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Case Report

Dorsal arachnoid web adjacent to paraspinal retained bullet: Blunt post-traumatic etiology ☆

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ABSTRACT

Dorsal arachnoid webs are uncommon, and of uncertain etiology. We present a case in which imaging findings of a dorsal arachnoid web were identified at the level of a known prior gunshot injury where a retained bullet was lodged adjacent to the spine, without associated penetrating injury to the spine, suggesting blunt post-traumatic etiology.

Introduction

Dorsal arachnoid webs are unusual and relatively poorly understood entities [1,2]. The etiology of dorsal arachnoid webs is speculative and largely unknown but believed to be because of an intradural extramedullary transverse band of arachnoid tissue that extends to the dorsal surface of the spinal cord, causing mass effect and dorsal indentation. A reliable secondary imaging finding, the scalpel sign, has been shown to accurately predict the presence of an arachnoid web [5]. It has been postulated that these webs arise from cysts deriving from the normal dorsal intradural spinal ligament, the septum posticum [1–3].

Case presentation

A 68-year-old male undergoing evaluation for lower back pain and pseudoclaudication was referred for a CT myelogram. He had a history of previous lumbar spine surgery at L4-L5 performed in 2005, which helped his low back symptoms initially but later developed problems with balance. Additional surgical decompression of the upper lumbar spine was performed in 2013 which transiently helped with his balance issues. He currently ambulates with a cane and uses a scooter for longer distances.

The patient reports that he had been shot approximately 40 years ago while on duty as a law enforcement officer and had a retained bullet lodged in the upper right paraspinal tho-

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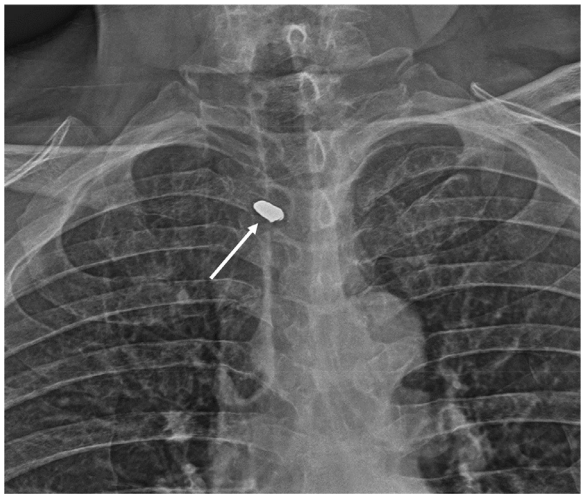

Fig. 1 – PA radiograph of the chest shows chronic findings of a 0.22 caliber bullet lodged at the right lateral margin of the T3 vertebral body (arrow).

rax [Fig. 1]. The bullet was known to be .22 caliber composed of copper-plated lead. The gunshot entry wound was in the right axilla, with bullet traveling through the right lung, before lodging in the right posterior elements of the T3 vertebra [Fig. 2]. There was no penetrating injury to the spine.

An MRI had been requested for evaluation of his lower back pain but was not performed because the selected imaging center did not want to assume the risk of imaging the patient due to the history of prior gunshot injury and known presence of the paraspinal bullet fragment. This is despite reports that nonferromagnetic projectiles (eg, lead, copper, brass, or zinc) neither undergo heating nor significant translational or rotational forces and are generally considered safe to scan.

Consequently, the patient was referred to us for further evaluation with CT myelography. Imaging showed that the patient had congenital variant segmentation of the spine with 7 cervical, 12 thoracic, and 5 lumbar vertebrae, with a fully segmented lumbarized S1 element and rudimentary riblets at L1. The CT myelogram revealed prior surgical changes of posterior lumbar spine decompression from the levels of L2-S1. Multilevel lumbar spine degenerative changes were identified including high-grade spinal canal stenoses at the L4-L5 and L5-S1 interspaces.

CT myelographic imaging of the thoracic spine also revealed a characteristic scalpel deformity of the dorsal spinal cord described in association with dorsal arachnoid webs [Fig. 2] just above the level of the retained right paraspinal bullet fragment. The spinal cord was displaced anteriorly within the thecal sac and deformed/flattened posteriorly. There was no anterior transdural herniation of the spinal cord or evidence for loculated cyst.

Discussion

The 2 primary differential conditions for dorsal arachnoid web include ventral transdural herniation of the spinal cord and

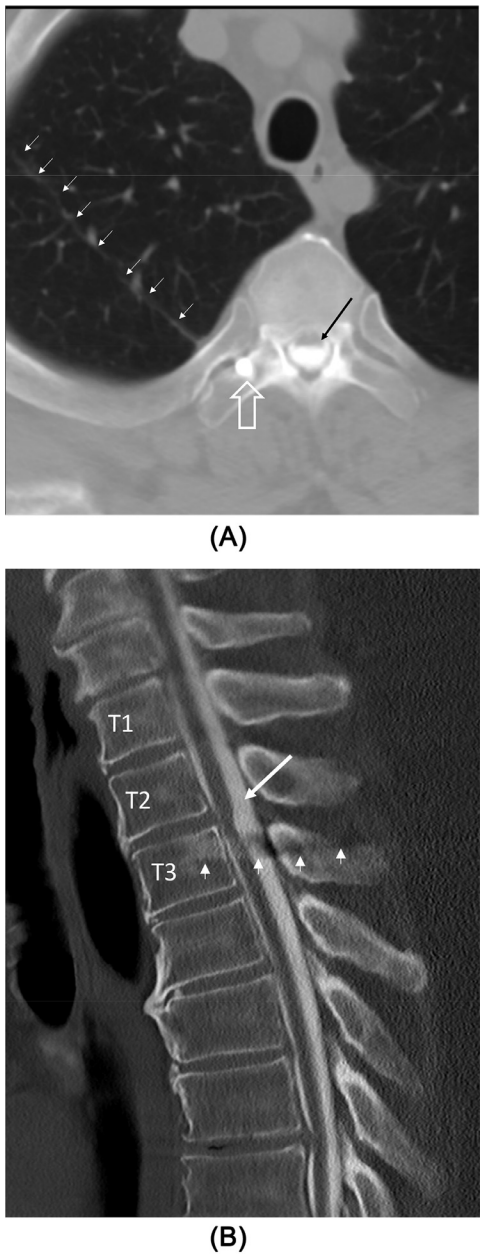

Fig. 2 – (A) Axial CT myelogram image at the level of T3 shows the retained bullet (Block arrow) lodged in the right posterior elements of T3. A chronic linear bullet tract/scar can be seen coursing obliquely through the right lung (small white arrows), corresponding to known right axillary bullet entry location. Within the spinal canal there is anterior displacement with posterior flattening deformity of the upper thoracic spinal cord (long black arrow) at this location. (B) Sagittal CT myelogram at the level of the upper thoracic spine shows characteristic "scalpel sign" associated with a dorsal arachnoid web at the level of the upper T3 vertebral body (long arrow). The ill-defined hypoattenuation coursing through the spine at the level of the upper body of T3 is due to beam hardening reconstruction artifact related to the retained bullet (small arrows).

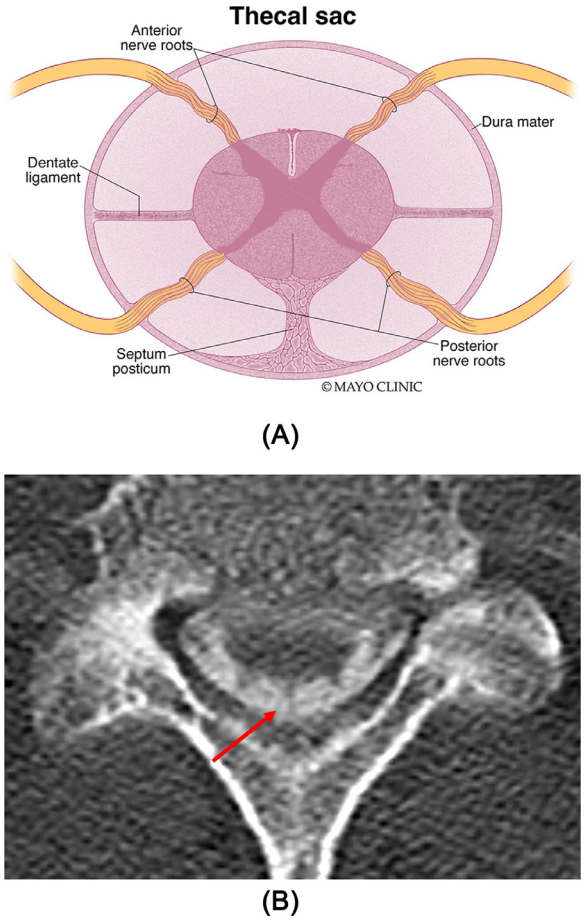

Fig. 3 – Cross section diagram of the thecal sac (A) and axial CT myelogram image from upper thoracic spine (B). The septum posticum consists of a thin membranous partition which extends from the midline dorsal spinal cord to the dorsal thecal sac (red arrow) from the levels of the cervical to lower lumbar regions. Injury to the septum posticum has been postulated as the possible structural location from which dorsal arachnoid webs and/or arachnoid cysts develop.

primary intradural arachnoid cyst. Imaging manifestations of transdural herniation include protrusion of spinal cord beyond the anterior dural margin, which was clearly not present in this case. A loculated intradural arachnoid cyst will typically not fill with contrast and have clearly demarcated proximal and distal margins, differentiating this condition from a dorsal arachnoid web.

The etiology of dorsal arachnoid web remains largely unknown, but one proposed theory is that they arise from arachnoid herniation originating from the normal posterior intradural spinal ligament, also known as the septum posticum [2]. The septum posticum was first described in 1843 by Magendie [4], who found it to be composed of thin, transparent lamellae irregularly separated by small spaces of various shapes and sizes. The septum posticum divides the posterior spinal subarachnoid space longitudinally (Fig. 3), extending from the levels of the cervical to the lower dorsal spine regions. Forceful CSF flow from a transient post-traumatic shock wave may disrupt normal posterior arachnoid membranes leading to a compressive arachnoid band and/or loculated dorsal intradural extramedullary CSF arachnoid collection.

Evidence supporting involvement of the septum posticum is that arachnoid webs characteristically occur dorsally within the spinal canal in location and have not been described in anterior or lateral intradural locations. An upside-down dorsal scalpel sign has been reported where anterior displacement of the spinal cord within the thecal sac occurs above the arachnoid web [6]. Dorsal arachnoid webs also most frequently involve the upper thoracic region, with analysis of 36 cases from the literature showing that the most common site of arachnoid cysts is in the thoracic region between the 3rd and 7th vertebral levels [3]. A possible explanation for this is that the anterior-posterior dimension of the dorsal subarachnoid space and consequently the intradural extent of the septum posticum is greatest in the upper thoracic region due to curvature of the spine, a factor which may account for the observed increased susceptibility for dorsal arachnoid web formation at these levels.

Prior surgical reports [2] have revealed dorsal arachnoid webs to be due to a spectrum of changes ranging from thickened transverse arachnoid membranes to distended fluid-filled collections within the layers of the septum posticum, presumably containing CSF. A posttraumatic etiology has been suspected but difficult to prove. Many cases have been reported in the absence of known trauma. A developmental etiology cannot be excluded, at least as a precipitating cause for dorsal arachnoid web. Additional etiologic considerations include congenital dural defects, postinfectious and inflammatory causes, and postoperative changes.

We could not identify any prior reports of dorsal arachnoid web formation in association with gunshot injury to the spine. In this case report there was no penetrating injury of the spinal cord at the time of initial gunshot injury or any other time. The findings in our case imply that a ballistic pressure wave related to the decelerating bullet through the chest and paraspinal soft tissues likely disrupted the dorsally located arachnoid membranes of the septum posticum, leading to the formation of a dorsal arachnoid web with incomplete arachnoid cyst. It is plausible that other forms of trauma resulting in blunt injury to the spine such as falls from a height, or during sports activities such as skateboarding, bicycling, or trampoline could also lead to the formation of dorsal arachnoid web. The intense forces and shear pressure wave generated by these other forms of blunt trauma could also conceivably result in injury or partial disruption of the septum posticum leading to subsequent dorsal arachnoid cyst/web formation. The latency between injury and diagnosis was 40 years in our case, suggesting that the history of prior remote trauma may be overlooked.

Conclusion

The presence of a dorsal arachnoid web at the level of known gunshot trauma with retained paraspinal bullet suggests a traumatic etiology for this entity. The characteristic posterior and upper thoracic location of dorsal arachnoid webs impli-

cate the septum posticum and prominent dorsal subarachnoid space as predisposing anatomic factors. The imaging findings presented in this case report help provide an insight into one of the possible mechanisms accountable for this entity.

Patient consent

The patient presented in this report has authorized the use of his medical records for research purposes.

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