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Percutaneous Vertebroplasty Guided by a Combination of CT and Fluoroscopy

Afshin Gangi, Bruno A. Kastler, and Jean-Louis Dietemann

Summary: We describe the technique of percutaneous vertebroplasty using methyl methacrylate. We injected under the guidance of CT and fluoroscopy a group of 10 patients with back pain caused by a variety of vertebral lesions including severe osteoporosis ($n = 4$), hemangiomas ($n = 5$) and metastasis ($n = 1$). Over varying periods of follow-up (ranging from 4 to 17 months) none of the injected vertebral bodies demonstrated compression. All patients had relief of back pain; none had complications related to the technique. We emphasize that the efficacy of this technique in preventing vertebral collapse could not be evaluated in this small sample; a well-controlled study would be required to determine the proper indications and efficacy of this treatment.

Index terms: Spine, vertebrae; Spine, special procedures; Fluoroscopy; Spine, computed tomography; Spine, surgery

Percutaneous vertebroplasty (PV) is a procedure intended to prevent vertebral body collapse and pain in patients with unhealthy vertebral bodies. Vertebral body replacement and stabilization with methyl methacrylate has been previously reported (1, 2). Percutaneous injection has been proposed in vertebral hemangiomas (3), painful vertebral body tumors, and painful osteoporosis with loss of height and/or compression fractures of the vertebral body (4) (Bascoulergue Y, et al. Percutaneous injection of methyl methacrylate in the vertebral body for the treatment of various diseases. Presented at the 74th Meeting of the Radiological Society of North America, Chicago, November 1988). Until now, PV has been performed with a single imaging technique: fluoroscopy or computed tomography (CT). This paper describes vertebroplasty under the guidance of both techniques (5) (Gangi A, et al. Interventional radiology guided by combination of CT and Fluoroscopy. Presented at the Meeting of the Radiological Society of North America, November 1992).

Methods

Patients and Materials

From May 1991 to July 1992, 14 PVs, guided by a combination of CT and fluoroscopy, were performed on 10 patients, six women and four men ranging in age from 35 to 86 years. Four patients had severe osteoporosis with collapse of two adjacent vertebrae (thoracic vertebrae T6 and T7, T7 and T8, and lumbar vertebrae L1 and L2, L3 and L4), five had vertebral hemangiomas (T8, T10, T10, T11, and L2) including two cases of spinal cord compression and paravertebral tissue invasion, and one had a vertebral body metastasis (T7) (Table 1). In the patients with osteoporosis the injection of both adjacent vertebrae was performed during the same intervention. When there was doubt concerning the diagnosis of vertebral lesions, a biopsy was performed during the same procedure using the coaxial technique before the injection of methyl methacrylate.

Technique of Injection

For fluoroscopy, a mobile C-arm was used (BV-25, Philips Medical Systems International, Da Best, Netherlands), positioned in front of the CT gantry (Hilgert Advantage, General Electric, Milwaukee, Wis). Two mobile monitors were placed in front of the physician, displaying the last stored image and the fluoroscopic image (Fig 1).

With the patient in a prone position, under neuroleptanalgesia and local anesthesia, a 10- to 12-gauge trocar needle (Escoffier, Thonon Les Bains, France) was introduced into the vertebral body. Different approach routes can be selected: the transpedicular and intercostovertebral route for the thoracic level and the posterolateral and the transpedicular route for the lumbar level. The needle was guided safely under CT. A sterile field had to be guaranteed, and the heads of the C-arm were covered to prevent contamination. Cortical perforation required the aid of a surgical hammer (AESCLAP, Tuttlingen, Germany). When the needle was in the optimal position (needle tip in the anterior third of the vertebral body) (Fig 2), the imaging mode was switched to fluoroscopy.

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TABLE 1: Summary of patients with percutaneous vertebroplasty

No	Sex	Age (Years)	Disease	Vertebra	Clinic Symptoms	CT Findings	Length of Follow-Up (Months)
1	M	59	Hemangioma	L2	Back pain	Thickened vertical trabeculae (TVT)	17
2	F	35	Hemangioma	T10	Back pain	TVT	16
3	F	55	Hemangioma	T8	Back pain/ Paraparesia	TVT, paravertebral masses, epidural extensions	15
4	F	71	Osteoporosis	T7-T8	Back pain	Compression fractures	15
5	M	72	Osteoporosis	L3-L4	Back pain	Compression fractures	13
6	F	70	Hemangioma	T10	Back pain/ Paraparesia	TVT, paravertebral masses, epidural extensions	11
7	F	41	Hemangioma	T11	Back pain	TVT	11
8	M	45	Metastasis	T7	Back pain	Lytic lesions	5
9	F	86	Osteoporosis	L1-L2	Back pain	Compression fractures	4
10	M	65	Osteoporosis	T6-T7	Back pain	Compression fractures	5

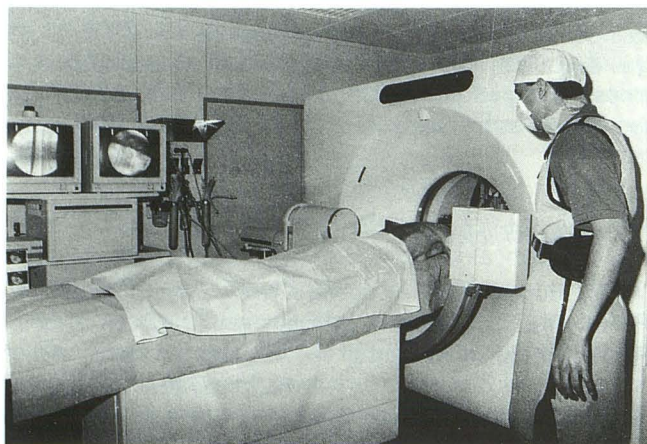


Fig. 1. Patient preparation before the intervention. The mobile C-arm fluoroscopy is installed in front of the CT scanner. Two mobile monitors face the operator. The vertebral lesion is centered by fluoroscopy.

Vertebral venography was performed by the injection of 10 to 15 mL of Iohexol in order to ascertain the location of the vertebral venous plexus and to determine the diffusion of the glue. When the needle tip was positioned in a venous structure, the needle was moved forward to avoid intravenous injection of the cement.

A package of methyl methacrylate (Microlok, Howmedica, Swindon Wiltshire, England; or Palacos low viscosity, Schering-Plough, Levallois-Perret, France) is composed of a packet of 40 g of powder and a tube of 20 mL of fluid monomer. We did not use additional antibiotics in the acrylic glue. After the venography, the acrylic glue was prepared by mixing 20 g of powder (half the packet) and 10 mL of fluid monomer. Because the acrylic cement was not radiopaque enough by itself, various chemical com-

pounds containing barium, tantalum, or tungsten were added. We used 1.5 g of tantalum for the mixture. During the first 30 to 50 seconds after mixing, the glue was very thin. It then became pasty and thick. The acrylic cement had to be injected during its pasty polymerization phase to prevent distal venous migration. Four to 8 mL of acrylic glue were injected using a 2-mL Luer Lock syringe mounted on a pressure regulator (Meadox, Oakland, Calif) to facilitate the injection of this viscous mixture.

At this stage, the intervention had to be performed quickly, because the glue began to thicken after 3 minutes, and any further injections became impossible.

This phase of the procedure was controlled under strict lateral fluoroscopy. The injection of acrylic glue was immediately stopped whenever an epidural or paravertebral opacification was observed to prevent spinal cord compression. When vertebral filling is insufficient, a contralateral injection has been suggested in order to complete the filling (4).

After the vertebral filling, the stylet of the needle was replaced and the needle was removed before the cement began to set (Fig 3). Six to 7 minutes after mixing the methyl methacrylate began to harden.

Monitoring of the arterial pressure was necessary during the procedure because methyl methacrylate injections can induce brief drops in arterial pressure. Total procedure time with two operators ranged from 20 to 50 minutes.

Results

No complications occurred in the immediate follow-up period. All patients showed a rapid regression of pain within 24 to 48 hours, allowing hospital discharge after 2 days. The most serious potential complication during injection is epidural

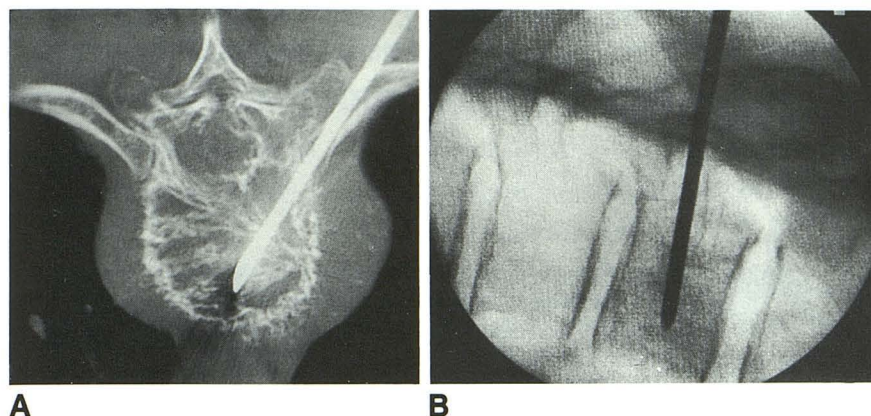


Fig. 2. A, CT scan shows a vertebral hemangioma with invasion of the paravertebral tissue. The needle placement is guided by CT in the anterior portion of the vertebral body through the costotransverse joint.

B, With the needle in the optimal position, the imaging mode is switched to fluoroscopy.

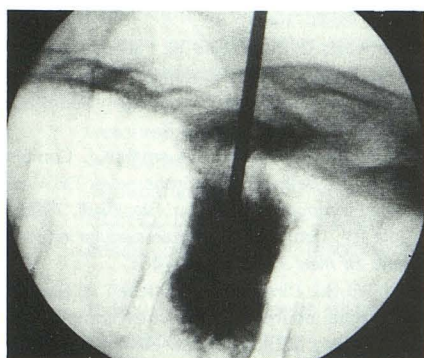


Fig. 3. Injection of methyl methacrylate controlled by fluoroscopy. This demonstrates good packing of the vertebral body.

overflow of methyl methacrylate with spinal cord compression. This risk was avoided by monitoring the vertebral filling by lateral fluoroscopy. The next most serious complication is infection. To avoid this complication, strict sterility during the intervention is mandatory. The risks of allergic accidents, hypotension, and pulmonary emboli are limited in this procedure, because the quantities of acrylic glue injected in PV are far less than those used in orthopedic surgery. None of these complications were observed in our patients (6–8).

Each patient was examined immediately after the procedure and on the following day in order to detect any sign of spinal or radicular compression. The examination continued on a monthly basis during the quarter after intervention and, subsequently, biannually. During the first 8 weeks, the patients checked their temperatures twice a week to detect fever, which is a sign of infection. A plain-film radiography was performed after PV during the hospitalization and then every 6 months. No recurrence of pain occurred and no change of acrylic glue was detected after 6 months in any patient, and none of the injected

vertebral bodies demonstrated compression. Among the four patients who have been observed over a longer period, this has remained the case.

No recurrence of pain was reported; the patients were able to return to normal lives. With two patients, who presented with vertebral body hemangiomas and spinal cord compression, the vertebroplasty was followed by surgical laminectomy with low bleeding during intervention.

Two patients have died subsequently of unrelated causes. The patient with vertebral metastasis died in June 1992 without recurrence of vertebral pain. An 86-year-old woman with two vertebroplasties for osteoporosis died in August 1992 of pneumonia and heart failure.

Discussion

PV, like other interventional procedures, is usually performed with a single imaging technique: fluoroscopy or CT, both of which have advantages and drawbacks.

Fluoroscopy offers multiple planes and direct imaging with the disadvantages of poor soft-tissue contrast and significant radiation exposure for both patient and operator. With fluoroscopy alone the position of the needle must be controlled from a different angle at every step of needle positioning. CT is well suited for precise interventional needle guidance, because it provides good visibility of bone and surrounding soft tissues. It also prevents damage to adjacent vascular, neurologic, and visceral structures. The disadvantages of this method are its single-plane capability and delayed imaging.

Using CT alone, the loss of time during the glue-injection phase is caused by the number of scans necessary to control the vertebral filling. At this moment in the intervention only 2 to 3 minutes are available before the acrylic glue be-

comes too thick to inject. Another drawback is that venography is difficult to visualize with CT. To address these concerns, a combination of CT and fluoroscopy for interventional procedures has been recommended (Gangi A, et al, Radiological Society of North America Meeting, November 1992) (5). The needle was placed precisely and safely under CT guidance; the injection of the methyl methacrylate required real-time imaging and was therefore performed under fluoroscopic control.

The combination of mobile C-arm fluoroscopy and CT allows an easy visualization of the needle tip, and the progression of the needle can be followed step-by-step in three dimensions. Thus the radiologist is able to visualize more accurately the relationship between the needle path and the critical bony landmarks on the spine.

In summary, we describe here the technique of PV under the guidance of CT and fluoroscopy. We have used this technique in attempting to prevent compression fractures and relieve pain in spinal lesions. Our *preliminary* experience seems to be encouraging; however, this is a small series from which we cannot draw any statistically valid information concerning the efficacy of this technique. A large study with well-defined inclusion

criteria is required, and long-term follow-up is necessary to verify its safety and efficacy.

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