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Percutaneous Cervical Vertebroplasty in a Multifunctional Image-Guided Therapy Suite: Hybrid Lateral Approach to C1 and C4 Under CT and Fluoroscopic Guidance

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Abstract

A 76-year-old patient suffering from two painful osteolytic metastases in C1 and C4 underwent percutaneous vertebroplasty by a hybrid technique in a multi-functional image-guided therapy suite (MIGTS). Two trocars were first placed into the respective bodies of C1 and C4 under fluoroscopic computed tomography guidance using a lateral approach. Thereafter, the patient was transferred on a moving table to the digital subtraction angiography unit in the same room for implant injection. Good pain relief was achieved by this minimally invasive procedure without complications. A hybrid approach for vertebroplasty in a MIGTS appears to be safe and feasible and might be indicated in selected cases for difficult accessible lesions.

Key words: Percutaneous vertebroplasty—Computed tomography—Fluoroscopy—Cervical spine—Osteolytic metastases—Bone implant—Pain treatment

Percutaneous vertebroplasty (PVP) is increasingly gaining acceptance as standard of care for patients suffering painful osteolytic metastases of the spine [1]. Percutaneous injection of acrylic cement allows a pain relief by stabilization of the vertebral body [2, 3].

Our study describes the treatment of two cervical osteolytic lesions located in the right lateral atlas and in the body of C4 by a single-stage hybrid intervention avoiding movement of the patient during the procedure. After a computed tomgraphy (CT)-guided trocar placement into the osteolytic metastases, digital subtraction angiography (DSA)-guided implant injection was conducted in the same room after a translation of the patient in the exact same position on a rail-guided table.

Case Report

A 76-year-old woman with known metastatic disease from an adenocarcinoma of unknown origin was admitted to the authors' hospital for treatment of refractory pain in the upper cervical spine. Conventional images and CT of the cervical spine showed an osteolytic lesion of the atlas in the right lateral portion and a second osteolysis in the body of C4 (Fig. 1A). On magnetic resonance imaging (MRI), there was no epidural tumor involvement.

In an interdisciplinary meeting among orthopedic surgeons, neuroradiologists, and interventional radiologists, the decision was made to treat the two osteolytic metastases of C1 and C4 with percutaneous vertebroplasty, aiming for stability and pain control. In order to employ the best possible technique for access path, injection control, and, at the same time, avoiding patient repositioning during the intervention, a single-stage hybrid lateral approach under CT and fluoroscopic guidance was proposed.

The procedure was performed under general anesthesia in a multifunctional image-guided therapy suite (MIGTS), which integrates the technology and infrastructure for sterile image-guided therapy with CT, fluoroscopy, DSA, and a new OR table [4, 5]. The patient was fixed in a left lateral position on the intervention table and immobilized on a vacuum mattress. Prophylactic antibiotic therapy with a third-generation cephalosporine (Rocephine 2 g intravenously; Roche Pharma, Reinach, Switzerland) was applied.

Intra-interventional imaging was performed on a spiral CT scanner (GE Hispeed Advantage; GE Medical Systems, Milwaukee, WI, USA; imaging parameter 140 kV, 380 mA, slice thickness 3 mm, pitch 1.5, slice increment 2.5 mm). First, a contrast-enhanced high-resolution volumetric scan from the skull base to the level of C5 was performed to define the access path and to demonstrate the course of the cervical arteries. Under CT fluoroscopic guidance using a collimation of 3 mm, a 14G 11-cm trephine-type needle with screw threads (Ostycut®; Bard Products, Angiomed, Berlin, Germany) was inserted in a strict axial direction just anterior to the vertebral artery and posterior to the internal carotid artery to reach the osteolytic destroyed lateral mass of C1. A similar procedure was conducted for the osteolytic lesion in the vertebral body of C4 (Fig. 1B). Penetration of the respective lesions could easily be achieved. After verification of the correct needle placement, the intervention table was driven via a remote control on a rail system into the fluoroscopy unit (Philips Integris V 5000; Philips Medical Systems, The Netherlands). Phlebography, performed by injection of a few milliliters of contrast material (Iopamiro 300; Iopamidolum, Bracco S.P.A. Milano, Italy) in a strict lateral position under fluoroscopic control, revealed a leakage into the intervertebral space at the level of C1. In C4, a strong hypervascularization of the osteolysis was demonstrated, but no leakage toward the vertebral artery was observed.

A cement composition of 18 ml polymethyl methacrylate (PMMA) (Simplex P, methylmethacrylate; Howemedica, Rutherford, NJ) powder, 2 ml barium powder, and 5 ml liquid polymer (Simplex P, Polymer; Howemedica)] providing up to 8 min of extended polymerization time under room temperature [6, 7] was loaded into a 10-cc injector device (10 cc Leveen; BSC, Watertown, MA, USA). The injector was connected to the

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Fig. 1. **A**. Axial computed tomography showing an osteolyic lesion of the right lateral atlas mass (arrow) and another osteolysis in a sagittal reconstruction of C4 (curved arrow). The right-sided osteolytic lesion of the atlas abuts the vertebral artery. The cortex along the vertebral artery is intact, whereas at the medial cortex, a fracture zone with mild displacement can be delineated. Note the cortical breakthrough of the posterior vertebral surface at the C4 level. **B**. Lateral access path to the osteolytic lesion in C1 (left) and the entirely destroyed C4 (right) between the internal carotid artery (curved arrow)/internal jugular vein (arrowhead) anteriorly and the vertebral artery (arrow) posteriorly under CT fluoroscopic guidance.

needles and the cement preparation was injected under continuous fluoroscopic control mainly in the lateral projections with intermittent checks in the anteroposterior projection in order to gain optimal filling while avoiding significant PMMA leakage toward the spinal canal and the vertebral arteries. Approximately 1 ml of PMMA was administered at C1 and 2 ml at C4 level. On both levels, a good filling of the osteolytic lesions could be obtained (Fig. 2A,B).

Vertebroplasty was concluded uneventfully within a total time of less than 2 h and the patient exhibited no neurologic symptoms when she woke up from general anesthesia. Substantial pain relief resulted and she no longer required pain medication. The follow-up was unremarkable, with stable pain relief 6 month after the intervention.

Discussion

Various approaches for vertebroplasty of the cervical spine were mentioned in the literature depending on the location. The single treatment of C1 described in the literature was performed via a posterior approach after coil occlusion of the vertebral artery [8]. For the C2 level, a transoral procedure was proposed [9, 10], whereas the mid and lower cervical spines are usually assessed by an anterolateral approach [6]. In the reported case with a patient suffering from two painful cervical osteolyses at the C1 and C4 level, an intervention using an established access route without patient repositioning was not possible. Therefore, we decided to apply a lateral approach with similar access paths to reach both lesions in the same patient position. In order to perform this access safely, a visualization of vital structures adjacent to the metastases—primarily the course of the vertebral and carotid arteries—was mandatory. We therefore chose a hybrid approach by CT guidance for the needle placement and fluoroscopic guidance for cementing.

A combination of CT-guided needle placement and fluoroscopically controlled implant injection has been already described originally by Gangi et al. [11]. Our technique differed from the procedure outlined in their article based on the technologies available to us: First, the procedure was performed in a MIGTS that integrates the technology and infrastructure for sterile image-guided interventions [4]. The state-of-the-art imaging modalities, including spiral CT and a high-resolution DSA unit, provided an optimal visualization for both needle placement and implant injection. Repositioning of the patient is avoided by a rail system that enables the transfer of the intervention table with a remote control from the CT to the DSA unit. Second, the stable patient fixation on a vacuum mattress in a lateral position offers a good operator control. Third, we used a 14G trephine-type needle with screw threads; as in the presented case, a precise entering of a small area for safe cement delivery was mandatory. This needle type allowed a very exact advancement [12], as the penetration of the cortex is achieved with a drilling action (see http://www.emedicine.com/radio/topic 844.htm). In order to find the correct entry point at the cortical surface, especially in cases with a tangential entry point, hammering might be helpful to accomplish bony contact.

Although there exist new cements on the market in which barium or zirkondioxid is already added [13, 14], we still utilized a conventional PMMA product because of familiarity with the mechanical properties and the dynamic of polymerization.

Venography with an iodinated contrast agent before injecting the PMMA is carried out to characterize collateralization to the basivertebral venous complex [15]. In patients with severe allergy to iodinated contrast media or chronic renal insufficiency, gadolinium-based agents have been used [16].

The good analgetic effect in this patient was achieved with only small amounts of approximately 1 ml PMMA at the C1 level and 2 ml at the C4 level. This matches the observation in biomechanical studies that a restoration of vertebral body integrity resulting in patientś pain relief can be achieved with only small volumes of cement [17]. Moreover, the application of relatively small cement portions increases the safety of the interventional procedure by diminishing the risk of leakage to sensitive structures.

In conclusion, the case presented demonstrates that a single-step hybrid lateral access under CT and DSA guidance is safe and feasible without patient repositioning. This approach seems to be fast, reliable, and easy to perform in selected patients with multiple lesions and difficult access paths such as in the upper cervical spine.

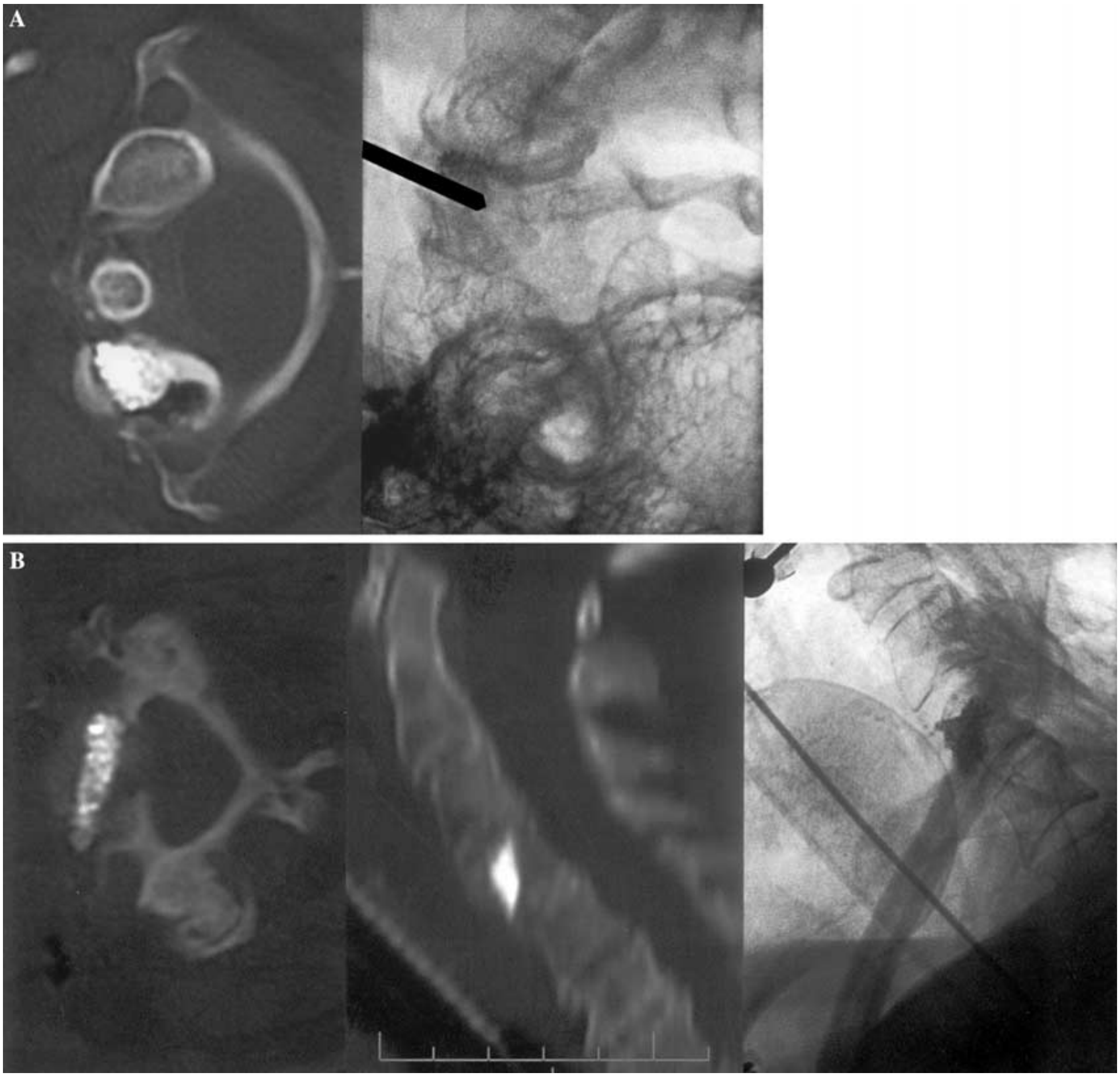

Fig. 2. **A**. Fluoroscopy image during the filling process of the right C1 body lesion and axial computed tomography after vertebroplasty. The distritbution of cement can be better appreciated on CT images than plain films. No leakage toward the vertebral artery can be observed. **B**. Post-procedural axial CT with sagittal reconstruction and lateral radiograph of the cervical spine after vertebroplasty revealing a sufficient cement filling at the C4 level. No cement leakage toward the spinal canal and the vertebral artery can be observed.

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