. Spinal stability was reconstructed by supplemental spinal instrumentation and intertransverse arthrodesis with banked cancellous allografts. Myelopathy and radicular pain gradually resolved after decompression surgery. The patient was free of sensory abnormality and regained satisfactory ambulation two years after surgical decompression.

Keywords Vertebroplasty · Polymethylmethacrylate · Epidural extravasations · Thoracic myelopathy · Surgical removal

Introduction

Percutaneous vertebroplasty (PVP) with polymethylmethacrylate (PMMA) was developed by Gailbert et al. [10] in France during 1980s. Initial successes were achieved in treating aggressive vertebral hemangiomas [6, 10, 11], painful osteolytic vertebral metastases, and myelomas [5, 15, 25]. Indications of PVP with PMMA have been extended to the treatment of vertebral compression fractures secondary to osteoporosis [8, 9, 12, 16, 18, 19]. Although PVP is validated as a safe and effective procedure, several complications have been reported. Among them, extravasations of PMMA cement is the most prevalent and occurs in 11–81% of PVP cases described in the literature [1, 2, 4, 5, 7, 9, 13, 22, 27]. Although extravasations of PMMA cement could be reduced by increase of the cement viscosity [3] and are usually of little clinical consequence [7, 8,

M.-H. Lin · S.-H. Yang (✉) · P.-Q. Chen
Department of Orthopedics,
National Taiwan University Hospital and
National Taiwan University College of Medicine,
7 Jhong-Shan South Road, 10002 Taipei, Taiwan
e-mail: dawnyang@ha.mc.ntu.edu.tw

T. T.-F. Shih
Department of Radiology,
National Taiwan University Hospital and
National Taiwan University College of Medicine,
Taipei, Taiwan

C.-C. Wu
Department of Orthopedic Surgery,
En Chu Kong Memorial Hospital,
San-Shia, Taipei County, Taiwan

25, 27], it can result in severe neurologic complications that require surgical decompression [7, 17, 20–24, 26].

In the current case report, we document an osteoporotic compression fracture of T7 that was treated with PVP during which PMMA extravasated into the spinal canal and neuroforamen. The patient's resultant myelopathy and intractable radicular pain were successfully treated by surgically removing the extravasated PMMA cement from the epidural space and neuroforamina 4 months after the original procedure.

Case report

A 66-year-old man, a retired coal-miner, had been treated with corticosteroid to manage pneumoconiosis and asthma for 5 years. After having a few episodes of low back pain, he received multilevel PVP to treat osteoporotic compression fractures of the T12 and L1–L3 vertebrae [14]. He tolerated the procedure well and achieved relief of his low back pain. However, he had other episodes of pain over lower thoracic region several months later.

Approximately 10 months after the first operation, the patient underwent another PVP procedure, this time to treat compression fractures of the T7–T10

vertebrae. During PVP, as T7 was being treated, he reported sharp pain over the treated area that radiated to the chest wall. The pain was most severe on the right side. He also had dysesthesia over his trunk and lower extremities.

After PVP was completed, the patient could not stand and walk because standing erect elicited intolerable paresthesia, pain, and weakness in his lower extremities. His bowel and bladder function remained normal. The intensity of pain and severity of neurologic deficits progressively worsened over his trunk, thighs and legs. These symptoms and signs did not respond to several modalities of medical management, including nonsteroid anti-inflammatory drugs, local steroid injections, and physiotherapy.

This patient presented to our institution with these clinical manifestations 4 months after his neurologic deficit appeared. Radiographic studies revealed osteoporosis with compression fractures and retention of radiopaque material in the vertebral bodies of T7–T10, T12 and L1–L3 (Fig. 1). The lateral radiograph showed radiopaque density in the area of the T7 pedicles. Several linear opaque shadows were also observed in the paraspinal vessels. Computed tomography (CT) demonstrated extravasations of PMMA cement into the right lateral aspect of the thecal sac at T7, where

Fig. 1 Anteroposterior (**a**) and lateral (**b**) radiographs show diffuse osteoporosis with multiple compression fractures and retained radiopaque materials in the T7–T10, T12, and L1–L3 vertebral bodies. **b** Radiopaque density near the T7 pedicles suggests extravasations of PMMA. Paraspinal linear *opaque shadows* indicate leakage of PMMA into the paravertebral vessels

they caused marked encroachment of the spinal canal and right neuroforamina (Fig. 2). The extravasated radiopaque material severely compressed the adjacent spinal cord. Because nonsurgical treatments had not relieved the patient's neurologic deficit and because he had serious disability, surgical decompression was performed after detailed physical evaluation.

To maintain spinal stability during the extensive resection of the bony structures, the surgical procedures were started with posterior instrumentation, including the insertion of transpedicular screws and assembly of a rod on the left side. Laminectomy of T6–T8 was performed, and the posterior surface of the thecal sac was exposed. The facet joints of T6–T7 and T7–T8 on the right side were removed to uncover the neuroforaminae.

The extravasated PMMA cement posterior and lateral to the thecal sac and in the neuroforaminae was carefully removed without retraction of the dura mater. To remove the epidural PMMA anterior to the thecal sac, the right pedicle of T7 was carefully subtracted to the level of posterior vertebral cortex by using a high-speed burr. Then, the extravasated PMMA anterior to the thecal sac were removed in a direction parallel to the posterior vertebral cortex. No

retraction of thecal sac during the entire procedure of removing epidural PMMA cement.

Five large pieces and several tiny chips were removed from the epidural and neuroforaminal spaces (Fig. 3). The surgical procedures were completed after a rod was assembled on the right side and after banked cancellous allografts were placed at the intertransverse space. The postoperative lateral radiograph of the thoracic spine is shown in Fig. 4.

No neurological deterioration was observed in the perioperative period. Immediately after decompression surgery, the patient's pain on the chest wall was marked reduced, and he had no more sensory disturbances over his abdomen or legs. The severity of radicular pain on his chest wall, as measured on a visual analog scale (VAS), decreased from ten before surgery to six immediately after surgery. Further resolution of radicular pain on the chest wall was evident on follow-up visits.

This patient was trained to stand and walk 1 week after decompression surgery. However, his recovery of ambulatory function was delayed because of an intertrochanteric fracture of the right femur, which developed in an accidental fall about 2 months after surgical decompression. The fracture was initially treated with

Fig. 2 CT scan reveals extravasations of PMMA into the right lateral aspect of the thecal sac with marked encroachment of the spinal canal at T7 (**a, b**) and the neuroforamina between T7 and T8 pedicles on the right (**a, b, c**). Extravasated radiopaque material severely compressed the spinal cord at the corresponding level

Fig. 3 Five pieces of PMMA sized 8–18 mm were removed from the epidural and neuroforaminal spaces

Fig. 4 The postoperative lateral radiograph demonstrated the spinal instrumentation from T4 to T11, which maintained a good sagittal alignment of the thoracic spine

internal fixation and converted to hemiarthroplasty in 6 months later because union of the fracture was not achieved and because the lag screw cut through the femoral head.

On last follow-up 2 years after decompression surgery, the patient felt no sensory abnormality (VAS

of 0) on the chest wall, trunk or legs. He could ambulate more than 1 km without any supportive device. However, he typically used a cane while walking for a sense of security.

Discussion

The principal complication in PVP is epidural or foraminal leakage of PMMA that damages to the spinal cord and/or nerve roots [5]. This complication may occur by means of the basivertebral vein, defects in the posterior vertebral cortex, needle puncture holes, and an inadequate route of the needle [7, 27]. With radiologic study, leakage of PMMA is usually detected on intraoperative fluoroscopic images or postoperative radiographs. The detection rate is low with fluoroscopy and radiography than that with CT [22]. Despite the high rate of PMMA leakage, extrusions of PMMA cement are usually clinically asymptomatic [7, 8, 25, 27]. However, several reports describe the extravasation of PMMA cement into the spinal canal, where it caused severe neurologic complications including complete paralysis and incomplete paraparesis [13, 17, 20, 23].

Extravasations of PMMA into the epidural space of the spinal canal account for 22–38% of all detected PMMA leakages associated with PVP [7, 21, 22, 27]. Because PMMA leaks out of the vertebral bodies through different routes, various patterns of cement distribution can be observed and result in neurologic complications. Epidural PMMA leakage through the basivertebral vein leads to a distribution of cement resembling that of normal local venous engorgement [27]. This type of leakage distributes within the epidural plexus; it is relatively symmetrical and anterior to the thecal sac. Neurologic complications are not common in this type of leakage, even if the extravasated PMMA cement occupies about 25% of the spinal canal. Leakage of PMMA through the basivertebral vein is commonly seen in PVP for osteoporotic vertebral compression fractures [27].

The distribution of epidural cement leakage through posterior cortical defects, needle puncture holes, and inadequate needle route different from that through the basivertebral vascular foramina [7, 27]. Extravasated PMMA cement can be both anterior and posterior to the duramater, resulting in circumferential constriction of the thecal sac. A large amount of PMMA cement can extrude into the spinal canal and obliterate large cross-sectional areas of the spinal canal. Major neurologic complications may occur in this distribution pattern of PMMA leakage [13, 17, 23, 24].

When epidural leakage of PMMA leads to neurologic complications, the initial severity of the neurologic deficit and the treatment modalities influence the patient's possibility of recovery and final neurological status. When complete paralysis develops, no neurologic recovery is reported even after emergent decompression surgery [17, 24, 26]. Patients with incomplete paraparesis after complicated PVP may have severe disability if surgical decompression is not performed [1, 7, 13]. Laminectomy or laminotomy alone does not achieve adequate neural decompression to facilitate good recovery from incomplete paraparesis caused by extravasated PMMA cement [22]. Good recovery is usually reported in patients with incomplete paraparesis who undergo surgical removal of epidural cement [20, 22, 23]. Furthermore, those who have had a good recovery from incomplete paraparesis were all surgically treated on the same day or on the day after the PVP procedures causing the complication. We know of no reports about the effectiveness of surgical decompression in the patients whose incomplete paraparesis has been untreated for a certain period. In the current case, satisfactory neurologic recovery was still attained, though surgical decompression was performed 4 months after neurologic complications occurred.

Surgical techniques to remove epidural PMMA cement are seldom described in the literature. By mobilizing the thecal sac, extravasated PMMA cement anterior or posterior to the thecal sac of the lumbar spine can be completely removed in a posterior decompression operation [22, 23]. In the cervical and thoracic spine, mobilizing the squeezed spinal cord in a stenotic spinal canal can cause further neurologic deterioration. Therefore, it is difficult or even impossible to remove extravasated cement that is anterior to the thecal sac via a laminectomized space or cement posterior to the thecal sac via a corpectomized space. Our surgical technique included wide laminectomy and subtraction of the pedicle, which was perforated during PVP. In this way, extravasated cement in the thoracic spinal canal and neuroforamina was easily removed without applying retraction to the spinal cord. This surgical method should improve the safety of trying to remove epidural cement from the thoracic spinal canal. Disadvantages of this procedure consist of extensive resection of bony structures and the necessity for additional spinal stabilization, including instrumentation and fusion.

In conclusion, extravasated PMMA cement that encroaches the thoracic thecal sac can be completely removed through a working space created by means of laminectomy and subtraction of the affected pedicle.

Satisfactory neurologic recovery from incomplete paraparesis can be expected after epidural PMMA cement is surgically removed, even if neurologic deficit had been present for as long as 4 months.

References

1. Amar AP, Larsen DW, Esnaashari N, Albuquerque FC, Lavine SD, Teitelbaum GP (2001) Percutaneous transpedicular polymethylmethacrylate vertebroplasty for the treatment of spinal compression fractures. *Neurosurgery* 49:1105–1115
2. Barr JD, Barr MS, Lemley TJ, McCann RM (2000) Percutaneous vertebroplasty for pain relief and spinal stabilization. *Spine* 25:923–928
3. Bohner M, Gasser B, Baroud G, Heini P (2003) Theoretical and experimental model to describe the injection of a polymethylmethacrylate cement into a porous structure. *Biomaterials* 24:2721–2730
4. Cortet B, Cotten A, Boutry N, Flipo RM, Duquesnoy B, Chastanet P, Delcambre B (1999) Percutaneous vertebroplasty in the treatment of osteoporotic vertebral compression fractures: an open prospective study. *J Rheumatol* 26:2222–2228
5. Cotten A, Boutry N, Cortet B, Assaker R, Demondion X, Leblond D, Chastanet P, Duquesnoy B, Deramond H (1998) Percutaneous vertebroplasty: state of the art. *Radiographics* 18:311–320
6. Cotten A, Deramond H, Cortet B, Lejeune JP, Leclerc X, Chastanet P, Clarisse J (1996) Preoperative percutaneous injection of methyl methacrylate and N-butyl cyanoacrylate in vertebral hemangiomas. *Am J Neuroradiol* 17:137–142
7. Cotten A, Dewatre F, Cortet B, Assaker R, Leblond D, Duquesnoy B, Chastanet P, Clarisse J (1996) Percutaneous vertebroplasty for osteolytic metastases and myeloma: effects of the percentage of lesion filling and the leakage of methyl methacrylate at clinical follow up. *Radiology* 200:525–530
8. Cyteval C, Sarrahere MPB, Roux JO, Thomas E, Jorgensen C, Blotman F, Sany J, Taourel P (1999) Acute osteoporotic vertebral collapse: open study on percutaneous injection of acrylic surgical cement in 20 patients. *Am J Radiol* 173:1685–1690
9. Deramond H, Depriester C, Galibert P, Le Gars D (1998) Percutaneous vertebroplasty with polymethylmethacrylate: technique, indications, and results. *Radiol Clin North Am* 36:533–546
10. Galibert P, Deramond H, Rosat P, Le Gars D (1987) Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty. *Neurochirurgie* 33:166–168
11. Galibert P, Deramond H (1990) Percutaneous acrylic vertebroplasty as a treatment of vertebral angioma as well as painful and debilitating diseases. *Chirurgie* 116:326–334
12. Grados F, Depriester C, Cayrolle G, Hardy N, Deramond H, Fardellone P (2000) Long-term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty. *Rheumatology* 39:1410–1414
13. Harrington KD (2001) Major neurological complications following percutaneous vertebroplasty with polymethylmethacrylate: a case report. *J Bone Joint Surg Am* 83:1070–1073
14. Heini PF (2005) The current treatment—a survey of osteoporotic fracture treatment. *Osteoporotic spine fractures: the spine surgeon's perspective*. *Osteoporos Int* 16:S85–S92
15. Kaemmerlen P, Thiesse P, Jonas P, Berard CL, Duquesnel J, Bascoulegue Y, Lapras C (1989) Percutaneous injection of

- orthopedic cement in metastatic vertebral lesions (letter). *N Eng J Med* 321:121
16. Lapras C, Mottolese C, Deruty R, Lapras C Jr, Remond J, Duquesnel J (1989) Percutaneous injection of methyl-metacrylate in osteoporosis and severe vertebral osteolysis (Galibert's technic). *Ann Chir* 43:371–376
 17. Lee BJ, Lee SR, Yoo TY (2002) Paraplegia as a complication of percutaneous vertebroplasty with polymethylmethacrylate: a case report. *Spine* 27:E419–E422
 18. Mathis JM, Petri M, Naff N (1998) Percutaneous vertebroplasty treatment of steroid- induced osteoporotic compression fractures. *Arthritis Rheum* 41:171–175
 19. Mathis JM, Barr JD, Belkoff SM, Barr MS, Jensen ME, Deramond H (2001) Percutaneous vertebroplasty: A developing standard of care for vertebral compression fractures. *AJNR Am J Neuroradiol* 22:373–381
 20. Ratliff J, Nguyen T, Heiss J (2001) Root and spinal cord compression from methylmethacrylate vertebroplasty. *Spine* 26:E300–E302
 21. Ryu KS, Park CK, Kim MC, Kang JK (2002) Dose-dependent epidural leakage of polymethylmethacrylate after percutaneous vertebroplasty in patients with osteoporotic vertebral compression fractures. *J Neurosurg* 96(1 Suppl):56–61
 22. Schmidt R, Cakir B, Mattes T, Weneger M, Puhl W, Richter M (2005) Cement leakage during vertebroplasty: an underestimated problem? *Eur Spine J* 14:466–473
 23. Shapiro S, Abel T, Purvines S (2003) Surgical removal of epidural and intradural polymethylmethacrylate extravasation complicating percutaneous vertebroplasty for an osteoporotic lumbar compression fracture. Case report. *J Neurosurg* 98 (1 Suppl):90–92
 24. Teng MM, Cheng H, Ho DM, Chang CY (2006) Intraspinous leakage of bone cement after vertebroplasty: a report of 3 cases. *AJNR Am J Neuroradiol* 27:224–229
 25. Weill A, Chiras J, Simon JM, Rose M, Sola-Martinez T, Enkaoua E (1996) Spinal metastases: indications for and results of percutaneous injection of acrylic surgical cement. *Radiology* 199:241–247
 26. Wenger M, Markwalder TM (1999) Surgically controlled transpedicular methyl methacrylate vertebroplasty with fluoroscopic guidance. *Acta Neurochir* 141:625–631
 27. Yeom JS, Kim WJ, Choy WK, Lee CK, Chang BS, Kang JW (2003) Leakage of cement in percutaneous transpedicular vertebroplasty for painful osteoporotic compression fractures. *J BoneJoint Surg Br* 85:83–89