

# A patient with lung cancer metastatic to the fifth thoracic vertebra and spinal cord compression treated with percutaneous vertebroplasty and I-125 seed implantation

Yang Zuozhang, Xie Lin, Sun Hongpu, Huang Yunnchao, Ma Xiang, Yuan Tao, Zhang Jinlei, Zhao Ruilian

## ABSTRACT

Percutaneous vertebroplasty is a minimally invasive surgical technique for the treatment of spinal damage and pathological compression fractures. Iodine-125 (I-125) particles can inhibit the uncontrolled proliferation of tumor cells to achieve anti-tumor effects. We report treating a spinal cord compression and T5 metastatic lung cancer patient through percutaneous vertebroplasty and I-125 seed implantation. Three years of follow-up demonstrated that our surgical plan achieved a satisfactory clinical outcome with good postsurgical recovery of spinal column function and relieved the symptoms of spinal cord compression.

*Key words:* • neoplasm, metastasis • spine • embryo implantation • bone cement • vertebroplasty

**P**ercutaneous vertebroplasty (PVP) has been used to relieve pain and to prevent the collapse of vertebral bodies in patients with spinal osteolytic destruction and compression fracture; however, it only has a limited antitumor effect. Iodine-125 (I-125) particles function through a directional-blasting effect and can achieve maximum destruction of cancer cells with minimum damage to the normal tissue. The present report describes the treatment of a patient with spinal cord compression and T5-metastatic lung cancer through PVP and I-125 seed implantation. Our surgical plan achieved a satisfactory clinical outcome with good postsurgical recovery of spinal column function, and it relieved the symptoms of spinal cord compression.

## Case report

### *Clinical and radiological diagnosis and treatment*

A 38-year-old man was hospitalized six months after the resection of squamous cell carcinoma from his right lung. The patient suffered from three months of progressive back pain combined with two weeks of difficulty in walking and was admitted to our hospital in October 2005. Lying in bed, the patient felt significant tenderness at the T5 spinous process; the pain diminished below the 5th rib. The bilateral lower limbs showed muscle strength of grade IV with normal muscle tone. The patient had a visual analogue scale (VAS) score of 8, a Karnofsky performance status (KPS) score of 90, and a Frankel scale of D. Imaging with computed tomography (CT) and magnetic resonance imaging (MRI) showed T5 bone destruction associated with pathological compression fractures and spinal compression by the posterior vertebral soft-tissue mass (Fig. 1). The patient received T5 PVP combined with I-125 seed implantation during digital subtraction angiography (DSA). Six cycles of post-operative chemotherapy with 30 mg tetrahydropyranil adriamycin (days 1–2) and 120 mg docetaxel (day 1), as well as bisphosphonate treatment, were also performed.

### *Surgical procedure*

CT imaging results were scanned and analyzed using treatment-planning software (TPS, Beijing Kelizhong Institute of Medical Technology, Beijing, China) and were used for three-dimensional (3D) digital image reconstruction before the surgery. The 3D icons, isodose curve, and absorbed dose values were precisely determined and drawn according to the lesion size, lesion location, and the relationship with surrounding normal tissues (Fig. 2). The patient was placed in a prone position, and the transpedicular approach was carried out. The puncture point was located 2–3 cm adjacent to the spinous process. This position was determined on the basis of the tilt angle of the pedicle, the distance between the puncture point and the spinous process, and the depth from the skin to the pedicle,

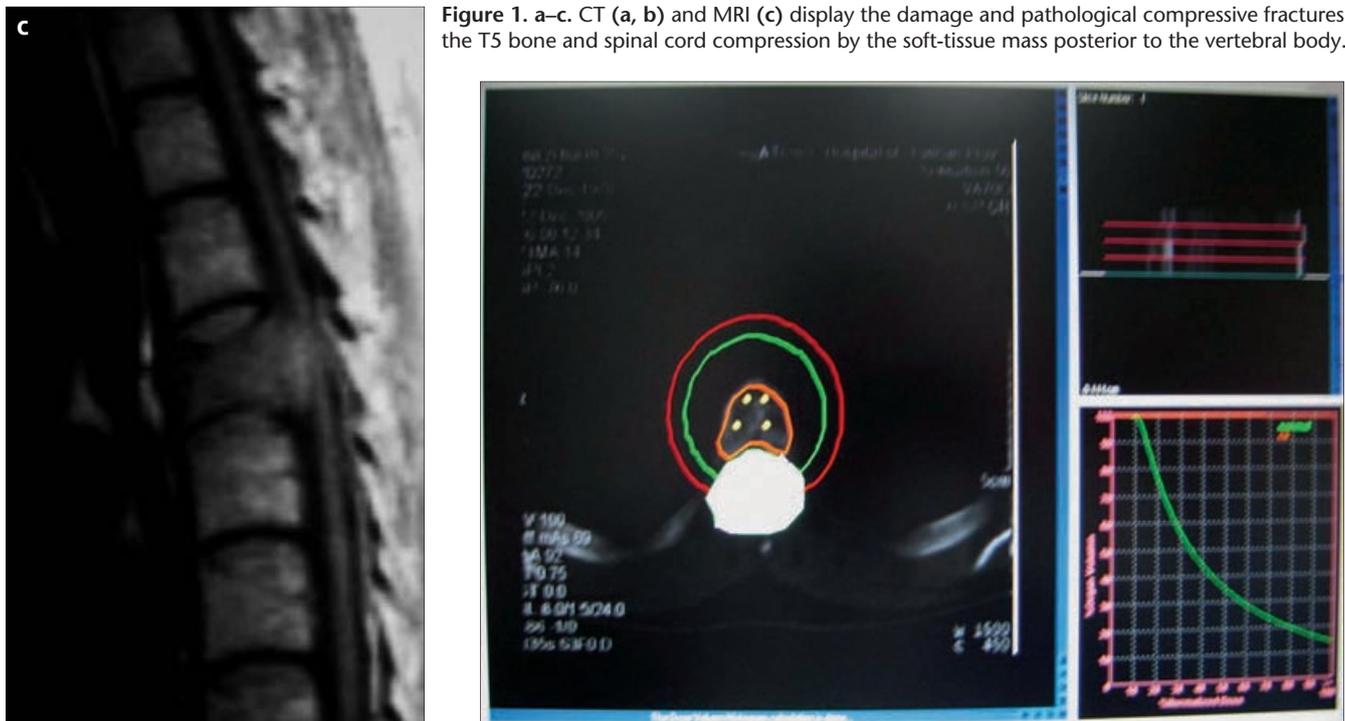
From the Department of Orthopedics (Y.Z. ✉ [yangzuozhang@163.com](mailto:yangzuozhang@163.com)), Tumor Hospital of Yunnan Province, The Third Affiliated Hospital of Kunming Medical College, Kunming, China.

Received 15 March 2011; revision requested 8 May 2011; revision received 12 May 2011; accepted 31 May 2011.

Published online 27 September 2011  
DOI 10.4261/1305-3825.DIR.4358-11.1



**Figure 1.** a–c. CT (a, b) and MRI (c) display the damage and pathological compressive fractures of the T5 bone and spinal cord compression by the soft-tissue mass posterior to the vertebral body.

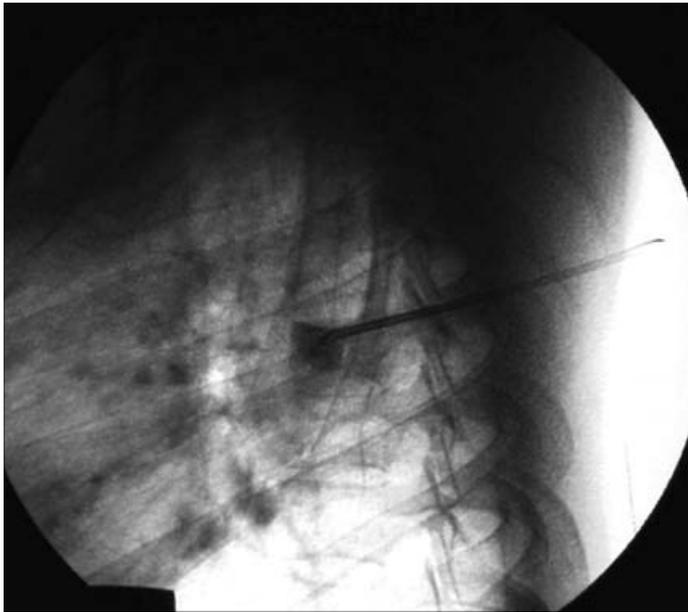


**Figure 2.** Determination of the radioactive dosage in the targeting area by treatment-planning software.

which were all determined by CT imaging. With the patient under 1% lidocaine local anesthesia and frontal fluoroscopic guidance, the puncture needle was placed within the “bull’s-eye” configuration in the pedicle shadow, with the needle inserted to the depth of cortical bone but without penetrating the front of the pedicle. The needle core was removed after the needle had completely penetrated the bone cortex and entered the vertebral body; the implantation needle was inserted through the channel formed by the existing needle,

and the I-125 particles (China Institute of Atomic Energy, Beijing, China) were implanted inside the targeting region with 0.3 cm spacing during the needle insertion process. The needles were inserted through a bilateral transpedicular approach, with the needle tip directed to the upper vertebral body on one side and the needle tip directed to the lower vertebrae on the other side, to achieve a 3D distribution of implanted I-125 particles inside the vertebral body. The direction of the needle tip was adjusted constantly during the implantation

process to achieve an ideal distribution of I-125 particles. After the completion of I-125 seed implantation, 5 mL of contrast agent were injected into the needle channel and detected by DSA to record the dispersion of contrast agent in the vertebral body and its recovery through the venous flow. The residual contrast agent and blood in the vertebral body were removed by vacuum to reduce pressure in the vertebra. Polymethylmethacrylate bone cement (mixed with non-ionic contrast agent) was made freshly, drawn into a syringe



**Figure 3.** Injection of polymethylmethacrylate cement under lateral fluoroscopic monitoring.



**Figure 4. a–c.** Post-operative CT (a, b) shows good distribution of I-125 particles and the presence of bone cement in the T5 vertebral body with no signs of leakage; CT 3D (c) reconstruction shows I-125 seeds in orange.



and injected after it had turned into a paste (Fig. 3). The entire injection process was monitored under lateral fluoroscopy and closely observed for leakage of the bone cement out of the vertebral body. The needle tip was continuously rotated during the injection to maintain distance from the hard bony lesions, achieve satisfactory bone-cement filling, and reduce the occurrence of leakage. After injection, the puncture needle was withdrawn to the cortical bone level, and the needle core was re-inserted. The needle was then rotated to prevent it from sticking to the bone cement, and it was pulled out before the cement had hardened. Nine I-125 seed particles were implanted at an initial dose of 2.92 cGy/h/particle. The 90% isodose curve covered 90% of the targeting tumor volume with a matched peripheral dose of 95 cGy. In total, 3.0 mL of cement were injected. The condition of the cement was reviewed by CT scan after completion of the polymerization.

#### *Post-operative follow-up*

Post-operative CT review of the patient showed that the I-125 seed distribution and the cement filling in the patient's T5 vertebral body were satisfactory with no signs of leakage (Fig. 4). The patient experienced relief of his back pain one day after the surgery with a VAS score of 3 and could walk with crutches two days after the surgery. The patient's back pain was completely relieved two months after the surgery, and the lower limbs regained their baseline muscle strength (with KPS score of 100 and Frankel scale classification of E). Review with MRI also confirmed the satisfactory distribution of I-125 particles, the presence of the cement filling in the patient's T5 vertebral body, and complete disappearance of the soft-tissue mass posterior to the vertebral body (Fig. 5). Two years of follow-up after the surgery demonstrated satisfactory recovery of spinal function in the patient, and MRI demonstrated that there was no local tumor recurrence in T5 and no signal changes in the spinal cord (Fig. 6). The patient had multiple bone metastases three years after the surgery and died of brain metastasis; however, the T5 vertebral body remained stable.

#### **Discussion**

Distant metastasis is one of the characteristics of malignant tumors, and spinal metastases occur in approximately



**Figure 5.** MRI shows good distribution of I-125 particles and the presence of bone cement in the T5 vertebral body and the complete disappearance of the soft-tissue mass posterior to the vertebral body.



**Figure 6.** Two years after the surgery MRI shows no local recurrence of the tumor and no changes in spine signal.

60% to 70% of tumor patients during either the early or late stage; the thoracic spine is most commonly affected (1). Studies from Wilson and Calhoun (1) and Tofe et al. (2) show that the incidence of bone metastases due to lung cancer is 22%–60%. Therefore, lung cancer is the most common primary cancer in the context of bone metastases. This prevalence is because the Baton vertebral venous plexus around the spinal dura mater and the spine has slow blood flow and no venous valves, and therefore, it is easy for cancer cells to tether and ultimately form metastatic lesions. In addition, lung cancer cells can also directly invade the spine. These factors all contribute to rendering spine as the predilection site for bone metastases due to lung cancer (3). The morbidity of bone metastases includes pain, fracture, spinal cord compression, and hypercalcemia (3, 4). In pulmonary cancers, the incidence rate of pathological bone fractures is 57%, most of which affect the spine, whereas the incidence of metastasis-induced spinal cord compression is 15% (4).

Lung cancer patients who suffered from malignant spinal cord compression were mostly at the advanced stage of cancer progression (5). Open surgeries in these patients induce major trauma, which necessitates a long post-operative period for recovery: radiotherapy cannot improve spinal stability. Therefore, the treatment of these patients was not

actively performed in the past because of the lack of effective techniques and economic considerations; many patients decided not to continue with treatment.

With the development of spine surgery, PVP has been used as an effective, minimally invasive method in treating spinal metastatic tumors in recent years (6). PVP can effectively relieve pain in patients with metastatic spinal tumors and stabilize the spine; however, it has a limited antitumor effect (7). Notably, radiotherapy does not affect the mechanical properties or the efficacy of bone cement. Because I-125 particles have the advantages of a long half-life, low energy, good sustainability, and precise positioning, this tool can be used to block the uncontrolled proliferation of tumor cells (8–10). Precise implantation of radioactive sources into the target tissue and reasonable distribution of the sources based on volume and density of the target tissue and relationship with the adjacent vital organs achieves directional blasting, maximum destruction of cancer cells, and minimal damage to normal tissue (11). The patient's pain was relieved after surgery as indicated by a significantly decreased VAS score and an increased KPS score compared with pre-operative values. MRI review two months after the surgery demonstrated the complete disappearance of the vertebral soft-tissue mass posterior to the vertebral body. Two years of follow-up after the surgery showed a

functionally well-recovered spine with no signs of local recurrence that were visible upon MRI. The patient suffered from multiple bone metastases and died from brain metastases three years after the surgery. However, the patient had a stable T5 vertebral body, indicating that PVP combined with interstitial implantation of I-125 seeds successfully restrained the development of local tumor lesions.

In conclusion, we have presented a case of treatment for a spinal cord compression and T5 metastatic lung cancer patient through PVP and I-125 seed implantation. Our surgical plan has achieved a satisfactory clinical outcome with good postsurgical recovery of spinal column function and relieved the symptom of spinal cord compression.

#### Conflict of interest disclosure

The authors declared no conflicts of interest.

#### References

- Wilson MA, Calhoun FM. The distribution of skeletal metastases in breast and pulmonary cancer: concise communication. *J Nucl Med* 1981; 22:594–597.
- Tofe AJ, Francis MD, Harvey WJ. Correlation of neoplasms with incidence and localization of skeletal metastases: an analysis of 1,355 diphosphonate bone scans. *J Nucl Med* 1975; 16:986–989.
- Scutellari PN, Antinolfi G, Galeotti R, Giganti M. Metastatic bone disease. Strategies for imaging. *Minerva Med* 2003; 94:77–90.
- Chamberlain MC, Kormanik PA. Epidural spinal cord compression: a single institution's retrospective experience. *Neuro Oncol* 1999; 1:120–123.
- Weigel B, Maghsudi M, Neumann C, Kretschmer R, Müller FJ, Nerlich M. Surgical management of symptomatic spinal metastases: postoperative outcome and quality of life. *Spine* 1999; 24:2240–2246.
- Yang ZZ, Xu JB, Yuan T, et al. Treating metastatic vertebral tumor with percutaneous vertebroplasty: a report of 28 cases. *Ai Zhong* 2005; 24:194–198.
- Weill A, Chiras J, Simon JM, Rose M, Sola-Martinez T, Enkaoua E. Spinal metastases: indications for and results of percutaneous injection of acrylic surgical cement. *Radiology* 1996; 199:241–247.
- Anglesio S, Calamia E, Fiandra C, et al. Prostate brachytherapy with iodine-125 seeds: radiation protection issues. *Tumori* 2005; 91:335–338.
- Xue J, Waterman F, Handler J, Gressen E. Localization of linked 125I seeds in post-implant TRUS images for prostate brachytherapy dosimetry. *Int J Radiat Oncol Biol Phys* 2005; 62:912–919.
- Xu J, Mei MH, Chen Q, Yang JH, Qiu WJ. Interstitial 125 I implants for liver malignancies. *Chinese Journal of Experimental Surgery* 2005; 22:368–369.
- Jiang YL, Meng N, Wang JJ, et al. CT-guided iodine-125 seed permanent implantation for recurrent head and neck cancers. *Radiat Oncol* 2010; 5:68.