MRI findings in spinal cord penetrating injury: three case reports

Aspects IRM des plaies vertébromédullaires : à propos de trois cas

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Abstract Stab wounds of the spinal canal are rare and constitute an uncommon cause of spinal cord injury. They are usually responsible for an immediate neurological deficit that requires emergency therapeutic management to minimize the extent of neurological deficit and to prevent further loss of neurological function. Magnetic resonance imaging (MRI) is used to evaluate damage to the spinal cord, including contusions, hematoma and compression of extramedullary origin. We report the MRI findings in three patients admitted for spinal canal penetrating injury with neurological symptoms.

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Introduction

MRI findings in patients with penetrating injury of the spinal canal can include various features, from spinal-cord destruction to a normal-appearing spinal cord [2]. Magnetic resonance imaging (MRI) can reveal spinal cord damage resulting from direct cord penetration, spinal cord compression of extramedullary origin, and injury to the bone and ligaments [7]. We report on three patients admitted for penetrating spinal injury with neurological symptoms and investigated by emergency MRI. We discuss the value of this visualization technique in the evaluation, diagnosis and management of stab wounds of the spinal canal.

Case 1

A 34-year-old man was admitted to the emergency department for a stab wound in the lower thoracic spine. Physical examination showed a puncture wound with cerebrospinal fluid outflow. Neurological examination showed right crural monoparesis with cutaneous hyperesthesia. The examination protocol consisted of sagittal and axial T1- and T2-weighted images using a 1.5 Tesla MRI system. T2-weighted MRI showed high signal intensity of the spinal cord at the T9–T10 level corresponding to spinal cord contusion. In the meantime, the knife track demonstrated even higher signal intensity on T2-weighted imaging (Fig. 1). As an emergency case, the patient underwent prophylactic tetanus treatment associated with a T9-T10 laminectomy, which allowed suturing of the cut dura. In the immediate surgical follow-up, the patient received prophylactic anti-biotherapy for 48 hours.

Case 2

A 24-year-old man was stabbed with a knife 6 hours before admission to our hospital. On arrival, the patient was awake, with no orientation deficits and stable vital signs. Physical examination showed a stab wound in the thoraco-lumbar region. Neurological examination revealed left crural monoparesis. Sagittal and axial T2-weighted MRI showed spinal cord contusion, from the knife track extending from the skin wound to the spine, expressed as linear high-signal intensity through the posterior soft tissue and bony elements of the lumbar spine at the level of L1-L2 (Fig. 2). A simple suture of the skin injury was achieved with a favorable clinical outcome.

Case 3

A 24-year-old man was admitted to our hospital with stab wounds in the cervical spine. On admission, the patient was hemodynamically stable with no orientation deficits. Neurological examination showed a picture typical of Brown-Séquard syndrome. The T1- and T2-weighted MRIs of the sagittal view of the spine, and axial T2- and T2*-weighted MRIs revealed left spinal cord edema at the C4-C5 level (Fig. 3). After 4 days in the neurosurgery ward, the patient received intensive physiotherapy.

Figure 1 Sagittal T1- (a) and T2- (b) weighted MRIs show spinal cord contusion as a low signal and high signal, respectively, in the cord at the level of T9-T10 (arrow). Note the high-signal knife track (short arrow).

Figure 2 Sagittal and axial T2-weighted MRIs show a high signal in the spine corresponding to cord contusion, and a linear high signal at the level of L1-L2 representing the knife track (arrow).

Figure 1 L’IRM du rachis dorsal en coupes sagittales pondérées T1 (a) et T2 (b) montre un foyer de contusion médullaire en hyposignal T1 et hypersignal T2 en regard du niveau T9-T10 (flèche). À noter le trajet lésionnel postérieur (flèche courte).

Figure 2 L’IRM du rachis lombaire en coupes sagittale et axiale pondérées T2 montre un hypersignal centromédullaire correspondant à une plaie médullaire. Le trajet lésionnel apparaît en hypersignal linéaire (flèche).
Discussion

Stab wounds of the spinal cord are relatively rare and represent approximately 25% of all spinal cord injuries [1]. They occur mostly in young male adults. All levels of the spinal cord may be affected, but injuries are mostly to the thoracic spine [3]. These injuries may range from a normal-appearing cord to complete cord destruction. However, permanent loss of function may occur, with secondary ischemic injury, even in an apparently normal spinal cord [4]. Indeed, patients are usually admitted with immediate neurological symptoms at the acute stage of injury, with complete or partial deficits [1,8]. Our three patients manifested immediate, permanent neurological deficits.

X-rays should include anteroposterior and lateral views of the spinal canal to assess bone damage, and CT-scanning is useful to elucidate the nature of bony injury and to delineate the trajectory of the knife. Furthermore, CT may reveal bony fragments, disk herniation, foreign bodies and pneumocephalus as well as hematoma as a source of neurological deficits [1,4]. MRI is the visualization technique of choice for detecting spinal cord injury as it allows accurate assessment of spinal cord anatomy. However, its main disadvantage is that the presence of ferromagnetic knife fragments can lead to artifacts that may prevent accurate image interpretation [4]. With spinal cord injuries, MRI can reveal pathological characteristics, and the locations and extent of lesions. MRI sequences currently used include sagittal and axial T₁ and T₂-weighted images, which can uncover cord edema, while T₂*-weighted images are good for detecting acute hematoma [7]. Intramedullary injuries include contusion, hematoma and knife-track damage. Contusion is shown as hypointense signals on T₁-weighted images and hyperintense signals on T₂-weighted images [7]. Oxyhemoglobin contributes by revealing acute hemorrhage as an isosignal or low-signal intensity on T₂-weighted images [7,2]. The knife-track lesion appears as a linear high-signal intensity on T₂-weighted images. MRI may also reveal a posttraumatic pseudomeningocele, resulting from disruption of the spinal dura causing a cerebrospinal fluid (CSF) fistula, which appears iso-intense compared with CSF signals, using all MRI sequences. Paraspinal soft tissue damage appears as a high-signal intensity on T₂-weighted images extending from skin wound to the spinal cord. Extramedullary hematomas such as an epidural hematoma with biconvex margins, or a subdural hematoma with a concave margin facing the cord and convex margin facing the vertebral, show signal intensities that depend upon bleeding and age. Disruption of anterior and/or posterior longitudinal ligaments appears as a discontinuous linear band of low-signal intensity. Disc herniation, bone fractures and vertebral-artery lesions in cervical spine injury are well demonstrated by MRI [7]. Subacute lesions may show up as atrophic changes on both T₁- and T₂-weighted MRIs. Cavitations appear as hyperintense signaling on T₂-weighted images distal to the transection, suggesting formation of a syrinx. There is a strong correlation between MRI findings and the severity of neurological symptoms [1,5,6]. The prognosis depends on the injury. Patients with minimal and no cord changes on MRI have the best outcome whereas patients with parenchymatous hemorrhage or contusion have poor prognoses [8].

Figure 3 Sagittal T₁- (a) and T₂- (b) weighted images, and axial T₁- (c) and T₂*- (d) weighted images clearly demonstrate a penetrating lesion at the level of C4-C5 (arrow) as abnormally low- and high-signal intensity areas, respectively.

Figure 3 L'IRM du rachis cervical en coupes sagittales pondérées T₁ (a) et T₂ (b) et en coupes axiales pondérées T₂ (c) et T₂* (d) montre un foyer de contusion médullaire en hyposignal T₁ et hypersignal T₂ et T₂* en regard du disque intervertébral C4-C5 (flèche).
On admission to the emergency department of the hospital, all patients with spinal cord injuries should receive a broad-spectrum antibiotic and a prophylactic tetanus shot. The surgical treatment of spinal cord penetrating injury remains controversial. Indications requiring potential surgical management include CSF fistulas; devitalizing tissue, to minimize the chance of infection; knife fragments containing lead or copper, to reduce the risk of inflammatory complications; and hematoma, with compression of the spinal cord and/or nerve roots. However, the impact of surgical management on long-term neurological outcome remains uncertain [3,4]. Whenever surgery is indicated, the objective of the treatment, the severity of neurological symptoms and the presence of systemic injuries all need to be considered.

Conclusion

MRI is the modality of choice for the evaluation of spinal canal penetrating injury in patients with neurological symptoms. This visualization technique allows the classification of different types of lesions, ranging from spinal cord edema to complete spinal cord transection. It is also a useful tool for the surgical management of such patients.

References