

Computed tomographic findings of the brain in adult HIV-infected patients at Doctor George Mukhari Academic Hospital, Ga-Rankuwa, Pretoria, South Africa

John Osi Ozoh, Olakunle Adewunmi Towobola¹, Gboyega Adebola Ogunbanjo², Evelyn M. Kangawaza¹

Departments of Diagnostic Radiology, ¹Internal Medicine and ²Family Medicine and Primary Health Care, Sefako Makgatho Health Sciences University, Pretoria, South Africa

Abstract

Background/Aim: The aim of this study is to determine the pattern of computed tomographic (CT) findings in HIV-infected patients referred for CT brain at Doctor George Mukhari Academic Hospital (DGMHA) and to correlate the CD4 counts with CT brain findings of the patients on antiretroviral (ARV) drugs, and those that are ARV naïve.

Methods: A descriptive, retrospective review of CT brains obtained from 128 slices Philips and GE, CT scanners, medical records, and laboratory results of 364 adult HIV-infected patients over a 6-month period (October 1, 2016–March 31, 2017) was conducted at Radiology Department of DGMHA. Statistical analyses were made using a Statistical Program for Social Sciences software (SPSS version 19.0).

Results: From the 364 CT brain findings of HIV-infected patients reviewed, 46.2% were male and 53.8% were female. The findings were as follows: brain atrophy (168; 46.2%); infarcts (55; 15.1%); hydrocephalus (24; 6.6%); white matter disease (18; 4.9%); mass lesions (13; 3.6%); rim enhancing lesions (12; 3.3%); intracranial bleed (11; 3.0%); tuberculous granuloma (32; 8.8%); tuberculous meningitis (15; 4.1%); and cryptococcal meningitis (2; 0.5%). Opportunistic infections and mass lesions still predominate at CD4 count <200 cells/mm³ although the reduction in the prevalence of opportunistic infections was observed. Brain infarct was seen at CD4 count <200 cells/mm³, and brain atrophy was seen at all CD4 count levels (median = 84 cells/mm³).

Conclusion: This study was conducted in the post-highly active ARV therapy era, and the most common CT scan brain finding was brain atrophy, followed by brain infarct.

Keywords: Brain, computed tomography, HIV-infected adult patients

Address for correspondence: Dr. John Osi Ozoh, P.O. Box 202, Willow Acres, Pretoria East, Pretoria, South Africa.
E-mail: osiozoh@nl.rogers.com

INTRODUCTION

HIV/AIDS was first reported in June 1981,^[1] and it continues to be a major global public health issue. In a 2016, the UNAID/WHO report, which was updated in March 2017, an estimated 36.7 million people were living

with HIV (including 1.8 million children), and this translates to a global HIV prevalence of 0.8%.^[2]

Computed tomographic (CT) scan is important as a screening radiological investigation in HIV-infected

Access this article online	
Quick Response Code:	Website: www.wajradiology.org
	DOI: 10.4103/wajr.wajr_48_17

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How to cite this article: Ozoh JO, Towobola OA, Ogunbanjo GA, Kangawaza EM. Computed tomographic findings of the brain in adult HIV-infected patients at Doctor George Mukhari Academic Hospital, Ga-Rankuwa, Pretoria, South Africa. West Afr J Radiol 2019;26:15-24.

patients because of its wide availability, noncomplicated technique, relatively low cost, and high speed of acquisition of images in unstable patients compared with MRI.^[3]

The different types of brain pathologies in HIV-infected patients are assumed to be determined by the level of immunosuppression. Benign and malignant brain tumors as well as metastases are the differential diagnoses when the CD4 cell counts are $>500/\mu\text{L}$.^[4] Opportunistic infections and AIDS-related brain tumors such as lymphoma are more common in severely immunocompromised patients. HIV-related dementia, meningitis (bacterial, tuberculosis [TB], and syphilitic) and progressive multifocal leukoencephalopathy (PML) are also included in this category.^[4] Cytomegalovirus, ventriculoencephalitis, brain abscess (bacterial or fungal), cryptococcal infection, and tuberculoma are common at CD4 cell counts of $<100/\mu\text{L}$, while angioinvasive fungi (*Aspergillus*) associated with sinus infection predominate at CD4 cell count of $<50/\mu\text{L}$.^[4]

The CT scan findings in the brains of HIV/AIDS patients can be divided into four categories, namely direct effect of HIV infection, opportunistic infections, vascular diseases, and neoplasm. Hongsakul and Laothamatas found that the brain is a major site of predilection for HIV, with approximately two-thirds of the patients developing brain involvement during their disease.^[5] They also found CT scan brain findings of age-inappropriate brain atrophy, white matter disease (WMD), toxoplasmosis, cryptococcoma, PML, tuberculoma, tuberculous abscess, tuberculous meningitis, bacterial meningitis, cerebritis, lymphoma, stroke, and even normal brain, in the same study.^[5] From Nigeria, Eze and Eze recorded a 100% diagnostic yield of positive brain CT scan findings among anti-retroviral (ARV) naïve HIV/AIDS patients.^[6] The following brain CT scan findings comprising cerebral hemiatrophy, diffuse cerebral atrophy, acute intracerebral bleed, infarct-like lesions, multiple ring-enhancing lesions with mass effect, solitary ring-enhancing lesions, and nodular lesions were documented in their study.^[6]

A study conducted in KwaZulu Natal, a province in South Africa,^[7] revealed that toxoplasmosis was found to be the most frequent cause of intracranial mass lesion among HIV-positive patients, followed by primary central nervous system lymphoma. Furthermore, the same study revealed that less common causes included tuberculoma, cryptococcoma, abscesses, and gummas.

Highly active ARV therapy (HAART) for people infected with HIV was introduced in South Africa in 2004. In the pre-HAART era, neurologic diseases were documented at

7%–20% and the prevalence rates of neurologic infections ranged between 39% and 70%.^[8] In the post-HAART era, the prevalence of HIV-related dementia and opportunistic infections have significantly declined, but HIV-associated neurocognitive disorder that impairs the quality of life have either increased or have been unmasked since the advent of ART.^[8]

This study is put together to evaluate the impact of the use of HAART, its effects on CT scan findings and CD4 counts of HIV-infected patients following the introduction of HAART in South Africa. The study also provides an opportunity to assess the association of various manifestations of HIV infection on CT scan brain findings.

Objectives

The broad objective of the study is to evaluate the association of HIV infection with CT scan brain findings; the specific objectives are as follows:

1. To determine the frequency distribution of brain CT findings in adult HIV-infected patients, and
2. To correlate the CD4 cell count levels of adult HIV-infected patients with their brain CT scan findings.

METHODS

A retrospective review of both pre- and post-contrast CT brain scan findings, medical records, and laboratory results of adult HIV-infected patients were done at the Diagnostic Radiology and Imaging Department of Doctor George Mukhari Academic Hospital (DGMH), for a period of 6 months from the October 1, 2016, to March 31, 2017. Brain CT scan images were acquired using Philips 128 Slices Ingenuity, and GE 128 Slices Optima machines. The images were stored in Picture Archiving and Communicating System software from where the images were retrieved for the study. The study accommodated all HIV-infected patients aged 18 years of age or older and had been diagnosed with HIV infection based on confirmatory laboratory results.

Pre- and post-contrast brain CT scan of the patients was reviewed by the principal investigator and another fully accredited radiologist in order to eliminate interobserver variability. Consensus reports from both radiologists were used for this study. The presence of the following CT scan brain findings which had been previously reported^[3,5] are listed below:

- a. HIV encephalopathy was defined as age-inappropriate brain atrophy. Brain atrophy was diagnosed in this study as follows: prominent cerebral sulci (cortical atrophy) and ventriculomegaly (central atrophy) advanced more than age

- b. Toxoplasmosis was defined as a single or multiple rim/nodular enhancing, hypo/isodense lesion with perilesional edema and mass effect at basal ganglia and/or cerebral hemisphere
- c. PML was defined as asymmetrical focal nonenhancing, hypodense white matter lesion without mass effect
- d. TB was defined as ring/nodular/irregular enhancing iso/hypodense/slightly hyperdense lesion and/or target lesion as well as basal cistern leptomeningeal enhancement
- e. Meningitis was defined as leptomeningeal enhancement with or without basal cistern enhancement
- f. Lymphoma was defined as homogeneous or rim enhancing (RE), hyper or hypodense lesion with perilesional edema at periventricular and deep grey matter regions
- g. Infarction was defined as nonenhancing or gyriform enhancing, ill- or well-defined hypodense lesion of vascular territory or perforating substance
- h. Calcified tuberculous granuloma or calcified neurocysticercosis was defined as hyperdense oval-shaped lesion
- i. Early intracranial hemorrhage or bleed was defined as extravascular accumulation of blood as hyperdense lesion within different intracranial spaces
- j. Normal CT scan brain findings were defined as a negative finding.

The remaining patient's variables, namely demographic characteristics, clinical presentation, use of ART, and CD4 results were retrieved from each patient's record. We utilized the Statistical Program for Social Sciences software (SPSS version 19.0, IBM, New York City, USA) for analysis. Data generated from the study were subjected to descriptive statistics for demographic characteristics, CD4 cell counts, and the proportion of patients that were on ART. Results were expressed in percentage, range, mean, and standard deviation, while CT scan findings were expressed as a frequency of occurrence as well as proportions. Significance testing for differences between CT scan findings of patients on ARV versus ARV-naïve patients was performed with $P \leq 0.05$ considered as the measure of statistical significance. The percentage of patients at different levels of CD4 count (cells/mm³) was determined and expressed in relation to CT scan findings.

All statistical tests of differences between patients on ARVs versus ARV naïve patients resulting in *P* values were calculated using a two-tailed analysis of variance.

RESULTS

The principal researcher reviewed 3700 brain CT scans of patients and 364 brain scans met the inclusion criteria

based on the laboratory confirmation of the diagnosis of HIV infection. There were slightly more females (196; 53.8%) than males (168; 46.2%). The patients were aged between 18 and 88 years (mean age: 41 years and standard deviation: ± 11.6 years). There was no information in 14 patients' records for ARV therapy. Among the 350 (96.2%) records, 314 (89.7%) had been or were on ARV therapy when the CT scans were done, and the remaining 36 patients were not on ARV. Among those on ARV, 28 patients (8.9%) were recorded to have defaulted ARV therapy. In addition, from the 314 patients on ARV therapy, CD4 cell count results were available for 171 patients (48.9%) and these ranged between 1 and 1291 cells/mm³ with a median of 84 cells/mm³ [Table 1].

CT scan findings were classified as RE, bleed, infarcts, mucosal thickening of the paranasal sinuses, mass lesions, atrophy, hydrocephalus, and WMD. Others were identified as cryptococcal meningitis, bacterial meningitis, tuberculous meningitis, tuberculous granuloma, mastoiditis, arteriovenous malformation, and neurocysticercosis. The most prominent CT scan findings were brain atrophy [168; 46.2%; Figures 1 and 2] and infarcts [55; 15.1%; Figures 3 and 4]. Other less prominent CT findings were as follows: 31 patients with mucosal thickening of paranasal sinuses (8.5%); 24 cases [6.6%; Figures 5 and 6] of hydrocephalus; 18 cases [4.9%; Figures 7 and 8] of WMD; 13 cases [3.6%; Figures 9 and 10] of mass lesions; 12 patients (3.3%) had RE features, and there were 11 cases (3.0%) of intracranial bleed. RE was caused predominantly by toxoplasmosis [10 cases; 2.8%; Figures 11 and 12]. Other features, which were found among the patients, included: 32 cases [8.8%; Figure 13] of tuberculous granuloma, 15 cases [4.1%; Figures 14 and 15] of tuberculous meningitis, and 2 cases (0.5%) of cryptococcal meningitis [Table 2].

Table 1: Demographic characteristics and human immunodeficiency virus variables of the patients

Variables	Results Frequency (%)
Age (years)	
Range	18-88
Mean	41
SD	11.6
Gender	
Females	196 (53.8)
Males	168 (46.2)
ARVs (n=350)	
Yes	314 (89.7)
No	36 (10.3)
CD4 count (cells/mm ³)	
Range	1-1291
Median	84

SD – Standard deviation; ARV – Anti-retroviral



Figure 1: Axial nonenhanced computed tomographic brain of a 29-year-old female patient with the advanced retroviral disease, who presented with headache and neck pain on tuberculosis treatment. Images demonstrated marked age inappropriate cerebral atrophy



Figure 2: Axial nonenhanced computed tomographic brain of a 29-year-old female patient with advanced retroviral disease, who presented with headache and neck pain on tuberculosis treatment. Images demonstrated marked age inappropriate cerebral atrophy

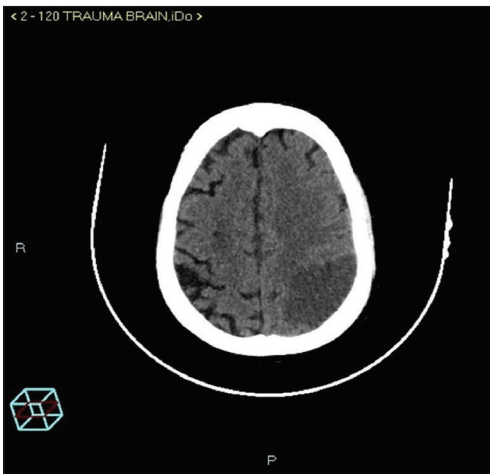


Figure 3: A 34-year-old male patient who is retroviral disease positive, on tuberculosis treatment with severe anemia and confusion. Pre- and post-contrast axial computed tomographic scan images showed the wedge-shaped low-attenuation area in the left posterior parietal lobe with associated effacement of the sulci and gyri on the ipsilateral side. Postcontrast computed tomographic brain also demonstrated luxury perfusion within the area of the infarct

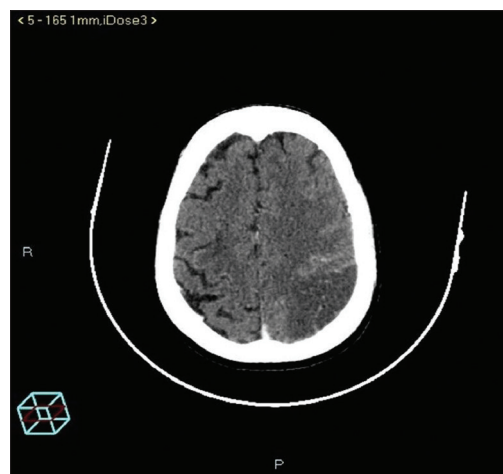


Figure 4: A 34-year-old male patient who is retroviral disease positive, on tuberculosis treatment with severe anemia and confusion. Pre- and post-contrast axial computed tomographic scan images showed wedge-shaped low-attenuation area in the left posterior parietal lobe with associated effacement of the sulci and gyri on the ipsilateral side. Postcontrast computed tomographic brain also demonstrated luxury perfusion within the area of the infarct

Among the 364 CT brain scans, 58 (15.9%) showed normal CT scan findings.

The major clinical presentations of patients at the time of CT scans showed that approximately 41% had confusion 21% presented with headache, 11.0% had seizures, and 8% had neck stiffness [Table 2].

Clinical presentations of patients at the time of CT scan are shown in Table 3 for patients on ARV therapy and those who were ARV naïve.

Patients on ARV therapy who presented with confusion were 107 (45.0%) as compared with 9 (37.5%) ARV naïve

patients ($P = 0.6629$). Among those who presented with headaches, 54 (22.7%) were on ARV therapy as against 6 (25%) who were ARV naïve ($P = 0.5188$). Seizure was recorded in 32 patients (13.4%) on ARV compared with 3 (12.5%) who were ARV naïve ($P = 0.4042$). Neck stiffness was noted in 22 patients (9.2%) for those on ARV as compared with 2 (8.3%) for those who were ARV naïve. Left-sided weakness was found in 13 patients (5.5%) of ARV treated as against 1 case (4.2%) in ARV naïve ($P = 0.0367$). Those who presented with collapse were seven patients (2.9%) for ARV treated and one patient (4.2%) in the ARV naïve [$P = 0.0182$]. Furthermore, patients who presented with psychosis were 3 (1.3%) in



Figure 5: Axial noncontrast computed tomographic scan brain of a 47-year-old retroviral disease positive female patient who presented with confusion, posttreatment of meningitis. Images demonstrated ventriculomegaly of the lateral ventricles (including the third and fourth ventricles not shown in the above images), in keeping with hydrocephalus. Periventricular hypodensities suggest possible acute hydrocephalus



Figure 6: Axial noncontrast computed tomographic scan brain of a 47-year-old retroviral disease positive female patient who presented with confusion, posttreatment of meningitis. Images demonstrated ventriculomegaly of the lateral ventricles (including the third and fourth ventricles not shown in the above images), in keeping with hydrocephalus. Periventricular hypodensities suggest possible acute hydrocephalus

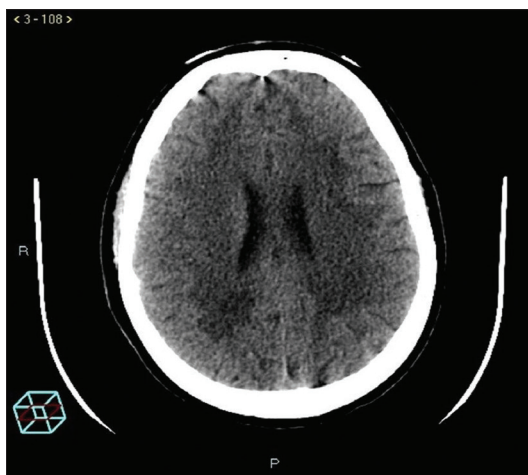


Figure 7: Axial nonenhanced computed tomographic brain of a 24-year-old female patient with HIV, with clinical presentation of confusion, and fever. Images show periventricular hypodensities suggestive of white matter disease

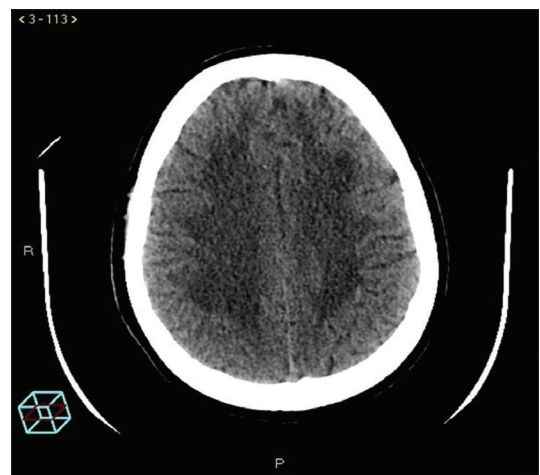


Figure 8: Axial nonenhanced computed tomographic brain of a 24-year-old female patient with HIV, with clinical presentation of confusion, and fever. Images show periventricular hypodensities suggestive of white matter disease

the ARV treated as against two patients (8.3%) in the ARV naïve. ARV-treated patients also presented with right-sided weakness, tremor, and loss of consciousness without corresponding occurrences in the ARV naïve.

The difference in the CD4 count (cells/mm³) for patients on ARV (range: 1–1291; median = 84 cells/mm³) was statistically significant ($P = 0.0148$) when compared with CD4 count of patients who were ARV naïve (range: 1–360; median = 54 cells/mm³). CT scan findings show that the occurrence of infarcts was more among patients on ARV therapy (14.6%) against 8.3% among patients who were ARV naïve although the difference was not statistically

significant. The occurrence of atrophy between those on ARV therapy (33.1%) and those not on treatment (27.8%) was not statistically significant ($P = 0.4836$). Other CT scan findings recorded among patients on ARV (bleed, mucosal thickening, intracranial mass, and WMD) were either too small between the two groups or did not occur in one of the two groups to derive any statistically significant difference [Table 4].

The CD4 count (cells/mm³) for patients was assessed in relation to the types of CT scan findings. The most dominant CT scan finding was brain atrophy, observed in patients at all levels of CD4 count, (range: 1–1291;

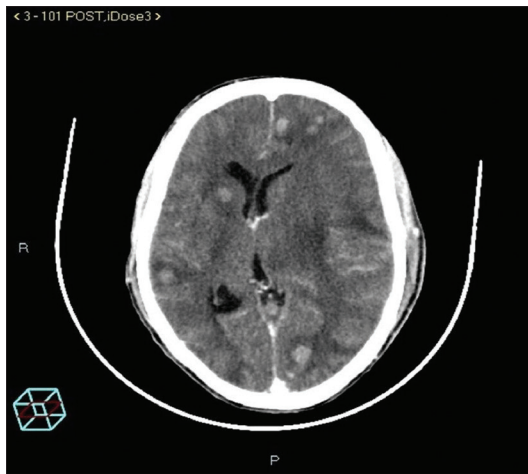


Figure 9: A 35-year-old male patient who is retroviral disease positive on highly active antiretroviral therapy presented with 3 weeks' history of right-sided weakness and inability to talk. Postcontrast axial computed tomographic scan brain showed multiple rim-enhancing lesions with vasogenic edema in the left parietal lobe. Multiple solid and nodular enhancing lesions with vasogenic edema were in addition noted in both cerebral hemispheres. The diagnosis was suggestive of lymphoma. There is also associated left to right subfalcine herniation

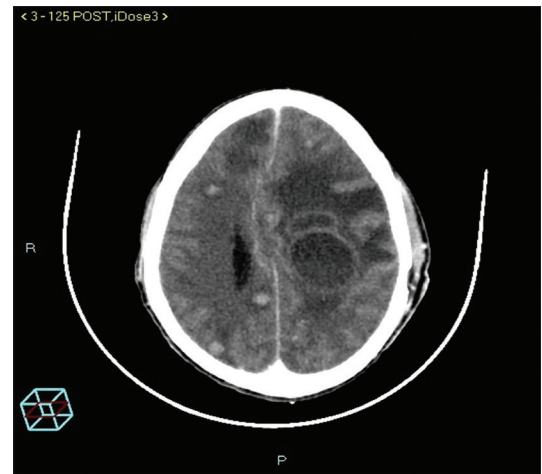


Figure 10: A 35-year-old male patient who is retroviral disease positive on highly active antiretroviral therapy presented with 3 weeks' history of right-sided weakness and inability to talk. Postcontrast axial computed tomographic scan brain showed multiple rim-enhancing lesions with vasogenic edema in the left parietal lobe. Multiple solid and nodular enhancing lesions with vasogenic edema were in addition noted in both cerebral hemispheres. The diagnosis was suggestive of lymphoma. There is also associated left to right subfalcine herniation

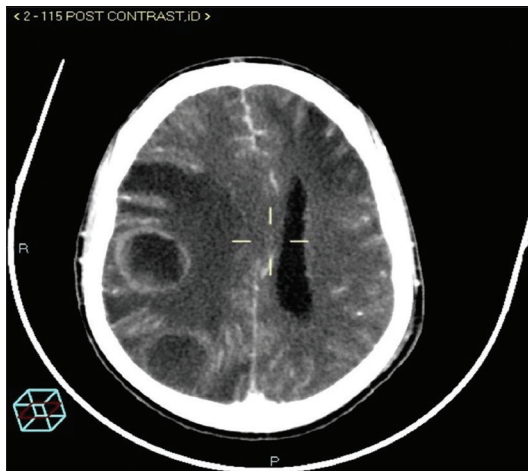


Figure 11: Axial postcontrast computed tomographic scan brain of a 19-year-old retroviral disease positive male patient on ARVs. The patient presented with seizures. Images showed multiple thick walled, rim-enhancing low-attenuation lesions with associated vasogenic edema. Note effacement of the right lateral ventricle, right to left subfalcine herniation, and early hydrocephalus. A diagnosis of toxoplasmosis was made, and the patient improved remarkably after treatment



Figure 12: Axial postcontrast computed tomographic scan brain of a 19-year-old retroviral disease positive male patient on antiretrovirals. The patient presented with seizures. Images showed multiple thick walled, rim-enhancing low attenuation lesions with associated vasogenic edema. Note effacement of the right lateral ventricle, right to left subfalcine herniation, and early hydrocephalus. A diagnosis of toxoplasmosis was made and the patient improved remarkably after treatment

median = 84 cells/mm³) This was followed by TB in which patients with CD4 count between 50 and 199 cells/mm³ were the most affected. Hydrocephalus and infarct were detected in patients with CD4 count (<200 cells/mm³). CT scan finding of "bleed" was found predominantly among patients with CD4 count >500 cells/mm³. Cases of WMD and mass lesions were infrequently found among the patients, and such findings were independent of the level of CD4 count. Mucosal thickening of paranasal sinuses

occurred in patients who had CD4 count of <200 cells/mm³ and those with CD4 count >500 cells/mm³ [Figure 16].

DISCUSSION

From the 364 adult HIV-infected patients, whose CT scan findings were reviewed in our series, 196 (53.80%) were female and 168 (46.20%) were male, which showed a slight female predominance. In the study by Eze and Eze, they had twice the number of males when compared with females,

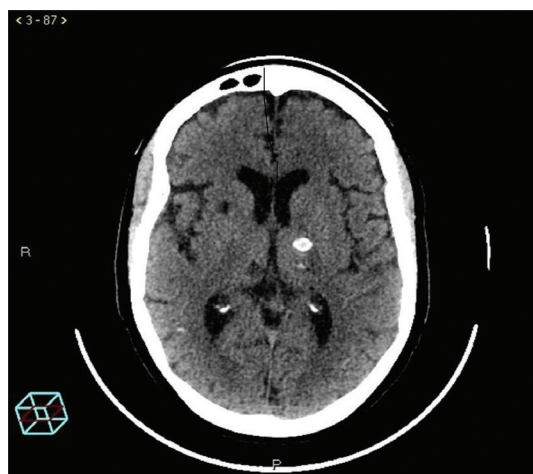


Figure 13: A 44-year-old male patient with a history of retroviral disease on highly active antiretroviral therapy. There is previous history of tuberculosis. Clinical diagnosis of stroke was made. Nonenhanced axial computed tomographic scan images demonstrated 6 mm oval-shaped low-attenuation area in the right basal ganglia suggestive of lacunar infarct. There is another subcentimeter low-attenuation area in the right thalamic region in keeping with thalamic lacunar infarct. Multiple calcifications were noted in both cerebral hemispheres in keeping with calcified tuberculosis granuloma. Differential diagnosis is calcified neurocysticercosis



Figure 14: A 28-year-old female patient retroviral disease positive defaulted on highly active antiretroviral therapy. Patient on subsequent follow-up, presented with a severe headache and confusion. On examination, neck stiffness and Kernig's sign were positive. Clinical diagnosis of meningitis was made. Postcontrast axial computed tomographic images showed exuberant enhancement of the basal cisterns, as well as the leptomeninges, and the Sylvian fissures, in keeping with tuberculosis meningitis



Figure 15: A 28-year-old female patient retroviral disease positive defaulted on highly active antiretroviral therapy. Patient on subsequent follow-up, presented with a severe headache and confusion. On examination, neck stiffness and Kernig's sign were positive. Clinical diagnosis of meningitis was made. Postcontrast axial computed tomographic images showed exuberant enhancement of the basal cisterns, as well as the leptomeninges, and the Sylvian fissures, in keeping with tuberculosis meningitis

for example, 24 males (66.67%) and 12 females (33.33%).^[6] Disparity in the gender predominance between the two studies may be attributed to the larger number of patients and the predominance of reported infected HIV-positive females in South Africa.

Our study compared the major clinical presentations of the HIV-infected adult patients who were on ARVs against

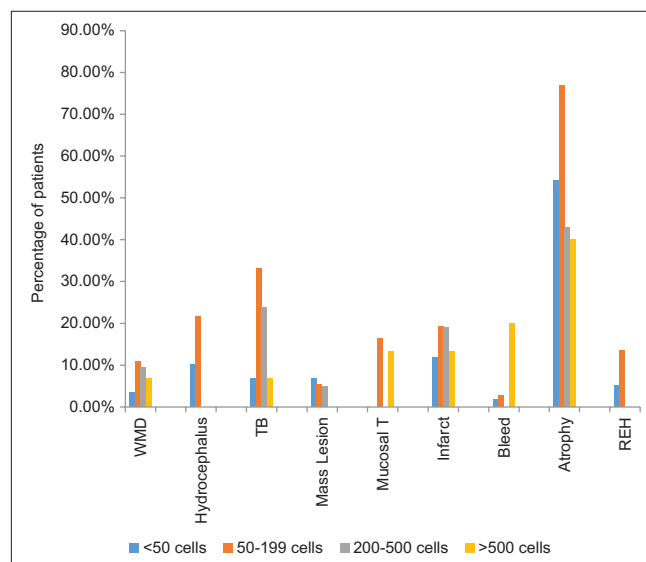


Figure 16: D4 counts of patients in relation to the brain computed tomographic scan findings. WMD = White matter disease; TB = Tuberculosis; REH = Rim enhancing

those who were ARVs naïve. Mental confusion was the major clinical presentation and was statistically significant and higher in those on ARVs when compared with those patients who were ARV naïve. This observation is most likely due to IRIS, which is in agreement with findings in literature.^[8-10] Although not statistically significant, other major presentations, namely headache, seizures, and neck stiffness were also found to occur more in those on ARVs, than those that were ARV naïve. Rothman *et al.* also found confusion, headache seizures, and neck stiffness to be

Table 2: Computed tomographic scan findings for all 364 patients (n=364)

CT findings	n (%)
Rim enhancing (overall)	
Toxoplasmosis	12 (3.3)
Tuberculosis abscess	10 (2.8)
Bleed (overall)	11 (3.0)
Bilateral subdural hematoma	1 (0.3)
Epidural bleed	1 (0.3)
Right-sided subdural hematoma	1 (0.3)
Right-sided subdural hygroma	1 (0.3)
Others	7 (1.9)
Atrophy (overall)	168 (46.2)
Infarcts	55 (15.1)
Mucosa thickening of paranasal sinuses	31 (8.5)
Cryptococcal meningitis	2 (0.5)
Bacterial meningitis	1 (0.3)
Tuberculous meningitis	15 (4.1)
Tuberculous granuloma	32 (8.8)
Mastoiditis	1 (0.3)
Arteriovenous malformation	1 (0.3)
Neurocysticercosis	1 (0.3)
Mass lesions (overall)	13 (3.6)
Lymphoma	11 (3.0)
Macroadenoma	1 (0.3)
Meningioma	1 (0.3)
Hydrocephalus	24 (6.6)
White matter disease (overall)	18 (4.9)
Positive as white matter disease	15 (4.1)
Progressive multifocal leukoencephalopathy	3 (0.8)

CT – Computed tomographic

Table 3: Clinical presentations of human immunodeficiency virus-infected patients at the time of computed tomographic scans

Presentations	Frequency (%)		P
	HAART treated (n=238)	HAART naïve (n=24)	
Confusion	107 (45.0)	9 (37.5)	0.6629
Headache	54 (22.7)	6 (25.0)	0.5188
Seizures	32 (13.4)	3 (12.5)	0.4042
Neck stiffness	22 (9.2)	2 (8.3)	0.2288
Left-sided weakness	13 (5.5)	1 (4.2)	0.0367
Right-sided weakness	13 (5.5)	0	-
Collapse	7 (2.9)	1 (4.2)	0.0182
Psychosis	3 (1.3)	2 (8.3)	0.0300
Tremor	3 (1.3)	0	-
Loss of consciousness	3 (1.3)	0	-

HAART – Highly active antiretroviral therapy

common clinical presentations which are predictive of intracranial lesions on brain CT scans in HIV-infected adult patients.^[11] In the same study, they conclude that when these clinical presentations are incorporated into guidelines for determining the need for emergency head CT scans, it will result in 53% reduction in the number of head CT scans ordered in the emergency department.

The most common brain CT scan findings in our study, was diffuse brain atrophy and similar CT scan findings were obtained by Hongsakul and Laothamatas.^[5] To complement these findings even higher results had been reported in the

study by Senocak *et al.* (90%).^[12] From the study by Senocak *et al.*^[12] HIV encephalitis, which was attributed to direct infection of the CNS with HIV, was found in 60% of the patients, and the most frequent radiological finding was brain atrophy. Although, from this study, it is difficult to associate a particular value of CD4 count with brain atrophy (range: 1–1291; median = 84 cells/mm³), a previous report by Srivastan^[13] has emphasized that HIV-positive patients continue to show evidence of brain atrophy and dysfunction despite the advent of HAART. These may probably explain why brain atrophy is the most common finding in our study. Our study differed with the findings of Eze and Eze who found diffuse brain atrophy as the third-most common findings in their series.^[6] The most common brain CT scan findings by Eze and Eze,^[6] was cerebral infarction, but their finding was higher and not in agreement with other findings in the literature.^[5] However, the finding of cerebral infarct in the present study represented the second highest brain CT scan finding. Among the 364 adult HIV-infected patients that underwent brain CT scan in the present study, very few cases of toxoplasmosis, tuberculous meningitis, and cryptococcal meningitis were found compared with higher values obtained by Hongsakul and Laothamatas in Thailand.^[5] Lower prevalence rates of the opportunistic infections were obtained in our study. This is probably attributable to the widely accepted evidence that HAART reduces the prevalence of central nervous system opportunistic infections,^[8] and HAART is relatively more available in South Africa, which mirrors the situation in the developed countries. Diagnostic yield of TB granuloma and lymphoma, obtained in the present study were higher than the figures found in the literature.^[5] The TB granuloma yield mirrors the higher prevalence of TB in South Africa, which has the third highest burden of the disease in the world, after India and China, with an estimated incidence of 450 000 cases of active TB in 2013.^[9,14]

The median of CD4 cell count of 84 cells/mm³ for those on ARV was statistically significant and higher than those that were ARV naïve (54 cells/mm³). This finding is in agreement with the study by Dean and Berger who also found that HAART has significantly increased life spans and changed the whole landscape of neurological complications.^[8] In the present study, the observed prevalence rate of infarct for HIV-infected adult patients on HAART was higher in comparison with adult patients who were ARV naïve although there was no statistical difference between the two groups. The similar prevalence rate of infarct had been reported by Singer *et al.*,^[15] and they attributed it to the aging population of adult HIV-infected patients, prolonged effect of HAART, and the effect of the HIV virus on the arterial wall.

Table 4: CD4 cell count and computed tomographic scan findings of patients on antiretrovirals and those who were antiretroviral naïve

	ARV treated patients (n=314), n (%)	ARV naïve patients (n=36), n (%)	P
CD4 count (cells/mm ³)			
Range	1-1291	1-360	0.0148
Median	85	54	
Mean	183	82	
CT findings			
Bleed	11 (3.5%)	Nil	0.5781
Infarcts	46 (14.6%)	3 (8.3%)	0.4836
Atrophy	104 (33.1%)	10 (27.8%)	0.6523
Mucosal thickening	25 (8.0%)	1 (2.8%)	-
Toxoplasmosis	4 (1.3%)	Nil	-
Intracranial mass	Lymphoma: 10 (3.2%) Meningioma: 1 (0.3%) Macroadenoma: Nil	1 (2.8%) Nil 1 (2.8%)	-
White matter disease	18 (4.9%)	Nil	-

ARV – Antiretroviral; CT – Computed tomographic

This finding in this study is in agreement with the report of a study by Mlay and Bakari^[16] and Ortiz *et al.*^[17] however, it is in contrast with the report from the study by Graham *et al.*^[4] It is known that a CD4 count of <200 cells/mm³ is associated with a higher risk for stroke.^[18] Furthermore, carotid intima was found to be thicker in HIV-infected patients, and rapid progression was more likely in those with immunodeficiency.^[19] As a result, a stroke could be a late manifestation of HIV infection, and hence early detection of the infection is of clinical importance.^[16]

As seen in this study, HIV-infected adult patients with CD4 counts of 200cell/mm³ or more who have associated low prevalence of positive head CT scan findings as seen in this study may not benefit from head CT scan. However, patients in this category would benefit more from brain MRI scan as an investigative modality of choice. Our study has examined various clinical presentations (clinical variables), together with the CD4 count of adult HIV-infected patients that might be predictive of those patients who would benefit most from head CT scan.

CONCLUSION

This study examined computed tomographic findings of the brain in adult HIV-infected patients at DGMHAH. The study found that the most common CT scan brain finding was brain atrophy, followed by brain infarct. The study was carried out in the post-HAART era; however, opportunistic infections and mass lesions still predominate at CD4 count <200 cells/mm³. Although the reduction in the prevalence of opportunistic infections was observed, brain infarct was seen at CD4 count >200 cells/mm³, and brain atrophy between 1 and 1291 CD4 cells/mm³ (median = 84 cells/mm³)

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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