Case Report

Transpedicular Contrast-enhanced CT-guided biopsy of the body and dens of the axis avoiding the trans-oral approach: Technical report and literature review

ABSTRACT

This technical report illustrates the technique to perform computed tomography (CT)-guided bone biopsies in the body and dens of the axis (C2 vertebra) through a posterior transpedicular approach with the use of preoperative contrast-enhanced scans to highlight the course of the vertebral artery. The technique is presented through two exemplification cases: a pediatric patient with osteoblastoma and secondary aneurysmal bone cyst and one adult patient with melanoma metastasis. This case highlights the potential of the CT-guided posterolateral/transpedicular approach for performing safe and effective biopsies in the body and dens of C2, even in pediatric patients.

Keywords: Axis, bone neoplasm, cervical vertebra, image-guided biopsy, radiology, interventional, spiral computed, tomography, cancer metastasis, sarcoma

INTRODUCTION

Percutaneous bone biopsy is commonly used as an initial diagnostic tool for histopathological assessment of bone lesions, particularly neoplasms, and infections, in both the axial and appendicular skeleton.[1,2] Computed tomography (CT)-guided biopsy has been shown to be effective and safe for diagnosing spinal bone lesions and has a higher success rate than fluoroscopic-guided biopsy of the spine while being less invasive than open surgical biopsy.[3-5] Cervical spine biopsies, particularly those targeting the second cervical vertebra (C2), are often performed utilizing an anterior transoral approach due to its relative straightforwardness and fewer surrounding vital structures.[6-11] However, the anterior approach has its challenges, including potential damage to the oropharyngeal structures and a restricted working field, posing technical difficulties and complications. Furthermore, the surgical preparation in combination with general anesthesia, in which transoral biopsies are performed, could increase the complexity of the setting, in which they are performed.[12-14] Alternatively, the posterolateral transpedicular (or extrapedicular lateral) approaches are described as methods to approach C2, with very few literature reports, especially for the access of the dens and body.[12,15,16] Although the posterolateral transpedicular approach could be more technically challenging, it has the advantages of requiring less preparation and just patient sedation, in addition to being performed in a simpler setting.[17,18] These

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factors make the posterolateral approach a viable alternative to the transoral approach for some patients.[17-19] Ultimately, the decision regarding which approach to use should be informed by consultation with an interdisciplinary team, taking into account the specific clinical situation.[20-22]

CASE REPORTS

Case 1

An 8-year-old boy was brought to our emergency department, experiencing neck pain and presenting a noticeable mass in the upper cervical region. An X-ray of the neck was performed, which revealed a radiolucent lytic lesion affecting the vertebral body of C2. Therefore, a CT of the neck was performed on the same day, demonstrating an extensive lytic and expanding lesion affecting the body, the odontoid process, and the lamina of C2. A CT-guided needle bone biopsy was therefore scheduled for the next few days.

For the procedure, a posterolateral approach was deemed the most appropriate for this patient. The procedure was performed under deep sedation with spontaneous breathing with the patient in the right lateral decubitus on the CT bed. Then, a contrast-enhanced CT scan was performed to better visualize the anatomy of the cervical arteries and the surrounding structures, such as the spinal cord and vertebral artery. In this case, there was an aberrant path of the vertebral artery due to the expanding cortex of C2 [Figure 1].

A 12G needle with the Bonopty Insertion Set (AprioMed, Uppsala, Sweden) was used during the procedure. Under CT guidance, the insertion point was marked on the skin, and a sequential scan was used to guide the needle insertion using the coaxial technique.

The bone access was performed on the left lateral lamina of C2, under the path of the extraforaminal tract of the vertebral artery that was previously highlighted by the contrast CT. The tip of the needle was guided with a craniocaudal trajectory through the body of the axis and inside the dens, reaching the target and obtaining two samples through the coaxial system, one sample from the body and one sample from the dens [Figure 2]. During the procedure, a low-dose scan was used to minimize patient radiation exposure.

After the biopsy was completed, a final CT scan was taken to check for any immediate complications like local hematomas.

The biopsy was technically successful, and the histopathological report diagnosed an aneurysmal bone cyst with some multinucleate giant cells, therefore excluding malignancy. The final histological diagnosis was osteoblastoma with a wide area of aneurysmal bone cyst-like changes.

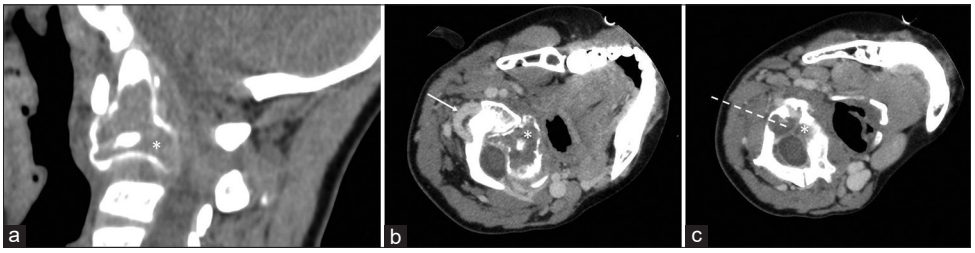

Figure 1: (a) A sagittal view of a computed tomography (CT) scan showing a lytic and expanding lesion within the body of the C2 vertebra. Noticeable thinning of the cortical bone is clearly visible. (b) An axial view of a contrast-enhanced CT scan, highlighting the course of the vertebral artery (arrow). Additionally, the scan shows the lytic lesion within the C2 vertebra (asterisk). (c) The planned path of the needle for biopsy is delineated by a dotted line. This shows the proposed trajectory for biopsy, carefully planned to avoid damage to the vertebral artery and other crucial structures

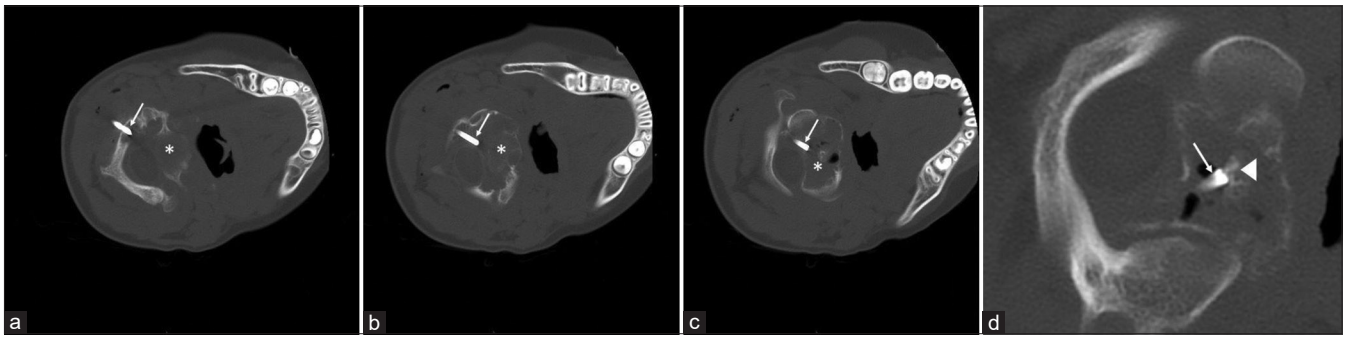

Figure 2: (a) The initial positioning of the needle (arrow) at the onset of the procedure, (b and c) the mid-procedure progress, capturing the needle (arrow) en route to its target, and (d) the successful positioning of the needle (arrow) within the target lesion, the apex of the odontoid process (arrowhead)

Case 2

A 59-year-old male patient presented to the emergency department for worsening laterocervical paresthesia over the last 3 months. A CT of the neck was performed, revealing a predominantly lytic alteration in the body of C2. A CT-guided needle bone biopsy was therefore scheduled for the next few days.

Furthermore, in this case, a posterolateral approach was deemed the most appropriate. Like the first case, the biopsy was performed under sedation with spontaneous breathing, this time with the patient in the prone on the CT bed. A contrast-enhanced CT scan was performed to visualize the course of the vertebral artery. In this case, the vertebral artery was compressed and slightly dislodged by the tumor, which invades the vertebral foramen [Figure 3].

Using the same technique, the bone access was performed on the right lateral lamina of C2, under the path of the extraforaminal tract of the vertebral artery that was previously highlighted by the contrast CT. The tip of the needle was positioned in the body of C2, reaching the target and obtaining two samples through the coaxial system [Figure 4].

After the biopsy was completed, a final CT scan was taken to check for any immediate complications like local hematomas.

The biopsy was technically successful, and the histopathological report diagnosed a metastasis from melanoma.

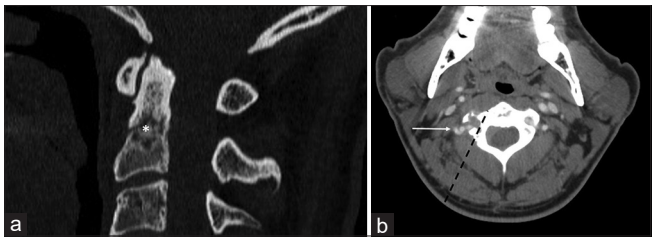

Figure 3: (a) A sagittal view of a computed tomography (CT) scan showing a lytic lesion within the body of the axis (asterisk). (b) An axial view of a contrast-enhanced CT scan, highlighting the course of the vertebral artery (arrow), which appears to be compressed and dislocated by the tumor which invades the foramen of the vertebral artery

DISCUSSION

In this technical report, we have described two cases of patients who underwent percutaneous CT-guided bone biopsy of the C2 vertebra with a transpedicular (posterolateral) needle approach. Biopsies of the body and dens of the C2 vertebra are typically performed using the anterior transoral approach,[16] and very few literature is available regarding the posterolateral approach, especially when accessing the dens of C2 is required [main studies reporting percutaneous needle access of C2 are summarized in [Table 1]. Other feasible approaches are the anterolateral, the lateral, and the posterolateral.[15,20]

The procedures described were performed under sedation and spontaneous breathing, as opposed to the general anesthesia often required for the anterior approach.[6,13] This conferred the added benefit of making the procedure less complex as general anesthesia and an extensive surgical setup are not necessary with the posterior approach; this choice helped reduce potential procedural risks and shorten the operative time.

The use of contrast media was pivotal in successfully and safely executing this procedure since, in the reported cases, the vertebral artery was very close to the lesion and followed an aberrant path due to bone alteration.

In conclusion, merging our experience with literature data, we believe that the posterior approach for biopsy of C2 can be a viable, and in some cases preferable, alternative to the conventional anterior approach. By being less invasive, requiring less complex preparation, and presenting a lower risk of oropharyngeal damage, it offers a safe and effective way of diagnosing and assessing lesions in the C2 vertebra. Nevertheless, each patient's specific clinical situation and individual characteristics should inform the choice of approach, ensuring the most suitable method is utilized for each case. Further studies are needed to better understand the indications and contraindications of the posterior approach in different patient populations.

Figure 4: (a) Contrasted enhanced axial pre-procedural CT showing the compression of the right vertebral artery by neoplastic tissue (asterisk). (b) the needle's progress halfway through the procedure asit moves toward its intended target, and (c) the needle successfully reaching and being positioned within the target lesion (arrow).

Table 1: Main studies reporting percutaneous needle access of C2, transoral

First author, year	Reference	Patients number	Type of procedure	Guiding technique	Approach	Anesthesia
Sun *et al*., 2010	[19]	10	Vertebroplasty	CT	Anterolateral (9), posterolaterl (1)	Sedation
Anselmetti *et al*., 2012	[8]	25	Vertebroplasty	Fluoroscopy/CT	Anterior, TO	General
Guo *et al*., 2012	[23]	9	Vertebroplasty	CT	Lateral	Sedation
Kaminsky *et al*., 2013	[6]	1	Vertebroplasty	Fluoroscopy	Anterior, TO	General
Cohen *et al*., 2013	[10]	15	Vertebroplasty	Fluoroscopy	Anterior oblique transdiscal	General
Sun *et al*., 2013	[11]	13	Vertebroplasty	Fluoroscopy	Anterolateral	Sedation
Wiesner *et al*., 2018	[20]	7	Biopsy	CT	Posterolateral	Sedation
Moulin *et al*., 2021	[9]	1	Vertebroplasty	CT	Anterior, TO	General
D'Ortenzio *et al*., 2021	[13]	1	Biopsy	CT	Anterior, TO	General
Haas *et al*., 2021	[18]	1	Biopsy	CT	Posterolateral	General
Shamhoot *et al*., 2022	[7]	9	Vertebroplasty	Fluoroscopy	Anterior, TO	General
Tarabay *et al*., 2022	[17]	1	Vertebroplasty	CT	Lateral	Sedation
Spinnato *et al*., 2022	[15]	7	Biopsy	CT	Posterolateral	Sedation

CT - Computed tomography; TO - Transoral

Author contributions

Conceptualization, N. P., P. S.; methodology, G. F, F. P. and P. S.; investigation, L. G. S, and N. P; data curation, N. P., and M. M; writing-original draft preparation, N. P., P. S., L. G. S., F. P.; writing-review and editing, N. P., P. S. and G. P.; visualization, G. F., P. S and F. P.; supervision, G. F., P. S.; project administration, P. S. All authors have read and agreed to the published version of the manuscript.

Declaration of patient consent

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

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Rimondi E, Staals EL, Errani C, Bianchi G, Casadei R, Alberghini M, *et al.* Percutaneous CT-guided biopsy of the spine: Results of 430 biopsies. Eur Spine J 2008;17:975-81.
2. Müller R, Hildebrand T, Rüegsegger P. Non-invasive bone biopsy: A new method to analyse and display the three-dimensional structure of trabecular bone. Phys Med Biol 1994;39:145-64.
3. Leffler SG, Chew FS. CT-guided percutaneous biopsy of sclerotic bone lesions: Diagnostic yield and accuracy. AJR Am J Roentgenol 1999;172:1389-92.
4. Michalopoulos GD, Yolcu YU, Ghaith AK, Alvi MA, Carr CM, Bydon M. Diagnostic yield, accuracy, and complication rate of CT-guided biopsy for spinal lesions: A systematic review and meta-analysis. J Neurointerv Surg 2021;13:841-7.
5. Gul SB, Polat AV, Bekci T, Selcuk MB. Accuracy of percutaneous CT-guided spine biopsy and determinants of biopsy success. J Belg Soc Radiol 2016;100:62.
6. Kaminsky IA, Härtl R, Sigounas D, Mlot S, Patsalides A. Transoral C2 biopsy and vertebroplasty. Interv Med Appl Sci 2013;5:76-80.
7. Shamhoot IA, Rezk EM, Elkholy AR. Transoral vertebroplasty for the treatment of C2 painful metastatic lesions; evaluation and outcome. Clin Neurol Neurosurg 2022;221:107410.
8. Anselmetti GC, Manca A, Montemurro F, Tutton S, Chiara G, Battistella M, *et al*. Vertebroplasty using transoral approach in painful malignant involvement of the second cervical vertebra (C2): A single-institution series of 25 patients. Pain Physician 2012;15:35-42.
9. Moulin B, Brisse H, Dutertre G, Brenet O, Queinnec M, Cottu P, *et al*. CT-guided vertebroplasty of first (C1) or second (C2) cervical vertebra using an electromagnetic navigation system and a transoral approach. Diagn Interv Imaging 2021;102:571-5.
10. Cohen M, Zeitoun D, Blanpain S, Brochard C, Lellouche J, Deramond H. Percutaneous vertebroplasty of the C2 body and dens using the anterior oblique ascending transdiscal approach. J Neuroradiol 2013;40:211-5.
11. Sun G, Wang LJ, Jin P, Liu XW, Li M. Vertebroplasty for treatment of osteolytic metastases at C2 using an anterolateral approach. Pain Physician 2013;16:E427-34.
12. Shriver MF, Kshettry VR, Sindwani R, Woodard T, Benzel EC, Recinos PF. Transoral and transnasal odontoidectomy complications: A systematic review and meta-analysis. Clin Neurol Neurosurg 2016;148:121-9.
13. D'Ortenzio R, Tolhurst S, Harvey M, Ghag R, Heran MK. The CT guided transoral approach: A biopsy technique for a poorly differentiated chordoma in a 5 year old. J Radiol Case Rep 2021;15:1-8.
14. Katzir M, Hoang N, Bourekas E, Carrau R, Mendel E. Stereotactic CT image guidance and biplanar fluoroscopy for transoral C2 vertebroplasty and direct anterolateral subaxial vertebroplasty: A surgical technique note on access to the axial and subaxial spine. Acta Neurochir (Wien) 2020;162:2533-6.
15. Spinnato P, Rimondi E, Facchini G. Percutaneous CT-Guided biopsy of the craniovertebral junction: Safety, diagnostic yield, and technical notes. Diagnostics (Basel) 2022;12:168.
16. Reddy AS, Dinobile D, Orgeta JE, Peri N. Transoral approach to CT-guided C2 interventions. Pain Physician 2009;12:253-8.
17. Tarabay B, Freire V, Yuh SJ, Gennari A, Shedid D, Boubez G, *et al.* CT guided percutaneous vertebroplasty of C2 osteolytic lesion: A case report and technical note. J Spine Surg 2022;8:70-5.

18. Haas P, Hauser TK, Kandilaris K, Schenk S, Tatagiba M, Adib SD. Posterolateral epidural supra-C2-root approach (PESCA) for biopsy of lesions of the odontoid process in same sitting after occipitocervical fixation and decompression-perioperative management and how to avoid vertebral artery injury. Neurosurg Rev 2021;44:2947-56.
19. Sun G, Jin P, Li M, Liu X, Li F, Yu AK, *et al.* Percutaneous vertebroplasty for treatment of osteolytic metastases of the C2 vertebral body using anterolateral and posterolateral approach. Technol Cancer Res Treat 2010;9:417-22.
20. Wiesner EL, Hillen TJ, Long J, Jennings JW. Percutaneous CT-Guided biopsies of the cervical spine: Technique, histopathologic and microbiologic yield, and safety at a single academic institution. AJNR Am J Neuroradiol 2018;39:981-5.
21. Saifuddin A, Palloni V, du Preez H, Junaid SE. Review article: The current status of CT-guided needle biopsy of the spine. Skeletal Radiol 2021;50:281-99.
22. Feroz I, Makhdoomi RH, Khursheed N, Shaheen F, Shah P. Utility of computed tomography-guided biopsy in evaluation of metastatic spinal lesions. Asian J Neurosurg 2018;13:577-84.
23. Guo WH, Meng MB, You X, Luo Y, Li J, Qiu M, *et al.* CT-guided percutaneous vertebroplasty of the upper cervical spine via a translateral approach. Pain Physician 2012;15:E733-41.