Focal Cement Accumulation in Lytic Metastatic Lesions: a New Sign in Vertebroplasty?

J.M. DEBNAM, D. SCHELLINGERHOUT

Department of Radiology, Section of Neuroradiology
The University of Texas MD Anderson Cancer Center; Houston, Texas, USA

Key words: vertebroplasty, lytic metastasis

Summary

We describe a unique imaging appearance of focal cement accumulation inside lytic metastatic lesions in four patients with pathologic vertebral fractures undergoing vertebroplasty. This appearance differs from the normal, trabecular appearance of cement distribution in osteoporotic vertebrae.

Two patients, in whom the lytic metastasis was completely filled with cement, had a complete pain response, and two patients, in whom the lytic metastasis could only be partially filled, had an incomplete response. Focal cement accumulation in a lytic lesion may be a predictor of favorable patient outcome in patients with lytic metastasis.

Introduction

Symptomatic metastasis to the spine occur in 30% of patients with cancer during the course of their disease^{1,2}. Tumors that commonly metastasize to bone include prostate, breast, lung, renal and thyroid cancer, and account for 80% of skeletal metastases^{3,4}. Pain from the metastasis is the presenting complaint in the majority of cases⁵ and is often difficult to manage because of reduced mobility and performance status⁶. Patients with widespread metastatic disease are often not surgical candidates so non-operative treatments including analgesic medications, radiotherapy, hormone therapy,

cytotoxic drugs and bisphosphonates are increasingly used⁷. Percutaneous vertebroplasty has also been described for pain relief and instability of metastatic vertebral body lesions⁸⁻⁹. Patients who suffer from significant, focal or mechanical pain due to osteolytic metastases unresponsive to analgesic medications are potential candidates for vertebroplasty¹⁰.

The purpose of this series is to describe a unique imaging appearance of focal polymethylmethacrylate (PMMA) cement accumulation inside osteolytic metastatic lesions in four patients who underwent vertebroplasty for treatment of pathologic vertebral fractures. We compare this focal accumulation to the normal trabecular or lace-like appearance of cement distribution in benign compression fractures and correlate this imaging finding to pain control outcomes.

Materials and Methods

We performed a retrospective review of the clinical findings and imaging data from four consecutive patients (three women and one man; age range, 62-79 years; mean age 67.8 years) who underwent vertebroplasty at our institution for lytic metastasis between April 2005 and December 2006. The institutional review board approved this study and waived the right for informed consent.

All four patients underwent a physical examination by the physician performing the proce-

duration between five and 29 days (mean 12 days) before the procedure. The clinical presentation included back pain, specifically at the site of the lytic metastasis which was subsequently treated, on the visual analog scale (VAS) of 10/10 in three patients and 6/10 in one patient. Pre-procedure MDCT (GE Medical Systems, Milwaukee, WI) was performed on all four patients, defining the lesion as a lytic metastasis, between five and 30 days before the procedure (mean 15.5 days).

Following the vertebroplasty, all four patients were again evaluated by the physician who performed the procedure between five and 173 days (mean 42 days) after the procedure. Three of the four patients were evaluated with MDCT following the procedure between 0 days and six days (median three days). All patients were unaware of the degree of filling of the lytic metastasis.

Results

Vertebroplasty Procedure

Two of the procedures were performed with the patient under general anesthesia and two with conscious sedation. All four procedures were performed on a C-arm angiographic unit (Axion Artis; Siemens Medical Solutions, Erlangen, Germany). Informed consent was obtained before the procedure. A transpedicular approach was utilized in two patients and a parapedicular approach in two patients, followed by standard coaxial vertebroplasty techniques. The procedure was terminated when there was complete filling of the lesion with cement in two patients and migration of the cement in the other two patients. There were no treatment complications.

Immediate and Follow-up Vertebroplasty Results

In all four cases, during the vertebroplasty procedure, there was a focal appearance of the cement collection within the lytic metastasis. The follow-up MDCT imaging also demonstrated a focal collection of cement within the lytic metastasis in all three patients. There was complete filling of the lytic metastasis with cement in two patients and incomplete filling in the other two patients.

The clinical outcome was excellent in both cases with complete filling as the VAS decreased to 0/10. In the two patients with incomplete filling, the VAS decreased to 3/10 and 2/10. Patient demographics, lesion location and results of the procedures are summarized in Table 1.

Table 1 Characteristics of four patients with focal collection of contrast after vertebroplasty.

Patient #	Age/ Sex	Primary Cancer	Location	Pre-VAS	Vertebroplasty	Lesion Filling	Post-VAS
1	66/F	Renal	T5	10/10	T5	Complete	0/10
2	79/M	Prostate	T10	10/10	T10	Complete	0/10
3	64/F	Breast	L/4 and L/5	6/10	L/4 and L/5	Incomplete	3/10
4	62/F	Breast	T7	10/10	T7	Incomplete	2/10

VAS = Visual Analog Scale

Figure 1 (Patient #1): a 66-year-old woman with metastatic renal cell carcinoma and a pathological fracture involving T5 of the vertebral body. A) Axial non-contrast enhanced CT with lytic metastasis in the dorsal left aspect of the T5 vertebral body (arrows). B) Sagittal non-contrast enhanced CT shows a pathologic fracture of the T5 vertebral body with involvement of the superior and inferior endplates and the posterior wall (arrows). C) AP image from the vertebroplasty demonstrates a focal collection of cement inside the lytic metastasis (arrows).

Illustrative Cases

Patient 1: a 66-year-old woman with a history of metastatic renal cell carcinoma and a pathological fracture involving the T5 vertebral body. The patient presented complaining of mild back pain for six months with an acute exacerbation, now rated 10/10 on the VAS. MDCT examination (Figure 1A,B) demonstrated a lytic metastasis within the dorsal left aspect of the T5 vertebral body.

Fractures of the superior and inferior endplates and the posterior wall caused 15% loss of vertebral body height. Complete filling of the lytic focus within the left aspect of the vertebral body with 1cc of cement was achieved. The cement demonstrated a focal appearance within the lytic lesion (Figure 1C). Following the procedure, the patient's pain decreased to 0/10 on the VAS.

Patient 2: a 79-year-old man with a history of metastatic prostate cancer to the spine, treated with radiation therapy, who presented with low back pain, rated as 10/10, localized at the T10 level. The MDCT examination demonstrated a lytic focus within the left aspect of the T10 vertebral body, without significant loss of vertebral

body height. Kyphoplasty was attempted on the left side of the vertebral body, but balloon inflation was difficult to achieve due very sclerotic bone. Six cc of cement were then introduced under fluoroscopic guidance demonstrating a focal appearance within the anterior aspect of the vertebral body, ventral to the location of the attempted kyphoplasty. Following the procedure, the patient's pain decreased to 0/10 on the VAS.

Patient 3: a 64-year-old woman with metastatic breast cancer complaining of lower back pain, rated as 6/10 on the visual analog scale. MDCT examination demonstrated a lytic metastasis at the L4 and L5 levels (Figure 2A). There was an intervertebral disc herniation along the inferior endplate of L4, but no further loss of vertebral body height. At L5, approximately 3 cc of cement was injected into the lytic lesion within the anterior aspect of the vertebral body and 2 cc was injected into the lesion at L4 (Figure 2B).

The procedure was terminated early at both levels due to posterior migration of cement within the vertebral body. Follow-up MDCT examination demonstrated a focal appearance

of cement in the lytic lesion with incomplete filling of the lytic lesions at both levels (Figure 2C). The patient's pain within the lower lumbar region decreased to 3/10 on the VAS.

Patient 4: a 62-year-old woman with metastatic breast cancer presented with the complaint of mid back pain rated as 10/10. MDCT examination demonstrated mixed lytic and sclerotic appearance of the T7 vertebral body with a lytic focus along the ventral right aspect, without loss of vertebral body height. Vertebroplasty was performed at the T7 level, where the needle was advanced into the anterior, right aspect of the vertebral body. Approximately 1cc of cement was injected into this portion of the vertebral body, which appeared as a focal collection, before there was leakage of cement into the T7/8 intervertebral disc.

The patient's pain decreased to 2/10 on the VAS.

Discussion

We describe a unique imaging appearance of PMMA cement injected into vertebral fractures due to lytic metastasis, with a focal rather than trabecular distribution of the PMMA cement.

This focal pattern of PMMA distribution was apparent both during the procedure and on follow-up MDCT examination and differs from the normal trabecular appearance of PMMA cement injected into benign compression fractures or areas of the vertebral body, not involved with lytic metastasis (Figure 2B). We found in our patient series that complete filling of a lytic metastasis with PMMA cement may correlate with the degree of pain relief experienced following vertebroplasty.

The lack of pain reduction in our patients seems more related to lack of filling of the lytic metastasis than a compression deformity, as one patient with loss of vertebral body height, patient #1, and complete filling of the lytic metastasis had a complete pain response, and the patient with and intervertebral disc herniation and incomplete filling, patient #3, had an incomplete response. Of note, the focal filling of cement within a lytic metastasis should not be confused with the placement of cement inside the vertebroplasty cannula tract during the procedure.

Percutaneous vertebroplasty was designed

and introduced for the management of osteolytic tumors^{8,9} and later successfully applied to osteoporotic vertebral compression fractures^{11,12}. Vertebrae affected with lytic metastasis are frequently weakened and a source of severe pain³.

The analgesic effect provided by vertebroplasty may be related to stabilization of microfractures, reduction of mechanical forces, and/or destruction of the nerve terminals by cytotoxicity of PMMA in the cement due to vascular, chemical, and thermal forces^{8,13,14}. Pain reduction has been reported in 83-94% of patients following vertebroplasty for lytic metastasis^{8,13,14}.

Cotten et Al⁸ did not have similar results to our case series. They state that the degree of pain reduction does not correlate with the degree of PMMA cement filling of an osteolytic metastasis seen with CT examinations. Differences between the reports may be related to cement filling described in their report as between 75-100% rather than the dramatic response seen in two of our patients with complete filling of the lesions with cement. The small number of patients within our series may also account for the difference in findings.

Cement leakage during vertebroplasty is extremely common¹⁵. The injection should be immediately interrupted if the cement reaches the posterior cortex of the vertebral body¹⁶. Two of our cases were terminated early due to cement leakage and there was incomplete filling of the lytic metastasis. This may have lead to the incomplete pain response of both patients in our series.

Conclusions

We describe an imaging sign of focal cement accumulation within the site of lytic metastasis which differs from the normal or trabecular appearance of cement injected into a benign compression fracture or areas the vertebrae not involved with lytic metastasis. Complete filling of a lytic metastasis with cement may correlate with favorable patient outcomes and may become a goal of treatment.

Our study poses a useful testable hypothesis for future studies of the treatment of lytic metastases with vertebroplasty. We invite additional observations and confirmation of the sign by other investigators.

References

- 1 Cobb CA III, Leavens ME, Eckles N: Indications for nonoperative treatment of spinal cord compression due to breast cancer. *J Neurosurg* 4: 653-658, 1977.
- 2 Wong DA, Fornasier VL, MacNab I: Spinal metastases: the obvious, the occult, and the impostors. *Spine* 15: 1-4, 1990.
- 3 Porzsolt F, Tannock I: Goals of palliative cancer therapy. *J Clin Oncol* 11: 378-381, 1993.
- 4 Cohen HJ: Cancer and the functional status of the elderly. *Cancer* 80: 1883-1886, 1997.
- 5 Gokaslan ZL, York JE et Al: Transthoracic vertebrectomy for metastatic spinal tumors. *J Neurosurg* 89: 599-609, 1998.
- 6 Masala S, Roselli M et Al: Radiofrequency heat ablation and vertebroplasty in the treatment of neoplastic vertebral body fractures. *Anticancer Res* 2: 3129-3133, 2004.
- 7 Schachar NS: An update on the nonoperative treatment of patients with metastatic bone disease. *Clin Orthop Relat Res* 382: 75-81, 2001.
- 8 Cotten A, Dewatre F et Al: 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, 1996.
- 9 Kaemmerlen P, Thiesse P et Al: Percutaneous injection of orthopedic cement in metastatic vertebral lesions. *N Engl J Med* 32: 121, 1989.
- 10 Barr JD, Barr MS et Al: Percutaneous vertebroplasty for pain relief and spinal stabilization. *Spine* 25: 923-928, 2000.
- 11 Jensen ME, Evans AJ et Al: Percutaneous polymethylmethacrylate vertebroplasty in the treatment of osteoporotic vertebral body compression fractures: technical aspects. *Am J Neuroradiol* 18: 1897-1904, 1997.
- 12 Cortet B, Cotten A et Al: Percutaneous vertebroplasty in the treatment of osteoporotic vertebral compression fractures: an open prospective study. *J Rheumatol* 26: 2222-2228, 1999.
- 13 Fournay D, Schomer D et Al: Percutaneous vertebroplasty and kyphoplasty for painful vertebral body fractures in cancer patients. *J Neurosurg* 98: 21-30, 2003.
- 14 Weill A, Chiras J et Al: Spinal metastases: indications for and results of percutaneous injection of acrylic surgical cement. *Radiology* 199: 241-247, 1996.
- 15 Cortet B, Cotten A et Al: Percutaneous vertebroplasty in patients with osteolytic metastases or multiple myeloma. *Rev Rheum Engl Ed* 64: 177-183, 1997.
- 16 Gangi A, Guth S et Al: Percutaneous vertebroplasty: indications, technique, and results. *Radiographics* 23: 10e, 2003.

J. Mathew Debnam, M.D.
 The University of Texas MD Anderson
 Cancer Center
 1515 Holcombe Blvd., Unit 370
 Houston, Texas 77030, USA
 E-mail: matthew.debnam@mdanderson.org