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Research article

Percutaneous vertebroplasty in tumoral spinal fractures with posterior vertebral wall involvement: Feasibility and safety

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ABSTRACT

Purpose: to evaluate the technical feasibility and safety of CT and fluoroscopy guided percutaneous vertebroplasty in the treatment of tumoral vertebral fractures with posterior wall involvement.
Materials and methods: Institutional review board approval and informed consent were obtained for this study. Sixty-three consecutive adult patients (35 women, 28 men; mean age +/− standard deviation: 69 years +/− 14) with tumoral spinal fractures that compromised the posterior wall were treated by means of percutaneous vertebroplasty with CT and fluoroscopy guidance. Only local anesthesia was used during these procedures. Postoperative outcome was assessed using the Kostuik index.
Results: Sixty-three vertebroplasties were performed on thirty-four thoracic (54%), twenty-six lumbar (41%), and three (5%) cervical vertebrae. The etiologies of the fractures were metastasis in twenty-eight (44%), myeloma in twenty-five (40%) and hemangioma in ten (16%). Almost all fractures (94%) were consolidated after vertebroplasty (score of Kostuik < 3) ($p < 0.001$). No major complications were reported in our series of cases.
Conclusion: This study suggests that tumoral spinal fractures with posterior vertebral wall involvement can be successfully and safely treated by CT- and fluoroscopy-guided percutaneous vertebroplasty.

1. Introduction

Percutaneous vertebroplasty (PVP) was first performed in 1987 by Deramond [1]. It consists of the percutaneous injection of a biomaterial, usually methyl methacrylate, into a lesion of a vertebral body. The principal indications for vertebroplasty are painful or aggressive hemangioma, osteoporotic vertebral collapse, osteolytic metastasis and myeloma. It is also used for pain control of metastasis and osteoporotic fractures. The evolution of the materials and increased expertise of operators has allowed for an expansion of its use to the treatment of traumatic fractures and metastatic vertebrae with cortical involvement.

The tumoral extension to the posterior wall remains controversial, some authors counter-indicate vertebroplasty in these cases because of the risk of nerve compression by cement leakage. Only three studies have been published showing its feasibility [2–4].

The objective of our study was to evaluate the feasibility and safety of percutaneous vertebroplasty in the treatment of tumoral vertebral fractures with posterior wall involvement.

2. Materials and methods

Patients were enrolled after providing written informed consent. From December 2010 to November 2013, 63 consecutive adult patients were prospectively treated in our radiology department by means of CT and fluoroscopy-guided percutaneous vertebroplasty.

There were twenty-eight men and thirty-five women. The mean age (mean age +/− standard deviation) of all patients was 69 years +/− 14 (range 27–91 years).

All patients who had painful vertebral fractures associated with osteolytic destruction from malignant disease were considered candidates to the procedure. The indication for percutaneous vertebroplasty was determined at a multidisciplinary consensus meeting composed of an experienced interventional radiologist, a neurosurgeon, an oncologist and an orthopedic surgeon. In these meetings the patient's underlying functional status, his life expectancy, the origin of the primary tumor and their response to painkillers were considered. Anatomic location and quantity of the metastasis were also evaluated.

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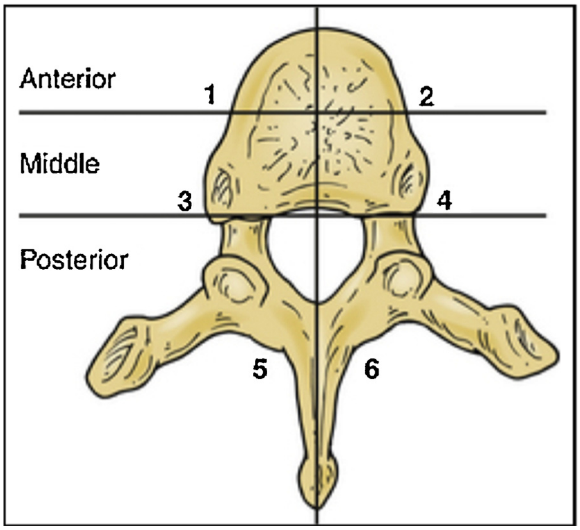

Fig. 1. Kostuik scores pre and post vertebroplasty.

Vertebroplasty was preferred over radiotherapy since it more accessible in our institution and provides immediate stabilization.

Before undergoing PV, all patients were informed not just about the well-known risks but also about the rare but serious possible risks associated with treatment: infection, anesthetic hazards and spinal cord or nerve root compression.

Vertebral biopsies were obtained during vertebroplasty for histologic examination in each patient. The etiologies of fracture were metastasis in twenty-eight patients, myeloma in twenty-five, and hemangioma in ten.

Computed tomographic (CT) scans of the spine were systematically obtained before the procedure. On the basis of the images obtained fractures were classified according to the Kostuik Index [5], which divides the vertebra into six segments (Fig. 1). It is based in the three-column classification of Denis, which are further divided in half in the sagittal plane to create six columns (1, anterior right; 2, anterior left; 3, middle right; 4, middle left; 5, posterior right; 6 posterior left). When the lesion compromises three or more segments, the vertebra is considered unstable and needs treatment as soon as possible.

Technique of percutaneous vertebroplasty

All procedures were performed by one interventional radiologist (N.A., with 15-year experience).

After hemostatic control, procedures were performed under aseptic conditions in an interventional CT suite using CT (GE Lightview 8-row MDCT scanner; GE Healthcare, Milwaukee, WI) and lateral fluoroscopy (Stenescop C-arm; GE healthcare) guidance.

This double guidance system allows easy visualization of the needle tip and its progression can be followed step-by-step in three dimensions; it also provides a real-time imaging of the methyl methacrylate injection (PMMA) [6].

In thoracic and lumbar vertebrae cases, patients were placed in a prone position on the CT table with an optionally placed support under the abdomen to decrease lumbar lordosis and simplify access to the vertebra. In the cases of cervical vertebrae patients were placed in a decubitus position.

We first performed CT image acquisition of the entire spine with the following parameters: collimation, 8 × 1.25 mm at 100 kV and 250 mAs; rotation time, 0.5 s; pitch, 1.4; field of view, 500 mm, matrix, 512 × 512; standard soft-tissue kernel. Multiplanar reconstructions (with a section thickness of 1.25 mm) were analyzed at a workstation (ADW 4.2; GE Healthcare) to plan the approach and at the same time evaluate the Kostuik index. This planning consisted of (1) analyzing the anatomy of the vertebra and (2) determining the best approach – transpedicular, inter-costo-vertebral or latero-vertebral – depending of the level and type of lesion treated.

Fig. 2. Six-column system of Kostuik for evaluation of stability in spin.

An imaginary line of the needle trajectory passing through the vertebral body was drawn on the axial CT images for guidance, and the angle was then calculated. A skin entry point was determined, and the distance was measured from the midline. (Fig. 2)

Using a 22-gauge needle, a local anesthesia (lidocaine 1% [Xylocaine; Astra, Sodertalge, Sweden]) was administered in subcutaneous tissues. Three minutes later, under fluoroscopy guidance and according to the angle previously determined, a 20-gauge 20-cm Chiba needle (Thiebaud, Thonon-les-Bains, France) was inserted until bone contact was made. An axial CT acquisition (SmartStep system) confirmed the correct positioning of the tip of the Chiba needle. Local anesthesia of the periosteum was then administered at the vertebral entry point. After its hub had been removed, the Chiba needle was used as a guide for a 13-gauge 10-cm Trocar t'am (Thiebaud, Thonon-les-Bains, France; standard size) which was inserted under iterative CT and fluoroscopy into the vertebral body up to the most anterior portion of the tumor, where a biopsy was performed using a coaxial cannula (Fig. 3).

PMMA bone cement (Biomet, Thiebaud, Thonon-les-Bains, France) was prepared in a closed-system mixer (M'NX, Thiebaud, Thonon-les-Bains, France) adding tungsten powder (4 g) to increase its radiopacity. Several 1cc. Luer-Lok™ syringes were filled with cement in its early liquid phase (Fig. 4).

Under continuous fluoroscopy, cement with a consistency of "tooth paste" was gently injected into the most anterior part of the tumor before continuing towards the posterior wall. Step-by-step control was performed to ensure more precise analysis of the cement distribution. The procedure was stopped if the fluoroscopy images showed cement leakage through the posterior wall or if the patient complained of pain or paresthesias that could reflect the compression on posterior nervous structures (Fig. 5).

The complete filling of the vertebrae was attempted weighing the augmented risk of cement leakage as the injected volume increased (Fig. 6).

Finally, a CT scan of the whole spine was obtained to evaluate the post procedure Kostuik index and to assess any complications.

The average time of procedure (from positioning of the patient on the CT table to his exit from the intervention room was 35 min (range, 30–40 min).

Following PV patients were hospitalized for 24 h. An independent assessor performed a clinical follow-up one-month after the procedure paying close attention to detect any neurological deficit.

MR and CT imaging were performed at 1 month and 6 months to indicate (1) status of the cemented vertebrae and (2) search for new vertebral compression fractures adjacent to the treated vertebra.

Patient details and clinical information were obtained from the medical records and relevant details were entered into an excel worksheet (Excel 05; Microsoft Corp., Redmond, WA).