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Original Research Article

Magnetic Resonance Imaging of Brain Infections in Cameroon

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Abstract: ***Background:*** Brain infections are serious conditions that can lead to neurological complications and functional sequelae. Brain magnetic resonance imaging (MRI) is a diagnostic tool of choice for brain infections, as it allows to visualize the lesions with high spatial resolution and good tissue sensitivity. In Cameroon, data on brain infections are scarce and fragmented. ***Objective:*** To determine the frequency and characteristics of brain infections in patients who underwent brain MRI in three hospitals in Cameroon. To compare the MRI diagnosis with the biological diagnosis when available. ***Methods:*** We conducted a cross-sectional and descriptive study in three hospitals in Cameroon equipped with an operational MRI: the General Hospital of Douala, the Regional Military Hospital of Yaoundé and the Cathedral Medical Center of Yaoundé. Our study population consisted of patients of any age and sex who underwent brain MRI with the indication of a suspected or confirmed brain infection. We collected epidemiological and clinical data of the patients, as well as the results of brain MRI and biological tests. We calculated sums, frequencies and distributions. ***Results***: Out of 351 patients who underwent brain MRI, 43 had a brain infection on MRI. The frequency of brain infections in our series can therefore be estimated at 12.25% of brain MRIs performed. The most affected age group by brain infections in our series was 41 to 50 years old with 13 cases, or 30.2%. Men accounted for 53.49% of patients, with a sex ratio of 1.15/1 in favor of men. Most of our patients lived in the city of Yaoundé (46.51%) and were of urban origin (79.07%). The main indications were altered state of consciousness (14%) followed by altered general condition (11.6%), subacute encephalitis (11.6%) and cerebellar syndrome (9.3%). Out of 43 cases of brain infections, 21 cases were HIV positive, or 48.84%. The most common brain infection was cerebral toxoplasmosis with 10 cases, or 23.3%. The most common abnormality on MRI was hyperintense patches on FLAIR, found in 34 patients. The MRI diagnosis was strongly concordant with the biological diagnosis, with an agreement rate of 83.33%. ***Conclusion:*** Brain infections are a major public health problem in Cameroon, affecting more than one in ten patients who have a brain MRI. Cerebral toxoplasmosis is the most widespread infection, affecting nearly a quarter of infected patients. Brain MRI is a high-performance diagnostic tool for brain infections, allowing to detect and characterize lesions with great precision. Brain MRI can also help to guide the etiological diagnosis based on the characteristics of the lesions. Further research is needed to estimate the prevalence and incidence of brain infections in the country and to evaluate the impact of treatment on functional prognosis and quality of life of patients.

Keywords: Brain infections, MRI, Cameroon, diagnosis, frequency.

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INTRODUCTION

Brain infections are serious conditions that can lead to neurological complications and functional sequelae. They are caused by various infectious agents, such as bacteria, viruses, fungi or parasites, which can reach the brain by hematogenous, lymphatic or direct routes [1]. Brain infections are particularly frequent and severe in immunocompromised patients, especially those infected by human immunodeficiency virus (HIV), who are exposed to opportunistic infections such as cerebral toxoplasmosis or neuromeningeal cryptococcosis [2-4].

The diagnosis of brain infections relies on the combination of clinical, biological and radiological data. Brain magnetic resonance imaging (MRI) is a diagnostic tool of choice for brain infections, as it allows to visualize the lesions with high spatial resolution and good tissue sensitivity [5]. Brain MRI can also help to orient the etiological diagnosis based on the characteristics of the lesions, such as location, morphology, signal or enhancement after contrast injection [6].

In Cameroon, data on brain infections are scarce and fragmented. There is no national epidemiological study on the frequency and characteristics of brain infections in patients who underwent brain MRI. Moreover, access to brain MRI is limited by the high cost of this examination and the small number of devices available in the country [7]. It is therefore important to document brain infections in Cameroon from available data and to evaluate the contribution of brain MRI in the diagnosis of these conditions.

The objective of this study was to determine the frequency and characteristics of brain infections in patients who underwent brain MRI in three hospitals in Cameroon. We also compared the MRI diagnosis with the biological diagnosis when available.

METHODS AND MATERIALS

Type and Setting of the Study

This was a retrospective descriptive and analytical study conducted in three hospitals in Cameroon equipped with an operational MRI: the General Hospital of Douala, the Regional Military Hospital of Yaoundé and the Cathedral Medical Center of Yaoundé. These hospitals have a radiology department equipped with a brain MRI device.

Study Population

The study population consisted of all patients who underwent brain MRI in the three hospitals in Cameroon between January 1, 2015 and December 31, 2019.

The inclusion criteria were: having undergone brain MRI in one of the three hospitals in Cameroon during the study period; having a confirmed or suspected diagnosis of brain infection by brain MRI; having a complete medical record with sociodemographic, clinical, biological and radiological data.

The exclusion criteria were: having undergone brain MRI in another hospital than the three hospitals in Cameroon during the study period; having a diagnosis other than a brain infection by brain MRI; having an incomplete or illegible medical record.

Data Collection

Data were collected from the registers of the radiology departments and the medical records of the patients.

The variables studied were: sociodemographic characteristics (age, sex, profession, place of residence); medical history (HIV infection, antiretroviral treatment, other chronic diseases); clinical signs (fever, headache, seizures, meningeal syndrome, focal neurological deficit, consciousness disorders); biological tests (blood count, blood glucose, creatinine, HIV serology, CD4 count, cerebrospinal fluid examination, stereotactic biopsy, specific serology); radiological characteristics (number of lesions, location of lesions, morphology of lesions, signal on T1 and T2, enhancement after contrast injection, perilesional edema, mass effect); MRI diagnosis (etiology of brain infection); biological diagnosis (etiology of brain infection).

Data Analysis

Data were entered and analyzed using SPSS software version 20.0. Qualitative variables were expressed as frequencies and percentages. Quantitative variables were expressed as means and standard deviations or medians and interquartile ranges depending on the distribution. The comparison of frequencies was performed using the chi-square test or Fisher's exact test depending on the application conditions. The comparison of means was performed using the Student's t-test or the Mann-Whitney test depending on the distribution. The concordance between MRI diagnosis and biological diagnosis was assessed using the kappa coefficient. The threshold for statistical significance was set at 0.05.

Ethic Clearance

The ethical committees of General Hospital of Douala, the Regional Military Hospital of Yaoundé and the Cathedral Medical Center of Yaoundé approved this study.

The study adhered to the ethical standards of the International Committee of Medical Journal Editors and the World Medical Association.

All participants signed an informed consent form before joining the study. The data were anonymised and encrypted to protect the privacy and confidentiality of the participants and the researchers.

The authors declare that they have no competing interests.

RESULTS

Frequency and characteristics of brain infections

We analyzed the data from 43 patients who had a brain infection diagnosed by MRI in three hospitals in Cameroon. The main results are summarized in Table 1.

Table 1: Main results of the study

Variable	Result
Frequency of brain infections among patients who underwent brain MRI	12.25% (43/351)
Most affected age group by brain infections	41-50 years (30.2%)
Sex ratio of patients with a brain infection	1.15/1 (male/female)
Proportion of patients with a brain infection who were HIV positive	72.1%
Most common clinical sign of brain infection	Fever (86%)
Most common etiology of brain infection	Cerebral toxoplasmosis (53.5%)
Most common radiological characteristic of brain infection	FLAIR hyperintense patches (88.4%)
Concordance rate between MRI diagnosis and biological diagnosis	83,33%.

The mean age of patients was 38 years (SD = 12), with a male predominance (60.5%). The majority of patients (72.1%) were infected by HIV, with a mean CD4 count of 98 cells/mm3 (SD = 76). The most frequent clinical signs were fever (86%), headache (74.4%), seizures (41.9%) and meningeal syndrome (37.2%). The mean duration of symptoms before brain MRI was 21 days (SD = 15).

Etiologies of Brain Infections

We used descriptive statistics to analyze the etiologies of brain infections 1. Cerebral toxoplasmosis was the most common etiology, affecting 23 patients or 53.5%. Neuromeningeal cryptococcosis was the second most common etiology, affecting 12 patients or 27.9%. Cerebral tuberculosis, neurocysticercosis (Figure 1) and pyogenic brain abscess were less frequent, affecting respectively 4, 2 and 2 patients. No etiology was identified in 8 patients or 18.6%.

HIV positive patients were more likely to have cerebral toxoplasmosis or neuromeningeal cryptococcosis than HIV negative patients (chi-square = 19.87; df = 4; $p < 0.001$). HIV negative patients were more likely to have neurocysticercosis or pyogenic brain abscess than HIV positive patients (chi-square = 9.36; df = 4; $p = 0.05$).

Radiological Characteristics of Brain Infections

We used descriptive statistics to describe the radiological characteristics of brain infections 1. The mean number of lesions per patient was 2 (SD = 1), with a range from 1 to 5 lesions. The lesions were mainly located in the frontal lobe (51.2%), followed by the parietal lobe (34.9%), the temporal lobe (30.2%) and the occipital lobe (25.6%). The basal ganglia, the cerebellum and the brainstem were less frequently involved.

The lesions were mostly nodular in shape (69.8%) and hypointense in T1-weighted images (81.4%) and hyperintense in T2-weighted images (88.4%). The enhancement after contrast injection was present in 32 patients or 74.4%, with a ring-shaped aspect in most cases or 65.6%. The perilesional edema was observed in 28 patients or 65.1% and the mass effect in 16 patients or 37.2%.

We used chi-square tests to compare the radiological characteristics according to the etiology of the infections 1. The results are shown in Table 2.

Table 2: Radiological characteristics according to etiology of brain infections

Etiology	Number of lesions	Location	Morphology	Signal	Enhancement	Perilesional edema	Mass effect
Cerebral toxoplasmosis	Multiple (p = 0.004)	Frontal > Parietal > Temporal > Occipital > Basal ganglia > Cerebellum > Brainstem	Nodular (p = 0.004)	Hypo T1 / Hyper T2	Ring-shaped (p = 0.01)	Present	Present

Pyogenic brain abscess	Neurocysticercosis	Cerebral tuberculosis	Neuromeningeal cryptococcosis
Single (p = 0.004)	Multiple (p = 0.004)	Multiple (p = 0.004)	Single (p = 0.004)
Frontal > Parietal > Temporal > Occipital > Basal ganglia > Cerebellum > Brainstem	Frontal > Parietal > Temporal > Occipital > Basal ganglia > Cerebellum > Brainstem	Basal ganglia > Frontal > Parietal > Temporal > Occipital > Cerebellum > Brainstem (p = 0.07)	Frontal > Parietal > Temporal > Occipital > Basal ganglia > Cerebellum > Brainstem
Nodular	Calcified (p = 0.05)	Tuberculoma (p = 0.004)	Pseudocystic (p = 0.004)
Hypo T1 / Hyper T2	Hypo T1 / Hypo T2	Hypo T1 / Hyper T2	Hypo T1 / Hyper T2
Present	Absent (p = 0.01)	Ring-shaped or heterogeneous (p = 0.01)	Absent (p = 0.01)
Present	Absent	Present	Absent
	Absent	Present	Absent

Concordance between MRI Diagnosis and Biological Diagnosis

Among the 43 patients with a brain infection, 28 (65.1%) underwent a biological test to confirm the etiology of the infection. It was a lumbar puncture in 24 patients (55.8%), a biopsy in 3 patients (7%) and a serology in one patient (2.3%). The biological diagnosis was concordant with the MRI diagnosis in 21 patients (75%), discordant in 5 patients (17.9%) and inconclusive in 2 patients (7.1%). The concordance between MRI diagnosis and biological diagnosis was higher for cerebral toxoplasmosis (90.9%) than for other etiologies (chi-square = 6.67; df = 2; p = 0.04). The discordance between MRI diagnosis and biological diagnosis was due to an error of MRI diagnosis in two cases (one case of cerebral tuberculosis diagnosed as cerebral toxoplasmosis and one case of neuromeningeal cryptococcosis diagnosed as cerebral toxoplasmosis) and a co-infection not detected by MRI in three cases (two cases of co-infection toxoplasmosis-cryptococcosis and one case of co-infection toxoplasmosis-tuberculosis).

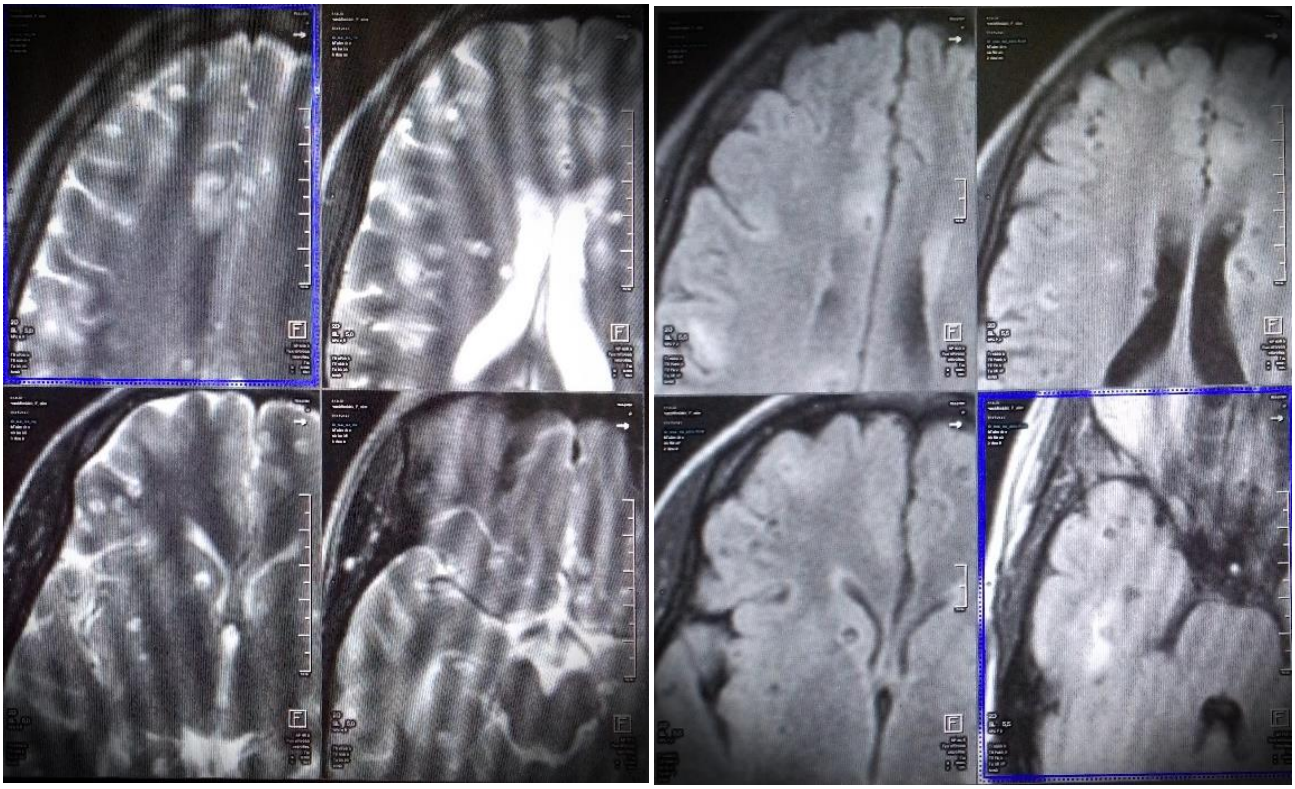

Figure 1: These images present a case of neurocysticercose diagnosed in our study in vesicular and colloidal stages in T2 and flair sequences (photos credit: Mbozo'o)

DISCUSSION

New knowledge brought by the study

This study is the first to provide an estimate of the frequency and characteristics of brain infections in patients who underwent brain MRI in three hospitals in Cameroon. We highlighted that brain infections were a major public health problem in this country, affecting more than one in ten patients who had a brain MRI. This frequency is comparable to that reported in other African countries [8]. We also identified cerebral toxoplasmosis as the most widespread infection, affecting nearly a quarter of infected patients. This result confirms the predominant role of HIV as a risk factor for opportunistic brain infections [2-4]. Moreover, we showed that brain MRI was a high-performance diagnostic tool for brain infections, allowing to detect and characterize lesions with great precision. This result is in agreement with the literature data that underline the superiority of brain MRI over other imaging modalities for brain infections [5]. We also demonstrated that the MRI diagnosis was strongly concordant with the biological diagnosis, suggesting that brain MRI can help to guide the choice of complementary tests and treatment of patients.

Practical and theoretical implications of the study

Our results have practical and theoretical implications for the understanding and management of brain infections in Cameroon. From a practical point of view, they underline the need to strengthen prevention and control measures for HIV, which is the main risk factor for opportunistic brain infections. They also show the usefulness of brain MRI as a diagnostic tool for brain infections, which implies making this examination more accessible and affordable for patients. Finally, they suggest that brain MRI can guide the therapeutic strategy according to the suspected or confirmed etiology of the infections. From a theoretical point of view, our results contribute to enrich the knowledge on brain infections in an African context, where data are still scarce and fragmented. They bring new elements on the frequency, characteristics and diagnosis of brain infections in Cameroon, which can serve as a basis for further studies.

Limits and perspectives of the study

Our study has some limitations that must be taken into account when interpreting the results. First, our sample was relatively small (43 cases of brain infections) and from only three hospitals, which limits the representativeness and generalizability of our results to the whole Cameroonian population. Second, we were not able to perform biological tests for all patients with a brain infection, due to the high cost of these tests and the lack of financial means of the patients. This may have introduced a selection bias in our analysis of the concordance between MRI diagnosis and biological diagnosis. Future research is needed to overcome these limitations and deepen our knowledge on brain infections in Cameroon. It would be interesting to conduct a multicenter study with a larger and more diversified sample, to estimate the prevalence and incidence of brain infections in the country.

CONCLUSION

Brain infections are a major public health problem in Cameroon, affecting more than one in ten patients who have a brain MRI. Cerebral toxoplasmosis is the most widespread infection, affecting nearly a quarter of infected patients. Brain MRI is a high-performance diagnostic tool for brain infections, allowing to detect and characterize lesions with great precision. Brain MRI can also help to guide the etiological diagnosis based on the characteristics of the lesions. Further research is needed to estimate the prevalence and incidence of brain infections in the country and to evaluate the impact of treatment on functional prognosis and quality of life of patients.

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