Review Article

Spinal Cord Hemorrhage

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Background and Purpose: Spinal cord hemorrhages are rare conditions that can be classified based on the primary location of bleeding into intramedullary (hematomyelia), subarachnoid hemorrhage (SAH), subdural hemorrhage, and epidural hemorrhage. We conducted a literature review to better understand the presenting symptoms, etiology, diagnosis, and treatment of spinal cord hemorrhages. *Methods:* We performed a literature search using PubMed with the key words spinal hemorrhage, hematomyelia, spinal subarachnoid hemorrhage, spinal subdural hematoma, and spinal epidural hematoma *Results:* Most commonly, spinal hematomas present with acute onset of pain and myelopathy but a more insidious course also may occur. Spinal SAH may be especially difficult as it may cause cerebral symptoms. The etiologies vary based on the type (location). The most common causes are trauma, iatrogenic causes, vascular malformations, and bleeding diatheses. Management is often aimed toward rapid surgical decompression and correction of the underlying etiology if possible. Conservative management, including administration of large doses of corticosteroids, reversal of anticoagulation, and close monitoring, has been used as bridging for surgical procedure or as the mainstay of treatment for patients with mild or improving symptoms. *Conclusions:* The variable and overlapping presentations of spinal cord hemorrhages make the diagnosis challenging. Maintaining high levels of clinical suspicion and utilizing magnetic resonance imaging may help in making the right diagnosis. Future studies should aim to create standardized outcome grading system and management guidelines for patients with spinal hemorrhage. **Key Words:** Spinal cord—hemorrhage—hematomyelia—subdural hematoma—subarachnoid hemorrhage—vascular malformations—anticoagulation.

Introduction

Vascular diseases of the spinal cord (strokes) are much less common than vascular diseases of the brain. The incidence of spinal cord infarction is estimated to be approximately 3 per 100,000 person-year.[1] Even less common is spinal cord hemorrhage. It is most commonly found in association with spinal cord trauma. Still, spontaneous bleeding into the spinal cord or adjacent structures does occur. Similar to the brain, spinal cord hemorrhages can be classified based on the primary location of the bleeding into intramedullary (hematomyelia), subarachnoid hemorrhage (SAH), subdural hemorrhage, and epidural hemorrhage. The etiology varies by location. The most common cause of bleeding is trauma. Vascular malformations and bleeding diatheses are the most common causes of nontraumatic bleeding affecting the spinal cord. The incidence of spinal cord

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hemorrhage remains unknown. Owing largely to difficulties in recognition, it may be underreported.[2] The variable presentations of the spinal cord hemorrhage add to the diagnostic challenges. Hemorrhage usually presents as acute, painful myelopathy, with the symptoms and signs reflecting the level of the lesion, the severity of the bleeding, and the acuity.

In this article we review the clinical presentations of different types of hemorrhage affecting the spinal cord, shedding light on the different etiologies, diagnosis, and management for each type.

Vascular Anatomy of the Spinal Cord

When compared with the arterial and venous anatomy of the brain, the vascular anatomy of the spinal cord is less defined. In addition, there is considerable variability in the vascular anatomy of the spinal cord. In general, the spinal cord is less prone to primary vascular injury than the brain.[3] Reasons for this relative protection include a rich collateralized spinal blood supply and its lower gray-to-white matter ratio.[3] The spinal cord is supplied by a network of anastomosis arising from 3 longitudinal vessels: two posterior spinal arteries and the anterior spinal artery. There is no direct communication between the anterior and the posterior circulation of the spinal cord.[4] Knowledge of the longitudinal anatomy is crucial for understanding spinal cord ischemia, whereas the cross-sectional vascular anatomy is more important for the recognition of spinal cord hemorrhages.

To summarize the longitudinal arterial anatomy to the spinal cord, blood is delivered to the anterior spinal artery by the medullary branches of the intradural vertebral arteries and subsequently by segmental radiculomedullary arteries. The blood is conveyed to the posterior spinal arteries by intradural vertebral arteries, which are from the medullary segments of the posterior inferior cerebellar arteries and segmental radiculopial arteries.[5,6] The number of collateral radiculomedullary arteries present at different levels of the spinal cord varies considerably among people. Specifically, the mid-thoracic level of the cord is vulnerable to ischemia because it is the site of terminal perfusion from flow coming from the upper cord and the flow from the Artery of Adamkiewicz, which supplies the lower thoracic region (T8-L3).

The cross-sectional arterial supply is divided into a central system, which perfuses the gray matter and parts of the white matter, and a peripheral system, which supplies the rest of the white matter.[5,6] Blood flows through the central system from deep to superficial, and is supplied by penetrating branches of the central sulcal arteries.[5,6] The sulcal arteries originate from the anterior spinal artery and course into the ventral median sulcus before entering the cord.[5,6] The penetrating radial arteries of the peripheral system arise from the vasocorona, which is formed by branches of the posterior spinal arteries.[5,6]

The venous drainage of the deep central regions of the spinal cord is equally divided between the anterior median spinal vein and the posterior median spinal vein. The superficial regions of the spinal cord are drained by radial veins that empty into the coronal venous plexus on the pial surface of the spinal cord. There is significant anastomosing between the deep and superficial venous drainage systems, and between the anterior and posterior venous systems.[5,6]

The anterior and posterior median spinal veins are leptomeningeal structures that unite to form ventral and dorsal veins that cross the dura mater to empty into segmental spinal (intervertebral) veins. The intradural venous plexus has direct anastomosis with the epidural venous plexus (Batson plexus). Eventually, the venous blood finds its way to the superior vena cava through several draining veins.

Clinical Presentations

The symptoms and signs of bleeding into or around the spinal cord are similar regardless of the primary site of hemorrhage. However, the manifestations of spinal cord hemorrhage vary depending on the acuity and both the longitudinal and cross-sectional location of the hematoma. Patients with spinal cord hemorrhage may develop symptoms acutely (minutes to days) or subacutely (days to weeks). However, a stepwise course of worsening or a slowly progressive course (weeks to years) may occur in less than 5%.[2,5-7]

The sudden onset of intense back or neck pain is a common feature.[2,6] It usually is the patient's chief complaint. The pain is usually located at the level of the hemorrhage but can radiate to the extremities.[2,8] The sudden onset of severe back or neck pain "le coup de poignard" or "the strike of the dagger" as described by Michon is a hallmark of SAH from spinal origin.[9] A history of previous episodes of back pain may be suggestive of sentinel (minor) hemorrhages.[10] Progressively worsening neurological symptoms include weakness and sensory loss at and below the level of the hemorrhage with or without bowel or bladder disturbances, which usually immediately follow the onset of pain and result from cord compression at the level of the bleeding.[2,6]

Depending on the level of the cord injury, patients will have either quadriplegia or paraplegia found on examination. In a meta-analysis of 613 patients with spinal hemorrhages, 30% had acute onset of complete paralysis with bowel or bladder disturbances and 16% had acute onset of incomplete paralysis with bowel or bladder disturbances.[2] Beevor sign may be found with a hemorrhage at the T-10 level of the cord. Usually, sensory loss to all modalities corresponding to the motor impairments will be found. Dissociated sensory loss with relative preservation of vibratory and position sense with loss of pain and temperature sense or vice versa may be found