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Journal of Pain Management & Medicine

Case Report

Diagnostic Radiologic Alternatives in Evaluating Spinal Epidural Hematomas in Patients Unable to Undergo MRI: A Case Report

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ABSTRACT

Evaluation of spinal epidural hematomas (SEH) without the use of magnetic resonance imaging (MRI) and in patients with inconclusive neurologic exams presents a diagnostic challenge. A 62-year-old man developed an iatrogenic SEH that was not found until six days later due to MRI intolerance and a continually vague neurologic exam. This case highlights the need for explicit diagnostic radiologic alternatives in evaluating spinal cord pathologies in this patient population. We explicitly outline available diagnostic radiologic alternatives to help guide clinicians who face similar diagnostic dilemmas.

Keywords: Spinal epidural hematoma; Computed tomography; Iatrogenic spinal cord injury; Magnetic resonance imaging

INTRODUCTION

Magnetic resonance imaging (MRI) is the current gold standard for diagnosing spinal epidural hematomas (SEH) and is sensitive for the presence of blood in the epidural space, extent of hemorrhage, degree of cord compression, and adjacent soft tissue injury [1]. However, MRI may not be possible in many patients for a variety of reasons including incompatible implantable devices and exam intolerance due to underlying medical illness [2]. Currently, there is no explicitly outlined diagnostic radiologic alternatives to guide clinicians who face this dilemma.

Computed tomography (CT) can play a significant diagnostic role in these patients, though with certain limitations. We present a case report highlighting the need for explicitly stated diagnostic radiologic alternatives and their rationale in evaluating spinal cord pathologies such as iatrogenic spinal cord injury post neuraxial procedures and SEH in patients who are unable to tolerate MRI and have vague neurologic exams. We offer possible diagnostic radiologic alternatives and their rationale, learned retrospectively, that optimizes the use of CT and can help guide clinicians who face this diagnostic dilemma.

CASE DESCRIPTION

Informed consent was obtained from the patient for the publication of this case report

A 62-year-old man with a past medical history of severe chronic obstructive lung disease (COPD) and ethanol use disorder presented to the emergency department with shortness of breath and chest wall pain after a fall. He was found to have numerous bilateral rib fractures and pulmonary contusions and was admitted to the Intensive Care Unit (ICU) for monitoring, given his underlying pulmonary disease, and for pain control. On hospital day (HD) 2, an epidural catheter was placed at the T9-T10 intervertebral level through which an epidural infusion of 0.125% bupivacaine with 10 mcg/ml of hydromorphone with a continuous epidural rate of 8 ml/h and patient controlled epidural analgesia setting of 2ml every 30 minutes. Laboratory markers of coagulation including platelet count, prothrombin time and partial thromboplastin time prior to placement were within normal limits. The patient was not on anticoagulants. The procedure was a traumatic and well tolerated. Of note, the patient's baseline neurologic exam prior to epidural placement was significant for bilateral lower extremity weakness attributed to underlying radiculopathy. Follow up exams were confounded by waxing and waning mental status secondary to combination of polypharmacy and alcohol withdrawal. On HD 5, he developed acute respiratory failure. Chest CT demonstrated findings consistent with multifocal pneumonia and treatment was initiated.

On HD 6, four days following epidural catheter placement, the patient's neurologic exam though still confounded demonstrated questioned increased lower extremity weakness and spasticity. There was no loss of bowel or bladder control. Concerns of an

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Received: September 11, 2020; **Accepted:** October 05, 2020; **Published:** October 12, 2020

Citation: Caleb TE, Shirin G, Stephanie W, Benjamin H, Maryam J, et al. (2020) Diagnostic Radiologic Alternatives in Evaluating Spinal Epidural Hematomas in Patients Unable to Undergo MRI: A Case Report. J Pain Manage Med 6:143. doi: 10.35248/2684-1320.20.6.143.

intraspinal process were raised. Review of the previous day's chest CT showed the epidural catheter with its tip located centrally within the spinal canal, raising the possibility of intramedullary positioning Figure 1. As his mental status was altered, the patient could not follow commands for a precise exam or self-report changes in his symptoms. The epidural catheter, which was MRI incompatible, was removed, and an MRI was ordered to further investigate the etiology of his possible neurologic symptoms and to help with prognosis given the concern for intramedullary catheter placement. However, the patient was unable to tolerate MRI due to respiratory instability and altered mental status. The possibility of intubating the patient for MRI was introduced. However, the risks of becoming tracheostomy and ventilatory dependent given his severe COPD and general frail state were felt to outweigh the benefits, especially if there would be little change in clinical management if the catheter had indeed been intramedullary.

On HD 8, his critical respiratory status stabilized, and it was felt that MRI could be tolerated. MRI demonstrated a SEH from T6-T9 with associated severe spinal canal narrowing and cord compression Figure 2. Based on the MRI, it was felt that a cord-compressing SEH was likely the underlying etiology of the patient's neurologic deficits, rather than iatrogenic spinal cord injury due to intramedullary catheter placement. An emergent laminectomy was performed for evacuation of the hematoma. Unfortunately, the patient experienced persistent lower extremity sensory and motor dysfunction over the following days. His motor and sensory function mildly improved after working with physical therapy in the hospital over a period of approximately 2 weeks, though not to baseline. Additionally, he developed painful lower extremity spasms. He was discharged to a skilled nursing facility for further rehabilitative therapy. At last contact, his neurologic status as described above had persisted.

DISCUSSION

Unattainability of MRI and a nebulous neurologic exam were two key factors that lead to the missed SEH diagnosis. Additionally, the chest CT initially obtained due to respiratory failure was heavily relied upon, which further contributed to the missed diagnosis. In particular, it was assumed that the position of the epidural catheter was intramedullary based on chest CT imaging. The possibility that the catheter was suspended in a cord-compressing epidural hematoma was seriously considered but after much inter-disciplinary discussion, it was ultimately deemed less likely because a hematoma was not conspicuous on the chest CT.

Understanding the diagnostic radiologic alternatives, and the reasoning behind their utilization, can improve diagnostic yield. The following alternatives are available, and their reasoning will be outlined below: First, non-enhanced CT timed within the hyper-

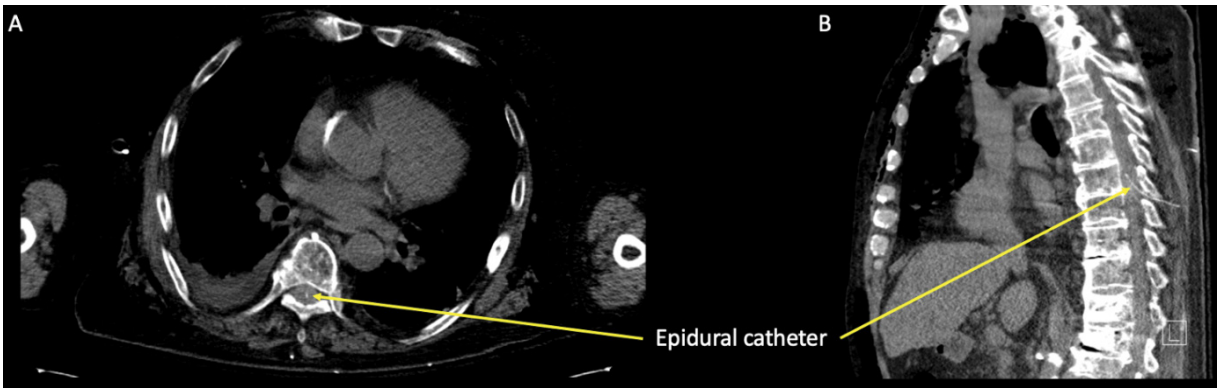

Figure 1: Axial and sagittal chest CT without contrast demonstrating epidural catheter placement. The epidural catheter (yellow arrows) is within the vertebral column as seen in the axial (A) and sagittal (B) views. There is no delineation between the spinal cord and other intra-vertebral column contents, excluding the hyperdense catheter.

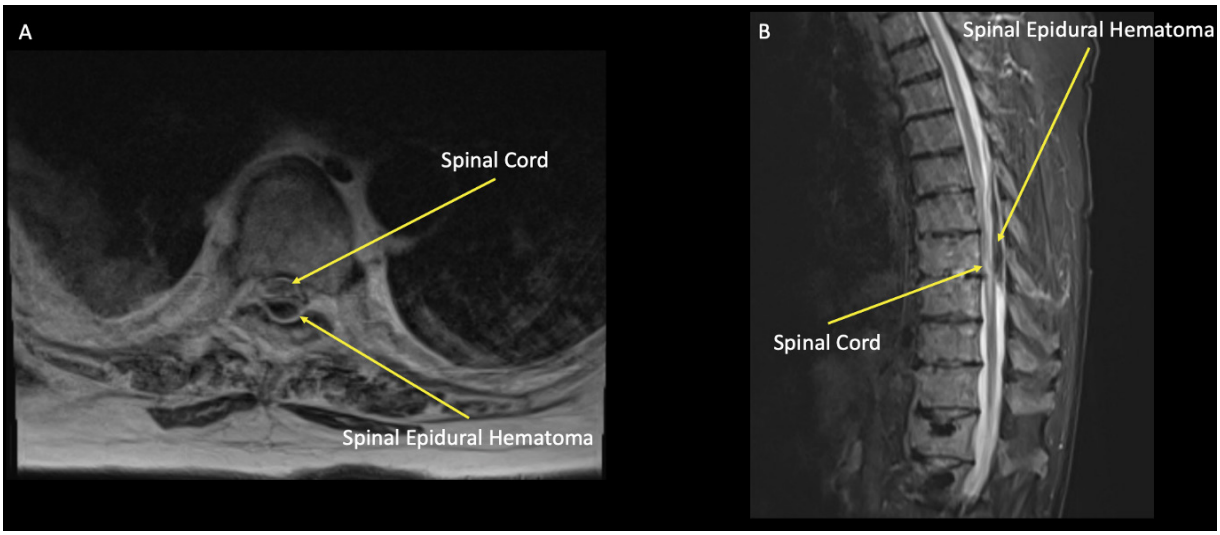

Figure 2: Axial and sagittal T2-weighted and STIR MRI demonstrating spinal epidural hematoma and spinal cord compression. Axial T2-weighted (A) and sagittal STIR (B) views demonstrate the spinal epidural hematoma at the level of T6-9. There is clear delineation between the spinal cord (grey/white) and the epidural hematoma (black). Additionally, there is abnormal T2-weighted hyperintensity within the spinal cord (B) indicating spinal cord edema secondary to severe compression. The epidural hematoma is located dorsally (classic location of SEH) and compresses the spinal cord anteriorly.

acute or acute phase of hematoma development is ideal. Second, CT myelogram may be used to delineate between epidural and intradural collections. Third, contrast-enhanced CT (CECT) may provide evidence for SEH if an enhanced membrane is observed. Fourth, dual-energy CT, where available, can help identify extradural blood products. Lastly, dedicated spine CT protocols (as opposed to observing the spine on chest CT as in this case) should be used.

First, timing of the CT plays a role in accurate interpretation. Hematomas follow a general pattern of evolution and resorption [3,4]. These changes affect the density of the hematoma as observed by changing Hounsfield units (HU) and therefore the CT appearance Figure 3. For non-enhanced CT (NECT), a hematoma within the hyperacute phase (<12 hrs) rapidly increases in density (approximately 75-90 HU) as plasma is resorbed and clot (aggregated platelets with a fibrin framework) forms [4-6]. In the acute phase (12-48 hrs), the hematoma retracts in size and decreases in density (approximately 40-75 HU) as enzymatic fibrinolysis begins [4,5,7]. Within the early subacute phase (2-7 days), the clot approaches a density similar to grey and white matter (approximately 20-40 HU). Lastly, in the late subacute (8 days-1 month) and chronic (>1 month) phase the fibrin framework is completely resorbed and the density becomes similar to cerebrospinal fluid (approximately 0 HU) [8]. Thus, the optimal time frame for use of a NECT is likely less than 2 days Figure 3.

Second, if NECT is obtained in the early subacute phase (hematoma isodense to spinal cord) and there is a clinical concern for SEH, a CT myelogram should be considered as a potential next step to demarcate intradural from extradural contents Figure 3 [9]. This assumes clinical stability to tolerate the procedure and may not be appropriate in all patients. If the patient is unable to tolerate a CT myelogram or it is otherwise not feasible, a CECT could also be considered. Hematomas can develop a peripherally enhancing membrane that can help delineate the collection from the spinal cord. Further, central enhancement can potentially be seen if there is active extravasation [10].

Next, where available a dual-energy CT could be considered to

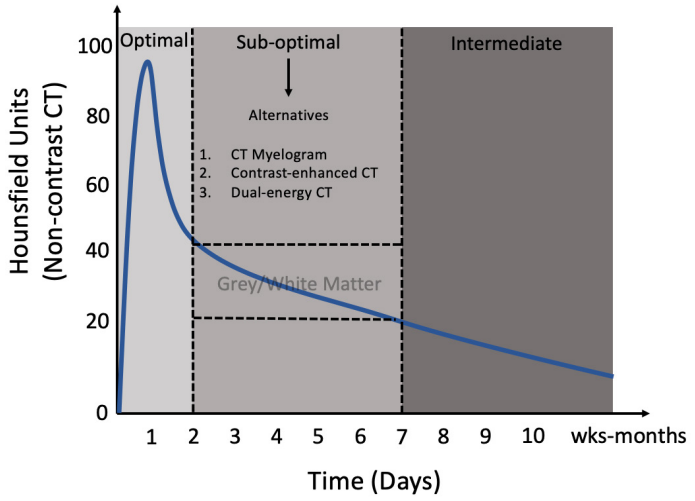

Figure 3: Approximate evolution of hematoma over time. In the hyper-acute and acute phase (< 2 days), hematomas are likely to be hyperdense to the spinal cord and therefore distinguishable. However, if imaged in the early subacute phase (2-7 days), the hematoma may appear isodense to the spinal cord and not distinguishable. Consider CECT and CT myelogram during this phase. Last, the hematoma is likely to be hypodense to the spinal cord in the chronic phase (weeks to months). However, the clinical value of diagnosis at this stage is of intermediate value.

delineate extradural blood products [11]. Dual-energy CT takes advantage of materials inherent differences in x-ray absorption by using both high and low x-ray spectra.

Lastly, evaluating the spine with dedicated spine CT protocols (as opposed to spine evaluation with other protocols such as chest CT protocols) will optimize diagnostic capabilities. Dedicated spine CT protocols include appropriate kilovoltage peak (kVp) (influences intensity of x-ray beam and is generally around 120kVp) and collimation that help to decrease artifact within the vertebral column [12]. Contents of the vertebral column are susceptible to volume-averaging and beam hardening artifacts due to the dense surrounding bone, making evaluation of the spinal cord and surrounding structures limited. Ultimately, there are limitations to the number of spinal pathologies that can be confidently assessed on chest CT [13]. In dedicated spine CT protocols, sagittal and coronal reconstructions are specifically designed to optimize the evaluation of the vertebral bodies and their contents.

Evaluation of spinal pathologies, including iatrogenic cord injury and SEH, without the use of MRI and in the setting of an ambiguous neurologic exam presents a diagnostic challenge and can delay intervention, leading to poor clinical outcomes [14,15]. We offer possible diagnostic radiologic alternatives, and their rationale/limitations, when faced with this dilemma. It is important to emphasize that even with exhaustion of these radiologic alternatives, iatrogenic cord injury and SEH may remain radiographically occult. MRI remains the gold standard and should be obtained as early as possible if clinical concerns of a SEH persist.

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