MR Imaging of Traumatic Brain Injury in Clinical Practice

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LEARNING OBJECTIVES

1. To present an imaging strategy for patients admitted with acute traumatic brain injury, and to propose a standardized imaging pattern analysis approach.
2. To review the most common types of traumatic brain injury and their imaging characteristics.
3. To show that there is a subset of patients with craniocerebral trauma in whom there is a discrepancy between CT findings and clinical neurological examination, and in whom MRI should be performed.
4. To identify quantitative imaging parameters that can serve as (surrogate) biomarkers for predicting patient prognosis and outcome.

ABSTRACT

For patients admitted with (acute) traumatic brain injury, CT and MRI examinations constitute an essential part of the diagnostic work-up. Increasingly, in daily clinical practice, imaging findings determine patient management and greatly influence the clinical course, especially the acute setting. There is no doubt that CT remains the first choice technique to determine the presence and extent of injuries (such as fractures, intra-and extra-axial hemorrhage, mass effect, etc.). CT findings are crucial in planning and guiding neurosurgical intervention. Multi-detector CT scanning allows simultaneous assessment of head and cervical spine, thereby obviating the need for plain X-rays.

However, there is a subset of patient with traumatic brain injury, in whom there is a discrepancy between the severity of clinical neurological findings and the paucity of relevant CT abnormalities. In these patients, MR imaging of the brain should be performed to inventorize parenchymal damage.

During this presentation, we will propose a standardized pattern analysis approach, in order to obtain a quick and complete inventory of the traumatic brain lesions. In clinical practice, it is important to understand the difference between primary and secondary lesions. Primary injuries occur as a direct result of the impact with damage to brain tissue. Examples include fractures, different types of traumatic haemorrhage (epidural, subdural, intracerebral, subarachnoid), cerebral contusion, diffuse axonal injury (DAI). CT- and/or MR-angiography are useful techniques to document traumatic blood vessel injury. Secondary injuries are caused by systemic factors such as increased intracranial pressure, edema, brain herniation, decreased cerebral blood flow, excitotoxic damage.

Increasingly, there is an important role for MRI of the brain in patients admitted with traumatic brain injury. In these cases, the multiparametric MRI should include diffusion, perfusion, and susceptibility-weighted imaging. Whenever there is a discrepancy between the patient's clinical status and imaging findings, MRI is indicated. Diffusion tensor imaging with fractional anisotropy mapping may show microstructural abnormalities in patients with mild TBI, even when traditional MRI sequences appear normal. Neuroimaging also plays a role in the chronic stage, identifying sequelae, determining prognosis, and guiding rehabilitation.

In conclusion, recent technological advances in CT and MRI have greatly improved our understanding of the pathophysiology of craniocerebral trauma and allow us to detect abnormalities, even in patients with mild head trauma, when routine imaging studies appear normal.