ORIGINAL RESEARCH PAPER

Radiodiagnosis

KEY WORDS: HIV, MRI Brain, CD4 Count, Neurological Manifestations, Opportunistic Infections.

SPECTRUM OF MRI BRAIN FINDINGS IN HIV PATIENTS WITH NEUROLOGICAL MANIFESTATIONS AND CORRELATION WITH CD4 COUNTS

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ABSTRACT

Background: Neurological complications are common in HIV and are closely related to immune status. MRI plays a key role in detecting CNS involvement. **Objective:** To evaluate MRI brain findings in HIV-positive patients with neurological manifestations and correlate them with CD4 counts. **Methods:** Twenty-five HIV-positive adults with neurological symptoms underwent MRI brain examination. MRI findings were analysed and correlated with CD4 cell counts.**Results:** Headache (72%), seizures (48%), and altered sensorium (40%) were the most common symptoms. Forty percent of patients had CD4 counts <100 cells/mm³. Cerebral toxoplasmosis (32%) was the most frequent diagnosis, followed by tuberculous CNS involvement (24%) and HIV encephalopathy (16%). Ring-enhancing lesions were the predominant MRI finding (56%). Lower CD4 counts were significantly associated with opportunistic infections (p=0.013), lesion burden (r=-0.684), and MRI severity score (r=-0.721).**Conclusion:** MRI is highly effective in detecting neurological complications of HIV. Lower CD4 counts are associated with more severe MRI abnormalities and a higher prevalence of opportunistic CNS infections.

INTRODUCTION

Despite advances in antiretroviral therapy (ART), neurological complications remain a major cause of morbidity and mortality in HIV-infected individuals. HIV affects the CNS early, and progressive immunosuppression predisposes patients to opportunistic infections, neoplasms, vascular complications, and HIV-associated neurocognitive disorders [1,2]. Neurological manifestations occur in 40–70% of patients and commonly include headache, seizures, altered sensorium, focal deficits, cognitive impairment, and behavioural changes [3,4]. The severity of CNS involvement is closely related to immune status, typically assessed by CD4 T-cell count [5]. Opportunistic infections such as toxoplasmosis, cryptococcosis, tuberculosis, and progressive multifocal leukoencephalopathy (PML) occur predominantly in advanced immunosuppression [6,13].

MRI is the imaging modality of choice for CNS evaluation in HIV because of its high sensitivity and excellent soft-tissue contrast [6]. It helps detect lesions and differentiate infectious, inflammatory, neoplastic, and vascular processes [7]. Correlating MRI findings with CD4 counts may improve assessment of disease severity and guide management [8]. Therefore, this study evaluated MRI brain findings in HIV-positive patients with neurological manifestations and examined their correlation with CD4 cell counts.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted in the Department of Radiodiagnosis over one year and included 25 HIV-positive adults presenting with neurological manifestations and having a CD4 count available within one month of MRI. Patients with MRI contraindications, traumatic brain injury, unrelated primary brain tumors, incomplete MRI studies, or unavailable CD4 counts were excluded.

MRI brain examinations were performed using standard protocols including T1-weighted, T2-weighted, FLAIR, diffusion-weighted, ADC, susceptibility-weighted, and post-contrast sequences as indicated. Demographic, clinical, laboratory, and MRI findings were recorded and correlated with CD4 counts. Statistical analysis was performed using SPSS, with $p < 0.05$ considered significant.

RESULTS:

1) Demography:

A total of 25 HIV-positive patients with neurological manifestations were evaluated. The majority belonged to the 31–40-year age group (32%), followed by the 41–50-year age group (28%). The mean age was 42.3 ± 11.2 years. Males accounted for 72% of patients.

2) Clinical Presentation:

Headache was the most frequent presenting symptom (72%), followed by seizures (48%), altered sensorium (40%), focal neurological deficits (32%), and cognitive impairment (20%).

Table 1. Demographic and Clinical Characteristics.

Variable	Number (%)
Total patients	25
Mean age (years)	42.3 ± 11.2
Male	18 (72%)
Female	7 (28%)
Headache	18 (72%)
Seizures	12 (48%)
Altered sensorium	10 (40%)
Focal neurological deficit	8 (32%)
Cognitive impairment	5 (20%)

3) CD4 Count Distribution:

Ten patients (40%) had CD4 counts below 100 cells/mm³, eight patients (32%) had counts between 100 and 200 cells/mm³, and seven patients (28%) had counts above 200 cells/mm³. These findings indicate that a large proportion of patients presented with advanced immunosuppression.

Table 2. CD4 Count Distribution

CD4 Count (cells/mm³)	Number	Percentage (%)
<100	10	40.0
100–200	8	32.0
>200	7	28.0
Total	25	100

4) MRI Diagnosis Spectrum:

Cerebral toxoplasmosis was the most common diagnosis, observed in eight patients (32%). Tuberculoma and tuberculous meningitis together accounted for six cases (24%). HIV encephalopathy was seen in four patients (16%), cryptococcal meningitis in three patients (12%), PML in two patients (8%), while CNS lymphoma and ischemic infarction were identified in one patient each (4%).

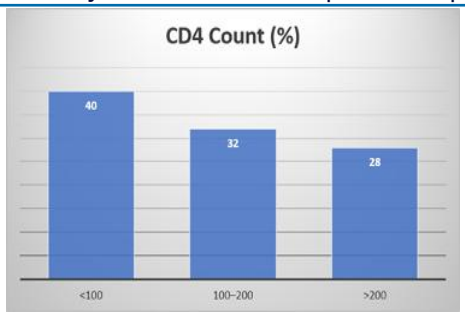
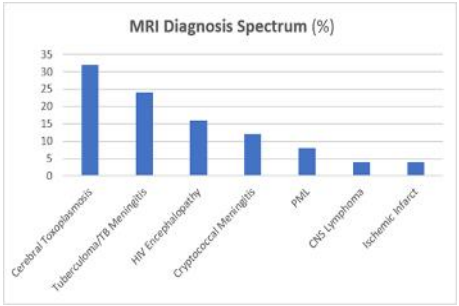


Table 3. MRI Diagnosis Spectrum

MRI Diagnosis	Number	Percentage (%)
Cerebral Toxoplasmosis	8	32.0
Tuberculoma/TB Meningitis	6	24.0
HIV Encephalopathy	4	16.0
Cryptococcal Meningitis	3	12.0
PML	2	8.0
CNS Lymphoma	1	4.0
Ischemic Infarct	1	4.0
Total	25	100

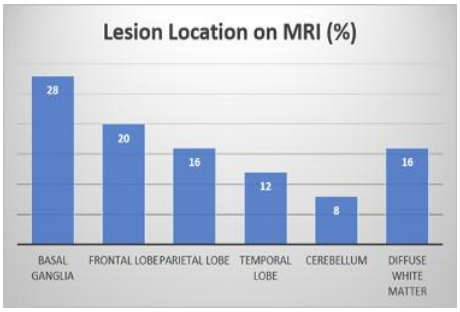


5) Lesion location:

Basal ganglia involvement was the most frequent site of disease (28%), followed by frontal lobe lesions (20%). Diffuse white matter abnormalities were noted in patients with HIV encephalopathy and PML.

Table 4. Distribution of Lesion Location on MRI

Lesion Location	Number	Percentage (%)
Basal Ganglia	7	28.0
Frontal Lobe	5	20.0
Parietal Lobe	4	16.0
Temporal Lobe	3	12.0
Cerebellum	2	8.0
Diffuse White Matter	4	16.0
Total	25	100

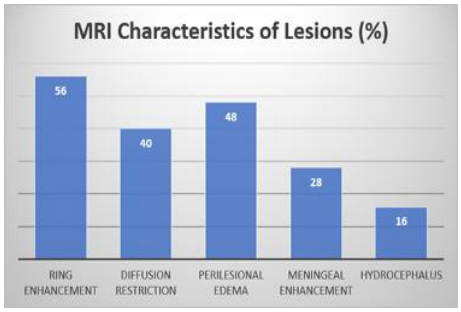


6) MRI Characteristics of lesions:

Ring-enhancing lesions represented the most common imaging pattern and were present in 56% of patients. Perilesional edema was observed in 48%, diffusion restriction in 40%, meningeal enhancement in 28%, and hydrocephalus in 16%.

Table 5. MRI Characteristics of Lesions

MRI Finding	Number	Percentage (%)
Ring Enhancement	14	56.0
Diffusion Restriction	10	40.0
Perilesional Edema	12	48.0
Meningeal Enhancement	7	28.0
Hydrocephalus	4	16.0



7) Correlation Between MRI Findings and CD4 Counts:

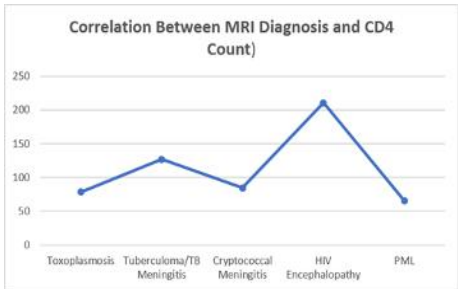
The lowest mean CD4 counts were observed in patients with PML (65.5 ± 12.3 cells/mm³), cerebral toxoplasmosis (78.4 ± 24.6 cells/mm³), and cryptococcal meningitis (84.6 ± 20.5 cells/mm³). Patients with HIV encephalopathy had relatively higher CD4 counts (210.5 ± 46.1 cells/mm³).

A statistically significant association was identified between CD4 counts below 100 cells/mm³ and opportunistic CNS infections (p=0.013). Ring-enhancing lesions and hydrocephalus were more frequently encountered in severely immunocompromised patients.

Table 6. Correlation Between MRI Diagnosis and CD4 Count

MRI Diagnosis	Mean CD4 Count (cells/mm³)
Toxoplasmosis	78.4 ± 24.6
Tuberculoma/TB Meningitis	126.8 ± 35.2
Cryptococcal Meningitis	84.6 ± 20.5
HIV Encephalopathy	210.5 ± 46.1
PML	65.5 ± 12.3

Patients with PML and toxoplasmosis had the lowest mean CD4 counts, indicating severe immunosuppression. HIV encephalopathy was observed at relatively higher CD4 counts.



8) MRI Severity Score:

An MRI severity score was developed to quantify the extent of central nervous system involvement. One point was assigned for each of the following imaging features: ring-enhancing lesion, diffusion restriction, perilesional edema, meningeal enhancement, hydrocephalus, and mass effect. Lesion burden was scored as 1 point for a single lesion, 2 points for 2–5 lesions, and 3 points for more than 5 lesions or diffuse involvement. The total MRI severity score ranged from 0 to 10, with higher scores indicating more severe radiological disease. Severity was categorized as mild (0–3), moderate (4–6), and severe (7–10).

Table 7: MRI severity score

MRI Parameter	Score
Ring enhancement	1
Diffusion restriction	1
Perilesional edema	1

Meningeal enhancement	1
Hydrocephalus	1
Mass effect	1
Multifocal involvement (>1 lobe)	1
Lesion burden:	
Single lesion	1
2–5 lesions	2
>5 lesions/diffuse disease	3

Table 8: Distribution of MRI Severity Score Categories

MRI Severity Category	Score Range	Number of Patients (n=25)	Percentage (%)
Mild	0–3	7	28
Moderate	4–6	13	52
Severe	7–10	5	20
Total	—	25	100

Interpretation: Most patients demonstrated moderate MRI severity, while severe imaging abnormalities were predominantly observed among patients with CD4 counts below 100 cells/mm³.

9) Correlation between CD4 count and MRI severity score:

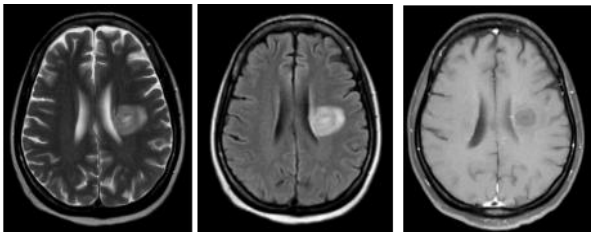
Pearson correlation analysis demonstrated a significant inverse relationship between CD4 count and MRI severity score ($r = -0.721$, $p < 0.001$). Lower CD4 values were associated with increasingly severe MRI abnormalities, emphasizing the role of immune suppression in the development of CNS pathology among HIV patients.

Table 9. Pearson Correlation Between CD4 Count and MRI Severity Score

Parameter	Mean ± SD	Pearson Correlation (r)	P Value
CD4 Count (cells/mm³)	128.6 ± 78.4		
MRI Severity Score	4.12 ± 1.63	-0.721	<0.001

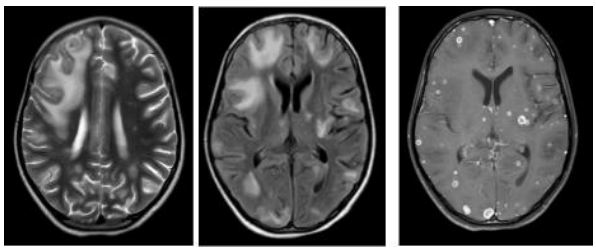
CASES

Case 1:



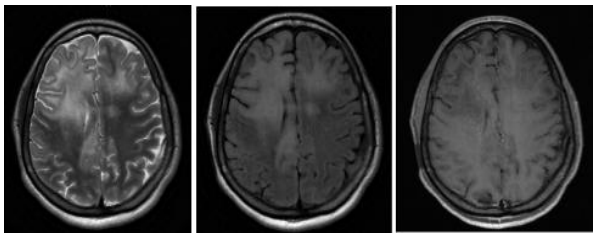
a) Axial T2, b) Axial FLAIR and c) post contrast axial T1 images demonstrate, irregular targetoid T2/FLAIR heterointense lesion showing eccentric enhancement with surrounding edema involving left corona radiata in periventricular location suggest cerebral toxoplamosis.

Case 2:



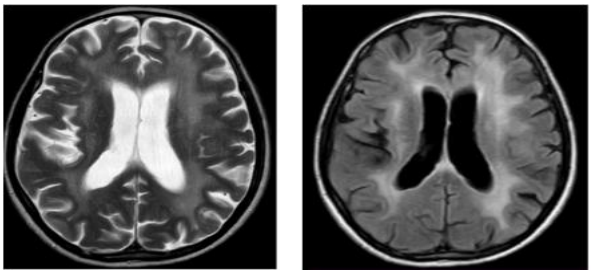
a) Axial T2, b) Axial FLAIR and c) post contrast axial T1 images demonstrate, multiple ring enhaning lesions scattered in grey white matter junction, subcortical white matter of bilateral cerebral hemisphere and bilateral basal ganglia & thalamus with extensive surrounding T2/FLAIR hyperintense edema- **suggest tuberculomas.**

Case 3:



a) Axial T2, b) Axial FLAIR and c) post contrast axial T1 images demonstrate, Asymmetrical T2/FLAIR hyperintensity involving deep and subcortical white matter of bilateral frontal lobes with involvement of subcotical U fibers and showing no contrast enhanacement - **suggest progressive multifocal leucoencephalopathy**.

Case 4:



a) Axial T2 and b) Axial FLAIR images demonstrate, symmetrical T2/FLAIR hyperintensity involving deep and subcortical white matter of bilateral frontoparietal and occipital lobes with sparing of subcotical U fibers. Extensive generalised cerebral atrophy - **suggest HIV encephalopathy**.

DISCUSSION

Neurological manifestations remain a significant cause of morbidity in HIV-positive patients, especially those with advanced immunosuppression [3,4]. In our study, most patients were middle-aged males, consistent with previous reports [3,4]. Headache, seizures, and altered sensorium were the most common presentations, largely reflecting opportunistic CNS infections despite ART availability [4].

Marked immunosuppression was common, with 40% of patients having CD4 counts below 100 cells/mm³, similar to earlier studies linking severe neurological complications to advanced immune deficiency [4,5]. Cerebral toxoplasmosis was the most frequent MRI diagnosis, followed by tuberculous CNS involvement, in agreement with published literature [9–11].

Ring-enhancing lesions were the predominant imaging finding and were mainly associated with toxoplasmosis and tuberculomas [12]. Frequent basal ganglia involvement further supported the diagnosis of toxoplasmosis [9,10]. Patients with PML, toxoplasmosis, and cryptococcal meningitis had the lowest CD4 counts, highlighting the association between profound immunosuppression and opportunistic infections [13,15]. HIV encephalopathy occurred at relatively higher CD4 levels, suggesting a distinct mechanism of direct HIV-related neuronal injury [14].

A key finding was the strong inverse correlation between CD4 count and MRI severity, with lower CD4 counts associated with greater lesion burden and more extensive radiological abnormalities [8]. The significant association between CD4 counts below 100 cells/mm³ and opportunistic infections emphasizes the importance of early identification and management of severely immunocompromised patients [4,5].

Overall, MRI remains indispensable in evaluating

neurological manifestations of HIV, enabling accurate detection and characterization of infectious, inflammatory, neoplastic, and vascular CNS lesions [6,7].

CONCLUSION

MRI is essential for evaluating neurological complications in HIV-positive patients. Cerebral toxoplasmosis and tuberculous CNS involvement were the most common diagnoses, with ring-enhancing lesions being the predominant imaging finding. Lower CD4 counts, particularly <100 cells/mm³, were significantly associated with opportunistic infections and greater MRI severity. The observed inverse correlation between CD4 count and disease burden highlights the value of combining MRI findings with CD4 assessment for early diagnosis, risk stratification, and timely management.

PATIENTS CONSENT

Written informed consent was obtained from the patient for publication of clinical details and imaging findings.

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