CLINICAL CASE - TEST YOURSELF | Head and neck imaging

Differential diagnosis of an intra-axial brain lesion. Tumor, infection, or inflammation?

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PART A

A female patient, aged 35, arrived at the Neurology Emergency Department without any notable medical background. She experienced a sudden onset of right-sided weakness, which was confirmed through clinical examination as right hemiparesis. Initial laboratory tests indicated a mild form of microcytic anemia, while the levels of white blood cells (WBC) and C-reactive protein (CRP) were within the normal range. As part of the diagnostic process, the patient underwent a magnetic resonance imaging (MRI) scan, which uncovered an intra-axial lesion exhibiting the following characteristics.

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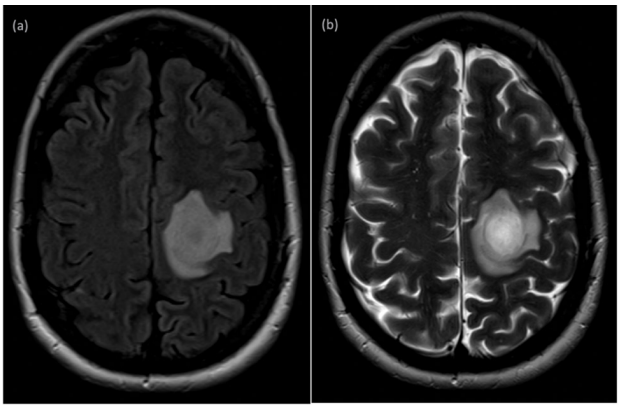

Figure 1. *FLAIR (a) and T2- WI (b)*

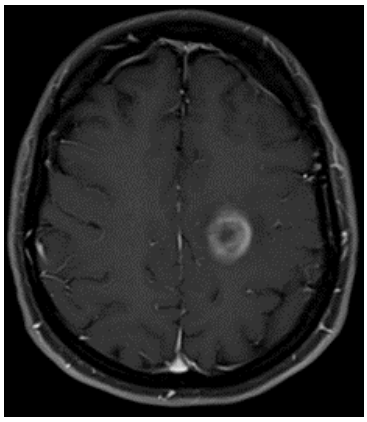

Figure 2. *T1- WI post contrast*

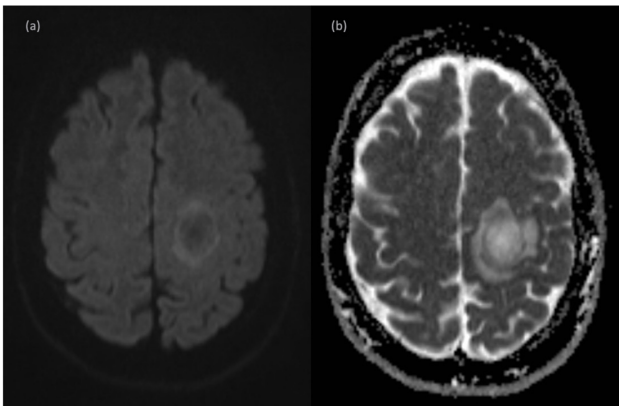

Figure 3. *DWI (a) and ADC map (b)*

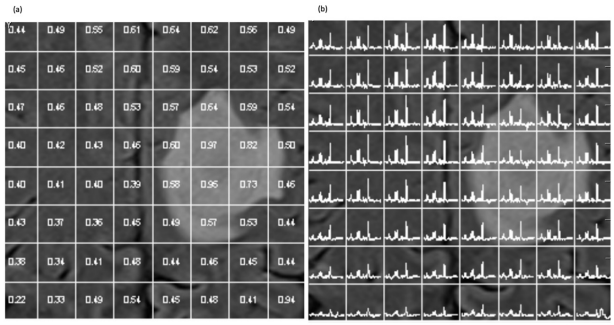

Figure 4. *MR Spectroscopy*

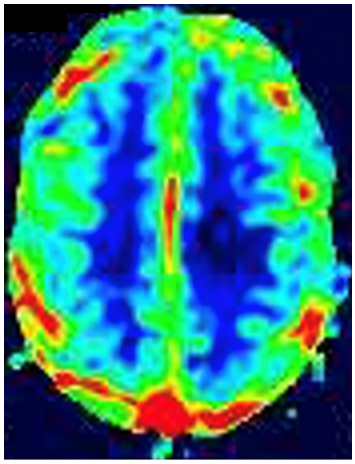

Figure 5. *CBV map*

PART B

Diagnosis: Tumefactive Demyelinating Lesion (TDL)

Discussion

Based on the clinical findings, the imaging results, and the progression of the disease, a diagnosis of TDL was made. Subsequent MRI scans performed 8 months later revealed the presence of multiple small ovoid lesions positioned perpendicular to the long axis of the lateral ventricles. These lesions are characteristic of Multiple Sclerosis (MS).

Tumefactive demyelinating lesion (TDL) is defined as a demyelinating lesion greater than 2 cm. As the name implies, these lesions exhibit imaging features that resemble other space-occupying lesions, such as high-grade gliomas and other types of brain tumors. [1,2]

The underlying pathophysiologic mechanism is yet to be determined. TDLs may occur either as an isolated finding, at the onset or alongside other disease processes as they progress. The majority of TDLs are attributed to MS, although other conditions such as Neuromyelitis Optica (NMO) and Acute Disseminated Encephalopathy (ADEM) have also been linked to TDLs. Less than 10% of individuals with a confirmed diagnosis of MS will experience a TDL. Conversely, in cases of initial isolated TDL (where no other MS lesion is observed in the first MRI), approximately 22% to 70% of individuals develop MS, with an estimated 5-year risk of MS conversion reaching 27%. [3]

TDLs have a female predilection, usually manifesting during the early to middle stages of adulthood, with an average onset occurring around the age of 37. [4]

The clinical symptoms of TDL can vary based on the size and location of the lesion, as well as the extent of mass effect. These symptoms can range from asymptomatic cases incidentally detected, to the sudden onset of hemiparesis. Other possible symptoms include headaches, seizures, aphasia, cognitive impairment, speech difficulties, or other focal neurological deficits. [3,5]

The role of imaging, and more specifically, the use of MRI techniques is crucial for the accurate diagnosis and differentiation from other intracranial lesions. There have been described four different MRI appearances depending on the most prominent conventional MRI characteristic: megacystic, Balo-like, infiltrative, and ring enhancing. [2,6]

On imaging, TDLs are typically large, with a diameter exceeding 2 cm and often display irregular borders. There is relatively little mass effect or surrounding edema. A central dilated vascular structure within the lesion has also been observed in TDL, which is thought to correspond to a vein draining towards the distended subependymal veins. [1,6] The location of TDLs is usually supratentorial, commonly involving the subcortical U fibers, with a predilection for involvement of the frontal and parietal lobes. [3,8]

The lesions may demonstrate contrast enhancement due to disrupted blood-brain barrier function, which can be depicted using contrast-enhanced T1-weighted imaging (WI). Various enhancement patterns have been described including open or closed ring, diffuse, homogeneous, punctate, or concentric pattern. An open ring pattern, where the incomplete section of the ring joins the grey matter side of the lesion, is indicative of a demyelinating cause. In TDLs, the ring enhancement signifies the progression of active inflammation away from the non-enhancing central region, which represents chronic inflammation. In the same area of ring enhancement, a T2 hypointense rim may be depicted. [1-3,6,8]

Diffusion weighted imaging (DWI) and ADC maps provide valuable information about the diffusion characteristics of TDLs. TDLs may exhibit peripheral restricted diffusion with the center of the lesion displaying high ADC values attributed to vasogenic edema and myelin destruction, while the periphery demonstrates low ADC values caused by the active inflammation process. The evolution of the diffusion restriction at the edge of the lesion on serial MRI scans observed in TDLs, is not typically encountered in abscesses or tumors. [3] ADC values may also aid in differentiating TDLs from neoplastic lesions with high cellular density including CNS lymphoma as the latter will display restricted diffusion. Differentiating TDLs from other tumors with necrotic areas might be more challenging as both lesions may display similar increase in ADC. [2,8]

Magnetic resonance spectroscopy (MRS) can be employed to assess the metabolic changes within TDLs. An increased choline (Cho) peak and a decreased N-acetyl aspartate (NAA) peak with an increased Cho to NAA ratio may be encountered in TDLs, a finding also common in neoplasia. The presence of a lactate peak and an elevated glutamate-glutamine peak are often considered as indicators supporting the presence of demyelination. [2-3,8]

Perfusion imaging techniques such as dynamic susceptibility contrast-enhanced MRI (DSC-MRI) or arterial spin labeling (ASL) can provide insight into the lesion's vascularity, aiding in distinguishing a TDL from other enhancing brain tumors. The mean relative cerebral blood volume within

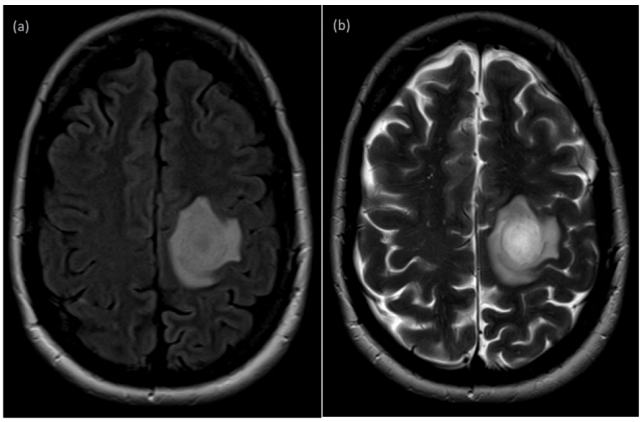

Figure 1. *FLAIR (a) and T2- WI (b) depicting a hyperintense lesion with a hypointense rim in the respective area of enhancement and limited perilesional oedema.*

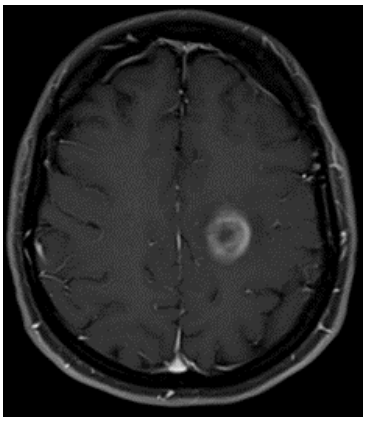

Figure 2. *T1- WI post contrast showing the same lesion with a concentric enhancement pattern.*

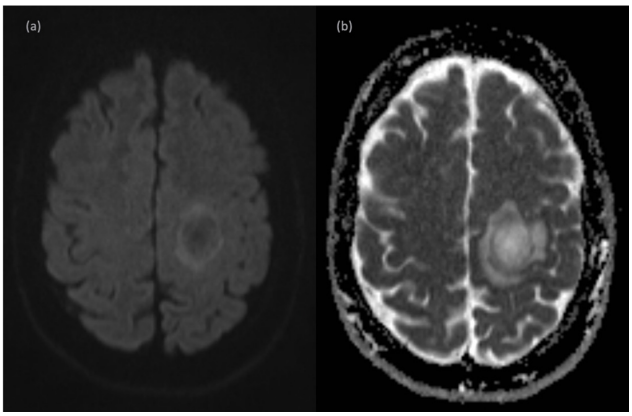

Figure 3. *DWI (a) and ADC map (b) demonstrate restricted diffusion only in the periphery of the lesion reflecting the inflammatory cell infiltrates.*

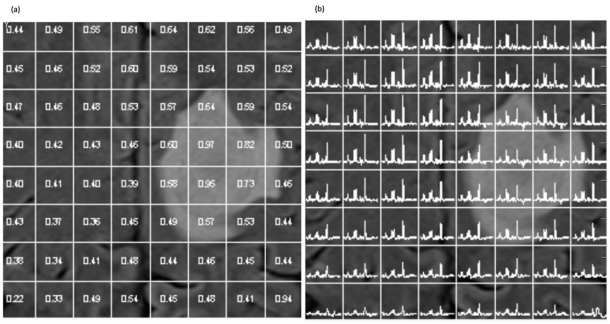

Figure 4. *MR Spectroscopy depicting low Cho to NAA ratio (a) and a negative double peak, representing lactate (b), in the area of interest.*

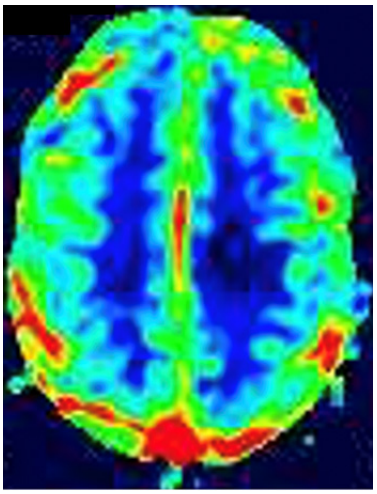

Figure 5. *CBV map depicting the area of interest with decreased CBV (dark blue colour).*

TDLs has been observed to be significantly lower compared to high-grade gliomas. [2-3,8]

TDLs can be solitary or multifocal. The presence of a solitary mass lesion may make the differentiation between TDL and neoplasm more challenging.

TDLs could imitate various intracranial conditions, such as primary brain tumors, abscesses, or other demyelinating processes. Compared to TDLs, high-grade gliomas tend to show a more prominent vasogenic edema and often display a complete ring enhancement pattern surrounding a central necrotic area. [2-3,8] Primary CNS lymphomas typically exhibit vivid enhancement along with restricted diffusion on DWI. Cerebral infective abscesses frequently demonstrate restricted diffusion in the central component. Radiologists should carefully consider the imaging findings and employ a multimodal approach to differentiate TDLs from these entities. [3]

The identification of a TDL often gives rise to a diagnostic challenge, especially when these lesions concern patients without a known history of demyelinating diseases. In certain instances, when there is diagnostic uncertainty, brain biopsy may be pursued, subsequently leading to increased morbidity and patient distress along with treatment delays. [3]

Understanding the distinctive imaging characteristics of TDLs is essential for accurate diagnosis and differentiation from other intracranial lesions. Integration of MRI sequences, assessment of lesion morphology, diffusion characteristics, spectroscopy, and perfusion imaging can aid radiologists in making the correct diagnosis, leading to appropriate patient management and treatment. Further research and collaboration between radiologists and neurologists are needed to enhance the understanding and recognition of TDLs. **R**

KEY WORDS
MRI, Inflammation, Tumefactive demyelinating lesion (TDL), Multiple Sclerosis (MS), Supratentorial

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