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Case Report

Percutaneous n-butyl cyanoacrylate embolization of cervical metastatic disease via an anterolateral approach ☆

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ABSTRACT

Symptomatic vascular spinal metastases will benefit from pre-operative tumor embolization – percutaneous with or without adjunct endovascular embolization. However, when a transpedicular approach is not feasible, an anterolateral approach may be a viable alternative. The authors report a 57-year-old woman with prior C3-T1 instrumentation who presented with acute cord compression from a pathologic C5 vertebral body fracture related to metastatic renal cell carcinoma. The patient underwent CT-guided direct tumor embolization with 33% n-butyl-2-cyanoacrylate via an anterolateral approach, followed by C5-corpectomy and anterior cervical C4-C6 fusion and plating with minimal blood loss (est. 20 cc) and a stable neurological exam post-operatively. In patients with highly vascular cervical metastatic disease who lack a viable transpedicular approach for preoperative tumor embolization, a CT-guided anterolateral approach is a viable alternative.

Introduction

Trans-arterial embolization of vertebral body tumors is often limited by ill-defined arterial supply, and comes with the risk of spinal cord ischemia [1]. Alternatively, direct tumor embolization offers greater local control over tumoral devascularization. Embolic agents vary, with a 2016 meta-analysis of preoperative embolization of spinal tumors, showing that particulate embolic agents, including polyvinyl alcohol and gelatin products were most commonly used, followed by liquid embolics such as Onyx and n-butyl-2-cyanoacrylate (n-BCA) [2]. While Onyx is frequently the preferred embolic agent in numerous cases, n-BCA offers its own advantages. Tissue embolized with n-BCA has been described as mimicking "rubber glue" allowing for easier resection following embolization [2]. Embolic agents are typically delivered to the involved vertebral body via a transpedicular approach

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as it allows for a shorter needle tract, with the junction of the transverse and mamillary processes guiding the needle tip towards the pedicle, perpendicular to the cortex of the bone, minimizing slippage [3]. However, the width of cervical pedicles and their proximity to the vertebral arteries has encouraged an anterolateral approach for cervical vertebroplasty/kyphoplasty for osteolytic vertebral metastases [4]. This change in approach, while not novel, brings unique challenges when adapted for n-BCA embolization. In addition, an anterolateral approach has been well-described for cervical disc decompression [5] and bone biopsy [6,7]. However, an anterolateral approach for direct percutaneous n-BCA embolization of cervical body metastatic disease has not been well described.

Renal cell carcinoma (RCC) makes up 2.2% of worldwide cancer incidence with ~2% annual mortality for all cancer types [8]. Up to 50% of patients with RCC present with locally advanced or metastatic disease, with ~30% developing bony metastases which are typically osteolytic resulting in pathologic fractures and spinal cord compression [9–12]. Surgical interventions carry an increased risk of intraoperative bleeding due to the highly vascularized nature of these tumors, making preoperative embolization vital for safe and effective debulking [13]. In this context, the choice of an embolic agent becomes crucial. Here we present the case of a patient with metastatic RCC causing a symptomatic C5 vertebral body fracture who underwent direct n-BCA tumor embolization via a percutaneous anterolateral approach. We discuss the technical considerations of this approach and the keys to avoiding complications under CT guidance. Though, the anterolateral approach comes with the risk of injury to the submandibular gland, carotid space (carotid artery, jugular vein, cranial nerves IX, X, X1), oropharynx and the vertebral arteries [4], it may be the only viable embolization approach in patients like ours.

Case report

A 57-year-old woman with a known history of metastatic renal cell carcinoma presented with a pathologic fracture of C5 vertebrae and underwent C3-T1 segmental fusion for stabilization. Postoperatively, her early course was uncomplicated. However, she presented 2-weeks later with progressive left greater than right upper extremity weakness with follow-up imaging showing expansion of the metastatic lesion with ventral compression of the thecal sac (Figs. 1A and B). Tumor debulking was planned; however, given the highly vascular nature of the lesion preoperative embolization was planned. The patient's prior instrumentation eliminated the standard transpedicular approach. A comprehensive discussion took place with the patient, emphasizing the risks of this approach, specifically carotid artery injury and esophageal injury, were weighed against the potential benefit of minimizing intraoperative blood-loss and were discussed with the patient.

Transfemoral cerebral angiography was performed using a 5F *Vert* diagnostic catheter revealing a co-dominant vertebrobasilar circulation. Both vertebral arteries had arterial feeders to the tumor (Figs. 1C and D), with the left vertebral artery demonstrating more robustly parasitized branches. Trans-arterial embolization was deferred due to high-risk of intracranial embolization *in-lieu* for direct percutaneous access via the left anterior triangle. A preprocedural CT angiogram of the head and neck was used to delineate our anticipated needle trajectory (Fig. 2A, *arrow*), passing anterosuperior to the left carotid sheath and postero-inferior to the esophagus and the left submandibular gland. Under intermittent CT-guidance, a 21-gauge Quincke-tip spinal needle (Fig. 2A, *orange-arrow*) was now advanced into the C5-vertebral body and the tumor bed. We then performed a "parenchymogram" to confirm an intra-tumoral and extra-vascular needle-tip positioning, as well as, to examine the venous outflow (Fig. 3A).

Despite being postcapillary, a powerful contrast injection can flow retrograde into the feeding arteries (eg, left vertebral artery opacification, arrowhead in Fig. 3A). Having gauged the manual pressure applied during contrast injection resulting in opacification of the left vertebral artery, we cautiously proceeded to embolize at a slower rate. The needle was flushed with D50 and then 33% n-BCA was injected using the same 3-cc syringe used to perform the parenchymogram (Fig. 3B). The above steps were repeated until adequate tumoral oblit-

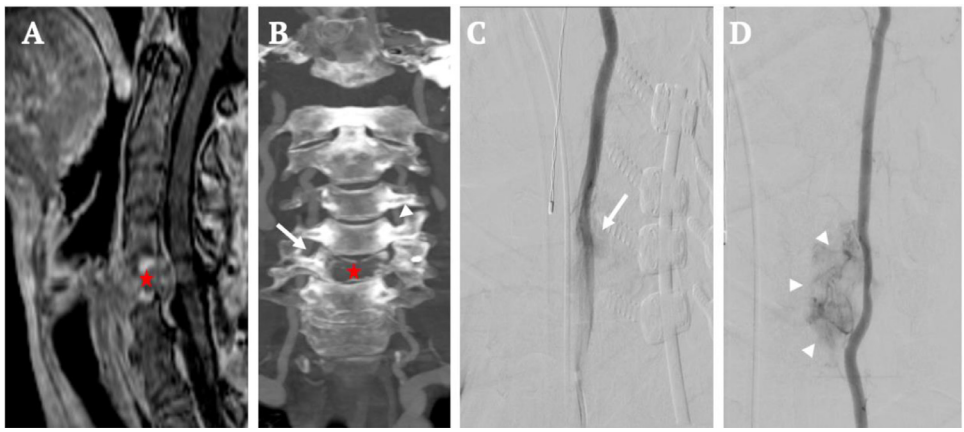

Fig. 1 – (A) MR imaging of the C5 metastatic lesion (star) showing ventral compression of the thecal sac. (B) CT-imaging of the C5 vertebral body lesion deriving vascular supply from several parasitized branches of the left (arrowhead, C) greater than right (arrow, D) vertebral arteries.

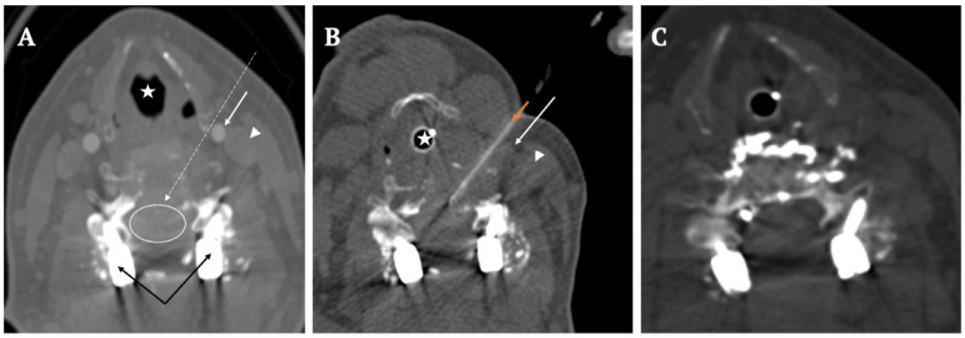

Fig. 2 – (A) Preprocedural CT angiogram of the head and neck delineating anticipated needle trajectory (*dotted-arrow*). (B) Under intermittent CT-guidance, a 21-gauge Quincke-tip spinal needle (*orange-arrow*) was advanced into the tumor bed, passing antero-superior to the left carotid artery (*white arrow*) and the left internal jugular vein (*arrowhead*); and posteroinferior to the trachea (*star*), esophageal origin (*red arrow*) and the left submandibular gland (*blue arrow*). (C) Postembolization CT-scan demonstrating n-BCA cast within the tumor bed.

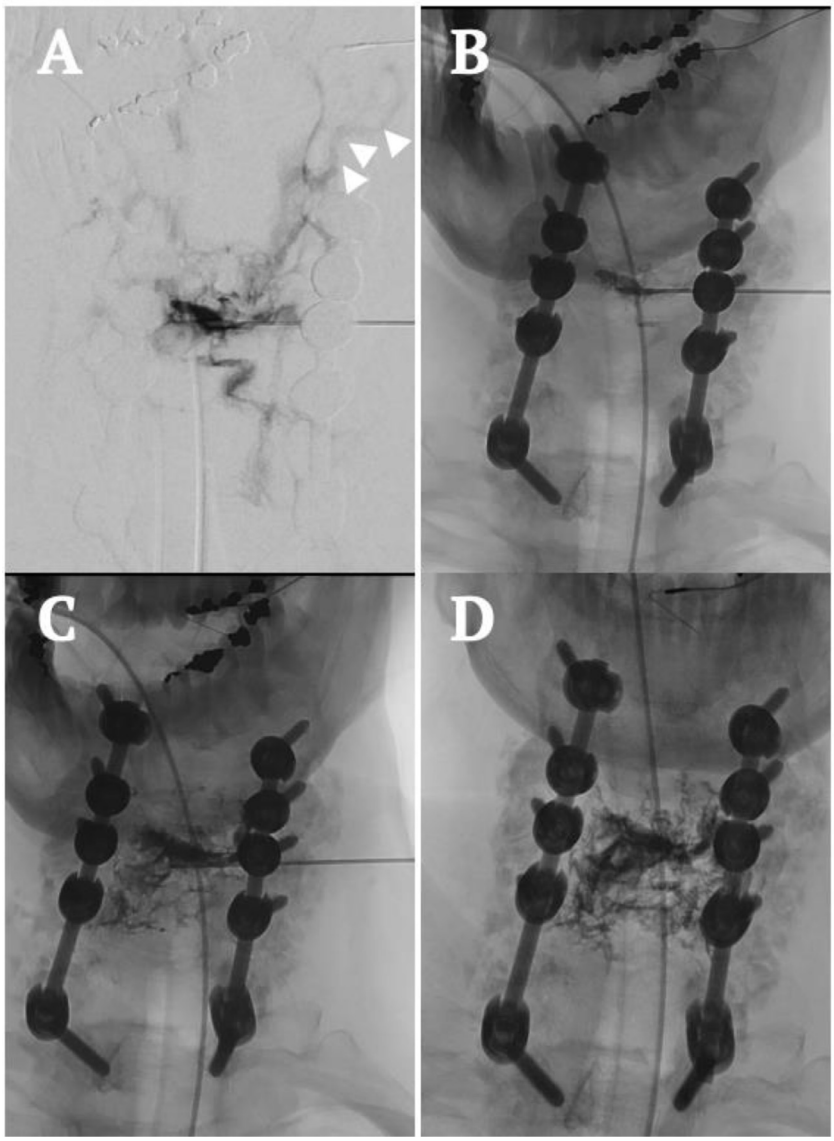

Fig. 3 – (A) "Parenchymogram" performed by contrast injection via the spinal needle, confirming intratumoral and extravascular needle tip positioning, with retrograde opacification of the left vertebral artery (*arrowhead*). (B, C, and D) Capture n-BCA cast after sequential embolization until adequate tumoral obliteration was achieved.

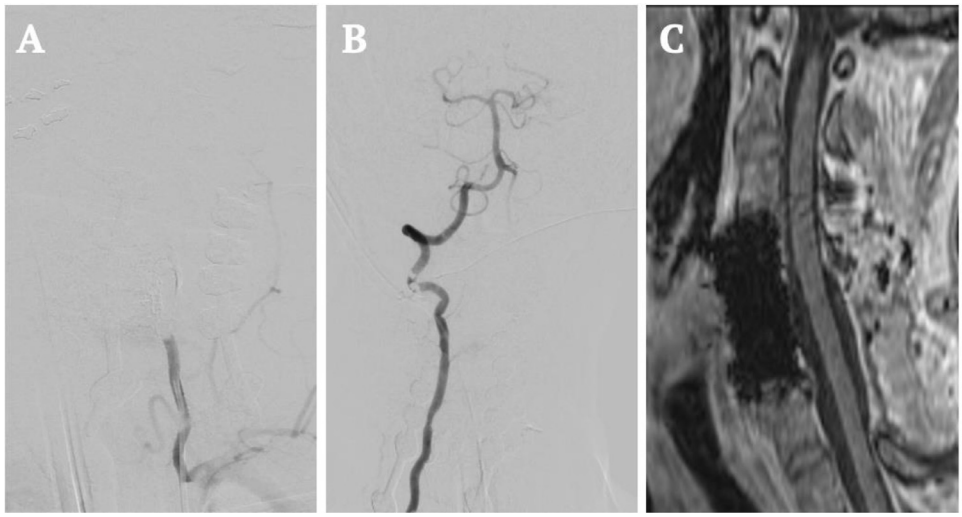

Fig. 4 – (A, B) Cerebral angiography showing retrograde penetration of embolic material via parasitized arterial branches into the left vertebral artery, without any distal occlusion or capillary phase defect. (C) Postcorpectomy and cervical fusion (C4-6) MR imaging demonstrating resolution of mass effect on the thecal sac.

eration was achieved (Figs. 3C and D). Unfortunately, despite the cautious injection of liquid embolic, there was retrograde penetration of embolic material via the parasitized arterial branches into the left vertebral artery (Figs. 4A and B). Right vertebral angiography did not show any intracranial vessel occlusions or capillary phase defects. The patient remained clinically asymptomatic from the left vertebral artery occlusion with baseline postprocedural neurologic examination. Following embolization, the patient underwent a C5 corpectomy and anterior cervical fusion C4-C6 with the use of allograft and plating with an estimated 20 cc of blood loss (Fig. 4C).

Discussion

The anterolateral approach for percutaneous interventions in the cervical spine has been described for vertebral body biopsy and intervertebral disc aspiration [3,6,7]; to the best of our knowledge, this case represents the first case report of the anterolateral approach being utilized for percutaneous embolization of cervical metastatic disease, supporting its use as a viable alternative to the transpedicular approach, especially when traditional methods are not feasible due to anatomical or procedural constraints.

Spinal renal metastases are highly vascular tumors with numerous reports describing massive intraoperative blood loss [14–16]. The risk of spinal cord ischemia with transarterial embolization has been cited as a reason to defer preoperative devascularization by some [17]; however, direct percutaneous embolization with liquid embolics can offer better control which reduces the risk of cord ischemia. While the transpedicular approach is traditionally preferred, the proximity of vertebral arteries may be considered a deterrent. Alternatively, it may be rendered unviable by prior instrumentation. The anterolateral approach requires the needle to pass closely to the carotid space (carotid artery, jugular vein, cranial nerves IX, X, X1), esophagus, and the ipsilateral submandibular gland (Fig. 2). A preoperative CT-angiogram can help outline the anatomy of carotid-sheath vasculature before the use of intraoperative CT guidance for local advancement of the needle. Once the needle tip is embedded within the tumor-bed, serial manual contrast injections should be performed to delineate the venous outflow (Fig. 3, “parenchymogram”). This will help confirm the intratumoral location of the needle-tip prior to injection of the embolic agent. Further, the presence of retrograde arterial reflux on the serial parenchymograms (Fig. 3A) can help gauge the force deployed during manual injection of the embolic agent. In our case, the iatrogenic occlusion of the left vertebral artery occurred during the final injection, and was likely caused by n-BCA reflux into the parasitized arterial feeders arising from the mid-V2 segment. Such complications underscore the necessity of continuous vigilance and the potential perils of prioritizing complete tumoral devascularization over patient safety. Hitherto the authors note that an angiographic “greed” for complete tumoral devascularization may be counterproductive, and if desired, may necessitate a higher concentration (ie, more viscous) embolic agent with or without concomitant intraarterial balloon protection.

Clinical decision-making in the context of patients considering preoperative embolization of metastatic RCC of the spine should reflect the unique details of each case. Though the anterolateral approach for direct tumor embolization offers a potential alternative, its inherent risks, and the variability of surgical skills across different surgeons cannot be downplayed. Further, the patient described in this case may not be representative of the larger patient population. Patients presenting with advanced RCC of the spine may have a wide variety of symptoms, which could affect each patient’s decision-making capabilities and priorities of care differently. Thus, our experience should not be considered evidence for the use of

this approach on all patients with metastatic RCC of the spine where a transpedicular approach isn't feasible.

Metastatic RCC of the spine poses a significant bleeding risk supporting the use of preoperative tumor embolization. Here we demonstrate that in patients with cervical metastatic disease with prior spinal instrumentation limiting the transpedicular approach, a percutaneous anterolateral approach can provide a viable alternative for n-BCA embolization. Further studies are needed to establish the generalizability of this technique for direct tumor embolization.

Patient consent

We hereby confirm that written and informed consent for the publication of this case, including any associated images and details, was duly obtained from the patient. The patient was made fully aware of the nature of the publication, its purpose, and the platforms on which it might be shared. All steps were taken to ensure the patient's understanding and comfort throughout the process, and their rights to privacy were upheld in accordance with ethical standards. Any information that could potentially reveal the patient's identity has been omitted or anonymized to maintain confidentiality.

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