ADVANCED MR IMAGING TECHNIQUES IN PRE-OPERATIVE DIAGNOSIS OF PRIMARY CNS LYMPHOMA

Zeeshan Azmat, Zafar Sajjad and **Humera Ahsan**

Department of Radiology, Aga Khan University Hospital, Karachi, Pakistan

Correspondence to: Dr. Azmat, Fellow in Neuroradiology, Aga Khan University Hospital, Karachi, 74800, Pakistan. Tel: +92-21-493-0051; email: zeeshan_30@hotmail.com

Pak J Neurol Sci 2007; 2(3):145-148

ABSTRACT

Although primary central nervous system lymphomas (PCNSL) represent only 1% of all non-Hodgkin's lymphomas (NHLs), in recent years there has been a dramatic increase in the frequency of PCNSL in both immunocompromised and immunocompetent patients. We present a case of PCNSL in an immunocompetent patient with focus on recent imaging advances and investigations.

Primary central nervous system (CNS) lymphoma refers to isolated involvement of the craniospinal axis in the absence of primary tumor elsewhere in the body. Once considered a rare occurrence, primary lymphomatous disease of the CNS is now encountered frequently, in both immunocompetent and immunocompromised patients.[1] The role of imaging is no longer limited to merely providing anatomic details. In this report, the value of the most commonly used advanced magnetic resonance (MR) imaging techniques, such as diffusion-perfusion imaging and MR spectroscopy, in the diagnosis of adult CNS lymphoma is explored.

CASE REPORT

A 35-year-old gentleman presented to the emergency room with complaints of headache and blurred vision for 20 days and right sided weakness for 14 days. Neurological examination revealed complete paralysis of the right upper and lower limbs with ipsilaterally decreased reflexes.

MRI brain showed a mass in the left basal ganglia that was isotense on T2 weighted imaging with surrounding edema and mass effect (Figure 1A). Post-gadolinium scans showed intense homogenous enhancement (Figure 1B). MR perfusion scanning displayed reduced regional cerebral blood volume (rCBV) in the affected area (Figure 1C). The lesion was hyperintense on diffusion weighted images and hypointense on ADC (apparent diffusion coefficient) maps (Figure 2, A and B). MR spectroscopy revealed reduced levels of the metabolite N-acetylaspartate (NAA), high peaks of choline (Cho) and lipid-lactate, and a very high Cho/NAA ratio of 8.02 (Figure 3 A and B). The MR features were all consistent with lymphoma. Brain biopsy confirmed lymphoma, classified as diffuse large B-cell non-Hodgkin's lymphoma according to the WHO system.

DISCUSSION

Primary CNS lymphoma may arise from different parts of the brain, with deep hemispheric periventricular white matter being the most common site of origin. Corpus callosum, cerebellum, orbits, and cranial nerves may also harbor the tumor.[2] Tumor histology almost always reveals intermediate- to high-grade extranodal non-Hodgkin's lymphoma of B-cell origin.[3] In patients with normal immunity, PCNSL classically presents as a solitary hemispheric mass with homogeneous enhancement on contrast administration.[4] In most patients, MR imaging reveals intermediate to low signal intensity on T1 weighted images and either isointense or hypointense signals (relative to grey matter) on T2 weighted images. Classic imaging findings of a space-occupying lesion, including mass effect and surrounding vasogenic edema,

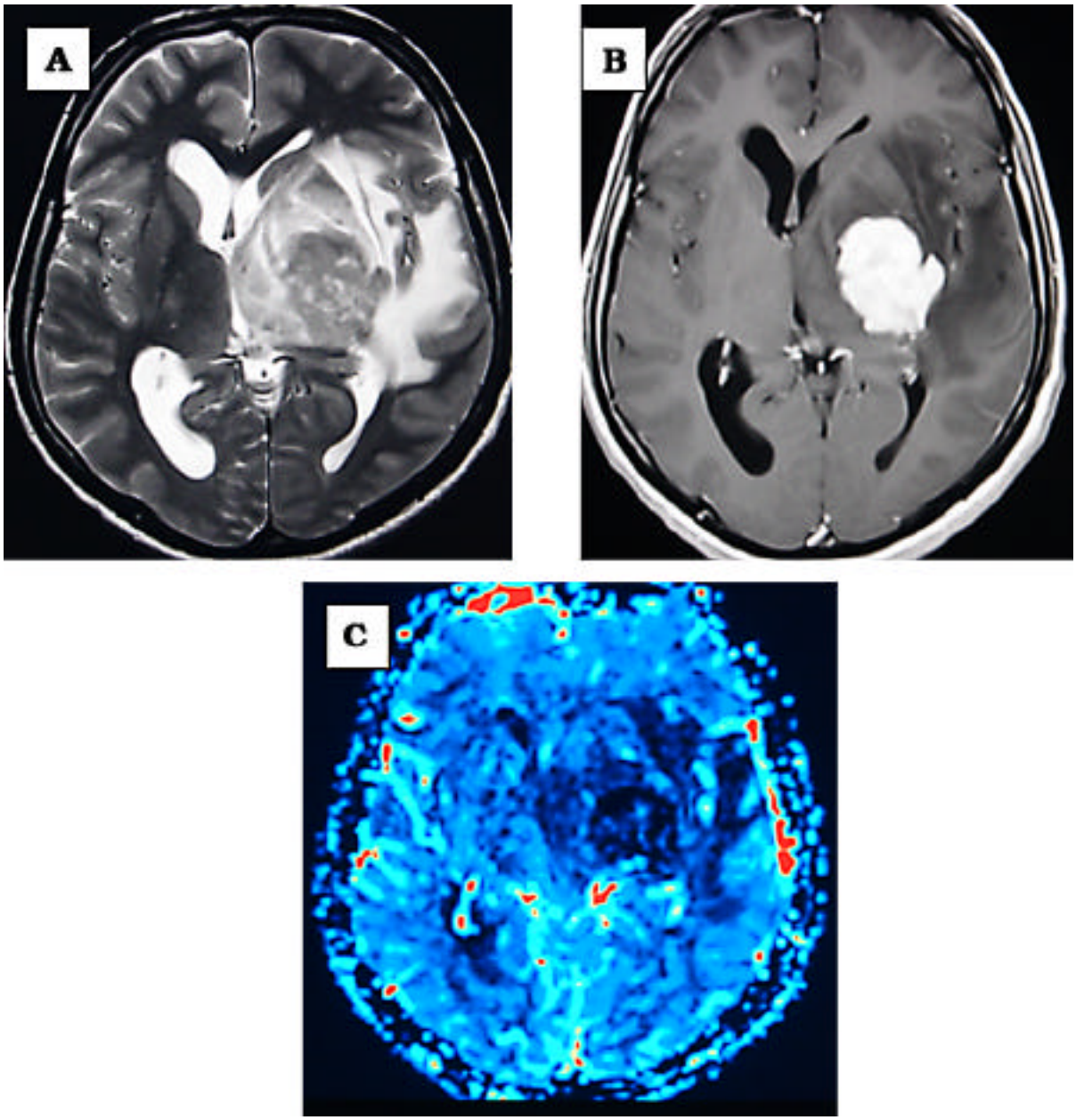

FIGURE 1 A: T2-weighted axial MR scan. B: T1-weighted axial post-contrast scan. C: MR perfusion scan. There is a T2 hypointense mass in the left basal ganglia with intense enhancement after contrast scan, and reduced rCBV on perfusion images (black arrow).

are seen as well. After infusion of paramagnetic contrast material, intense homogeneous enhancement (up to 74%) is the hallmark of primary CNS lymphoma in immunocompetent patients.[2,5,6] Hemorrhage and calcification within the tumor is rarely seen.

The advent of MR spectroscopy has added to the diagnostic capabilities enabling tissue characterization based on their molecular composition. It provides information about cell proliferation, degradation, neuronal viability and energy metabolism. Based on these characteristics, MR spectroscopy readily differentiates normal from abnormal brain tissues.[7,8] Typical MR spectroscopic features for lymphoma include elevated signals of lipid, lactate, and choline, and a reduced NAA signal.[9] This pattern can help in differentiating lymphoma from toxoplasmosis, which typically has elevated lactate and lipid signals but absence of the other metabolites in

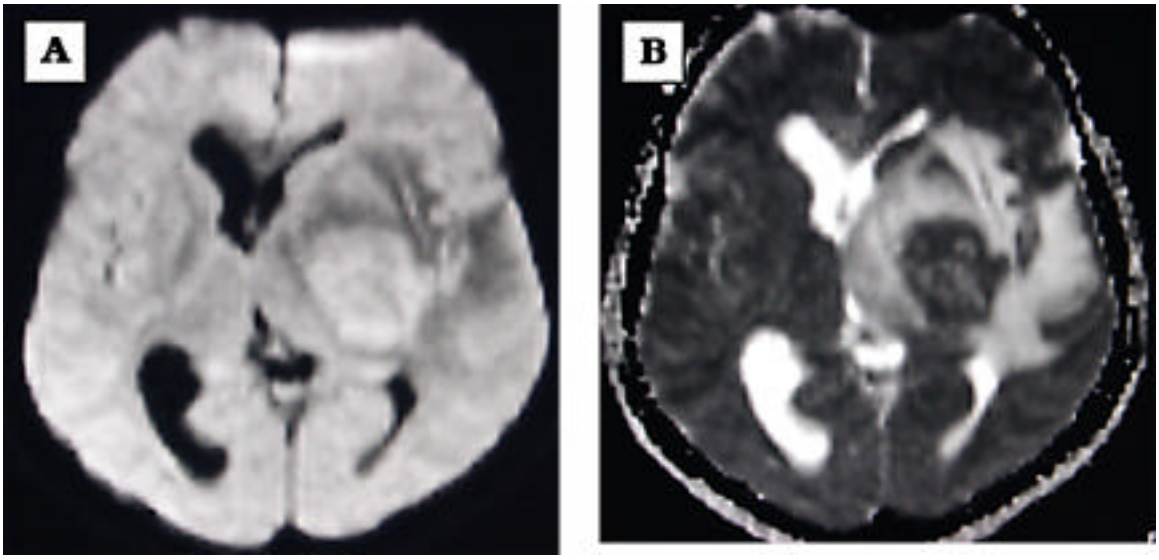

FIGURE 2. A: Diffusion weighted MR scan. B: ADC map. The mass is hyperintense on diffusion and hypointense on ADC.

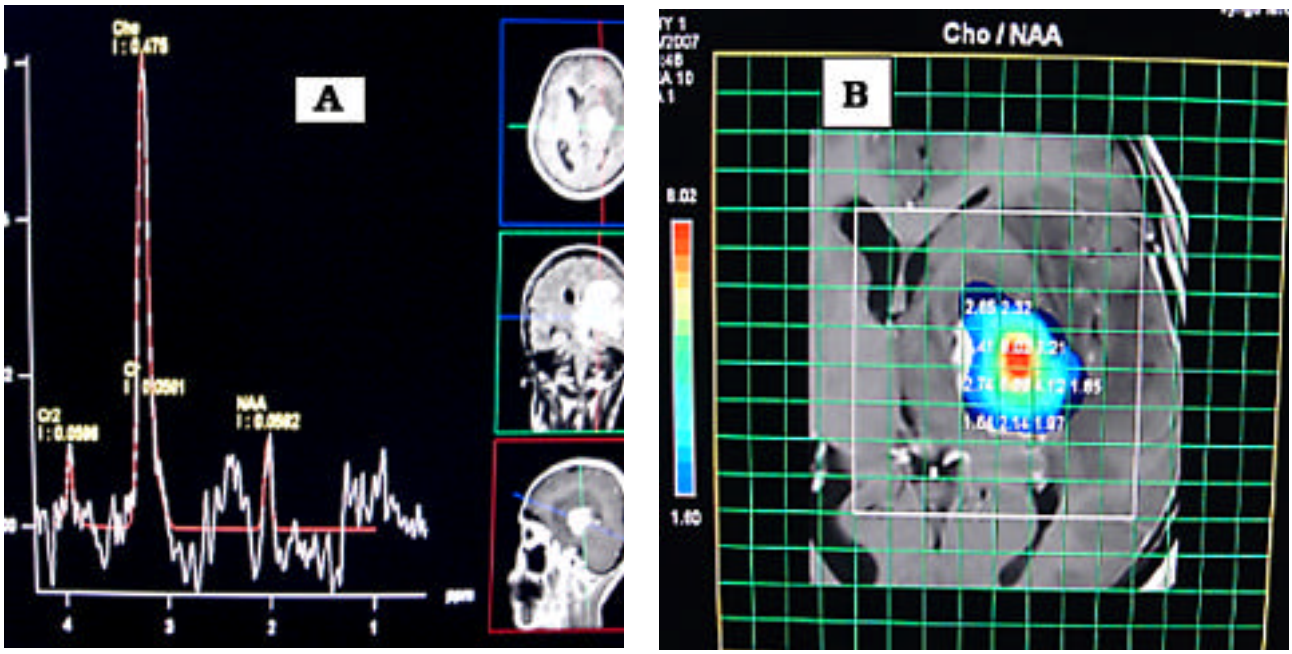

FIGURE 3. A: MR spectroscopy shows reduced NAA, and high choline and lipid-lactate peaks (arrow). B: Multivoxel MR spectroscopy shows Cho/NAA ratio of 8.02, which is very high.

MR spectra.[10] Published MR spectroscopic results showed a sensitivity of 79% and a specificity of 77% for a choline/NAA ratio of greater than 1 as an indicator of a neoplastic process.[8] Riyadh et al found that a choline/NAA ratio cut-off of 2.2 does reliably separate high-grade neoplasms from low-grade neoplasms and non-neoplastic conditions.

Perfusion MRI has developed into a very useful and promising adjunct to current imaging modalities. We are now able to not only visualize anatomic borders, but to observe physiological function within the tumor.[11] In rCBV perfusion imaging, the T2 (or T2*) MRI signal drop within or across a brain region is caused by spin dephasing from susceptibility effects during rapid passage of a paramagnetic contrast agent (gadolinium) through the capillary bed. The signal drop is used to compute relative perfusion to that region. rCBV maps are constructed using tracer kinetic principles by integrating the signal-time curve for each voxel.[12] The typical perfusion imaging feature for lymphoma is an rCBV that is low compared with that of primary high-grade neoplasms.[9]

Diffusion-weighted magnetic resonance (MR) imaging is a technique in which phase-defocusing and phase-refocusing gradients are used to evaluate the rate of microscopic water diffusion within tissues. A study published by Alexander et al shows lymphomas to be predominantly hyperintense to white matter on diffusion-weighted MR images and isointense to mildly hypointense to white matter on ADC maps, representing increased cellularity and low diffusivity.[13]

REFERENCES:

1. Maher EA, Fine HA. Primary CNS lymphoma. *Semin Oncol* 1999;**26(3)**:346-56.
2. Erdag N, Bhorade RM, Alberico RA, Yousuf N, Patel MR. Primary Lymphoma of the Central Nervous System Typical and Atypical CT and MR Imaging Appearances. *Am Roentgen Ray Soc*; 2001:1319-26.
3. DeAngelis LM, Yahalom J. Primary central nervous system lymphoma. In: DeVita VT, Jr H, S., Rosenberg SA, eds. *Cancer: Principles and Practice of Oncology:* Lippincott-Raven, Philadelphia; 1997:2233-42
4. Johnson BA, Fram EK, Johnson PC, Jacobwitz R. The variable MR appearance of primary lymphoma of the central nervous system: comparison with histopathologic features. *Am J Nerurorad* 1997; **18**: 563-572.
5. Roman-Goldstein SM, Goldman DL, Howieson J, Belkin R, Neuwelt EA. MR of primary CNS lymphoma in immunologically normal patients. *Am J Nerurorad* 1992;**13(4)**:1207-13.
6. Lanfermann H, Heindel W, Schaper J, et al. CT and MR imaging in primary cerebral non-Hodgkin's lymphoma. *Acta Radiol* 1997:259-67.
7. Bruhn H. Noninvasive differentiation of tumors with use of localized H-1 MR spectroscopy in vivo: initial experience in patients with cerebral tumors. *Radiology* 1989:541-8.
8. Butzen J, Prost R, Chetty V, et al. Discrimination between Neoplastic and Nonneoplastic Brain Lesions by Use of Proton MR Spectroscopy: The Limits of Accuracy with a Logistic Regression Model. *Am Soc Neuroradiology*; 2000:1213-9.
9. Al-Okaili RN, Krejza J, Wang S, Woo JH, Melhem ER. Advanced MR Imaging Techniques in the Diagnosis of Intraaxial Brain Tumors in Adults. *Radiographics* 2005:173-89.
10. Chinn RJ. Toxoplasmosis and primary central nervous system lymphoma in HIV infection: diagnosis with MR spectroscopy. *Radiology* 1995:649-54.
11. Perfusion magnetic resonance imaging to assess brain tumor responses to new therapies. 2006. (Accessed September 2006, at http://www.touchbriefings.com/pdf/1909/Rimner.pdf)
12. Rosen BR, Aronen HJ, Cohen MS. Diffusion and perfusion fast scanning in brain tumors. In: Leeds N, ed. Neuroimaging Clinics of North America: Philadelphia, Pa: WB Saunders Co; 1993:631-48.
13. Guo AC, Cummings TJ, Dash RC, Provenzale JM. Lymphomas and High-Grade Astrocytomas: Comparison of Water Diffusibility and Histologic Characteristics. *Radiology*; 2002:177-83.