

Combined Ultrasound- and Fluoroscopy-guided Percutaneous Cementoplasty and Ablation for a C2 Pathologic Fracture: A Case Report

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Learning Point of the Article:

This case introduces a novel anterolateral, caudal-to-cranial percutaneous approach to the axis vertebra combining ultrasound and fluoroscopic guidance for safe ablation and cementoplasty of C2 pathologic fractures.

Abstract

Introduction: Vertebral augmentation techniques are widely reported and effective for vertebral body fractures related to the thoracic and lumbar spine. However, techniques for accessing the cervical spine for vertebral augmentation purposes are limited. Historical approaches lack image guidance and/or involve open surgery. Our case involves a previously unreported, fully image-guided approach to the second cervical vertebra for ablation and vertebroplasty.

Case Report: A 52-year-old male with a history of renal cell carcinoma presented with acute, intractable neck pain. Computed tomography of the cervical spine showed a destructive lytic lesion which resulted in a non-displaced type II dens fracture. Magnetic resonance imaging with contrast administration confirmed a marrow-replacing, enhancing lesion within the body of the axis vertebra. His pain was poorly controlled despite medical management, and he was unfit for surgery or radiation therapy. We used a percutaneous, anterolateral, and caudal-to-cranial approach to access his second cervical vertebra for cement augmentation and radiofrequency ablation of the lesion. The procedure was performed without complication, and the patient experienced significant pain relief.

Conclusion: This case demonstrates that metastatic lesions of the axis vertebra, including those extending into the dens, can be safely and effectively treated using a percutaneous, image-guided anterolateral approach combining ultrasound and fluoroscopy. This technique may offer a lower-risk alternative to previously described approaches for patients who are not surgical or radiation therapy candidates. This technique is directly relevant to clinicians experienced in vertebral augmentation, such as interventional radiologists and spine surgeons, and may also serve as a referral option for patients presenting with axis vertebra pain due to fracture and/or metastatic lesion.

Keywords: Vertebroplasty, radiofrequency ablation, axis vertebra, cervical spine, lesion.

Introduction

Vertebral body ablation and augmentation are widely employed effective percutaneous treatments in the setting of painful vertebral body fractures related to neoplasm. Techniques for vertebral augmentation in the thoracic and lumbar spine are widely reported. However, techniques in the cervical spine,

especially involving the axis vertebra (C2), are limited [1]. Previously described techniques are not only technically difficult but also involve serious complication risk [1]. Historical approaches rely on techniques that do not utilize direct imaging guidance or require an open surgical approach. We describe a novel, fully image-guided approach for C2 ablation and

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vertebroplasty in the setting of a painful osseous metastases and fracture using conventional fluoroscopy and ultrasound.

Case Report

A 52-year-old male with history of renal cell carcinoma presented with acute onset intractable neck pain. Computed tomography (CT) of the cervical spine revealed a destructive lytic lesion in C2, resulting in a non-displaced type II dens fracture. Magnetic resonance imaging with gadolinium administration demonstrated a marrow replacing enhancing lesion within the body of C2 (Fig. 1). The patient's pain was inadequately controlled despite optimal medical management. Neurosurgery and radiation oncology consultations determined that the patient was not a candidate for surgical intervention or radiation therapy, respectively.

The decision was made to proceed with percutaneous C2 vertebroplasty and radiofrequency ablation of the lesion. A detailed review was conducted using pre-procedure axial imaging and anatomic references for vascular and nonvascular structures in the right neck. An anterolateral trajectory plan was generated to safely reach the C2 vertebral body under real time ultrasound and biplanar fluoroscopic imaging. This skin entry point mapped to approximately the fifth cervical (C5) vertebral body level (Fig. 2a). A plan was made to advance the Trocar medial to the sternocleidomastoid muscle and the common carotid artery (Fig. 2b). Careful consideration was made to remain below the carotid bifurcation to avoid damage to any branches of the external carotid artery. Once confirmed medial and posterior to the vascular structures, the trocar would be advanced to the deep retropharyngeal space (Fig 2c). Using biplanar fluoroscopy, the trocar was guided cranially toward the inferior endplate of C2 through the longus colli muscle toward

the level of the C2-C3 disc space while maintaining gentle medial traction (Figs. 2c and Fig. 3a).

With the trocar in place, in a coaxial fashion, a complementary bone drill was advanced to manually create a tract inside the C2 vertebral body toward the base of the dens (Fig. 3a). A radiofrequency ablation probe was subsequently advanced through the trocar and confirmed as terminating at the base of the dens using fluoroscopy. Following ablation, polymethyl methacrylate was injected under intermittent fluoroscopy (Fig. 3b and 3c).

Discussion

Osteolytic lesions of C2 often present a difficult painful clinical scenario to manage, given their precarious location. Most attempts to intervene carry high risk of serious neurovascular compromise or other complications. Traditional treatments include radiotherapy and open surgery. Percutaneous vertebral augmentation has been used as an adjunctive therapy historically, especially for pain control and stabilization [2]. Vertebroplasty techniques using an open surgical anterior approach have been described as well [1,3]. Other approaches have been described which are technically difficult and associated with high-risk complications. A posterolateral approach is associated with vertebral artery injury [4], a translateral approach with carotid artery injury [5], and a transoral approach with a high risk of infection, including retropharyngeal abscess or meningitis [6]. While some reported approaches rely on specialized equipment (e.g., curved needles), our technique does not require advanced instrumentation [7].

Most of these previously reported complications can be

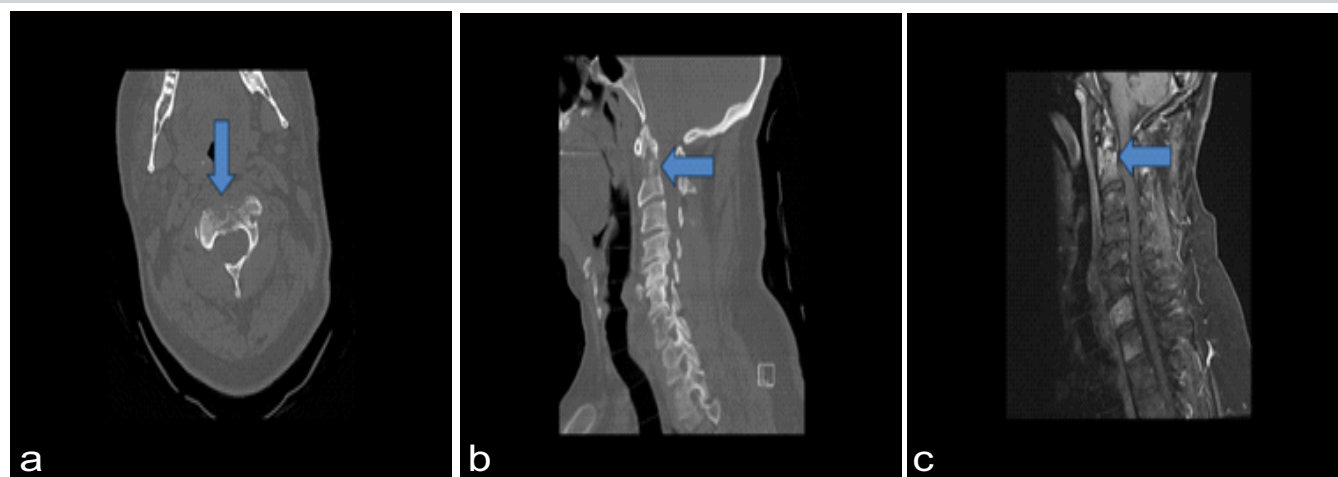


Figure 1: Pre-operative computed tomography (CT) and magnetic resonance imaging (MRI) demonstrating a C2 lytic lesion and pathologic dens fracture: Axial (a) and sagittal (b) CT images of the cervical spine demonstrate a destructive lytic lesion in C2 with a non-displaced type II dens fracture (arrow). Sagittal MRI with gadolinium revealed an enhancing metastatic lesion with marrow replacement within C2 (c, arrow).

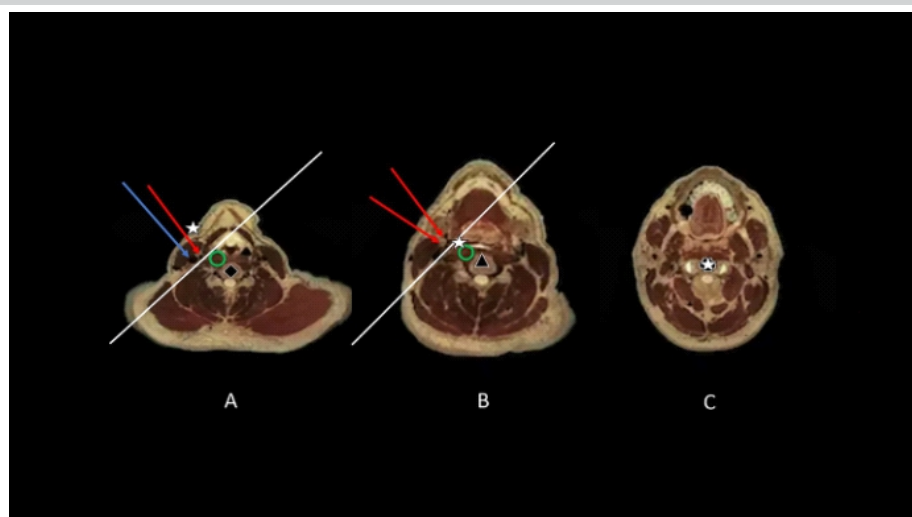


Figure 2: Anatomical mapping and trajectory planning of the novel anterolateral percutaneous approach to C2: Axial computed tomography cadaveric images labeled to demonstrate a novel percutaneous approach to C2. Skin entry site (a) at C5 (diamond), caudal to the carotid bifurcation. The skin entry site (star) is medial to the common carotid artery (red arrow) and jugular vein (blue arrow) and anterolateral to the midline spine. The angle of entry is cephalad and medial toward the longus colli muscle (green circle). The plane medial to the vessels must be reached before the level of the carotid bifurcation to avoid small branches not visible with ultrasound. Axial level (b) at the level of the carotid bifurcation (red arrows) demonstrates that the needle tip (star) is medial to the vessels at this point – approximately C4 (triangle). From here until the target the only structure left to traverse is the longus colli muscle (green circle). Axial image (c) at the level of C2 (cross) demonstrating needle deep to longus colli at target (star). Images used with permission (Micheau A, Hoa D, e-Anatomy, www.imaio.com, DOI: 10.37019/e-anatomy).

minimized using an image-guided percutaneous anterolateral approach with a combination of ultrasound and fluoroscopic guidance. Herein, we describe a novel technique that is performed under direct real-time imaging guidance using ultrasound to direct the needle medial to the sternocleidomastoid muscle and common carotid artery. Precision is required to traverse the anterior neck and ensure a trajectory below the carotid bifurcation as many small external

carotid branches may be violated with a higher approach. Following vertebral body access, the procedure is similar to radiofrequency ablation and cementoplasty at other levels. The risk of injury to vascular structures within the neck such as the carotid arteries and branches of the external carotid artery is minimal due to real-time ultrasound visualization.

The patient described in this case had an osteolytic lesion extending to the base of the dens. There is a paucity of data in the literature for percutaneous vertebroplasty at C2 with most of the data describing interventions involving the C2 vertebral body and not the dens [8]. Nevertheless, studies have shown vertebroplasty of C2 provides rapid pain relief in up to 80% of patients and spine stability in 87% of patients [1, 9]. This medial, caudal-to-cranial approach can be used for percutaneous ablation and stabilization of lesions

involving the C2 vertebral body, including those extending into the dens, as in this case. A percutaneous approach using image guidance enables less blood loss, shorter anesthesia time, and lower risk for damage to neurovascular structures in the neck. For appropriately selected patients, percutaneous vertebroplasty offers a favorable benefit-risk profile compared with non-operative medical management, with consistently

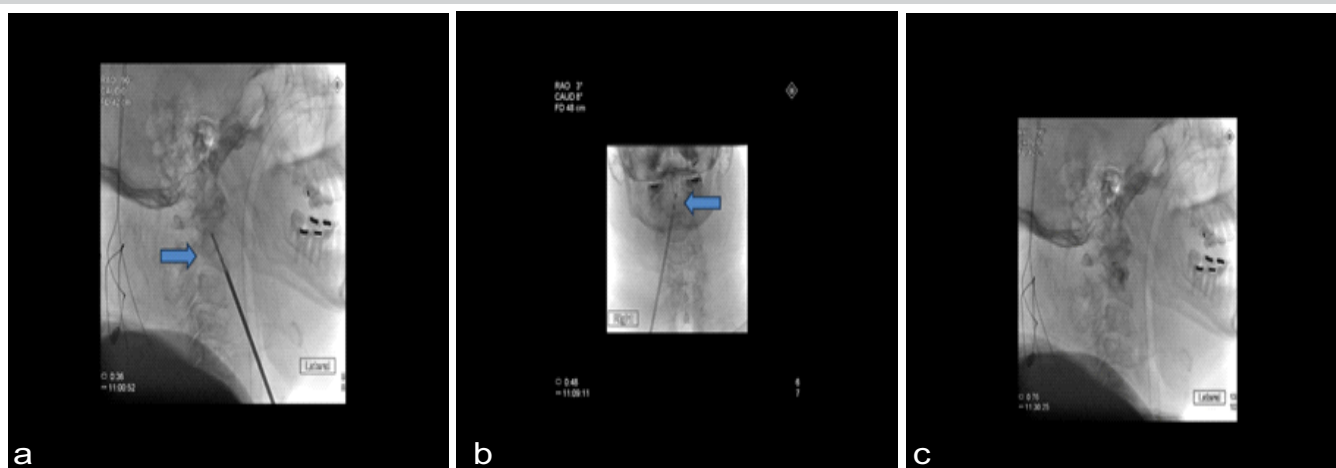


Figure 3: Intraoperative biplanar fluoroscopy confirming trocar advancement, RF ablation probe placement, and final cement interdigitation: Lateral image demonstrated successful advancement of the trocar to the inferior endplate of C2 with subsequent drilling (arrow) to create a tract within the C2 vertebral body toward the dens (a). Anterior-posterior fluoroscopy image showed placement of radiofrequency ablation probe (arrow) advanced through the trocar terminating at the base of the dens (b). Immediate post-procedure image confirming successful interdigitation of cement within C2 (c).

high reported success rates [10]. The technique described herein may be adopted by operators with experience in vertebral augmentation in non-cervical spine levels at institutions with access to ultrasound and fluoroscopy equipment.

Conclusion

This case describes a novel percutaneous image-guided approach to metastatic lesions in the dens for purposes of safe radiofrequency ablation and cement stabilization – resulting in pain relief for a patient with a paucity of other treatment options. Using an anterolateral approach that combines ultrasound and fluoroscopic guidance enables this procedure to be performed percutaneously by experienced operators with standard equipment. Interventional radiologists and spine

surgeons experienced in vertebral augmentation may use this technique if presented with a patient experiencing a lesion and/or fracture of C2. Orthopedic surgeons and neurosurgeons managing patients with cervical spine metastases and/or fractures may also consider this approach as a referral option when surgical intervention is not feasible.

Clinical Message

Patients who present with intractable pain secondary to metastatic involvement and fracture of C2 may be treated percutaneously under image guidance with standard radiofrequency ablation and cementoplasty techniques using an anterolateral caudal-to-cranial specific trajectory described herein.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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