European Spine Journal
https://doi.org/10.1007/s00586-018-5466-7

GRAND ROUNDS

Posterolateral cervical transpedicular corpectomy for the surgical management of metastatic tumor

Martin H. Pham[1] · Joshua Bakhsheshian[1]

Received: 8 August 2017 / Revised: 25 December 2017 / Accepted: 3 January 2018

Abstract

Management of metastatic spinal disease in the upper cervical spine can be particularly challenging. Depending on the level of the lesion and the patient's anatomy, multiple anterior approaches have been described for resection of the cancer, followed by posterior fixation and instrumentation. Although a single-stage posterolateral approach is now well established for thoracic pathology, less is known about the applicability of these principles when applied as an approach to the cervical spine. The authors present here a case using a posterolateral transpedicular approach for corpectomy and graft placement for circumferential reconstruction as a treatment of metastatic disease in the cervical spine to illustrate the feasibility of this technique, especially in the setting where the patient's anatomy or pathology may impede an anterior or combined circumferential approach.

Keywords Malignant spine tumor · Metastatic tumor · Transpedicular corpectomy · Cervical spine

Case presentation

A 73-year-old woman was brought to the LAC + USC Medical Center by her family with complaints of waxing and waning confusion. She had a history of triple-negative breast cancer treated with mastectomy, chemotherapy, and radiation therapy 20 years ago. Although a urinary tract infection was deemed to be the etiology of her altered mental status, computed tomography (CT) imaging demonstrated widely metastatic breast Ca to her lungs, chest wall, and both axial and appendicular skeleton. Her neurologic examination on neurosurgical evaluation was full strength with a Frankel grade of E, although she did exhibit bilateral Hoffman's, sustained clonus, and hyperreflexia.

✉ Martin H. Pham
martinpham@gmail.com

[1] Department of Neurosurgery, Keck School of Medicine, LAC + USC Medical Center, University of Southern California, 1200 North State Street, Suite 3300, Los Angeles, CA 90089, USA

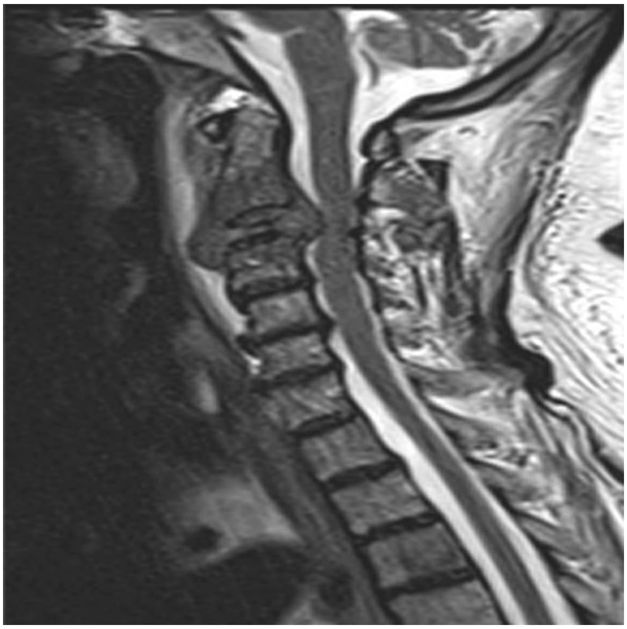

Fig. 1 Sagittal T2-weighted magnetic resonance imaging demonstrating a C3 lesion causing pathologic collapse and ventral cord compression

Diagnostic imaging

Further evaluation of the neuroaxis with magnetic resonance imaging (MRI) demonstrated a single epidural compressive lesion centered at C3 (Fig. 1). CT angiography (CTA) demonstrated a patent and dominant left vertebral artery, but her right vertebral artery appeared to be narrowed due to tumor compression.

Historical review

Metastatic spread of cancer to the spinal column is a frequent manifestation of systemic disease and occurs in up to 70% of cancer patients [1]. Up to 10% of patients will become symptomatic from these lesions [2]. When these occur in the cervical spine, spinal cord compression caused by the metastatic lesion is a common cause of pain, loss of mobility, and neurologic deficit [3]. Treatment of these metastatic tumors is usually multimodal and includes chemotherapy, radiation, and surgery.

Management of metastatic spinal disease is extremely challenging due to the wide range of neurological and biomechanical effects caused by the tumor burden. Surgical approach is oftentimes dictated after taking into account many aspects of the disease which will include tumor location, tumor biology, bone quality, surrounding anatomy, medical condition, and any previous treatments that the patient has already undergone [3, 5, 6, 12].

Surgical decompression and resection of metastatic cancer in the cervical spine is typically approached anteriorly as many of these lesions arise from the ventrally located vertebral body [3–6]. There are certain instances, however, where an anterior approach may be difficult. These may include a history of previous radiation where tracheal and esophageal retraction would be difficult, poor medical condition that would preclude a circumferential approach, failed posterior instrumentation requiring revision, kyphosis and instability requiring long-segment fusion, or high (C1–2) and low (cervicothoracic) lesions that would make an anterior surgical corridor particularly challenging [5, 7, 8].

Anterior approaches to the upper cervical spine at C1–2 include the transoral, transcervical retropharyngeal, and transmandibular approach. These exposures tend to be deep and narrow and carry risks of dysphagia, aspiration, and infection with oral flora, the last of which would be significant in a cancer patient undergoing chemoradiation [3, 5, 7, 13]. Exposure of the C2–3 disc space also remains challenging due to its location behind the mandible. Although the standard Smith–Robinson approach has been used to access this location with some satisfying results [14–18], this surgical corridor may be problematic for patients with short muscular necks or those large mandibles with chins extending over the C2–3 disc [14, 15]. A submandibular approach has also been described which requires a detailed appreciation of the neurovascular structures in this region [19].

Single-stage posterolateral approaches have been well described for metastatic cancer in the thoracic spine to avoid the morbidities associated with transthoracic resection [9–11]. The posterior transpedicular corpectomy approach for malignant tumors in the cervical spine has previously been described by both Ames et al. and Eleraky et al. (Table 1) [3, 11]. Ames et al. reported on three cases of metastatic cancer to the C2 vertebral body, all of which were resected posteriorly and reconstructed with Steinmann pin and methyl methacrylate fixation from the C1 lateral mass to the C3 endplate bilaterally [11]. Eleraky et al. subsequently described this technique in eight cases of malignant tumors that involved C2 (5 patients), C3 (1 patient), C5 (1 patient), and C7 (1 patient) [3]. Although follow-up is limited, the patients in both studies did well in the immediate perioperative period. Limitations do exist with this technique and include a limited reported experience and limited long-term follow-up. Nevertheless, this approach avoids any of the morbidities associated with complex anterior exposures and provides both circumferential decompression and immediate fixation and stability in a single-stage operation.

Table 1 Studies describing a single-stage posterolateral transpedicular approach for cervical corpectomy and graft placement

Author	Age	Sex	Level	Pathology	Posterior fusion	Anterior reconstruction	Preop Frankel	Postop Frankel
Ames et al. [11]	59	M	C2	Colon	Occiput–T1	Steinmann pins, methyl methacrylate	Intact	Intact
	63	F	C2	Renal	C1–6	Steinmann pins, methyl methacrylate	Intact	Intact
	43	F	C2	Breast	Occiput–T5	Steinmann pins, methyl methacrylate	Intact	Intact
Eleraky et al. [10]	57	M	C2	Melanoma	C1–4	None	E	Intact
	63	F	C2	Renal	C1–6	Steinmann pins, methyl methacrylate	E	Intact
	59	M	C2	Colon	Occiput–T1	Steinmann pins, methyl methacrylate	E	Intact
	65	F	C2	Lung	C1–4	None	D	E
	59	M	C2	Chordoma	Occiput–C5	Harms cage	C	D
	71	M	C3	Colon	C1–7	Harms cage	E	E
	59	M	C5, T1	Melanoma	C2–T2	Steinmann pins, methyl methacrylate	D	E
	62	M	C7	Neuroendocrine	C2–T6	Steinmann pins, methyl methacrylate	C	D
Current study	73	F	C3	Breast	C1–6	Fibular strut graft	E	E

Rationale for treatment

Because our patient possessed a short neck with a large mandible that obscured the C2–3 disc space even in extension, we opted to proceed posteriorly at C3 with an adaptation of the familiar posterolateral transpedicular approach to the thoracic spine. Pathology at the C2 or C3 vertebral bodies are amenable for resection from this posterior approach, since the C2 and C3 nerve roots can be sacrificed without motor function loss and the more laterally positioned vertebral artery allows for a feasible working channel for corpectomy and graft placement [3]. The spinal cord also occupies a lower proportion of volume within the dural sac and so the risks of spinal cord injury are lower as compared to exposures in the subaxial cervical or thoracic spine. We therefore proceeded with a single-stage posterior-only approach for a posterolateral transpedicular C3 corpectomy with graft placement and a C1–C6 posterior spinal fusion.

Surgical technique, procedure imaging

After the posterior cervical exposure in the usual fashion, posterior instrumentation was placed from C1 to C6 with bilateral C2 nerve root sacrifice for improved visualization of the C1–2 joint for C1 screws. A wide laminectomy was performed from C2 to C4. A right-sided C2–3 facetectomy was also completed. The right-sided C3 nerve root was sacrificed and the C3 lateral mass was removed with a high-speed drill just medial to the transverse foramen (Fig. 2). Preoperative

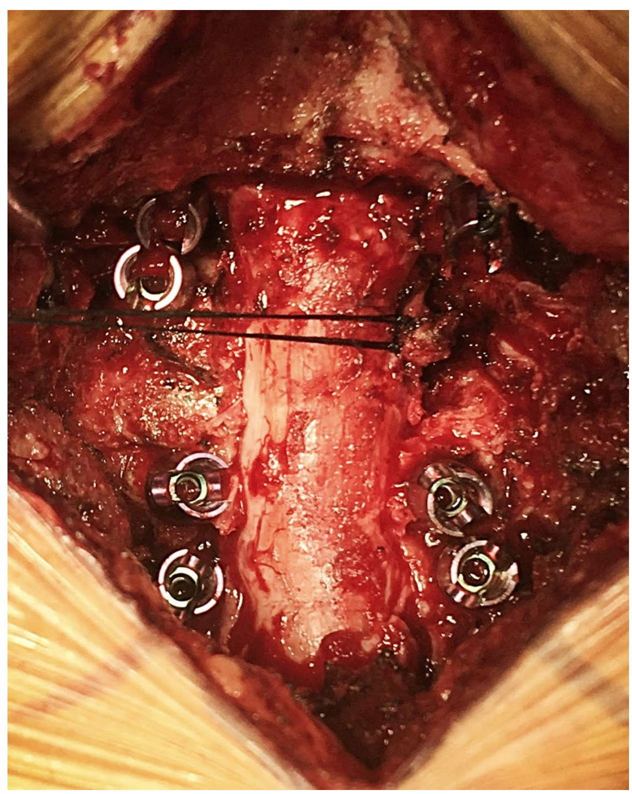

Fig. 2 Intraoperative view showing decompression of the spinal cord from C2 to C6. The right-sided C3 nerve root was ligated and a silk tie placed for gentle retraction contralaterally. The right-sided lateral mass was removed

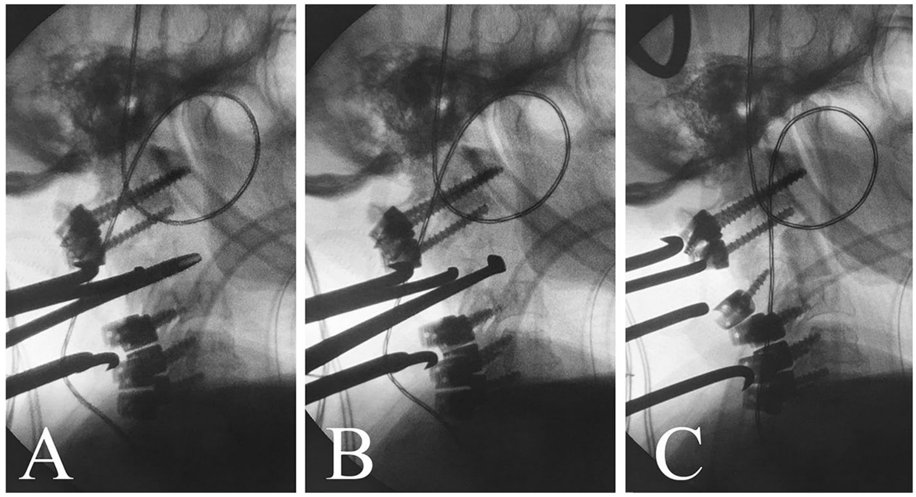

Fig. 3 Intraoperative lateral fluoroscopy views showing the various steps of the posterolateral corpectomy. **a** A pituitary rongeur was used for removal of the tumor-invaded vertebral body. **b** A Woodson Elevator was used to push the posterior longitudinal ligament away from the ventral dura to complete the circumferential decompression. **c** A fibular strut graft was placed within the corpectomy cavity for anterior column reconstruction

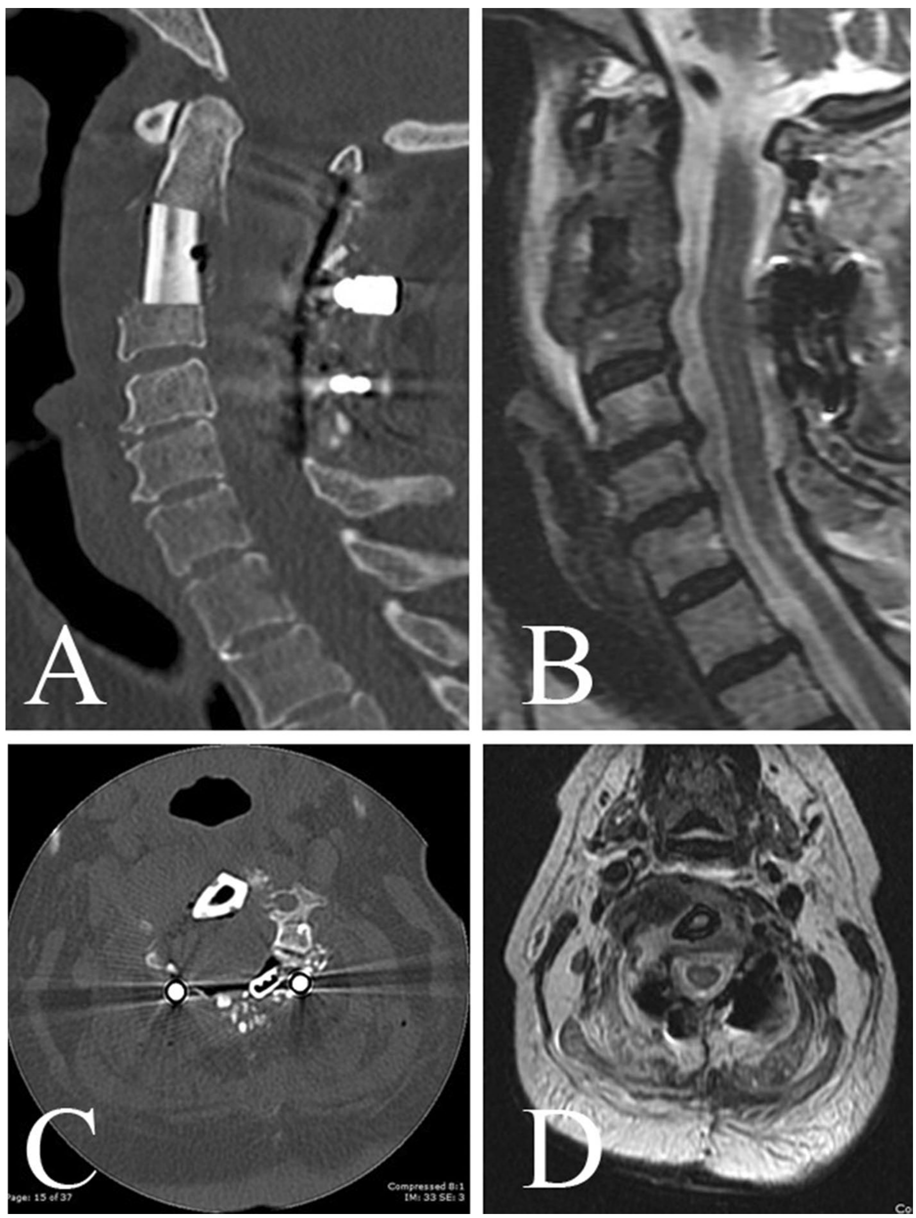

Fig. 4 Postoperative computed tomography in sagittal (**a**) and axial (**c**) cross sections as well as magnetic resonance imaging in sagittal (**b**) and axial (**d**) cross sections showing appropriate graft placement as well as circumferential spinal cord decompression, respectively

evaluation of the position of the right-sided vertebral artery on CTA in relation to the lateral mass bony anatomy assisted in its identification and subsequent gentle retraction, as well as a realistic expectation of the available surgical corridor to perform the corpectomy. The fact that it was surrounded by soft tumor also facilitated skeletonization. The pedicle was identified at this point for the posterolateral surgical corridor into the vertebral body. The soft tumor was subsequently removed with a combination of pituitary rongeur, high-speed drill, and curettes (Fig. 3). The ventral dura was carefully dissected away from the posterior vertebral body wall and a downgoing curette was used to tamp away the ventrally compressive tumor into the vertebral body cavity for further removal, completing the circumferential decompression. Anterior reconstruction was then performed using structural fibula strut allograft that was cut to size. Closure then proceeded in the usual fashion with irrigation, bone grafting, and a multilayer reapproximation of tissues. Neurophysiologic monitoring using somatosensory evoked potentials (SSEP) and motor evoked potentials (MEP) had been used throughout the case and were stable throughout its entirety as compared to a supine preflip baseline. Total operating time from skin incision to skin closure was 5 h and 26 min, of which approximately 1.5 h was needed to perform the circumferential decompression and corpectomy and 1 h was used to size and appropriately seat the fibular strut graft under fluoroscopic guidance. The estimated blood loss was 450 cc. There were no complications intraoperatively and no neurologic or vascular injuries.

Anterior column reconstruction in our patient was accomplished through the use of a tricortical fibular strut allograft. This graft material was chosen over a Harms cage or Steinmann pins and methyl methacrylate due to surgical corridor limitations and equipment availability. Although titanium mesh and Steinmann pins with methyl methacrylate are used commonly for anterior reconstruction in metastatic spinal disease, structural allograft remains a popular and effective option based on a recent systematic review and published consensus expert opinion [2].

Outcome

A postoperative CT and MRI demonstrated appropriate positioning of the graft and hardware as well as circumferential decompression of the spinal cord at that level (Fig. 4). The patient remained a Frankel grade E and was tolerating an oral diet and ambulating well on postoperative day 1. Her hospital course was uneventful and she was eventually discharged back home on postoperative day 5. There were no complications during this postoperative period.

During her outpatient visit with her oncologist 2 weeks later, she elected to pursue home hospice treatment for comfort care measures only without any further treatment to her systemic disease. She entered her home hospice program 18 days after surgery and subsequently died sometime after.

Compliance with ethical standards

Conflict of interest There were no conflicts of interest or sources of funding for this work.

References

1. Jacobs WB, Perrin RG (2001) Evaluation and treatment of spinal metastases: an overview. Neurosurg Focus 11:e10
2. Altaf F, Weber M, Dea N, Boriani S, Ames C, Williams R et al (2016) An evidence-based review and survey of expert opinion of reconstruction of metastatic spine tumors. Spine (Phila Pa 1976) 41:254–261. https://doi.org/10.1097/brs.0000000000001819
3. Eleraky M, Setzer M, Vrionis FD (2010) Posterior transpedicular corpectomy for malignant cervical spine tumors. Eur Spine J 19:257–262. https://doi.org/10.1007/s00586-009-1185-4
4. Cusick JF, Yoganandan N, Pintar F, Myklebust J, Hussain H (1988) Biomechanics of cervical spine facetectomy and fixation techniques. Spine (Phila Pa 1976) 13:808–812. https://doi.org/10.1097/00007632-198807000-00017
5. Cahill DW, Kumar R (1999) Palliative subtotal vertebrectomy with anterior and posterior reconstruction via a single posterior approach. J Neurosurg 90:42–47
6. Bilsky MH, Boland P, Lis E, Raizer JJ, Healey JH (2000) Single-stage posterolateral transpedicle approach for spondylectomy, epidural decompression, and circumferential fusion of spinal metastases. Spine (Phila Pa 1976) 25:2240–2249. https://doi.org/10.1097/00007632-200009010-00016 **(discussion 250)**
7. Vrionis FD, Small J (2003) Surgical management of metastatic spinal neoplasms. Neurosurg Focus 15:E12. https://doi.org/10.3171/foc.2003.15.5.12
8. Loblaw DA, Perry J, Chambers A, Laperriere NJ (2005) Systematic review of the diagnosis and management of malignant extradural spinal cord compression: the cancer care Ontario practice guidelines initiative's neuro-oncology disease site group. J Clin Oncol 23:2028–2037. https://doi.org/10.1200/JCO.2005.00.067
9. Shen FH, Marks I, Shaffrey C, Ouellet J, Arlet V (2008) The use of an expandable cage for corpectomy reconstruction of vertebral body tumors through a posterior extracavitary approach: a multicenter consecutive case series of prospectively followed patients. Spine J 8:329–339. https://doi.org/10.1016/j.spinee.2007.05.002
10. Gokaslan ZL, York JE, Walsh GL, McCutcheon IE, Lang FF, Putnam JB et al (1998) Transthoracic vertebrectomy for metastatic spinal tumors. J Neurosurg 89:599–609. https://doi.org/10.3171/jns.1998.89.4.0599
11. Ames CP, Wang VY, Deviren V, Vrionis FD (2009) Posterior transpedicular corpectomy and reconstruction of the axial vertebra for metastatic tumor. J Neurosurg Spine 10:111–116. https://doi.org/10.3171/2008.11.SPI08445
12. Tuzun Y, Izci Y, Sengul G, Erdogan F, Suma S (2005) Neurenteric cyst of the upper cervical spine: excision via posterior approach. Pediatr Neurosurg 42:54–56. https://doi.org/10.1159/000089511
13. Acosta FL, Aryan HE, Chi J, Parsa AT, Ames CP (2007) Modified paramedian transpedicular approach and spinal reconstruction for intradural tumors of the cervical and cervicothoracic spine:

clinical experience. Spine (Phila Pa 1976) 32:E203–E210. https://doi.org/10.1097/01.brs.0000257567.91176.76
14. Ying Z, Wen Y, Xinwei W, Yong T, Hongyu L, Zhu H et al (2008) Anterior cervical discectomy and fusion for unstable traumatic spondylolisthesis of the axis. Spine (Phila Pa 1976) 33:255–258. https://doi.org/10.1097/brs.0b013e31816233d0
15. Wilson AJ, Marshall RW, Ewart M (1999) Transoral fusion with internal fixation in a displaced hangman's fracture. Spine (Phila Pa 1976) 24:295–298. https://doi.org/10.1097/00007632-199902010-00022
16. Smith G, Robinson R (1958) The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. J Bone Jt Surg Am 40:607–624
17. Robinson R, Smith G (1955) Anterolateral cervical disk removal and interbody fusion for cervical disk syndrome. Bull Johns Hopkins Hosp 96:223–224
18. Zhang Y, Zhang J, Wang X, Chen D, Yuan W (2013) Application of the cervical subaxial anterior approach at C2 in select patients. Orthopedics 36:e554–e560. https://doi.org/10.3928/01477447-20130426-15
19. Russo A, Albanese E, Quiroga M, Ulm AJ (2009) Submandibular approach to the C2–3 disc level: microsurgical anatomy with clinical application. J Neurosurg Spine 10:380–389. https://doi.org/10.3171/2008.12.SPINE08281