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Use of Intraoperative Ultrasound in Diagnosis of Intradural Lesion in Patient Unable to Undergo Pre-operative MRI

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Abstract

Background and Importance: *Intraoperative ultrasound is a widely available and powerful tool in a spine surgeon's armamentarium. Particularly when pre-operative imaging or intraoperative visualization is limited, ultrasound can help characterize lesions, confirm adequate decompression, and more. We present a case in which intraoperative ultrasound helped to differentiate whether a mass lesion was extradural versus intradural in a patient unable to undergo pre-operative MR imaging.*

Clinical Presentation: *An 81-year-old female with a history of a suspected calcified, extradural, ventral lesion at the T2-3 disc space treated with T1-T5 posterior fusion and partial T3 corpectomy presented to clinic three years later with progressive difficulty ambulating. She was weak in hip flexion and had lower extremity hyperreflexia. Due to prior placement of an MRI-incompatible pacemaker, she underwent CT myelogram that demonstrated persistent lesion ventral to the spinal cord at T2. Due to its increase in size, there were concerns for an intradural mass rather than extradural calcified disk. She was taken to the operating where intraoperative ultrasound confirmed a large, intradural lesion causing posterior displacement of the spinal cord with severe compression. The dura was opened proximal and distal to the lesion, arachnoid and dentate ligaments separated, T3 nerve root coagulated, and the lesion was debulked and separated from the dura. Final pathology confirmed meningioma. Post-operatively, the patient was neurologically intact.*

Conclusion: *Intraoperative ultrasound can be used during spine surgery in patients unable to obtain pre-operative MRI to aid in identifying extradural versus intradural lesions to provide correctly indicated surgical intervention.*

Keywords: *calcified disk, intradural lesion, intraoperative ultrasound, CT myelogram, MRI incompatible.*

Background and Importance

Ultrasonography has been recognized as a modality that assists with intraoperative visualization of spinal lesions since the 1970s [1-5]. Because of its reported ease of use, low cost, and ability to provide real time images in the operating room, ultrasound has become popular adjunct to other pre-operative imaging modalities [5]. Especially in cases where pre-operative imaging or intraoperative visualization is limited, ultrasound can be an indispensable asset [6]. In this technical case illustration, we describe the case of a patient who had previously been incompletely diagnosed and insufficiently treated due to pre-operative imaging constraints. Intraoperative ultrasound was ultimately utilized to evaluate the location of a compressive lesion in the ventral thoracic spine and helped to provide definitive management, reinforcing its utility in the arsenal of the modern neurosurgeon.

Clinical Presentation

Patient is a female in her 80's with past medical history significant for heart failure, atrial fibrillation, and sick sinus syndrome for which she had an MRI-incompatible pacemaker placed. She originally presented to an outside hospital with urinary incontinence and progressively worsening lower extremity weakness and gait instability. As MRI was unable to be obtained, she underwent a CT myelogram which demonstrated a presumed extradural ventral calcified disk centered at the T2-3-disc space causing severe thoracic cord compression (Figure 1). At that time, she was treated with T2-3 laminectomies and facetectomies, partial T3 corpectomy, extradural mass removal, and T1-5 instrumented posterior fusion. Pathology of the mass demonstrated normal bone. She was discharged post-operatively to an acute rehabilitation facility but continued to experience decline in her mobility necessitating the use of a wheelchair.

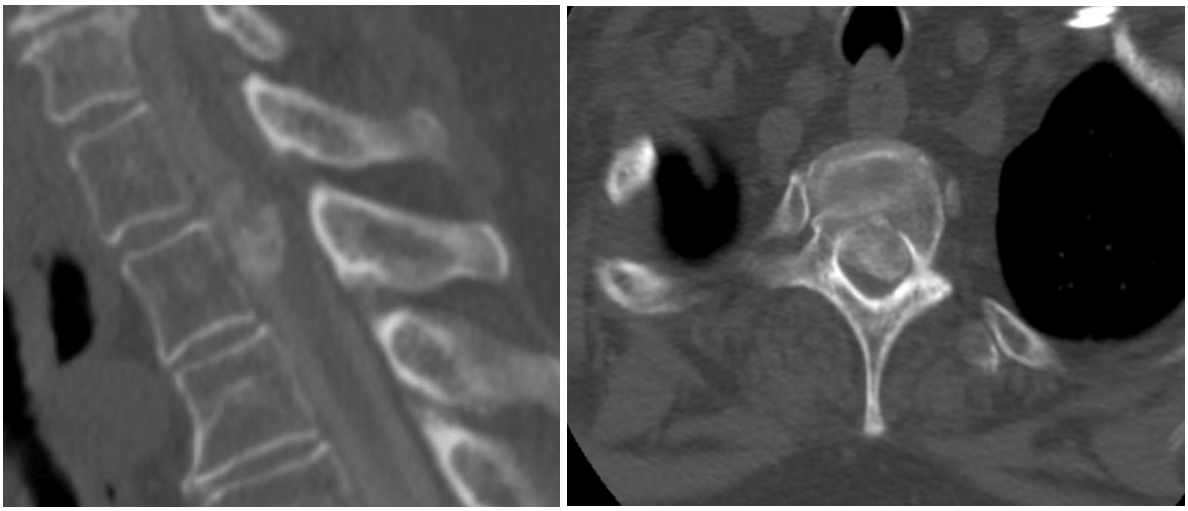

Figure 1: Initial CT myelogram of the thoracic spine prior to first surgical intervention a) sagittal b) axial. Note lack of contrast flow at the ventral aspect of the mass.

Four months post-operatively, a repeat CT myelogram was obtained which was notable for persistent calcified lesion posterior to the vertebral body of T2. She presented to a different surgeon who performed a T2 corpectomy with removal of T2-3 calcified extradural disc herniation, interbody cage placement, T1-2 laminectomy, and revision C7-T5 instrumented posterior fusion. Her lower extremity strength and ability to ambulate improved postoperatively, though she continued to require the use of a walker and endorsed reduced endurance.

Three years after her procedures, she was referred to our clinic with subjectively worsening leg weakness. On exam, she had ⅘ iliopsoas strength bilaterally with lower extremity hyperreflexia. A repeat CT myelogram was suggestive of a persistent lesion at T2 (figure 2). Given it was slightly enlarged from prior studies, it was felt this may represent an intradural meningioma and the patient was recommended to undergo re-operation for intradural exploration and possible mass resection. An in-depth discussion of risks and benefits was had with the patient and her family, and she consented to proceed with surgery.

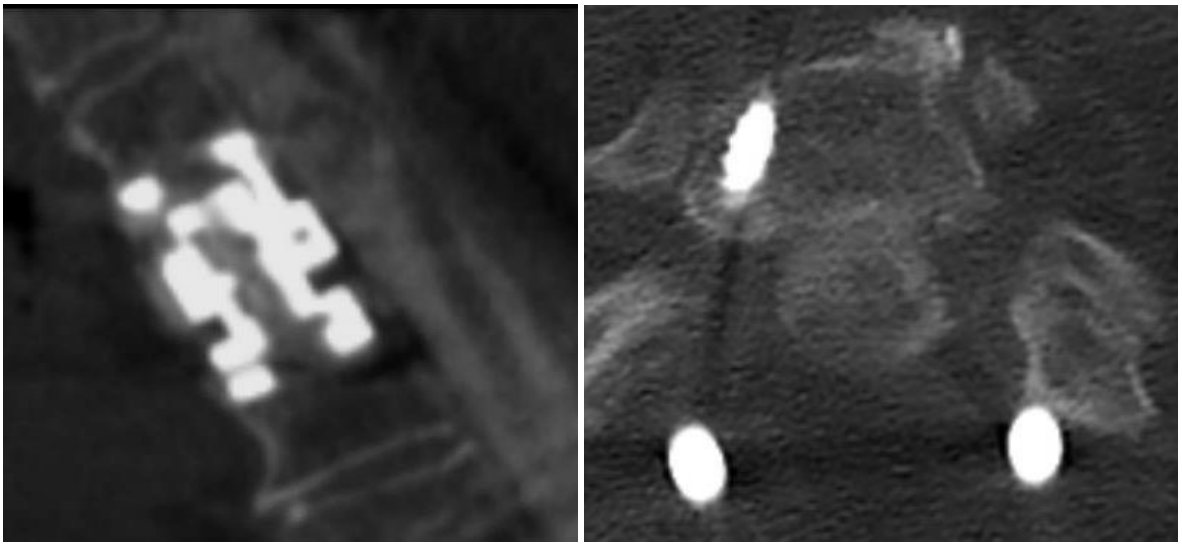

Figure 2: Pre-operative CT myelogram of the thoracic spine a) sagittal b) axial. Seen again is a persistent mass ventral to the spinal cord displacing the cord posteriorly.

Spinal exploration and tumor resection

In the operating room, baseline neuromonitoring data was obtained, revealing no motors in her right lower extremity, waxing and waning motor potentials in her left lower extremity, and no sensory potentials in either lower extremity. She was placed in the prone position and prepped and draped in sterile fashion. Prior midline incision was opened and the spinal fusion was explored. Loose hardware was revised and attention was then turned to the laminectomy site. Dorsal and lateral scar tissue was carefully dissected away from the dura. Using the ultrasound, a large, intradural lesion was identified causing posterior displacement of the spinal cord with severe compression (Figure 3). In addition, the ultrasound aided in confirming adequate laminectomy exposure prior to dural opening.

Figure 3: Intraoperative ultrasound, sagittal view. A large, intradural lesion seen causing displacement of the spinal cord posteriorly with severe cord compression.

Under microscopic magnification, the dura was opened proximally and distally to the lesion and tack-up sutures were placed. At this time, the spinal cord appeared draped over a large ventral mass (Figure 4). The arachnoid and dentate ligaments were separated, revealing the T3 nerve root that was coagulated and separated to expose the lesion. The spinal cord was slowly retracted laterally and the other nerve roots were skeletonized for better exposure. A biopsy was taken, with preliminary pathology suggestive of meningioma.

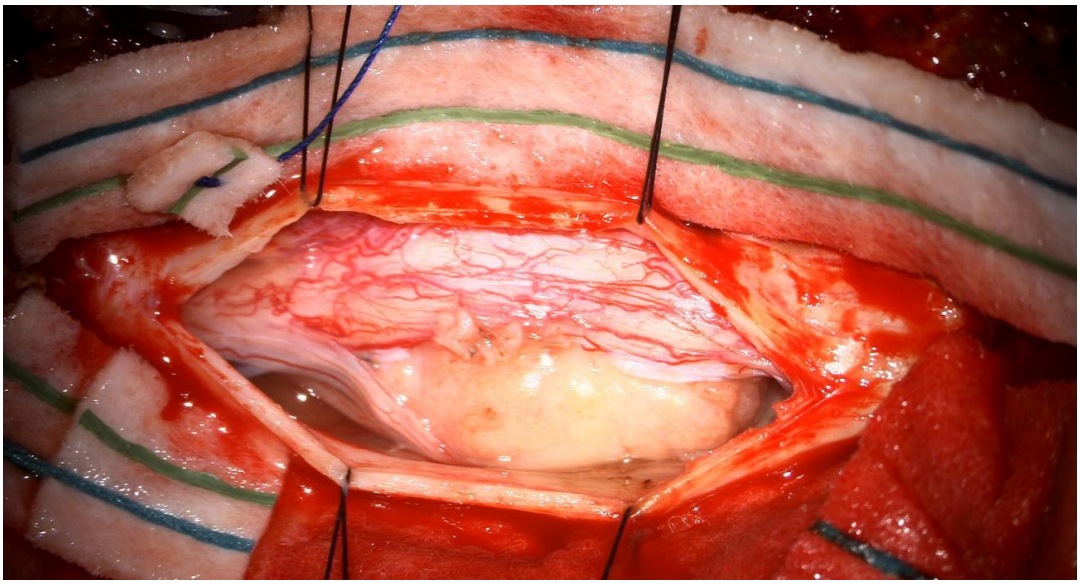

Figure 4: Intradural view after dural opening. The spinal cord is seen draped over a large ventral mass.

Using the ultrasonic aspirator, the core of the lesion was debulked and the mass was separated from the dura. The pedicle was located at the ventral-most aspect, which was coagulated and separated, thus removing the remainder of the mass that was sent for permanent pathology (Figure 5). The dura was closed with running 5-0 Prolene sutures. Valsalva maneuver was used to confirm no evidence of CSF leak. Using ultrasound, no further evidence of spinal cord compression was noted. Bilateral rods were placed, bone graft applied, one hemovac drain inserted, and the wound was closed in standard fashion. Neuromonitoring demonstrated presence of motor evoked potentials in bilateral lower extremities at the conclusion of the case.

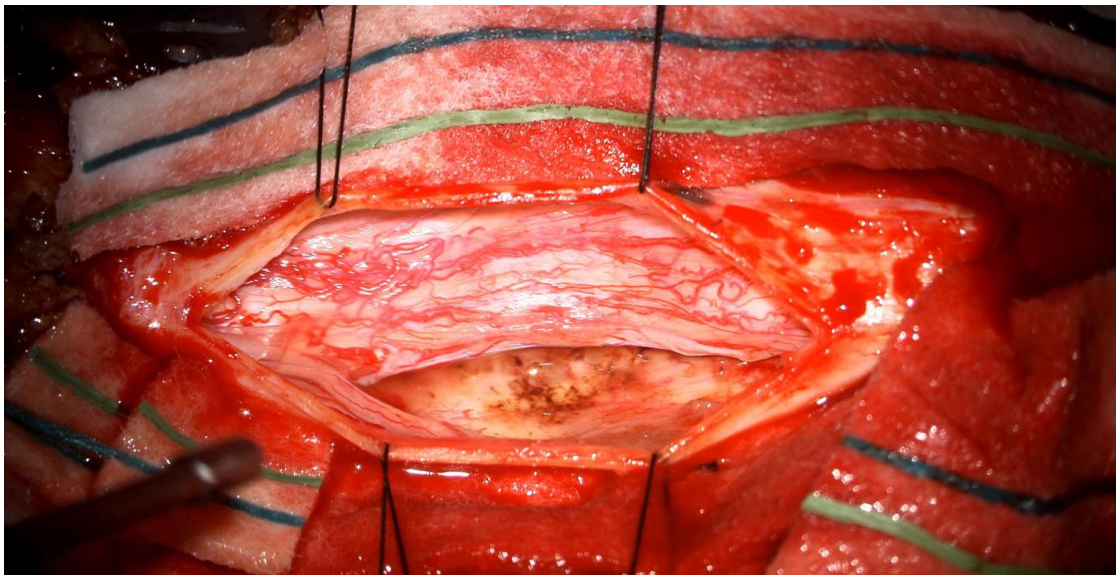

Figure 5: Intradural view after mass removal. Coagulated pedicle of the lesion is seen at the ventral-most aspect.

Post-operative course

Immediately after surgery, the patient was neurologically intact, with full strength in her extremities with no evidence of sensory deficits or signs of myelopathy. She was started on steroids that tapered off over one week. Drain was removed on post-op day 4 and she was discharged home on post-op day 6. Permanent pathology returned as World Health Organization (WHO) grade 1 meningioma. At six week and four-month follow-up in clinic, the patient remained neurologically intact and she reported that her walking, coordination, and urinary incontinence were all improved.

Discussion

This case report highlights the consequence of incorrect surgical diagnosis in the setting of inability to obtain an MRI imaging due to the patient's pacemaker. This patient initially presented with symptoms of thoracic myelopathy which has a broad differential diagnosis, of which structural etiology include spondylosis, calcified disc, trauma, neoplasms (extradural, intradural-extramedullary, intramedullary), and syringomyelia. In standard cases, pre-operative MRI helps to narrow the diagnosis, especially with regards to extradural versus intradural pathologies. CT myelogram is the alternative imaging modality used in patients unable to undergo MRI. Radiographic features that indicate an intradural lesion on a CT myelogram include intradural filling defect of contrast without any displacement of dura towards the spinal cord [7]. However, large lesions that efface the subarachnoid space or lesions originating from the dura may prevent intradural contrast flow and create difficulty in delineating between extradural and intradural lesions. Karnaze et al. reported in a retrospective study of 38 patients that MRI was superior to CT myelogram in detecting intradural meningiomas as CT myelography only showed inferior margin of the lesion due to CSF block which again can be difficult to distinguish from a compressive calcified disc preventing ventral CSF flow [8]. The patient in this case report underwent two prior surgeries under the assumption that the pathology was extradural disc calcification. If intraoperative ultrasound had been used after laminectomy was performed in the patient's initial surgery, an earlier diagnosis and treatment may have been given for the patient and obviate the need for a corpectomy, vertebral column resection, and cervicothoracic long construct fusion. As such, intraoperative ultrasound can be used after completion of decompression to confirm the offending pathology has been removed and if there is evidence of persistent compression, further exploration can be considered.

Conclusion

Intraoperative ultrasound can provide valuable information in patients unable to undergo MRI to distinguish intradural and extradural lesions that may be hard to diagnose on a CT myelogram. Use of ultrasound after laminectomy to assess the degree of spinal cord decompression and its relation to ventral pathology can aid in diagnosis and surgical decision making for patients undergoing spine surgery without pre-operative MRI imaging.

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