

MRI Findings of Primary CNS Lymphoma in 20 Patients of Stereotaxic Ward

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ABSTRACT

Purpose: To record the MRI features of primary central nervous system lymphoma (PCNSL) and compare these properties in monofocal and multifocal disease.

Methods: Eleven cases of monofocal disease were compared to 9 cases of multifocal disease. All patients were examined by non-enhanced and contrast-enhanced MRI. Tumor location, signal intensity, enhancement characteristics, age distribution, peritumoral edema, cystic changes, and the presence of calcifications were assessed. The MRI features were compared between the monofocal and multifocal patients.

Results: There were 20 cases including both the monofocal and multifocal cases. Contrast-enhanced images showed variable enhancement patterns: homogeneous enhancement (14 patients), and heterogeneous enhancement (6 patients). One case of hemorrhage and two cases of cystic formation were observed. Intra-tumoral calcification was not detected. The frontal lobe, the corpus callosum and the basal ganglia were commonly involved in both the monofocal and multifocal lesion.

Conclusion: Our data showed that PCNSL has a variable enhancement and edema pattern on MRI. Monofocal PCNSL cases typically have larger size tumors with mild or marked enhancement.

Keywords: Brain Neoplasm, Lymphoma, Magnetic Resonance (MR), Computed Tomography (CT)

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INTRODUCTION

Primary central nervous system lymphoma (PCNSL) is a rare disease, responsible for 6% of all intracranial malignant tumors and for 1-2% of all lymphomas¹⁻³. The incidence of PCNSL has newly been on the rise, both in immunocompromised and immunocompetent populations^{4,5}. A common property of PCNSL is multiplicity^{2,3,6-11}.

Unlike most other brain tumors, radical surgical excision of PCNSLs is not suggested because the lesions are significantly infiltrative¹². Even partial tumor resection seems to be a negative factor for outcome¹³. Early diagnosis of PCNSL as a chemosensitive and

radiosensitive tumor may shift the treatment from extensive surgery to radiotherapy¹⁴. The precise diagnosis of a PCNSL is very important for the treatment and outcome of the patient.

The typical imaging properties of PCNSLs have been explained and characterized in previous studies^{1-3,14-18}. This comparison would be helpful for the differential diagnosis and prediction of clinical outcome to compare monofocal and multifocal PCNSLs¹⁹. Therefore, this study reviews 20 patients with PCNSL (a) to identify neuroradiological properties and (b) to compare the MRI properties of PCNSL in cases of monofocal and multifocal disease.

MATERIALS AND METHODS

A retrospective review of brain tumors in the pathology archives of our institution, from 2011 to 2016, revealed 20 cases of PCNSL referred to stereotaxic ward of Shohada hospital for brain tumor biopsy. This retrospective study was performed with the approval of the review board and ethics committee of our institution.

The evaluated patients group consisted of nine women and eleven men ranging between 21 and 73 years of age (average 48 years) at the time of study. Both non-enhanced and contrast-enhanced MR images were acquired for all patients.

The MR images at 1.5T (Horizontal, GE Medical Systems, Milwaukee, WI) were acquired with a slice thickness of 8 mm. Axial pre-contrast spin echo (SE) T1 weighted image (WI) were obtained in all patients.

All scans were reviewed according to their location, including deep or superficial location in the brain, margin, and the characteristics of signal intensity. The presence of calcifications, cystic or necrotic changes, hemorrhage, and characteristics of enhancement were also evaluated. The existence of calcifications was determined on non-enhanced CT scans, if available. Cystic tumor components were defined as areas, which

appeared hypointense on T1WI, hyperintense on T2WI and hypointense on FLAIR sequences. Hemorrhage was defined as areas that appeared hyperintense on both T1WI and T2WI.

The degree of edema was judged as follows: a mean diameter of peritumoral edema of less than 10 mm was considered as mild edema, a mean diameter of 11-20 mm as moderate edema, and a mean diameter of more than 20 mm as marked edema.

Histopathology and immunohistochemistry evaluations were carried out in all cases.

RESULTS

Neuroradiological Findings

In our retrospective, 9 patients (45%) had multifocal lesions, which added up to a total of 26 lesions. The neuroradiological appearances of PCNSL were therefore classified as two groups: monofocal and multifocal disease.

Monofocal Group

The monofocal group included 11 patients (11 of 20, 3 women and 8men) that had several lesions. The lesions were primarily located in the frontal lobe (n =2), the

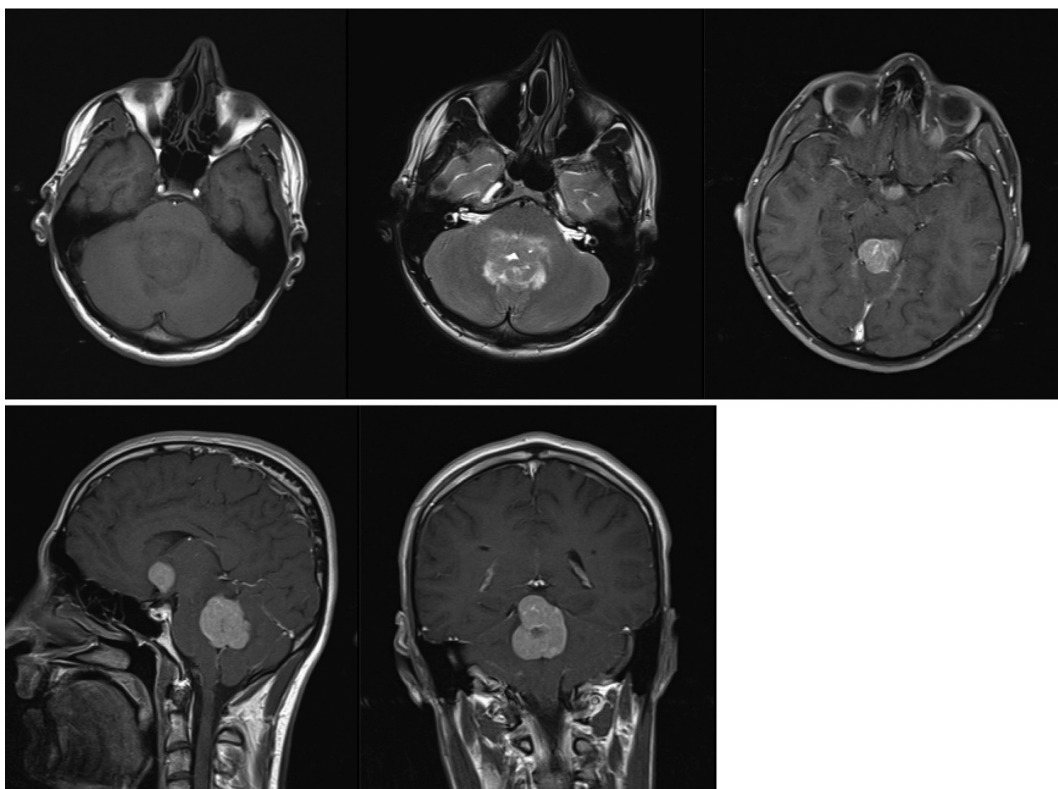


Figure 1. Images of 21-year-old woman with primary central nervous system lymphoma involving suprasellar region and cerebellum including pre-contrast axial T1-weighted image, pre-contrast T2-weighted image, and post contrast T1-weighted image

corpus callosum (n=2), partial lobe (n=5), basal ganglia (n=2). All lesions in the corpus callosum involved the genu or splenium. On T1WI sequences, all lesions appeared to be hypointense. On T2WI or on FLAIR sequences.

Location of Lesions

Perilesional edema was present in 10 cases of monofocal tumors, 2 cases of which showed mild, 3 showed moderate and 5 showed marked edema. The other five cases of multifocal tumors showed no edema. The degree of edema was not consistent with tumor size; some small lesions showed disproportionately marked edema. Lesions in the posterior fossa had no edema or mild edema, while moderate or marked perifocal edema was found in supratentorial lesions.

Edema Grade of Lesions

Cystic changes were found in two cases. The mean size of the two tumors was 2.5 cm (3.0 cm and 2.0 cm). A small round 4 mm diameter cyst was found in one case, whereas a stripy cyst formation was found for the other case. A histologically confirmed subacute hemorrhage, appearing as a patchy hyperintense signal on T1WI was found in one tumor in the basal ganglia region.

Monofocal lesions showed a variable contrast enhancement ranging from mild (n=2), to moderate (n=3), and to marked enhancement (n=6). The enhancement was homogeneous in 8 cases. In three of these 11 cases

heterogenous enhancement was noted.

Enhancement Grade of Lesions

Of the 11 patients with monofocal lesions, all of them received a plain CT scan. Furthermore, of these patients eight had an available enhanced CT scan. Five lesions appeared slightly hyperdense compared to the normal brain.

Multifocal Group

The multifocal group included 9 patients (9 of 20, 3 women and 6 men) that had several lesions. The lesions were primarily located in the frontal lobe (n=2), the corpus callosum (n=2), the temporal lobe (n=1), the parietal lobe (n =2), basal ganglia (n=1) and the cerebellum (n=1) thirteen lesions were located deep within the brain, whereas the other three were located superficially. All lesions in the corpus callosum affected the genu or splenium. On T1WI sequences, all lesions appeared to be hypointense.

Moreover, the lesions involved deep white or gray matter in the brain (n=12) or a superficial location (n=4). Multifocal lesions showed a hypointense signal on T1WI and a slightly hyperintense signal on T2WI or FLAIR imaging.

Of the 26 lesions, 20 had mild peritumoral edema, whereas the remaining six moderate edema

Following the contrast agent (Gd-DTPA) injection, 14 lesions in four patients showed marked enhancement,

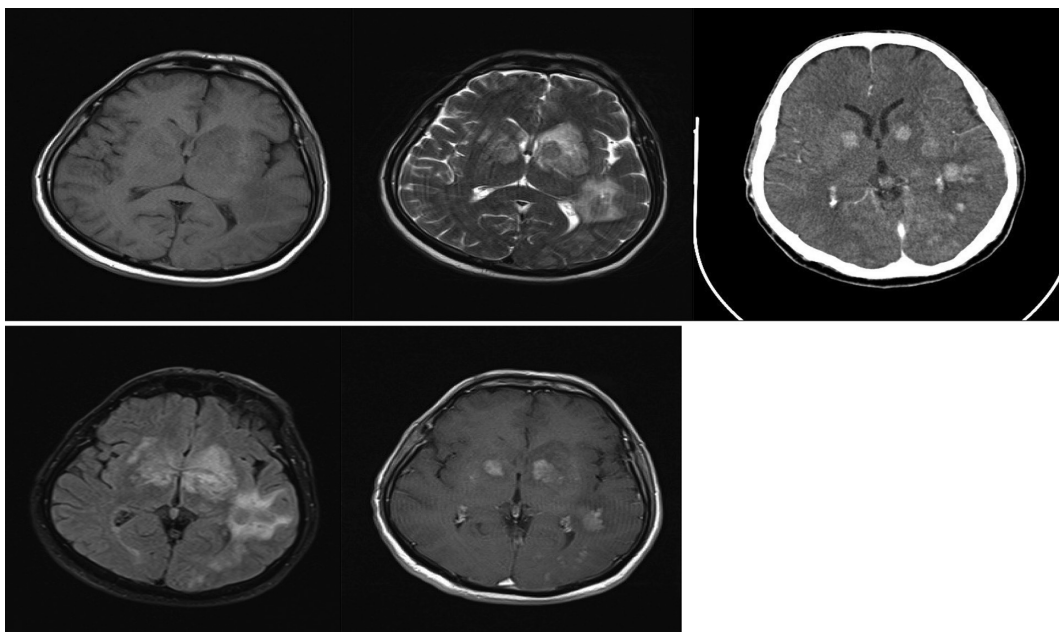


Figure 2. Images of 50-year-old man with lymphoma of bilateral basal ganglia and temporal lobe including, contrast CT image pre contrast-contrast T1-weighted image, axial T1-weighted image, postcontrast axial T1-weighted image

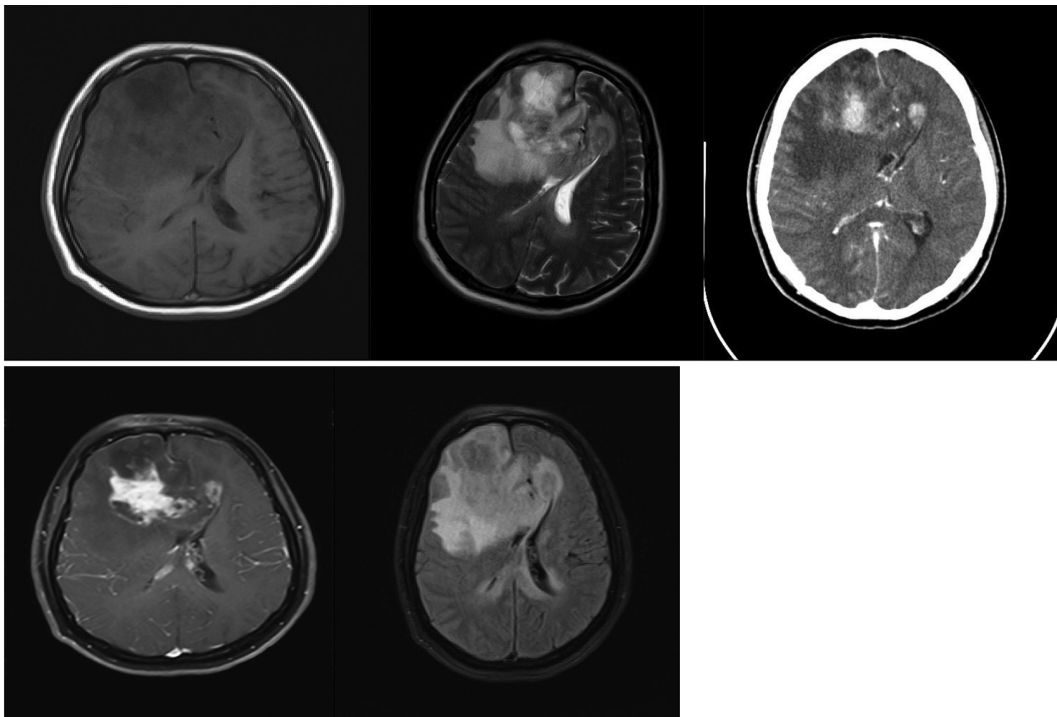


Figure 3. Images of 56-year-old woman with lymphoma involving frontal lobe bilaterally with cyst formation with marked edema including pre-contrast axial T1-weighted image, pre-contrast T2-weighted image and post-contrast axial T1-weighted image

whereas 12 lesions in three patients showed mild or moderate enhancement. Enhancement was homogeneous in 18 lesions and heterogeneous in eight lesions. The lesion with the small cyst formation showed heterogeneous enhancement. The ring of enhancement was completely closed in the two cases with ring-like enhancement. No subependymal spread was found in the group.

One patient received both a plain and enhanced CT scan. The lesions showed hyperattenuation and moderate homogeneous enhancement after contrast injection.

DISCUSSION

This study involves the evaluation of the MRI findings of 20 histologically confirmed cases of PCNSL in patients of stereotaxic ward and explain the imaging properties of monofocal disease with those of multifocal disease. Our study confirms previous results regarding the appearance of PCNSL on MR images. However, we detailed two characteristic enhancement features of the tumors that might be helpful in the differential diagnosis.

The mean age at diagnosis in this study was 48 years, which is lower than in previously reported data^{6,21}. In other publications, PCNSL usually occurred in the sixth decade^{15,22}. There was no significant difference for mean age between monofocal and multifocal lymphomas. Male predominance is generally recognized at a ratio of up to

1.2-1.7^{23,24} in PCNSL.

Multiplicity of PCNSL is a common feature^{2,3}. The highest reported number of lesions can be as high as eight¹⁰. We present one case with six lesions. The frequency of the multifocal tumor shows great variation (range 0-50%) in immunocompetent patients^{8,11}.

In our patients retrospectively, most lesions affected the frontal lobe, the corpus callosum, and the basal ganglia, which is consistent with previous studies^{8,16}. The classical 'mirror image' or 'butterfly pattern', caused by lesions involving the genu or splenium in a symmetrical pattern, was detected in two cases. We located 5% (1 of 20) of the lesions in the posterior fossa, which is lower than previously reported (12%)^{7,8}. PCNSL located both above and below the tentorium is reported to be rare¹¹, and consistently, only none of the patients in our study involved both sides of the tentorium.

The reason for the difference in lesion size is unclear. We hypothesize that multifocal tumors present symptoms at an earlier stage (and thus at a smaller size), because multiple lesions are likely to have a larger effect than single lesions.

Mild or moderate peritumoral edema is a common feature of PCNSL¹¹. It is generally less pronounced than in metastases or high grade gliomas²⁵. The fact that significant peritumoral edema is uncommon is probably

due to the infiltrative nature of the tumor^{3,26}. Our data did not support this idea, with 40% of the evaluated lesions with marked edema mostly in monofocal group^{2,27}. We also report four lesions with marked edema which were not reported previously as well. Contrary to Coulon's study, which describes lesser edema in the multifocal group than in the monofocal group³, we found minor edema in multifocal group and only one patient with multifocal lesion had significant edema.

On pre-contrast MR images PCNSL is known to appear as hypo- or iso-intense on T1WI, and hyper- or iso-intense on T2WI^{3,15-17}. Consistent with and the findings above, we did not detect a statistical difference between the monofocal and the multifocal groups. In contrast, the enhancement after injection of Gd-DTPA is known to be variable^{9,15,17}, and in multifocal disease, can even enhance to a different degree within the same patient^{11,28}; even tumors without any enhancement were described^{9-11,28}. In our retrospective study, all the lesions showed enhancement, but the degree and pattern was variable. Most lesions (20 of 37) showed marked enhancement, while the rest (17 of 37) exhibited mild or moderate enhancement. Mild or moderate enhancement was more frequent in monofocal disease.

As for the enhancement pattern, our data and previous studies concur in that enhancement is most commonly homogeneous¹⁴⁻¹⁸. Ring-like enhancement can be found in immunodeficient patients, but is rare in immunocompetent patients^{7,17}. Lesions with gyral-like and a radial enhancement pattern has been reported previously^{3,27,29}. The typical CT finding of PCNSL is that of a primarily iso- or hyperdense space-occupying mass with marked homogeneous enhancement^{7,8}. In this study, all lesions (n=12) with available CT data showed these features.

Furthermore, there are several uncommon findings for PCNSL in immunocompetent patients. First, cystic changes are a very uncommon finding in PCNSL in immunocompetent patients and when present, are usually small single cysts^{3,11,28}. In the present patient population, two small intratumoral cysts were present (average diameter 6 mm), which is in line with previously reported data¹¹. Secondly, intratumoral calcifications are rare in PCNSL, and to our knowledge, only two cases of PCNSL with calcification before treatment have been reported^{3,11}. Therefore, calcifications must be considered as a useful imaging feature to differentiate PCNSL from other intracranial tumors likelihood to calcify. However, calcifications are more frequently found after the patient has received chemotherapy or radiation treatment^{3,14}.

Lastly, very few cases with intratumoral hemorrhage have been described in the literature^{3,7,27}. Tumors with hemorrhage have a wide distribution. In Our study we present one lesion with chronic hemorrhage in the basal ganglia region.

In summary, our study of the MR imaging data of 20 cases of PCNSL in our stereotaxic ward of Shohada hospital. Tumors are mostly present in the 5th or 6th decade and they can be monofocal or multifocal. Lesions are commonly cited in the frontal lobe, corpus callosum, or the basal ganglia, and may exhibit a 'butterfly sign'. On pre-contrast MR images tumors frequently seem hypo- or iso-intense on T1WI and hyperintense on T2WI. Further, the tumors are naturally surrounded by edema and post Gd-DTPA enhancement is commonly homogeneous but variable. Calcifications, cyst formations, and hemorrhage are uncommon presentations and are rather indicative of other diseases. Considering the variable appearance of PCNSL in either monofocal or multifocal disease, awareness of the tumor morphology spectrum analyzed in this study would be useful for a correct diagnosis. In our study in monofocal group in comparison to multifocal group vasogenic edema was more significant and marked edema was not seen in multifocal group. Cyst formation was only detected in monofocal group and heterogeneous enhancement was seen dominantly in multifocal group.

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