

## CARE OF ADULT BRAIN TUMORS IN A DEVELOPING COUNTRY: A CROSS-SECTIONAL STUDY ABOUT 46 CASES

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### ABSTRACT

**Background:** Brain tumor is a public health concern demanding research efforts. Niger is not exempted. The scientific advance in the domain is not yet at the disposal of sub-Saharan Africa. Multidisciplinary care ought to bring a positive outcome on the prognosis. There, we aimed to identify brain tumors, assess their care and prognosis, and highlight some shortcomings to address. **Methods:** It was a descriptive, retro- and prospective study over 69 months including all the adults admitted and operated for brain tumors in the neurosurgical department of the Niamey National Hospital. The Khi<sup>2</sup> test was applied with a 95% confidence interval to assess the association between some variables. **Results:** The hospital incidence was 2.83%. The sex ratio M: F was 0.77. Young adults were most concerned with an average of  $45.39 \pm 17.36$  years old. Meningiomas (45.65%) were followed by gliomas (19.57%). Surgery consisted of complete resection for 69.57% of patients, gross total resection for 21.74%, and biopsy for 2 patients. The post-surgical follow-up was about pain, infection, edema, and convulsion. At mid-term it was about dysarthria, hemiplegia, hypertonia, and facial paralysis. We had 23.91% of histopathologic analysis. The adjuvant therapies comprised chemotherapy (8.7%) and radiotherapy (2%). We had a remission of 95.65%. **Conclusion:** There is a significant expansion concerning intracranial tumors in sub-Saharan Africa, particularly in Niamey. We need to be integrative, by participating in building a regional cancer registry under the umbrella of the Society for Neuro-oncology of sub-Saharan Africa, to achieve more.

**Keywords:** Brain tumors, Meningioma, Glioma, Cancer Registry, Niger

### INTRODUCTION

Brain tumors are the 2<sup>nd</sup> cause of death worldwide (Olivier Uwishema *et al.*, 2023). In sub-Saharan Africa, it is underestimated because of communicable diseases which represent a public health issue, and are therefore the focus of all research efforts (Mbi Feh *et al.*, 2021; Olivier Uwishema *et al.*, 2023). Niger is not exempt. The renewed interest in brain tumor pathology is due to scientific advances in diagnosis and treatment tools (Dillman & Bota, 2024; Roda *et al.*, 2024; Sherman *et al.*, 2024), even though in sub-Saharan Africa this progress is far from reaching compared to developed countries (Olivier Uwishema *et al.*, 2023). However, given the care is multidisciplinary, other spheres such as anatomo-histopathology, oncology, and radiology, need to coordinate progress if they are to provide prognostic benefits (Roda *et al.*, 2024; Tamimi & Juweid, 2017; Youssef & Wen, 2024).

This study was a contribution to the previous ones carried out in Niamey, and highlights the types of tumors encountered, their management and prognosis. It also aimed to highlight the difficulties still to overcome, and some risks factors related to the outcome. This is for the improvement of the management of this pathology which remains a public health problem.

## **METHODS**

### ***Study design***

This is a descriptive observational and analytic study, running from January 1, 2018, to September 30, 2023, for the prospective part, i.e. 69 months period.

### ***Study setting and population:***

Niger is the largest West African country (1,267,000 km<sup>2</sup>), bordered by Mali and Burkina Faso at west side, Libya and Algeria in north, Chad in east and Benin, Togo and Nigeria in south.  $\frac{3}{4}$  of the country is occupied by the Sahara Desert. The population estimated at 23,591,983 is unevenly distributed across the country. The capital, Niamey has the highest population density (5,356.6 inhabitants/km<sup>2</sup>) compared to the entire country (18.6 inhabitants/km<sup>2</sup>). According to WHO standard, Niger is far behind the required ratio neurosurgeons/inhabitants covered (1/1,685,142). (Hamma *et al.*, 2024) In Niamey, the National Hospital is the highest referral center due to the fact that 50% of the neurosurgeons are operating there.

The study was carried out on adult patients hospitalized and managed for brain tumors in the Neurosurgery Department of the National Hospital of Niamey. The study had a retrospective arm starting from January 1, 2018, to December 31, 2022, and a prospective arm starting from January 1, 2023, to September 30, 2023.

### ***Participants***

Patients admitted for diagnosis else than brain tumor or with a brain tumor out of the study period, patients less than 18 years old, patients deceased before surgical care or patients evacuated and patients with non-surgical management were not included. Poor records and patients lost to follow up were excluded from the study. The Files followed a selection process. (Figure 1).

### ***Variables***

The variables assessed were gender, age, risk factors, diagnosis through physical examination and imagery workup, complications, adjuvant therapies, and outcomes at hospital discharge.

### ***Data resources and measurement***

*Data collection tool:* Data were collected using an individual investigation form build and approved by the research team.

*Data collection:* Data was retrieved from the patient's files, surgical records, hospitalization records and by interview especially for the prospective arm of the study. After collecting data using the investigation form, it was transcript to Microsoft Excel 2016 and later on uploaded in Jamovi 2.3 for data analysis.

*Study size:* The sample size was determined by the studying period making sure we had a considerable size to carry out analytic study. We had 46 patients over 69 months.

*Bias:* Difficulties encountered during the study included missing information in several medical records and patients lost to follow-up. Files with non-exploitable data were put aside in the process.

### ***Data analysis***

Descriptive analysis was run, reporting numbers and frequencies for qualitative variables. For the quantitative variables, Mean, Median, Standard deviation and Percentiles were calculated. For the association between some variables, the statistical test used was the chi-square. The test was significant with a p-value < 0.05.

The outcome was defined by “dead”, “alive” and “resurge”.

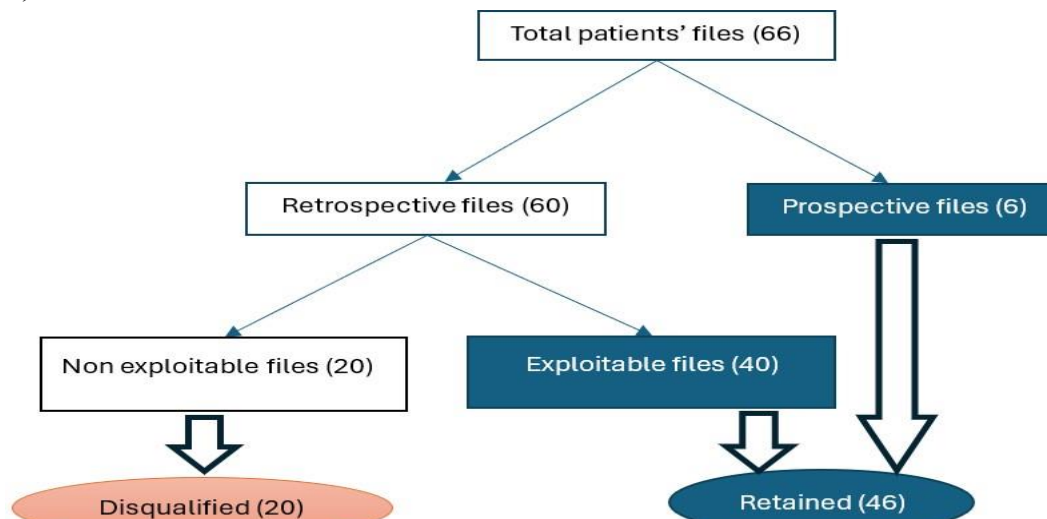
### ***Ethical considerations***

The research was carried out after authorization provided by both the dean of the faculty of health sciences and the director of the National hospital of Niamey. For the retrospective arm of the study the consent was not needed. For the prospective arm of the study, oral consent was obtained by the patient itself or from the guardians when the patient was not responsive. The confidentiality was ensured while moving from data collection to data entry for analysis.

## RESULTS

### Participants

1,625 patients were admitted to the Neurosurgery Department, including 46 cases of brain tumors after file processing (Figure 1), representing a hospital incidence of 2.8%. It was noted that 2019 had the highest incidence, 30.4%.



**Figure 1:** File processing flow chart

### Descriptive analysis

The most concerned age group ranged between 49 and 58 years old, with 14 patients (30.4%; n=14). The mean age was  $45.4 \pm 17.4$  years, with extremes of 18 and 84 years.

**Table 1:** Summary of clinical signs presented by the patients

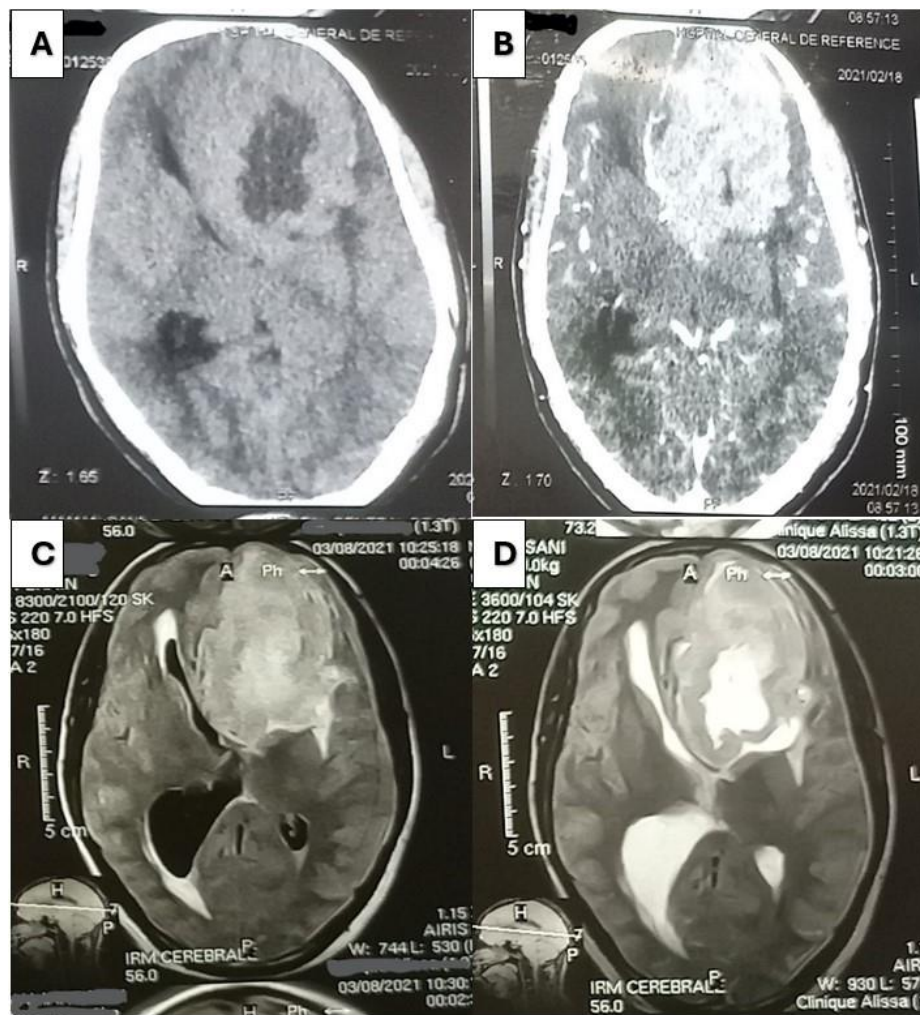
| Clinical aspects          | Frequency     | p-value* |
|---------------------------|---------------|----------|
| General status WHO 3      | 7% (n=3)      | 0.037    |
| Signs of ICH <sup>a</sup> |               |          |
| Headaches                 | 95,65% (n=44) |          |
| Vomiting                  | 23,91% (n=11) |          |
| Nausea                    | 21,74% (n=10) |          |
| Seizures                  | 28% (n=13)    | 0.761    |
| Vertigo                   | 26% (n=12)    | -        |
| Focal sign                |               | 0.171    |
| Visual impairment         | 23,91% (n=11) |          |
| Paresis                   | 21,74% (n=10) |          |
| Aphasia/Dysarthria        | 15,22% (n=7)  |          |
| Cognitive impairment      | 8,69% (n=4)   |          |
| Tumor's location          |               | 0.412    |
| Supra tentorium           | 78.3% (n=36)  |          |
| Sub tentorium             | 21.7% (n=10)  |          |

<sup>a</sup> Intracranial hypertension ; \* p-value is evaluated upon outcome

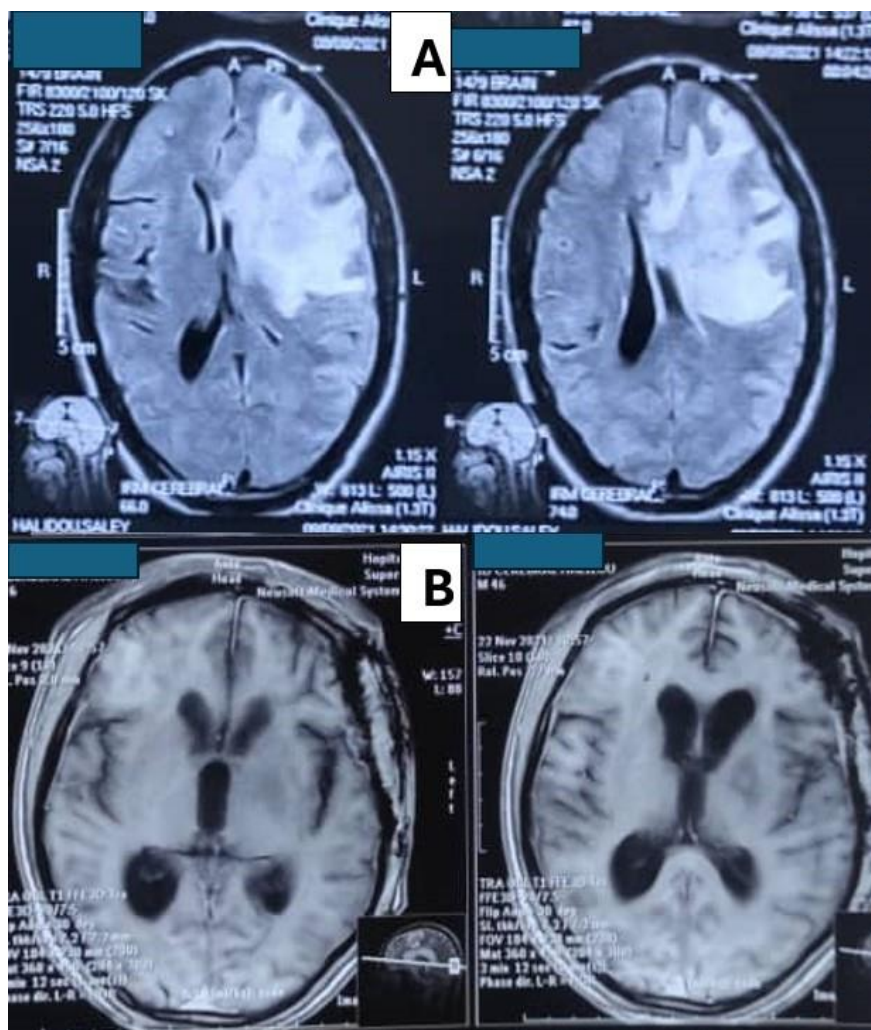
There were more females (56.5%; n=26) with M: F ratio of 0.77.  
 15.2% (n=7) of patients were exposed to ionizing radiation (X-ray).  
 Alcoholics and smokers accounted for 2.2% (n=1) and 15.2% (n=7) respectively.  
 Twelve patients had a past medical history, among which hypertension represented 58.33% (n=7). For past surgical history concerning five patients, brain tumorectomy accounted for 60% (n=3).  
 From a clinical point of view, the table (Table 1) lists the physical signs encountered.

On imagery workup, the most common tumor sites were the posterior fossa and parietal region, with 21.74% (n=10) each. 78.29% (n=36) of tumors were supratentorial. The lesion's features favored meningioma (Figure 2) (45.65%; n=21), glioma (Figure 3) (19.57%; n=9), glioblastoma (13.04%; n=6), and others accounting for 21.71% (n=10). Among 35 patients who had a mass effect on the imagery, perilesional edema, and brain herniation were the main effects of the lesion, accounting for 68.57% (n=24) and 20% (n=7) respectively.

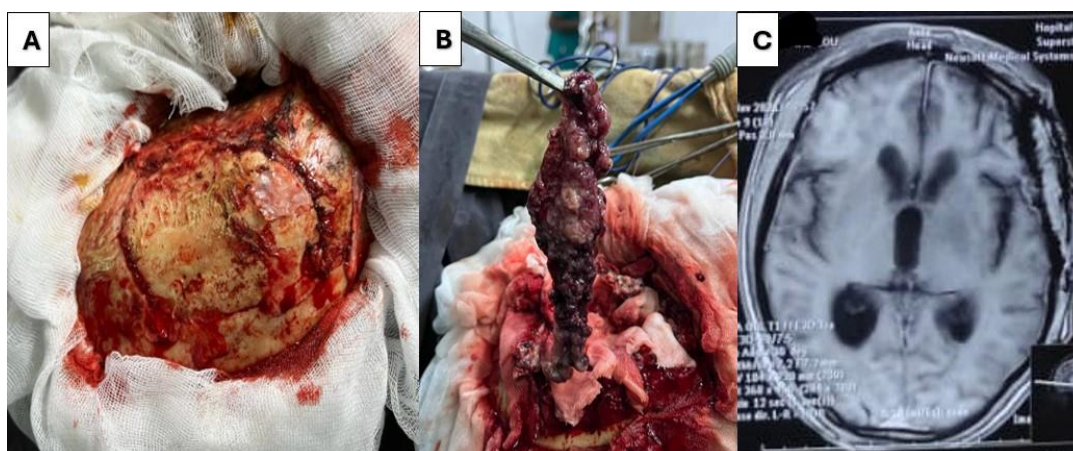
Surgically, complete resection was possible in 69.57% (n=32) of cases (Figure 4); it was a gross total resection for 21.74% (n=10) of cases, and a biopsy was performed for 2 patients (4.35%).



**Figure 2:** Preoperative images of an intracranial lesion with features of meningioma of the falx. (A) CT scan without injection, (B) CT scan with injection, (C) T1-weighted MRI, (D) T2-weighted MRI.



**Figure 3:** Brain MRI featuring a left frontal glioma with mass effect on the left lateral ventricle and midline shift (A), and post-surgical control featuring gross total resection (B)



**Figure 4:** Intraoperative (A, B) and postoperative (C) images of meningioma excised. (A) left uni-coronal approach, (B) entire surgical specimen, (C) postoperative T1-weighted MRI.

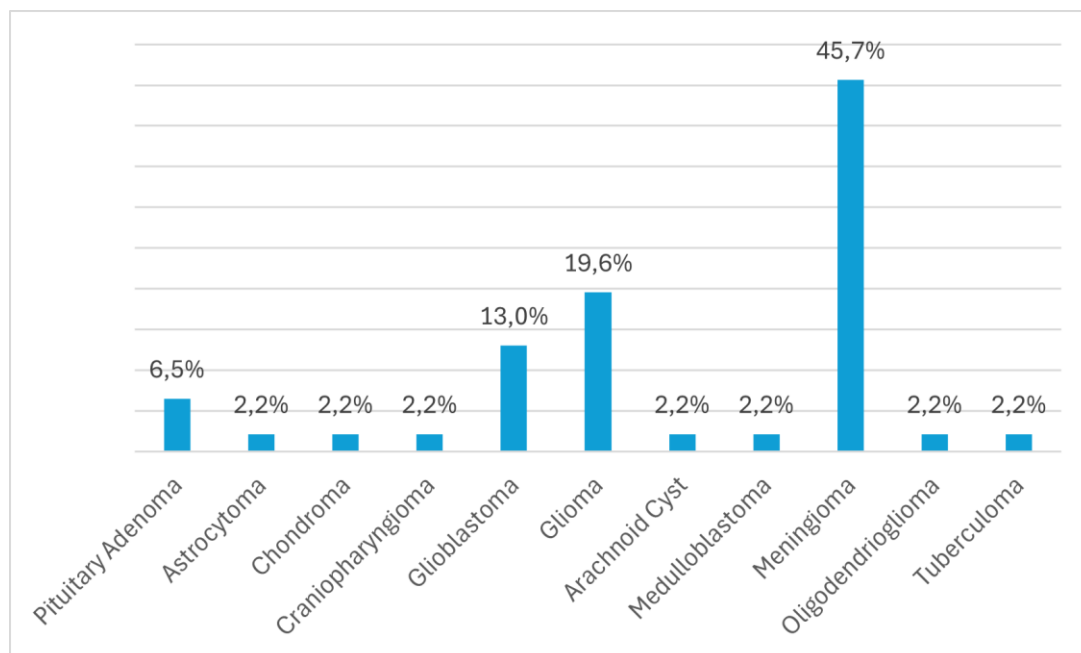
Following surgery, all patients received analgesia (acetaminophen and tramadol) and antibiotic prophylaxis (3rd generation cephalosporin). 91.3% (n=42) of patients required corticosteroid therapy (for mass effect of brain edema) and seizure treatment (phenobarbital or valproate sodium). Complications occurred in 7% (n=3) of patients and were characterized by dysarthria, hemiplegia, hypertonia, and facial paralysis (Table 2).

**Table 2: Post surgical evolution of the patients**

| Post surgical evolution | Frequency    | <i>p-value*</i> |
|-------------------------|--------------|-----------------|
| Post op short term      |              | 0.037           |
| Simple                  | 93.5% (n=43) |                 |
| With complications      | 6.5% (n=3)   |                 |
| Post op complications   |              | < .001          |
| Dysarthria              | 2.2% (n=1)   |                 |
| Hemiplegia              | 2.2% (n=1)   |                 |
| Facial palsy+others     | 2.2% (n=1)   |                 |

\* *p-value is evaluated upon outcome*

Histopathological examination was performed for 11 patients. Meningothelial meningioma and glioblastoma were the main tumors found, with 27.27% (n=3) and 18.18% (n=2) respectively (Figure 5).



**Figure 5: Breakdown of tumors by histopathology.**

Adjuvant chemotherapy and radiotherapy were used in 8.70% (n=4) and 2% (n=1) of patients respectively. Progression was marked by remission in 95.65% (n=44) of cases.

After performing analysis using the  $\chi^2$  test, we noticed there was a significant association between the nature of the tumor and the type of surgery, i.e. total or subtotal resection ( $p = 0.049$ ); between the general status and the outcome ( $p = 0.037$ ); between the occurrence of complications and outcome ( $p < .001$ ). The correlation between the convulsion, focal sign, tumor's location, and the outcome is not significant ( $p = 0.761$ ,  $p = 0.171$ , and  $p = 0.412$  respectively). (Table 1 and 2)

## DISCUSSION

### **Socio-demographic aspects**

The incidence of brain tumors in the general population in Africa remains difficult to assess (Mathieu Motah *et al.*, 2021; Olivier Uwishema *et al.*, 2023; Ulrick Sidney Kanmounye *et al.*, 2022). Several studies have highlighted the need to set up a brain tumor registry to assess the incidence (Mbi Feh *et al.*, 2021; Paul & Banerjee, 2023). Many countries in sub-Saharan Africa have been enrolled and are working towards this goal under the coordination of the Society for Neuro-Oncology Sub-Saharan Africa (SNOSSA).

The hospital incidence in this study was similar to that of most developing countries, particularly in sub-Saharan Africa (Bina W. Kakusa *et al.*, 2019; Mambila Matsalou GA *et al.*, 2023; Mathieu Motah *et al.*, 2021; Omer & Elhaj, 2017). Other countries with easier access to healthcare (universal health coverage or equivalent) and diagnostic and therapeutic technology have a much higher incidence (Baldi *et al.*, 2011).

The peak age of diagnosis is found in young adults, with an average age of 45.39 years. In developed countries, the average age of diagnosis is higher (5 years above), which may be explained by easier access to healthcare, the availability of diagnostic and therapeutic facilities, and an aging population. In Ethiopia, however, the average age is relatively younger (Ananya Abate Shiferaw *et al.*, 2023).

The predominance of women in this study did not differ from the literature (Alioune Badara *et al.*, 2015; Ananya Abate Shiferaw *et al.*, 2023; Ekouele *et al.*, 2019; Paul & Banerjee, 2023).

The radiation, especially ionizing ones, remains a risk factor for brain tumors. The causality relation has not been proved in this study because of the sampling. In the past decades, electromagnetic radiation was said to induce brain tumors. This has been ruled out by Qiang He and al.(He *et al.*, 2024)

### **Clinical aspects**

All patients in this study were conscious, including 3 with altered general conditions (WHO stage 3). In Ethiopia, all their patients were also conscious (Ananya Abate Shiferaw *et al.*, 2023; Laeke *et al.*, 2019). This parameter represents a risk factor for the patient's outcome.

Regarding intracranial hypertension syndrome, the clinical presentation differed from one study to another. Here, headache was the main clinical presentation (95.65%), as in the literature (Ananya Abate Shiferaw *et al.*, 2023; Bina W. Kakusa *et al.*, 2019; Doléagbénou *et al.*, 2020; Mathieu Motah *et al.*, 2021). Seizures and vertigo found in our study are widely encountered in the literature (Ananya Abate Shiferaw *et al.*, 2023; Bina W. Kakusa *et al.*, 2019; Doléagbénou *et al.*, 2020; Jokonya *et al.*, 2021; Laeke *et al.*, 2019; Mathieu Motah *et al.*, 2021).

The focal sign varies according to the tumor location. Although present in our series, there are differences in proportion with those in the literature (Table 3). This may be explained by our sampling (Rigau *et al.*, 2011).

**Table 3:** Comparison of focal signs proportion with Ananya A.(Ananya Abate Shiferaw *et al.*, 2023) and Jokonya L.(Jokonya *et al.*, 2021)

| <b>Focal signs</b>          | <b>Our series</b> | <b>Ethiopia, 2023</b> (Ananya Abate Shiferaw <i>et al.</i> , 2023) | <b>Zimbabwe, 2021</b> (Jokonya <i>et al.</i> , 2021) |
|-----------------------------|-------------------|--------------------------------------------------------------------|------------------------------------------------------|
| <i>Visual impairment</i>    | 23,91%            | 57%                                                                | 38%                                                  |
| <i>Paresis</i>              | 21,74%            | 23%                                                                | 64%                                                  |
| <i>Aphasia/Dysarthria</i>   | 15,22%            | 3%                                                                 | 9%                                                   |
| <i>Cognitive impairment</i> | 8,69%             | 0%                                                                 | 19%                                                  |
| <i>Cerebellum disorders</i> | 26%               | 12%                                                                | -                                                    |

### **Imagery**

On imagery, the tumor was mostly met at the supratentorial site (78.29%), while the posterior fossa accounts for 21.74% in our series. Given that our population is essentially adult, this difference in proportion between supra-tentorial and sub-tentorial sites is also found in the literature (Ananya Abate Shiferaw *et al.*, 2023; Bina W. Kakusa *et al.*, 2019). In Ethiopia in 2023, 74.51% of tumors were supratentorial (Ananya Abate

Shiferaw *et al.*, 2023). In France, a registry review by Baldi *et al.* found that 41.16% were supratentorial, with 32% having an unspecified location (Baldi *et al.*, 2011).

Meningioma was the most common tumor found in our series (45.65%), in line with Kanmounye *et al.* (Ulrick Sidney Kanmounye *et al.*, 2022) in their review and Paul and Bernajee in India (Paul & Banerjee, 2023). Brain herniation accounted for a significant proportion (20%), as does the study by Ananya *et al.* in Ethiopia, which found 15% with a mean midline shift of 11.7mm (Ananya Abate Shiferaw *et al.*, 2023). Hydrocephalus has also been reported in the literature (8.57% in our series), in varying proportions (Ananya Abate Shiferaw *et al.*, 2023; Bina W. Kakusa *et al.*, 2019).

### **Therapeutic considerations**

From a histopathological point of view, the proportion of patients who have undergone the examination remains low (24%), leading us to consider subsidies or other mechanisms to ease access to this workup, which is discriminative for proper management. The technical facilities available did not allow us to carry out a biomolecular study of these tumors. Meningioma accounts for 45.45% of anatomo-histopathology slides, which corroborates the literature from sub-Saharan Africa, where meningioma is the most frequently encountered lesion (Bina W. Kakusa *et al.*, 2019; Mathieu Motah *et al.*, 2021; Mbi Feh *et al.*, 2021; Victor-Claude Eyenga *et al.*, 2008). This contrasts with the Caucasian literature, notably in France (Baldi *et al.*, 2011; Rigau *et al.*, 2011), which is dominated by glioblastoma, followed by meningioma. This difference may be explained by the diagnostic pathway in developed countries, but also by a genetic predisposition in Caucasian countries (Tamimi & Juweid, 2017).

The management of brain tumors in Niamey needs to be substantially improved. The ratio **tumor lesion/chemotherapy (8%)**, **tumor lesion/radiotherapy (2%)**, and **tumor lesion/chemo-radiotherapy** remain low and unsuitable considering the scientific advances in the therapeutic field.

Surgically, we had 91.31% resections (total and subtotal) versus 4.35% biopsy. In France, Rigau V. (Rigau *et al.*, 2011) found a higher proportion of biopsies (22%), and 78% resection. In Uganda (Bina W. Kakusa *et al.*, 2019), the proportion of patients operated on is relatively low (47.3%).

### **CONCLUSION**

Brain tumors in sub-Saharan Africa in general, and in Niger in particular, are expanding rapidly. Despite encouraging results, surgical management in Niamey remains in need of improvement. Perioperative aspects and equipment (neuronavigation and operating microscope) need to be developed. Despite its multidisciplinary nature, few patients get to enter the care chain. Mechanisms for subsidizing and supporting patients need to be put in place for optimal management, to improve prognosis and survival. To gain more understanding of the socio-demographic burden of this pathology, Niger has signed up to take part in the cancer registry project initiated by the SNOSSA.

### **ABBREVIATIONS**

M: Male

F: Female

WHO: World Health Organization

SNOSSA: Society for Neuro-Oncology Sub-Saharan Africa

### **LIMITATIONS**

- Patients were not able to afford nor conduct a biomolecular assessment of their tumors

### **WHAT IS ALREADY KNOWN ON THIS TOPIC:**

- Brain tumors are a public health burden with great therapeutic challenges.
- Biomolecular workup is the pathway of accurate care.
- Neurosurgical care needs to go along with chemotherapy and/or radiotherapy after discussion in a multidisciplinary meeting.

### WHAT THIS STUDY ADDS:

- The profile of brain tumors differs from those of developed countries.
- There is an improvement in the diagnosis tools, especially the availability of imagery workups and histopathology.
- Great surgical achievements, despite the limited settings, are possible but still need to be accompanied by chemotherapy and/or radiotherapy which are still precarious.

### CONFLICTS OF INTEREST

The authors declared they have no conflicts of interest.

### AUTHORS' CONTRIBUTIONS

IAI: conception of the study, design of the work

BASN: data analysis, editing the manuscript

AAY: data acquisition, data analysis, interpretation of results

HCS: manuscript revision

NRAIH: manuscript revision

KA: work supervision

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