

Ring enhancing brain lesions: A Radiology Differential Diagnostic Challenge

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SUBMISSION: 15/1/2021 | ACCEPTANCE: 11/10/2021

PART A

A 48-year-old female patient was admitted to our hospital, with progressively worsening right hemiparesis and an episode of seizure.

The patient reported a history of a dental abscess that has been surgically drained 4 weeks ago. She had been under antibiotics for her odontogenic infection for 2 weeks. At presentation she reported headache, dizziness and mild numbness of her right arm. Her blood tests showed mild elevation of white blood cells

and neutrophils but were otherwise unremarkable.

A brain Computed Tomography (CT) scan (**Fig 1a,1b**) was performed upon arrival at the Emergency department and a brain Magnetic Resonance Imaging (MRI) study was performed the next day. The MRI protocol included FLAIR and T2WI (**Fig 2a,2b**), T1WI post contrast (**Fig 3**), diffusion weighted images and ADC map (**Fig 4a,4b**). Magnetic resonance spectroscopy (MRS) was also performed (**Fig 5a,5b**).



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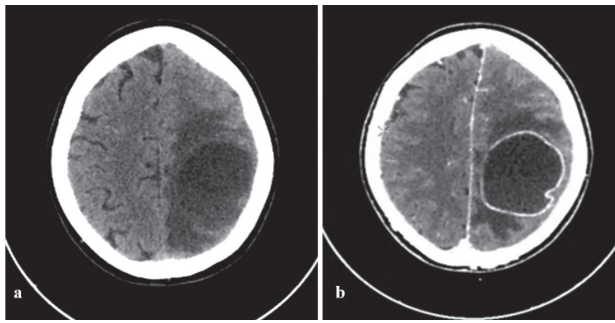


Fig. 1. Axial CT pre (a) and post (b) intravenous contrast

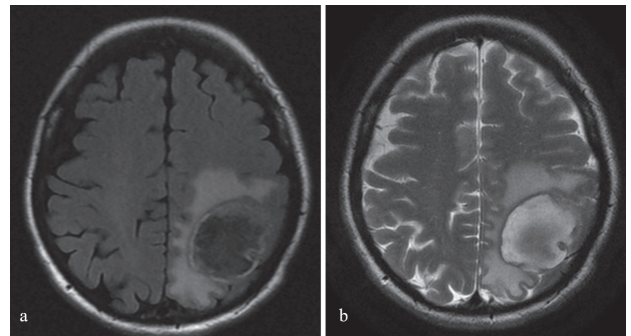


Fig. 2. Axial FLAIR (a) and T2WI (b)

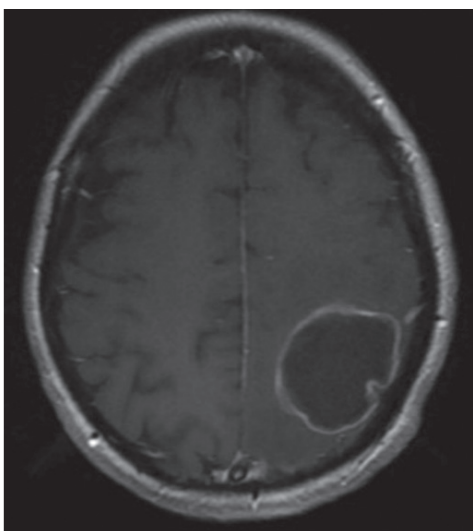


Fig. 3. Axial T1WI post gadolinium

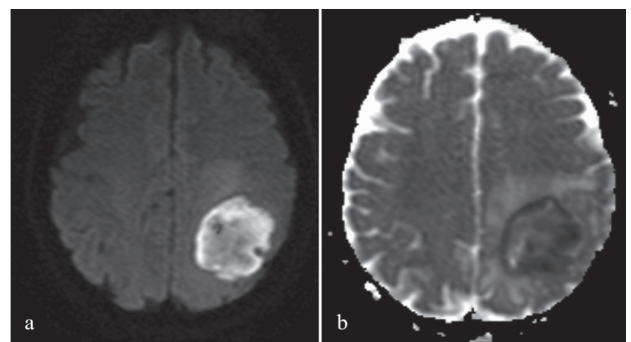


Fig. 4. DWI image (a) and ADC map (b)

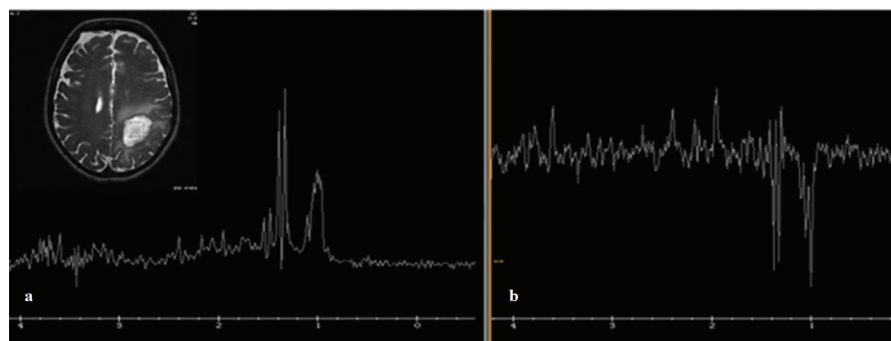


Fig. 5. Magnetic resonance spectroscopy (MRS) of the lesion core with short TE=35ms (a) and intermediate TE=144ms (b)

PART B

Brain abscess

CT (**Fig. 1a, 1b**) and MRI show a well circumscribed, ring enhancing brain lesion, of approximately 4cm in diameter, in the left parietal lobe, with surrounding edema and mass effect on the left lateral ventricle. The lesion appears with intermediate signal intensity on FLAIR (**Fig 2a**). On T2WI images the “dual-rim sign” is recognized, which consists of two concentric rims surrounding the abscess cavity, the outer one of which is hypointense, and the inner one relatively more hyperintense (**Fig 2b**). On post-gadolinium images the lesion presents ring-enhancement pattern (**Fig.3**). Diffusion weighted and ADC map images show restriction of diffusion (**Fig 4a,4b**).

The differential diagnosis of ring-enhancing lesions follows the well-known mnemonic of MAGIC DR L including Metastatic lesion, Abscess, Glioma, Infarction or Inflammatory lesion, Contusion, Demyelination, Resolving hematoma, and Lymphoma. However, having taken into account the clinical history and the imaging findings, the differential diagnosis list was shortened accordingly and finally comprised metastasis, abscess and glioma as well as lymphoma.

The presence of restricted diffusion in metastatic lesions is relatively rare; it is usually associated with a primary lung or breast cancer [6]. The restriction is attributed to the higher cellularity of the metastatic cells. CT scans of the chest and abdomen were performed to exclude the possibility of metastasis or generalized disease and there were no abnormal findings.

Primary central nervous system lymphoma, known to be a tumour with very high cellularity [1,2], usually appears hyperdense on CT and is relatively homogenous, presenting intense contrast enhancement on both CT and MRI. Due to its characteristic high cellularity, it shows restricted diffusion. In patients with immune deficiency however, lymphomas may have a ring enhancing morphology and imaging features might overlap those of a high-grade glioma or an abscess.

A brain abscess is the most common ring enhancing brain lesion that shows restricted diffusion. It develops from pathogens growing in the brain, following cerebritis. It may spread from a sinus infection or haematogenously. The pus-containing centre of the

brain abscess, due to its content of inflammatory cells, proteins, debris and bacteria, has a high viscosity and consequently shows restricted diffusion [1,3].

It has been reported that the ADC values of lymphoma and the centre of abscesses are significantly lower than that of high-grade glioma and metastasis. Nevertheless, low ADC values have been reported both in metastases and high-grade gliomas, maybe due to their heterogeneous cellular structure [2,4]. In cases that the clinical history and imaging are not very clear, advanced imaging may confirm the diagnosis of a brain abscess.

The method of choice for the differentiation of complex cases is MR spectroscopy. The classic spectrum of an abscess is very characteristic and includes peaks corresponding to lipids, lactate and amino acids (leucine, isoleucine, valine and alanine) [3,5]. Lactate is a non-specific metabolite produced by anaerobic glycolysis and it can be elevated either at the presence of an abscess or a necrotic tumour. However, the presence of elevated lactate, acetate and succinate results from the glycolysis and fermentation of infecting microorganisms [5]. Moreover, amino acids such as valine and leucine are end products of proteolysis by enzymes released by neutrophils in pus and they are not found in a brain tumour [5]. The MRS of our case demonstrated high concentration of lactate and amino acids with no presence of choline or NAA (**Fig.5a,5b**). Phase inversion at intermediate TE= 144ms is helpful to discriminate lactate or amino acid signals from lipid signals. Furthermore, there was no elevated concentration of metabolites at the periphery of the lesion. The findings of the MR spectroscopy were strongly suggestive of a brain abscess.

Taking into consideration all imaging findings and the clinical history, the diagnosis of a brain abscess was made.

The abscess was surgically drained, and the patient's clinical condition improved.

Regarding DWI, several authors report that progressive increase of ADC values during treatment could be an early index of medical response to antibiotics, earlier than the size reduction of the lesion and/or the presence of a gap in the peripheral rim

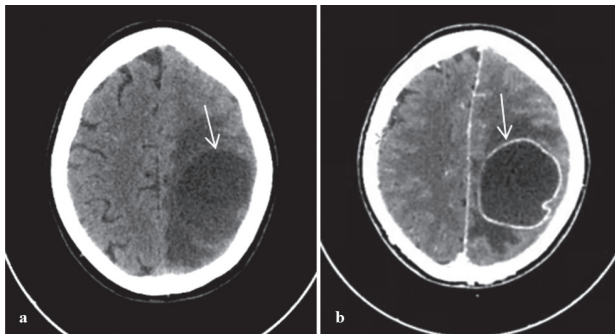


Fig. 1. Axial CT pre (a) and post (b) intravenous contrast shows a ring enhancing brain lesion (arrow) located in the left parietal lobe with surrounding edema.

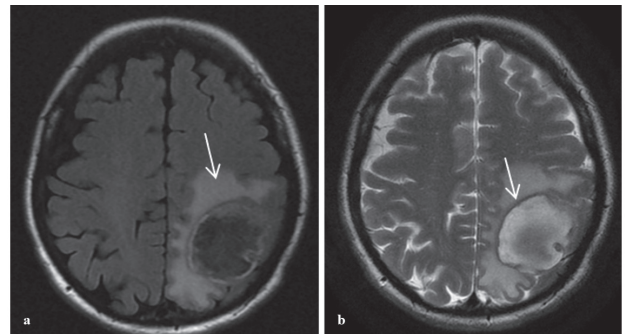


Fig. 2. Axial FLAIR (a) and T2WI (b) show a well circumscribed lesion in the left parietal lobe with surrounding edema (arrow in a). The lesion appears with intermediate signal intensity. T2WI image shows the dual-rim sign (arrow in b).

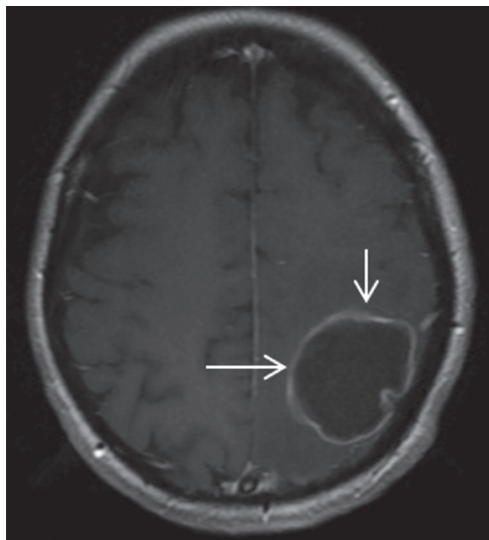


Fig. 3. Axial T1WI post gadolinium. Ring-enhancement pattern (arrows) of the lesion.

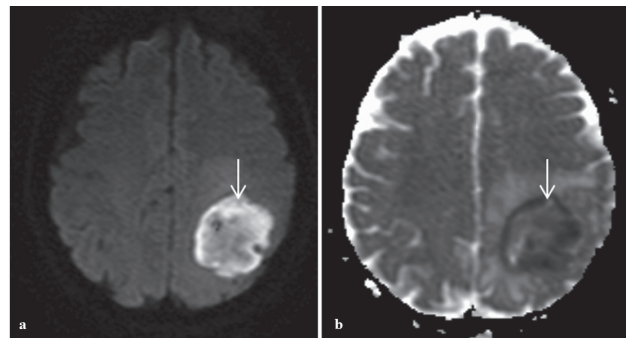


Fig. 4. DWI and ADC map. The lesion (arrows) shows restricted diffusion.

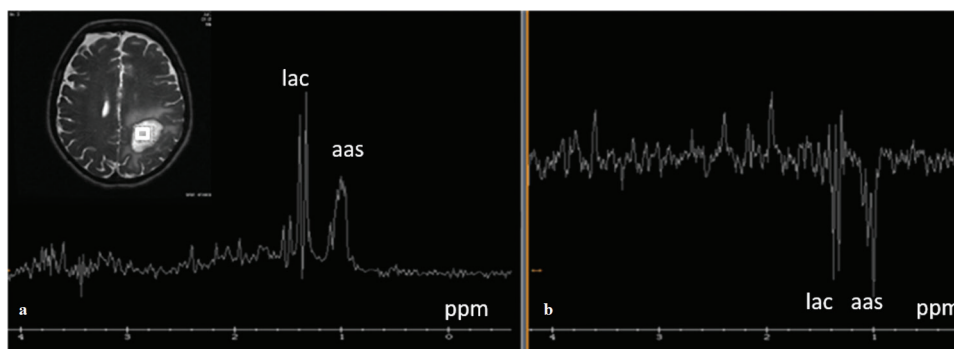


Fig. 5. Magnetic resonance spectroscopy (MRS) of the lesion core with short TE=35ms (a) shows elevation of lactate (lac) and amino acids (aas). Both peaks invert at intermediate TE=144ms (b) as typically expected for lactate and amino acids respectively (J-coupling effect). Choline or NAA is not recognized.

enhancement. Conversely, constantly low ADC values over time would be due to an ineffective therapy [1,6].

Moreover, some types of abscesses have typical HMRS profile. Pyogenic aerobic abscess typically presents peaks of cytosolic amino acids, lipids, alanine, acetate, succinate, and lactate. Pyogenic streptococcal spectrum presents lipids and lactate. Furthermore, typical finding in tubercular abscess is the presence of lipids and phosphoserine peak, while in fungal abscess is lipids and lactate. Finally, Nocardia abscess presents a peak of cytosolic amino acids and lactate while cysticercus

cytosolic amino acids, lactate, alanine, acetate, succinate, and choline [4].

In conclusion, ring enhancing lesions comprise a large range of differential diagnoses. The presence of restricted diffusion in a necrotic looking lesion should raise the possibility of an abscess, even in the absence of high fever. In doubtful cases, or to confirm the diagnosis MRS is the method of choice. **R**

Conflict of interest

The authors declared no conflicts of interest.



KEY WORDS

MRI, MRS, Diffusion, brain abscess

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Ioannidou K, Paresi A, Papavasileiou G. Ring enhancing brain lesions: A Radiology Differential Diagnostic Challenge. *Hell J Radiol* 2022; 7(1): 56-60.