ORIGINAL RESEARCH

Role of computed tomography and magnetic resonance imaging in evaluation of intracranial lesions associated with immunocompromised adult patients

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ABSTRACT
Immunocompromised patients, caused by HIV-infected patients, patients of chronic renal failure, patients receiving chemotherapy, have a reduced ability to fight infections making them susceptible to CNS infection, increasing their morbidity and mortality. Radiologic imaging with CT and MRI is often employed to supplement clinical evaluation in cases of suspected CNS lesions in these patients. Therefore the objective of this study is to study the usefulness of CT and MRI in characterization and differentiation of CNS lesions, and estimate the incidence of most common intracranial lesion in immunocompromised adult patients. All immunocompromised patients presenting with neurological symptoms underwent CT and MRI scan of the brain. Imaging findings were analyzed and described along with clinic-pathological data as appropriate. The different intracranial lesions in HIV infected patients were Tuberculosis (54.20%), HIV Vasculitis (14.20%), Toxoplasmosis (11.40%), Neurocysticercosis (8.50%), HIV Encephalitis (5.70%), Cryptococcosis (2.80%) and Progressive Multifocal Leukoencephalopathy (2.80%). Overall CT sensitivity was 28%, Positive predictive value (PPV) 100%, Diagnostic accuracy 28%, and MRI had 100% sensitivity and PPV of 100% for detection of CNS lesions in immunocompromised patients. Overall, the most common intracranial lesion in immunocompromised host in the present study is Tuberculosis constituting to 40% incidence, followed by HIV Vasculitis and PRES with 10% incidence each. MRI is an excellent tool for the imaging of brain in immunocompromised patients with neurologic disease, with CT playing a complimentary role.

Key words: Intracranial lesions; Immunocompromised; CT and MRI; HIV-AIDS

Introduction

Suppression of immune system by these immunocompromised states increases susceptibility to Central Nervous system (CNS) infection, increasing the morbidity, mortality and modifies the presentation, diagnosis, and recommended treatment of various CNS infections[1,2].

CNS complications in HIV infection can be seen in 20% of outpatients in HIV clinics and almost half of HIV patients being treated as inpatients[3]. Neurologic complications[2] can arise from the HIV infection itself, from opportunistic infections like tuberculosis(TB), Toxoplasmosis, Neurocysticercosis (NCC) or neoplasms like primary CNS lymphoma, and from treatment-related metabolic derangements like Immune Reconstitution Inflammatory Syndrome (IRIS).

Neurologic complications occur in 30%-60% of people receiving chemotherapy and undergoing solid organ transplantation and are prone to opportunistic infections[4].

Diagnosis of CNS infections remains a great challenge in immunocompromised patients as symptoms might both be masked and be mimicked by other conditions such as metabolic disturbances[5]. Hence early diagnosis of CNS infections in immunocompromised patients remains challenging

and radiological imaging plays a very important role in early diagnosis of CNS abnormalities.

Radiologic imaging is often employed to supplement clinical evaluation in cases of suspected intracranial lesions. While computed tomography (CT) is superior for evaluating osseous integrity and may be more readily available at many institutions, magnetic resonance imaging (MRI) has significantly greater sensitivity for evaluating the cerebral parenchyma, cord, and marrow for early changes[6].

Awareness of the CNS complications in immunocompromised patients is crucial, making an early diagnosis of CNS complication through clinical and radiological approach helps in early initiation of appropriate treatment to improve the outcome in these immunocompromised patients.

Methodology

Source of data: The data for the study was collected from outpatients and inpatients referred for CT and MRI to Department of Radiodiagnosis.

Study Design: Cross sectional study.

Sample size: By using Simple Random Sampling, a convenient sample of 50 eligible patients, attending Radiodiagnosis department of Basaweshwara Teaching and General Hospital, Kalaburagi during my study period were included in the present study.

Inclusion Criteria

1. Patients of 18years and above, irrespective of gender, with immunocompromised state presenting with neurological symptoms like headache, vomiting, fever, altered sensorium, hemiparesis, seizures, loss of speech, paraplegia, blurring of vision, loss of consciousness etc.
2. Patients willing to give informed written consent to take part in the study.

Exclusion Criteria

1. Patients with pre-existing neurological abnormalities prior to being diagnosed with immunocompromised state
2. Patients with contraindications to CT or MR Imaging: patients with ferromagnetic implants, claustrophobia etc.
3. Patients with any contra indications to the use of contrast agents

Methodology

Study subjects were selected after applying inclusion-exclusion criteria. Information was collected through prepared proforma from each patient. All patients diagnosed with immunocompromised state and presenting with neurological symptoms were included in the study. Informed written consent was taken from all the patients.

CT Study of brain was done in Philips 16-slice CT machine. It consists of contiguous axial sections of thickness 5mm of brain in cranio-caudal direction from the level of vertex till mentum. Reconstruction done with a slice thickness of 1.25mm. All images were viewed in a range of soft tissue and bone window settings.

MR imaging examinations was performed on a Philips Achieva 1.5-Tesla magnet MR system, using a head coil with the patient in a supine position with slice thickness of 4-5mm; with an inter-slice gap of 0.5 mm. MR spectroscopy and contrast were done on patients in whom the lesions could not be definitively characterized radiologically using MRI sequences alone.

The following sequences were obtained

- pre-contrast axial and sagittal T1 weighted sequence
- axial and coronal T2 weighted sequence
- axial fluid-attenuated inversion recovery (FLAIR) sequence
- diffusion weighted imaging (DWI)
- susceptibility weighted imaging/ gradient recalled echo (SWI/GRE)
- post contrast T1 weighted sequence
- Single/multi-voxel MR spectroscopy sequences were acquired following the recommended protocols.

Radiological characteristics of the lesions were analyzed and described along with appropriate clinico-pathological findings.

Results

Imaging findings used to characterise the diseases were Infarct, Mass lesion, Mass effect and vasogenic edema, Hydrocephalus, Location of abnormality, Enhancement, Meningitis, Vasculitis, Small vessel ischemic changes (SVIC) and Brain parenchymal cortico-atrophic changes (CAC).

Table 1: Table showing spectrum of imaging findings detected on CT and MRI

Findings	Detected on CT		Detected on MRI	
	Number	Percentage	Number	Percentage
Infarct	7	58.30%	12	100%
Mass lesion	10	43.40%	23	100%
Vasogenic edema	26	89.60%	29	100%
Hydrocephalus	9	100%	9	100%
Location	34	80.90%	42	100%
Enhancement	1	3.20%	37	100%
Meningitis	1	2.70%	21	100%

Vasculitis	0	0%	14	100%
SVIC	5	38.40%	13	100%
CAC	20	74%	27	100%

Detection of imaging findings on CT were comparable to MRI for hydrocephalus, vasogenic edema and cortico-atrophic changes, seen in 100%, 89.60% and 74% of the cases respectively. Mass lesion were detected on CT in only 45% of the cases (10 out of total 23 cases), with correct localisation of the lesions on CT in 80.90% cases (34 out of 42 cases) compared to MRI in which 100% lesions were corrected localised.

Infarcts were detected in 7 out of total 12 cases having infarct, corresponding to sensitivity of 58.3% on CT to detect Infarct. CT has a sensitivity of 38.4% (5 out of 13 cases) in detection of SVIC.

Poor sensitivity of CT to detect Meningitis and Vasculitis corresponding to 2.7% (1 out of total 21 cases) and ~0% (0 out of 14 cases) respectively.

Overall CT had a sensitivity of 49.7% and MRI had a sensitivity of 100% for detection of CNS abnormalities.

All pathological processes (infectious and non-infectious) were evaluated based on their characteristic imaging findings on CT and MRI. The CNS lesions diagnosed in HIV patients includes Tuberculosis, Toxoplasmosis, HIV Vasculitis, HIV Encephalitis (HIVE), Progressive Multifocal Leukoencephalopathy (PML), Neurocysticercosis (NCC).

Table 2: Table showing prevalence of intracranial lesions in HIV patients

Diseases	Number	Percentage
TB	19	54.20%
HIV Vasculitis	5	14.20%
Toxoplasmosis	4	11.40%
Cryptococcosis	1	2.80%
NCC	3	8.50%
HIV Encephalitis	2	5.70%
PML	1	2.80%
Total	35	22.80%

Of the total 35 HIV patients, there were 19 cases of tuberculosis (TB) corresponding to 54.2% of CNS abnormalities in HIV patients. Tuberculomas with or without tubercular meningitis, vasculitis and tubercular abscess were the varying presentation of TB in CNS. Among 19 cases of TB, CT picked up the disease in 1 case (5.2%), and MRI picked up the disease in all 19 cases (100%).

Next disease affecting HIV patients includes HIV vasculitis seen in 5 cases of total 35 cases, corresponding to 14.2%. HIV vasculitis causing infarct was corrected picked up by CT in 4 (80%) out of total 5 cases of HIV vasculitis, whereas MRI correctly picked up disease in 5/5 cases (100%).

Toxoplasmosis in HIV patients was seen in 4 patients corresponding to 11.4%%. CT had detected 2/4 cases (50%), whereas MRI detected 4/4 cases (100%) of toxoplasmosis. Neurocysticercosis (NCC) was seen in 8.50% of the HIV cases (3 out of 35 cases), in which CT picked up findings in 1 out of 3 cases (33.3%)

HIV encephalitis was detected in 5.70% of cases (2 out of 35 cases of HIV), in which CT was unable to pick up the findings. Cryptococcosis and PML each corresponds to 2.8% of the cases (1 out of 35 cases), which were all detected on MRI, and none detected on CT.

Overall CT had a sensitivity of 22.8% as compared to MRI with sensitivity of 100% for detection of CNS lesions in HIV patients.

Table 3: Table showing prevalence of intracranial lesions on CT and MRI in Post-chemotherapy patients

Diseases	Number	Percentage
1. Meningoencephalitis	1	16.60%
2. Fungal granuloma	1	16.60%
3. TB	1	16.60%
4. Metastasis	3	50%
Total	6	100%

Of the total 6 cases of patients who have received immunosuppressive chemotherapy agents for primary carcinoma, 3 cases (50%) with neurologicalsymptoms were found to have CNS metastasis, out of which CT detected 2 cases (66.6%) cases and MRI detected all 3 cases (100%). One case each of Fungal Granuloma, Meningoencephalitis and Tuberculosis were detected on MRI, whereas none of the cases were detected on CT (0%).

Overall sensitivity of CT was 33.30% and MRI has sensitivity of 100% for detection of CNS lesions in post-chemotherapy patients.

Table 4: Table showing total number of cases diagnosed on CT and MRI

		Diagnosis picked on MRI	
		Yes	**No**
Diagnosis picked on CT	Yes	14 (28%)	0
	No	36	0
Total		50 (100%)	0

CT detected CNS abnormalities in 14 cases, compared to MRI which detected CNS abnormalities in 50 cases (100%), corresponding to overall sensitivity of CT in detection of CNS abnormalities of 28%, Positive predictive value (PPV) of 100% and Diagnostic Accuracy (DA) of 28%.

MRI had overall sensitivity of 100%, PPV of 100% and Diagnostic accuracy of 100%

Table 5: Table showing prevalence of intracranial lesions in immunocompromised patients

CNS lesions	Number	Prevalence
TB	20	40%
HIV Vasculitis	5	10%
Toxoplasmosis	4	8%
Cryptococcosis	1	2%
NCC	3	6%
HIV Encephalitis	2	4%
PML	1	2%
PRES	5	10%
Encephalopathy sequelae to CKD	3	6%
Early cerebritis	1	2%
Meningoencephalitis	1	2%
Fungal granuloma	1	2%
Metastasis	3	6%
Total	50	100%

In the present study among all 50 cases, Tuberculosis is the most commonly detected CNS lesion in immunocompromised patients seen in 40% cases i.e., 20 out of 50 cases, followed by HIV Vasculitis and Posterior Reversible Encephalopathy Syndrome seen in 10% cases i.e., 5 out of total 50 cases, HIV Vasculitis seen predominantly HIV patients and PRES seen in CKD patients in renal failure.

Toxoplasmosis was seen in 8% (4 out of 50 cases) of the immunocompromised patients, all seen in HIV patients.

Neurocysticercosis (NCC), Encephalopathy sequelae to CKD and Metastasis were all seen in 6% (3 out of 50 cases) of the immunocompromised patients. HIV Encephalitis was prevalent in 4% of the cases, all of which were seen in HIV patients. Rest of the CNS lesions like Cryptococcosis, PML, Early cerebritis, Meningoencephalitis, Fungal Granuloma constituted approximately to 2% of the cases each.

Discussion

In the present study, clinical and neuro-imaging data obtained from 35 HIV sero- positive patients were analyzed and the following results were revealed.

Of the total 35 patients, most prevalent intracranial lesions in HIV patients was Tuberculosis (TB) with 19 out of 35 cases corresponding to 54.20%. Tuberculomas with or without tubercular meningitis, vasculitis and tubercular abscess were the varying presentation of TB in CNS. Among 19 cases of TB, CT picked up the disease in 1 case (5.20%), and MRI picked up the disease in all 19 cases (100%).

Next disease affecting HIV patients includes HIV vasculitis causing infarct seen in 5 out of total 35 cases, corresponding to 14.20%. HIV vasculitis causing infarct was corrected picked up by CT in 4 (80%) out of total 5 cases of HIV vasculitis, whereas MRI correctly picked up disease in 5/5 cases (100%).

Toxoplasmosis is the next most prevalent CNS opportunistic infection in HIV after TB, seen in 4 patients corresponding to 11.40%, followed by Neurocysticercosis (NCC) seen in 33.30% (3 out of 35 cases) HIV encephalitis corresponding to 5.70% prevalence seen in 2 cases. Cryptococcosis and PML each corresponds to 2.80% of the cases (1 out of 35 cases)

According to Ria Arnold, TusharIssar*et al*, in a study titled 7 "Neurological complications in chronic kidney disease" neurological complications are a major cause of morbidity and mortality among CKD patients. Common neurological complications in CKD include stroke, cognitive dysfunction, encephalopathy, peripheral and autonomic neuropathies.

Among 9 cases of CKD in this present study, most common neurological complication was PRES seen in 5 out of 9 cases corresponding to 55.50% prevalence, followed by Encephalopathy, sequelae to CKD in 33.30% cases. Early cerebritis, acomplication of CKD was seen in 11.10% cases. Among the neurological lesions of CKD, CT was able to detect 4 out of 8 cases, corresponding to sensitivity of 44.40%, as compared to 100% sensitivity of MRI[8].

In a study by Sonneville R, Magalhaes E, *et al.*, titled "Central nervous system infections in immunocompromised patients."in patients using chronic immunosuppressant therapy after solid organ transplantation or for other reasons, opportunistic infections depend on the level of immunosuppression and typically occur within 1 year following transplantation. Most frequent causes include CNS aspergillosis (approximate incidence, 0.2%), cryptococcal meningitis (0.1%), endemic fungi (0.2%), others like viral Meningoencephalitis (0.04%) and Tuberculosis (0.02%) as a result of community acquired infection[9].

The results were comparable to the present study in which out of 6 cases of chemotherapy induced immunosuppression, 1 case each of Viral Meningoencephalitis, Tuberculosis and Fungal granuloma was detected. In rest of the 3 cases revealed brain metastasis of previous haematological malignancies. Overall, CT was able to detect 2 out of 6 cases of Post-chemotherapy patients having CNS lesions, corresponding to 33.30% CT sensitivity as compared to 100% MRI sensitivity.

Ruth G. Ramsey1, Glen K. Geremia studied "CNS Complications of AIDS: CT and MR Findings" 10 and found MR is more sensitive than CT in diagnosing intra- cerebral infections. The superior contrast resolution of MR makes it a more sensitive cross-sectional imaging tool for evaluating intra-cerebral lesions associated with a variety of infectious processes.

This is comparable to the present study with overall sensitivity of CT 28%, compared to 100% sensitivity of MRI, 100% positive predictive value for detection of CNS diseases.

Overall, the most common CNS abnormality in immunocompromised host in the present study was Tuberculosis constituting to 40% incidence, followed by HIV Vasculitis and PRES with 10% incidence each. Toxoplasmosis seen predominantly HIV patients constituted 8% of the cases. NCC and Encephalopathy sequelae to CKD were seen in 6% of the immunocompromised patients each. HIV encephalitis was seen in 4% of the cases. Rest of the CNS abnormalities like Cryptococcosis, PML, Early cerebritis, Meningoencephalitis, and Fungal Granuloma constituted approximately to prevalence of 2%.

Conclusion

MRI is an excellent tool for the imaging of the brain in immunocompromised patients with neurologic disease, with CT playing a complimentary role. It provides novel insights into the extent of CNS involvement, the progressive nature of CNS lesions, as well as provides unique biomarkers that can be used to evaluate treatment regimens.

There are a wide number of possibilities in the evaluation of immunocompromised patients with neurologic disease. Imaging findings of the lesions in such patients may overlap, and differential diagnosis may be difficult; however, certain imaging characteristics and localizations of lesions may favor the diagnosis.

Diagnosis based only on MRI is sometimes very difficult in the presence of focal lesions. CT and MRI sequences play a complimentary role. Both need to be studied in conjunction.

Use of both CT and MRI sequences is advisable to achieve a high degree of accuracy in making a complete diagnoses that is unmatched by any other investigative tool.

References

1. John R. Haaga, Daniel T. Boll. CT and MRI of the whole body. 6th edi. Vol 1. Philadelphia, PA: Elsevier; c2017. p.966-968.
2. Anne G. Osborn Gary, Hedlund Karen, L. Salzman. Osborn's brain Imaging,pathology, and anatomy. 2nd edi. 2017Sept20. p.417-447.
3. KumarasamyN, SnigdhaVallabhaneni,*et al*. Clinical Profile of HIV in India. Indian Journal of Medical Research. 2005Apr;121:377-394.
4. Joseph R. Zunt. Central nervous system infection during Immunosuppression. Neurologic Clinics. 2002 Feb;20(1):1-5.
5. Castro I, Ruiz J, Tasias M, Montero M, Salavert M. Central nervous system infections in immunocompromised patients. Rev EspQuimioter. 2018 Sep;31Suppl 1(Suppl 1):56-61.
6. Iván Castro, Jesús Ruiz, Maria Tasias, *et al*. Central nervous system infections in immunocompromised patients. Official journal of Spanish society of chemotherapy. 2018;31(Suppl. 1):56-61.
7. Arnold R, Issar T, Krishnan AV, Pussell BA. Neurological complications in chronic kidney disease. JRSM Cardiovasc Dis. 2016 Nov 3;5:2048004016677687.
8. Sonneville R, Magalhaes E, Meyfroidt G. Central nervous system infections in immunocompromised patients. CurrOpinCrit Care. 2017 Apr;23(2):128-133.
9. Wright AJ, Fishman JA. Central nervous system syndromes in solid organ transplant recipients. Clin Infect Dis. 2014 Oct;59(7):1001-11.
10. Ruth G. Ramsey1, Glen K. Geremia, CNS Complications of AIDS: CT and MR Findings, AJR.1988Sept;151:449-454. 0361-803x/88/1513-0449 C American Roentgen Ray Society.