Tetra-compartmental spinal infection with conus medullaris syndrome: illustrative case

Edward G. Andrews, MD,1 Jasmine L. Hect, BS,1 Aditya M. Mittal, BS,1 Kamil W. Nowicki, MD, PhD,1 Vikas Agarwal, MD,2 and Peter C. Gerszten, MD, MPH1

Departments of 1Neurosurgery and 2Radiology, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

BACKGROUND Recent literature suggests that spinal infections are increasing in prevalence. Any compartment can be infected in the spine; however, multicompartmental infections are rare.

OBSERVATIONS To the authors’ knowledge, this report is the only reported case of a tetra-compartmental spinal infection consisting of epidural, subdural, subarachnoid, and intramedullary components with a contiguous lumbar spondylodiscitis resulting in conus medullaris syndrome requiring surgical intervention.

LESSONS This case highlights the importance of surgical intervention in severe cases such as the one illustrated in this report. Second, magnetic resonance imaging with and without contrast is required to check for spreading of the infection as these findings may change the surgical approach. Last, the use of intraoperative ultrasound is paramount to evaluate the subdural and intramedullary compartments in severe cases.

Recent literature suggests an increasing prevalence of spinal infection. Spinal infection can involve any compartment of the spine and occasionally can infect multiple compartments. Common forms of spinal infections include vertebral osteomyelitis, discitis, and epidural abscesses. Treatment varies considerably depending on what kind of infection a patient may have. Mechanisms of infection can include hematogenous spread or direct seeding from an outside source. To the authors’ knowledge, this case is the only described occurrence of spinal infection involving the epidural, subdural, and subarachnoid spaces along with associated intramedullary abscess. This report focuses on the treatment and management of a patient with extensive spinal infection.

Illustrative Case

A 62-year-old male with a past medical history significant for chronic low back pain presented with conus medullaris syndrome. He presented to an outside hospital emergency department 3 days prior to transferring to our hospital with acute worsening of chronic low back pain. He had fallen 10 days earlier without exacerbation of his pain at that time but reported developing flu-like symptoms 4 days later, including diffuse myalgias. He had no history of intravenous drug use or recent spinal injections. Computed tomography (CT) of his lumbar spine was unremarkable; specifically, no end-plate destruction or bony erosive changes were identified. He was given a nonsteroidal anti-inflammatory drug and discharged home with pain medication. His back pain progressed over the following days to the point that he could no longer ambulate. He returned to an outside hospital emergency department where magnetic resonance imaging (MRI) of his lumbar spine with and without contrast showed findings concerning for spondylodiscitis centered at L2–3 with a dorsal epidural contrast-enhancing collection concerning for abscess. In addition, there was contrast enhancement circumferentially around the cauda equina and a small contrast-enhancing collection in the conus medullaris (Fig. 1). Although the patient was

ABBREVIATIONS CT = computed tomography; MRI = magnetic resonance imaging; MSSA = methicillin-sensitive Staphylococcus aureus.

INCLUDE WHEN CITING Published February 6, 2023; DOI: 10.3171/CASE22447.

SUBMITTED November 6, 2022. ACCEPTED December 12, 2022.

* E.G.A. and J.L.H. contributed equally to this work.

© 2023 The authors, CC BY-NC-ND 4.0 (http://creativecommons.org/licenses/by-nc-nd/4.0/).
afebrile with a normal white blood cell count, inflammatory markers (erythrocyte sedimentation rate and C-reactive protein [CRP]) were elevated. Given the clinical picture and laboratory and imaging findings, the patient was admitted, and the infectious disease service consulted. Blood cultures drawn in the emergency department returned positive for gram-positive cocci. Given the complexity of his pathology, he was transferred to our institution’s intensive care unit 3 days after admission to the outside hospital. The patient was started on intravenous daptomycin to empirically cover methicillin-resistant Staphylococcus aureus the day prior to transfer, which was subsequently stopped on arrival at our institution.

On arrival, the patient was found to have an altered mental status in the context of fevers greater than 38.5°C, along with new urinary retention, for which a Foley catheter had been placed at the previous facility. The patient’s lower extremities were full strength to confrontation in all muscle groups, sensate to light touch, and were hyporeflexic but symmetric in bilateral patellar deep tendon reflexes. Rectal tone and perianal sensation to light touch and deep anal pressure were preserved. He had facial abrasions but otherwise no signs of trauma. While he was deemed a surgical candidate, further workup was pursued to elucidate the source of infection prior to taking him to the operating room. A transthoracic echocardiogram was negative for vegetations. MRI examinations of the brain, cervical spine, and thoracic spine were completed and remarkable for diffuse leptomeningeal enhancement throughout the cervical and thoracic spine. No additional collections were identified.

On the second day of hospitalization, he was taken to the operating room to evacuate the epidural collection. A standard midline laminectomy spanning from the L1 to L3 pedicles was performed after localization with fluoroscopy, and the laminae of L1 and L2 were fully exposed. After full L1 and L2 and partial T12 and L3 laminectomies, a large amount of epidural pus was encountered. This was evacuated after cultures were taken with suction and copious irrigation. The dura appeared otherwise normal in appearance. Ultrasound was used to investigate the presence of subdural collections. Hypoechogenic material was noted in the subdural space, prompting intradural exploration. A midline durotomy was made. A dense amount of phephlogous material surrounding the nerve roots was encountered. This was incompletely evacuated because of dense adherence to nerve roots. Examination of the conus revealed a subtle midline abnormality and an intracanal lesion was confirmed by ultrasound. Unfortunately, no ultrasound images were saved. A midline myelotomy was subsequently performed at the conus and the abscess presented itself, allowing for complete evacuation.

Immediate postoperative contrast MRI of the lumbar spine showed reduction in the size of the epidural and subdural abscesses, as well as the conus abscess (Fig. 2). The patient had no change from his preoperative exam. His urinary retention persisted despite Flomax (Boehringer Ingelheim Pharmaceuticals, Inc.). Cultures taken in the operating room grew methicillin-sensitive Staphylococcus aureus (MSSA) and were consistent with the positive blood cultures. The patient was placed on a standard 6-week course of nafcillin with rifampin for synergy. He was discharged home from the hospital 8 days after surgery with reduced back pain and resolved confusion.

He was seen in follow-up at 2 weeks and 1 month after surgery. He was doing well clinically with a nonfocal exam. His urinary retention had improved. Contrast MRI of his lumbar spine at 1 month postlumbar percutaneous catheterization showed complete resolution of the epidural, subdural, subarachnoid, and intracanal infection. Imaging demonstrated a

![FIG. 1. Preoperative lumbar contrast MRI showing multicompartamental infection. A: Sagittal image with the extent of infection spanning T12 to the superior portion of L3. The solid arrow highlights the intraconal abscess; the dotted arrow highlights the subdural component. B: Axial contrast image obtained through the intracanal abscess at L1. C: Axial contrast sequence at L2 through the subdural component of the infection. D: Axial contrast sequence at L2–3 showing the diffuse epidural abscess (arrow).](unauthentic.png)

![FIG. 2. Immediately postoperative lumbar contrast MRI showing improvement in the multicompartamental infection. A: Axial image with the reduced size of the conus abscess. B: Sagittal contrast sequence showing successful evacuation of the epidural and conus abscess. Contrast uptake in the subdural space is relatively unchanged.](unauthentic.png)
minor increase, however, in enhancement at the L2 inferior and L3 superior endplates as well as the L2–3 disc space (Fig. 3), consistent with the expected evolution of spondylodiscitis. At 6 months, the patient continued to do well clinically. He did report, however, new-onset left hip and lateral thigh pain; thus, a repeat lumbar MRI without contrast was obtained. No new collections in the epidural, subdural, subarachnoid, or intramedullary spaces were identified, and the L2–3 marrow irregularity was improved compared with his prior MRI, evidence that the spondylodiscitis was continuing to evolve as expected (Fig. 4). Unfortunately, the patient was lost to follow-up 6 months after surgery.

Discussion
Observations
This case is the only described occurrence of a tetra-compartmental spinal infection involving the epidural, subdural, and subarachnoid spaces along with an associated intramedullary abscess. The pathophysiology of tetra-compartmental spinal infection is unknown but is almost certainly due to either hematogenous or contiguous spread, the latter most likely given the presence of an adjacent spondylodiscitis. Alternatively, a combination of both mechanisms is possible with contiguous spread into the epidural compartment followed by hematogenous dissemination through the venous plexus. The spinal veins drain into the anterior and posterior radiculomedullary veins, which, in turn, drain into the paravertebral and intervertebral plexuses; thus, a spondylitis, spondylodiscitis, or epidural abscess could produce a thrombophlebitis and subsequent spread of infection into the subdural space, subarachnoid space, and eventually to the spinal cord parenchyma.

Lessons
The diagnosis of spondylodiscitis is often delayed because of the relatively nonspecific symptomatology. As in this case, weeks to months can pass before diagnosis. Predisposing factors include immunosuppression such as from HIV infection, diabetes mellitus, prior spine surgery, underlying spinal abnormalities, and distant infection such as endocarditis.1,2 The incidence of spinal infection has also increased with a growing geriatric population. Like spondylodiscitis, spinal epidural abscesses and spinal subdural abscesses, both relatively rare entities, have seen an uptrend in incidence and for similar reasons.3,4 Infection in the latter 2 compartments is most commonly secondary to contiguous spread from a spondylodiscitis or hematogenous seeding from infection elsewhere in the body.3,4 Intramedullary abscesses are exceedingly rare, with just over 100 cases reported in the literature. Hematogenous spread is almost exclusively the cause.5 Combined epidural abscess and subdural empyema have been reported twice in the literature.6,7

Three major groups of microorganisms are responsible for spinal infections: bacteria, fungi, and very rarely parasites. In spondylodiscitis,
up to 80% of infections are attributable to *Staphylococcus aureus*. Less commonly implicated organisms are *Escherichia coli* and other gram-negative rods. Anaerobes are the least common pathogen in less than 4% of cases. Spinal epidural abscesses were similarly overwhelmingly caused by *S. aureus*, in particular MSSA, at approximately 64%. The rarer subdural empyema is also a result of *S. aureus* infection, with up to 52% of cases attributed to this organism, as are spinal intramedullary abscesses, although the latter’s pathophysiology is less well documented given the paucity of cases.

The literature shows that early surgical decompression and drainage followed by antibiotic therapy is the mainstay of treatment. Fusion may be required at the time of surgery or in a delayed fashion if there is a kyphotic deformity as a result of pathological compression fractures or induced because of laminectomies at junctional levels such as at T12-L1. Evidence overwhelmingly shows that early surgical intervention within 5 days of initial presentation, especially in the case of epidural and subdural empyema, results in the highest likelihood of neurological preservation and/or recovery. In this particular scenario, fusion was not pursued because there was no gross instability on provocative testing during surgery nor was iatrogenic instability introduced since medial facetectomies were not performed nor was the disc space denuded as it would likely heal on the appropriate antibiotic regimen.

Treatment strategies vary depending on which compartment the infection is localized. Subdural abscesses are treated by surgical decompression followed by 4–6 weeks of an antibiotic regimen. Subdural infections or subdural empyemas are typically diagnosed using a combination of MRI and CT with myelography. If the infection is widespread, then a laminectomy may be necessary to remove the infectious material. Spinal epidural abscess is a relatively common infection of the spinal cord. Diagnosis is typically done through imaging of the entire spine as infection can occur in multiple locations. As with subdural abscesses, decompression followed by antibiotics is the gold standard of treatment. Conservative management is also an option in patients in whom surgery may be contraindicated. These include patients with comorbidities, extensive infection affecting the length of the spine, and minimal infection without symptoms. This patient appeared to be failing conservative management at an outside facility. Specifically, despite antibiotics being started at an outside facility 3 days prior and placing the patient on patient-controlled analgesia, he continued to experience worsening pain and retention prompting concern for urgent intervention. Intramedullary abscesses are rare, with few reported cases in the literature since they were first described. Because of the rarity of intramedullary spinal abscesses there is no standardized treatment strategy. Typically, treatment consists of drainage and intravenous antibiotic administration.

Isolated subarachnoid infection is rare. Infection of the subarachnoid space is difficult to treat. Treatment is usually supportive and focused on alleviating pain and associated symptoms. Steroid injections are contraindicated as they may exacerbate infection by introducing new microorganisms.

The root cause of the patient's extensive infection is mysterious. The patient's bacteremia likely seeded his L2–3 intervertebral disc, but the source of his bacteremia is unclear. He did not have a urinary, pulmonary, or cardiac source. He had no history of external trauma or procedural history to suggest external introduction of a pathogen. In fact, the patient’s only abnormality on physical exam was multiple abrasions on his face from his fall 1 month prior to presentation. To cause such an extensive infection, it is possible that his abrasions caused a bacteremia that superinfected an epidural hematoma from vertebral body injury that happened at the time of his fall, even though his CT of his lumbar spine was negative for fracture.

Of note, the patient did not undergo an immunological workup to determine if there was underlying, occult immunodeficiency. This was because he had a normal white blood cell count with a normal differential after clearing his infection. As well, he had no family history of immunodeficiency, nor did he have a history of recurrent infections. The patient did not develop a kyphotic deformity at the site of his surgical decompression. In the future, however, given the proximity of the laminectomies to the thoracolumbar junction, a posterospinal fusion may be required.

This case highlights multiple important points in the management of spinal infections. First, prompt, urgent surgical intervention is critical to ensure preservation of or improvement in neurological function. This patient remained neurologically intact, except for a neurogenic bladder, which improved slowly in the months following surgery. Second, careful evaluation of MRI with and without contrast for the presence of subdural or intramedullary spread is critical because these findings change the surgical approach—namely, opening the dura as opposed to simply evacuating an epidural collection. Third, in infection as extensive as seen here, diffuse contrast uptake on MRI in the epidural and subdural space can make effective evaluation of the spinal cord and the presence of an intramedullary abscess extremely difficult. Intraoperative ultrasound to accurately evaluate the subdural and intramedullary compartments is paramount.

References


Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Andrews, Nowicki, Gerszten. Acquisition of data: Andrews, Agarwal. Analysis and interpretation of data: Nowicki, Gerszten. Critically revising the article: all authors. Reviewed submitted version of the manuscript: Andrews, Hect, Mittal, Nowicki, Agarwal. Approved the final version of the manuscript on behalf of all authors: Andrews.

Correspondence
Edward G. Andrews: University of Pittsburgh Medical Center, Pittsburgh, PA. andrewse2@upmc.edu.