Technical Note

Fluoroscopically Guided C2 Percutaneous Vertebroplasty: A Surgical Technique Note on an Anterior Ascending Approach

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Background: C2 vertebroplasty is more challenging than transpedicular percutaneous vertebroplasty in the thoracic and lumbar spine.

Objective: We report an anterior ascending approach for C2 percutaneous vertebroplasty to avoid potential injury to vital structures surrounding the C2 vertebra.

Study Design: A technique note with 5 consecutive cases.

Setting: Neurosurgery department of a university hospital.

Methods: Fluoroscopically guided manual compression was applied using 3 fingers at the C5 level between the muscle and trachea. The larynx and trachea were displaced medially and the carotid artery laterally. The anterior cervical spine was palpated, and a 15-gauge 4-inch bone marrow biopsy needle was introduced through an anterior ascending approach. When the tip touched the intervertebral disc between C2 and C3, the needle was pushed through the disc until it penetrated into the C2 vertebral body. After confirming adequate needle insertion, vertebroplasty was performed.

Results: Pain relief was achieved in 4/5 (80%) patients. One patient possibly did not benefit from percutaneous vertebroplasty, and asymptomatic cement extravasation was detected in 2 patients.

Limitations: Sample size; impossibility of placebo control.

Conclusion: An anterior ascending approach for C2 percutaneous vertebroplasty is a valuable alternative for relieving pain caused by metastatic spinal tumors. This approach is familiar to surgeons performing anterior cervical discectomies, percutaneous nucleoplasty, or odontoid screw placement surgeries.

Key words: Vertebroplasty, pain, axis, cement leak, metastases, palliative medicine, spine, fracture

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Metastatic spinal tumors are painful and debilitating (1). Pain is frequently associated with a pathological vertebral fracture and spinal instability, secondary to bone destruction (2). Metastatic spinal lesions are frequently present in the thoracic and lumbar spine (1), whereas painful metastatic lesions involving the C2 vertebral body are infrequent (3-7).

Generally, the treatment regimen for these patients is palliative and involves a combination of medical therapy, radiation, and surgical intervention (1). Surgical stabilization poses the risk of severe compli-

cations because patients frequently present with poor clinical conditions and an advanced multimetastatic disease (8). Percutaneous vertebroplasty procedures have been successfully used for alleviating pain and functional disability associated with metastatic spinal lesions (1-7).

C2 vertebroplasty is technically more challenging than transpedicular percutaneous vertebroplasty is in the thoracic and lumbar spine (3-7). In this case series, we report an anterior ascending approach for C2 percutaneous vertebroplasty and its efficacy and safety evaluation.

Methods

Patients

From March 2013 to May 2015, 5 consecutive patients underwent C2 percutaneous vertebroplasty for treatment of intractable neck pain with C2 osteolytic metastasis. Table 1 presents patient demographic data, treatment outcomes, and complications.

The neurological status of patients was evaluated before the procedure for determining a baseline for the postprocedural comparison. Pain intensity was recorded using a visual analog scale (VAS) ranging from 0 (no pain) to 10 (extremely severe pain). All patients underwent enhanced computed tomography (CT) and magnetic resonance imaging examinations before the procedure for evaluating lesions and identifying the positional relationship of the carotid and vertebral arteries.

Surgical Technique

Under general anesthesia, a patient was placed in the supine position with the neck extended by placing a rolled towel under the shoulders. A soft strap was placed over the forehead for stabilization. The shoulders were gently distracted downward by using a tape. Biplanar C-arm fluoroscopy was used anteroposteriorly and laterally for directing the placement of a bone marrow biopsy needle.

At the entry point adjacent to the medial border of the right sternocleidomastoid muscle, firm pressure was digitally applied between the muscle and trachea and pointed toward the vertebral surface. The larynx and trachea were displaced medially and the carotid artery laterally through gentle manual compression (Fig. 1). The anterior cervical spine was palpated, and a 15-gauge 4-inch bone marrow biopsy needle (Medical Device Technologies, Gainesville, FL, USA) was introduced at the C5 level through an anterior approach. The needle tip was carefully directed in an ascending direction up to the anterolateral inferior part of the intervertebral disc between C2 and C3 (C2/3 disc). When the tip touched the C2/3 disc, the needle, guided through fluoroscopy, was pushed through the disc until it penetrated into the inferior part of the C2 vertebral body toward the axis of the C2 dens (Fig. 2). Vertebrography was performed before injecting cement. Small amounts (< 3 mL) of a contrast agent were injected into the vertebral body for evaluating potential routes of cement extravasation. After confirming an adequate needle insertion, cement with barium sulfate (Mendec Spine, Tecres SPA, Italy) was injected into the vertebral body and dens by using a 1-mL syringe. The cement flow was monitored through continuous fluoroscopy. The operation end point was the presence of adequate cement filling or a cement leak during injection.

Postoperatively, patients were instructed to complete 2 hours of bed rest, following which they were allowed unlimited sitting, standing, and walking. If no immediate complications were observed, patients were generally discharged the next day.

Table 1. *Demographic characteristics of patients before and after percutaneous vertebroplasty.*

	Age	Gender	Pathology	VAS before PV	VAS after PV	Follow-up months	Cement volume, mL	Complications
1	41	M	NPC	7	2	6	2.5	nil
2	47	M	Tougue carcinoma	8	1	8	4.5	leak
3	53	F	NPC	9	5	2	4	leak
4	58	M	HCC	8	7	15	3	nil
5	56	M	HCC	8	1	12	3.5	nil

PV: Percutaneous vertebroplasty, NPC: Nasopharyngeal carcinoma,
HCC: Hepatocellular carcinoma, VAS: Visual analog score

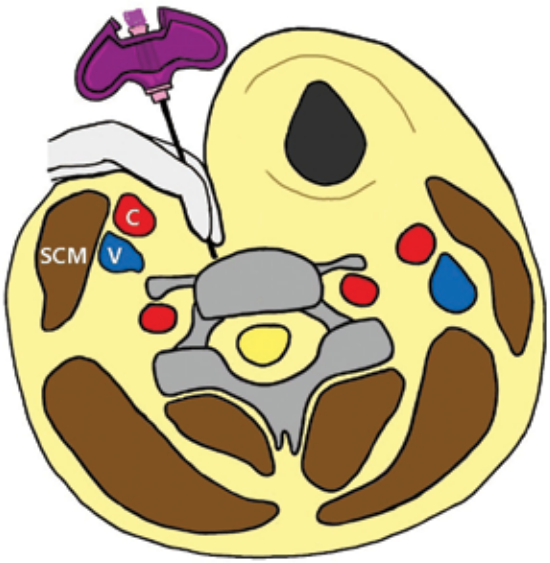


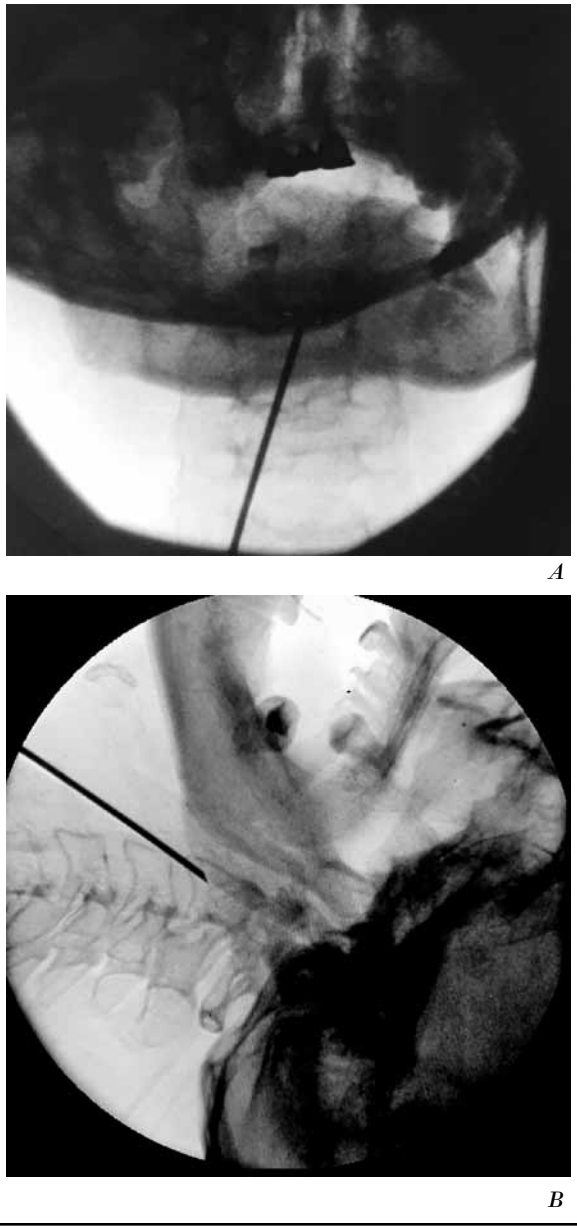
Fig. 1. *Illustration of the anterior ascending approach for C2 percutaneous vertebroplasty using manual compression for displacing the larynx and trachea medially and the carotid artery laterally.*

Results

Percutaneous vertebroplasty was successfully performed on all patients by using the anterior ascending approach. All patients (4 men and one woman) showed no pre- and postoperative neurological deficits. The patient age (mean ± SD) was 51 ± 7.0 years (range 41 – 58 years). The mean preoperative VAS was 8.0 ± 0.7. Patients were followed for 9.6 ± 5.1 months (range 3 – 16 months). The postoperative VAS was 3.2 ± 2.7. The amount of cement injected per vertebra varied between 2.0 and 4.5 mL (3.5 ± 0.8 mL). Pain relief (> 50%) was significant in 4/5 (80%) patients. One patient possibly did not benefit from percutaneous vertebroplasty (case 4); one month later, this patient underwent an occipital cervical fusion with laminectomy for spinal cord decompression.

Complications and Surgical Technique Incidents

The postoperative CT analysis for all patients showed asymptomatic cement leak in 2 patients (Fig. 3). No delayed complications or infections were detected during the follow-up period.



A

B

Fig. 2. *Intraoperative (A) anterior and (B) lateral fluoroscopic images showing the bone marrow biopsy needle position toward the C2 vertebral body.*

Discussion

The anterior ascending approach is a safe method of performing C2 percutaneous vertebroplasty. This approach is already familiar to surgeons performing anterior cervical discectomies, percutaneous nucleoplasty, or odontoid screw placement surgeries (9). Vital structures, such as the great vessels, trachea, and

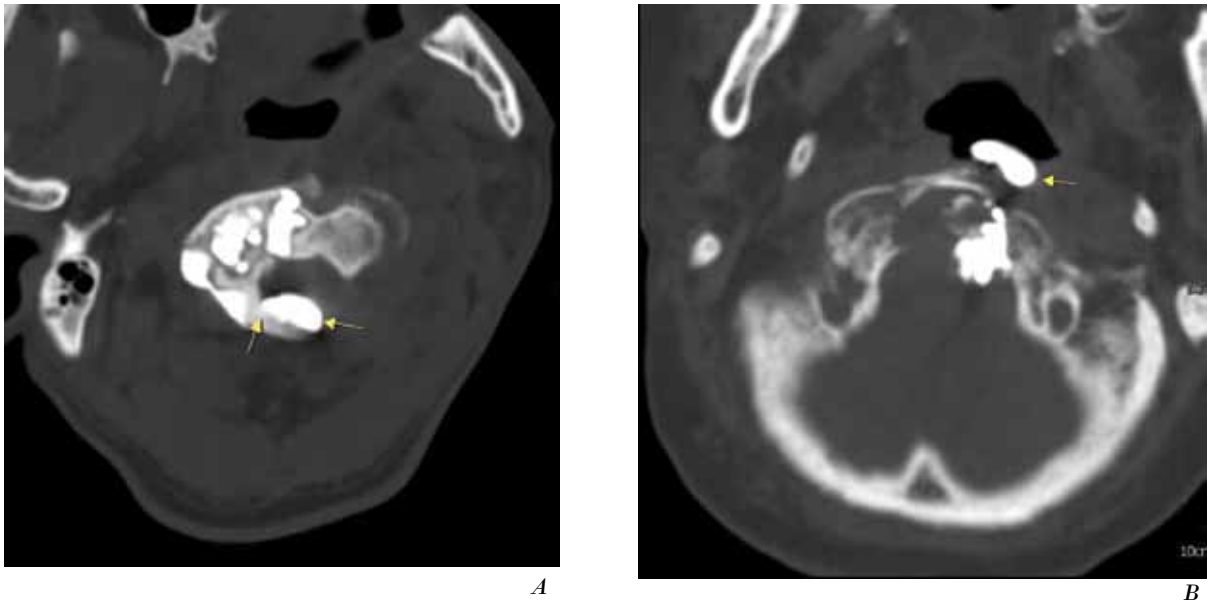


Fig. 3. *A. Cortical osteolysis and cement leaks in the spinal canal (arrow). B and C. Cortical osteolysis and paraspinal venous leakage (arrow).*

esophagus, are directly displaced using manual pressure with fingertips. The trachea and esophagus are displaced medially, and the sternocleidomastoid muscle and the carotid sheath are moved laterally. The anterior ascending approach is generally used for percutaneous nucleoplasty in the cervical spine (10).

Other methods, namely transoral (5-8), percutaneous anterolateral (4-11), and percutaneous submandibular approaches (12), have been described for C2 vertebroplasty. The transoral approach provides a direct access to the C2 region. However, there exists a risk of infection, including retropharyngeal abscess, meningitis, and encephalitis, because maintaining a sterile field with the transoral approach is often difficult (13,14). The anterolateral approach has a low infection rate; however, this approach is associated with a high incidence of complications (16.7%), including occipital neuralgia and cerebellar infarction (11). The percutaneous submandibular approach poses a high risk of damage to the great vessels and esophagus (4).

Prompt pain relief was achieved in 80% of the patients in our series. Vertebroplasty is a minimally invasive technique that yields immediate pain relief, bone strengthening, and vertebral stabilization (1,2). Radiotherapy is the standard palliative treatment for metastatic bone tumors, reducing pain within 10 – 14 days (15). However, radiotherapy could not be repeated for 4 patients with recurrent pain and a history of radiotherapy. Moreover, radiotherapy can result in delayed bone reconstruction, which increases the risk of vertebral collapse and neural compression (16).

Vertebroplasty for metastatic diseases is associated with a high incidence of cement leak. Cotten et al (16) observed complications of percutaneous vertebroplasty in 40 patients with osteolytic metastases and myeloma. Technical incidents or cement leaks were frequent, occurring in 29/40 (72.5%) patients. Despite possibly being asymptomatic, the cement leak rate was high (40%) in our patients. In our series, paravertebral leaks possibly occurred because of cortical osteolysis and paraspinal venous leakage in the metastatic vertebral body (Fig. 3). Another possible reason for cement leaks was a high filling volume of > 4 mL; therefore, we do not recommend exceeding a cement filling volume of 4 mL for C2 vertebroplasty.

Conclusion

Although different approaches exist, we prefer on anterior ascending approach for C2 percutaneous vertebroplasty. This approach is already familiar to surgeons performing anterior cervical discectomies, percutaneous nucleoplasty, or odontoid screw placement

surgeries. Using manual compression for displacing the larynx, trachea, and carotid artery can avoid injuries of the great vessels, trachea, and esophagus surrounding the C2 vertebra and provide a valuable alternative for pain relief.

Disclosure

The authors have no conflict of interest regarding any drugs, materials, or devices described in this study.

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