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Histopathological Characteristics of Central Nervous System Tumors in a Single Moroccan Center

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Abstract: Tumors of the central nervous system represent a heterogeneous group of tumors with a varied histopathologic spectrum and a variable frequency. In this study, we retrospectively analysed the epidemiological and the histopathological data of central nervous system tumors collected in our department. This study includes 657 central nervous system tumors histologically diagnosed from 2004 to 2016. It concerns all CNS tumors according to the WHO classification. The characteristics of patients, including age, sex, location, and histologic diagnosis were analyzed. Tumors were equally seen in males and females (sex-ratio=0.99:1). The mean age at the time of diagnosis was 38 years. 24% were children and teenagers. The commonest location was intracranial (92.3%). The primary tumors accounted for 92.8% of CNS tumors. Tumors were benign in 53.5% and malignant in 46.5% of cases. The most common histologic type is astrocytic tumors (30%), followed by meningeal tumors (26.7%). In adults, the three commonest categories were meningothelial tumors, astrocytic tumors and oligodendroglial tumors. For children and teenagers, astrocytic tumors were the most prevalent, followed by embryonal tumors and ependymal tumors. There was a male predominance for astrocytic, ependymal and oligodendroglial tumors and medulloblastomas. In contrast, meningiomas and schwannomas were more frequent in female. The most frequent intracranial tumors were astrocytic tumors, meningeal tumors and embryonal tumors. In spinal cord, meningeal tumors, schwannoma and ependymal tumors were the most prevalent. In the absence of a national register of CNS tumors in Morocco, we performed this study which may reflect epidemiological and histopathological characteristics of these tumors in our region. Globally, our results were in accordance with those of other studies around the world. However, we noted a higher proportion of tumors in children and teenagers.

Keywords: Central nervous system tumors; epidemiology; histopathology.

INTRODUCTION

Tumors of the central nervous system (CNS) represent a heterogeneous group of tumors with a varied histopathologic spectrum and a variable frequency. More than 140 types and subtypes are described in the WHO classification [1]. Epidemiological studies have shown a steady increase in the incidence of these tumors over the last few decades in both genders and in all age groups; however, there has been some debate whether this increasing trend is accurate or an artefact. It is mostly attributed to improvements in neuroimaging access and technology [2-4]. The International Agency for Research on Cancer (IARC) showed that the worldwide incidence rate of CNS tumors in 2002 was 3.7/100,000 persons among males and 2.6/100,000 persons among females. In 2008, the rates has increased to 3.8/100,000 persons in males and 3.1/100,000 persons in females [5]. In children, brain tumors are the primary cause of cancer-related mortality, and are the most common solid tumors, comprising 20% of all neoplasms [2].

In Morocco, there is no national register of CNS tumors and there is few Moroccan studies including all CNS tumors, intracranial and medullar, of adult and children [6]. In the region of Fez, this is the first study concerning these tumors. Its objective is to describe demographic and histological characteristics of the Central nervous system tumors collected in the department of pathology, Hassan II university hospital, Fez, Morocco, which may reflect regional charecteristics.

MATERIALS AND METHODS

A retrospective study was carried out in the department of pathology of the Hassan II university hospital, fez, Morocco. It analyzed data of CNS tumors diagnosed between 2004 and 2016. Data, including age of patients at the time of admission, gender and anatomical location of the tumor were collected from medical records. Age was expressed as mean and range and was stratified into two groups: children and teenagers (age≤18 years) and adults (age>18 years), and into various groups by decade. Sex was expressed by percentage and sex ratio. Location was expressed by frequency and was divided into intracranial (supratentorial and infratentorial) and medullar location. Histological categorization of tumors was based on the World Health Organisation (WHO) classification 2007 [1]. Tumors were divided into 15 categories: astrocytic tumors, oligodendroglial tumors, ependymal tumors, choroid plexus tumors, other neuroepithelial tumors, neuronal and mixed neuronal-glial tumors, tumours of the pineal region, embryonal tumors, tumours of the cranial and paraspinal nerves, meningeal tumours, tumours of the haematopoietic system, germ cells tumours, familial tumour syndromes, tumours of the sellar region and metastatic tumours. Pituitary tumors were not included because they are not included in this classification.

Age and sex distribution were analysed according to topography, and distribution of the different histological types was analysed according to age, sex and topography. The age was unknown for 27 patients and the location for 121 patients. Then, these cases were excluded in the statistics related to these data. Descriptive statistic was used for demographic variables such as age and sex, for location and for histological categorization of tumors. Data analysis was performed using Epi-Info7 version 7.1.0.6.

RESULTS

A total of 657 cases of CNS tumors were included in the study.

Age and gender

There were 328 males (49.9%) and 329 females (50.1%) with a ratio of 0.99:1. There was a male predominance in children and teenagers with a ratio of 1.4 and a female predominance in adults with a ratio of 0.89:1. The mean age at the time of diagnosis was 38 years (range, 2 months–91 years) overall, 36.7 years (range, 8 months–91 years) for male patients, and 39.2 years (range, 2 months–82 years) for female patients. 158 (24%) were children and teenagers and 499 (76%) were adults. The adults were then about three times more affected than the children and teenagers. Distribution by decades and by sexe is shown in figure 1.

Location

Regarding anatomic distribution of the tumors, location was known in 535 cases. The commonest location was intracranial (92.3%; 494 of 535). It was divided into supratentorial (73.7%, 357 of 484) and infratentorial (26.3%, 127 of 484). The exact location (supratentorial or infratentorial) was unknown in 10 cases of intracranial tumors. Medullar location was less frequent than intracranial location (7.7%, 41 of 535).

Gender and age by location

Among the 494 patients with an intracranial tumor, 265 cases were males (53.6%) and 229 cases were females (46.4%). Among the 41 cases of spinal cord tumors, 26 cases were females (63.5%) and 15 were male patients (36.5%). The supratentorial tumors were more frequent in adults compared to children and teenagers: 81.8% and 39.2% respectively. On the other hand, subtentorial tumors were more frequent in children and teenagers compared to adults: 60.8% and 18.2% respectively.

Histological types

The primary tumors accounted for 92.8% (610 cases) of CNS tumors and the secondary for 7.2% (47 cases).Tumors were benign in 352 cases (53.5%), and malignant in 305 cases (46.5%). Tumor's repartition according to histological type is presented in table 1.

The tumors were graded according to the WHO 2007 classification [1]. Among the astrocytic tumors, glioblastoma was the commonest type (58.9% of astrocytic tumors), followed by pilocytic astrocytoma (18.3%), diffuse astrocytoma (13.7%), anaplastic astrocytoma (7.6%) and pleomorphic xanthoastrocytoma (1.5%). Meningeal tumors were represented by meningioma (93.1% of meningeal tumors), and heamangioblastoma (6.9%). (Table 1)

Histological types by age and sex

The histological spectra were different from children and teenagers to adults. In the two groups, benign tumors were slightly more frequent (53.2%, 84 of 148 and 53.7%, 268 of 499 respectively). Malignant tumors represented 46.8% in children and teenagers (74 of 158) and 46.3% in adults (231of 499). For the adults, top three types of malignant tumors were glioblastomas, metastatic tumors, and anaplastic oligodendrogliomas.

However, for children and teenagers, the most frequent CNS malignanties were medulloblastomas, glioblastomas and grade III ependymomas. Details of all histopathological categories according to age are provided in table 1.

Gender predominance varied according to histological type. Repartition of sex according to histopathological categories is provided in table 1.

Histological types by location

Repartition of histological types was variable according to location. Table 2 provides histological repartition in intracranial and spinal tumors.

Table-1: histological types according to age and gender

Histological types	Total n (%)	Adults n (%)	Children & teenagers n (%)	Male n	female n	Sex ratio M/F
Astrocytic tumors	197 (30)	145 (29)	52 (33)	112	85	1.31
Pilocytic astrocytomas	36 (5.5)	6 (1.2)	30 (19)	22	14	1.57
Diffuse astrocytomas	27 (4.1)	21 (4.2)	6 (3.8)	14	13	1.07
Anaplastic astrocytomas	15 (2.3)	10 (2)	5 (3.2)	7	8	0.87
Glioblastomas	116 (17.6)	106 (21.2)	10 (6.4)	67	49	1.36
Pleomorphic xanthoastrocytomas	3 (0.5)	2 (0.4)	1 (0.6)	2	1	NA
Meningeal tumors	175 (26.7)	167 (33.4)	8 (5.1)	59	116	0.50
Meningiomas	163 (24.8)	157 (31.5)	6 (3.8)	53	110	0.48
-Grade I	-155 (23.6)	-150 (30.1)	-5 (3.2)	-52	-103	0.50
-Grade II	-6 (0.9%)	-5 (1)	-1 (0.6)	-0	-6	NA
-Grade III	-2 (0.3%)	-2 (0.4)	-0	-1	-1	NA
Heamangioblastoma	12 (1.9%)	10 (2)	2 (1.3)	6	6	1
Oligodendroglial tumors	62 (9.5)	53 (10.6)	9 (5.7)	37	25	1.48
Oligodendrogliomas	48 (7.3)	42 (8.4)	6 (3.8)	29	19	1.52
-Grade II	-19 (2.9)	-16 (3.2)	-3 (1.9)	-13	-6	2.16
-Grade III	-29 (4.4)	-26 (5.2)	-3 (1.9)	-16	-13	1.23
Oligoastrocytomas	14 (2.2)	11 (2.2)	3 (1.9)	8	6	1.33
-Grade II	-4 (0.7)	-2 (0.4)	-2 (1.3)	-2	-2	1
-Grade III	-10 (1.5)	-9 (1.8)	-1 (0.6)	-6	-4	1.50
Embryonal tumors	60 (9.2)	19 (3.8)	41 (25.9)	36	24	1.50
Medulloblastomas	56 (8.5)	17 (3.4)	39 (24.6)	34	22	1.54
PNET	4 (0.7)	2 (0.4)	2 (1.3)	2	2	NA
Metastatic tumors	47 (7.2)	45 (9)	2 (1.3)	25	22	1.13
Ependymal tumors	44 (6.7)	24 (4.8)	20 (12.7)	23	20	1.15
Subependymoma	1 (0.2)	1 (0.2)	0	1	0	NA
Ependymoma grade I	5 (0.8)	5 (1)	0	1	4	NA
Ependymoma grade II	28 (4.2)	14 (2.9)	13 (8.2)	15	13	1.15
Ependymoma grade III	10 (1.5)	3 (0.7)	7 (4.5)	7	3	2.33
tumours of the cranial and paraspinal nerves	23 (3.5)	22 (4.4)	1 (0.6)	6	17	0.35
Schwannomas	23 (3.5)	22 (4.4)	1 (0.6)	6	17	0.35
neuronal and mixed neuronal-glial tumors	13 (2)	7 (1.5)	6 (3.8)	6	7	0.85
Gangliogliomas	6 (1)	3 (0.7)	3 (1.9)	3	3	0.50
-Grade I	-2 (0.3)	-2 (0.4)	-0	-1	-1	NA
-Grade II	-4 (0.7)	-1 (0.2)	-3 (1.9)	-2	-2	NA
DNET	5 (0.8)	2 (0.4)	3 (1.9)	2	3	NA
Neurocytoma	1 (0.2)	1 (0.2)	0	0	1	NA
Liponeurocytoma	1 (0.2)	1 (0.2)	0	1	0	NA
tumours of the sellar region	12 (1.8)	6 (1.2)	6 (3.8)	7	5	1.40
Craniopharyngiomas	12 (1.8)	6 (1.2)	6 (3.8)	7	5	1.40
lymphomas and heamolymphoid neoplasm	10 (1.5)	9 (1.8)	1 (0.6)	7	3	2.33
familial tumour syndromes	5 (0.7)	0	5 (3.2)	3	2	NA
SEGA	5 (0.7)	0	5 (3.2)	3	2	NA
choroid plexus tumours	4 (0.6)	0	4 (2.5)	4	0	NA
Choroid plexus papilloma	2 (0.3)	0	2 (1.3)	2	0	NA
Choroid plexus papilloma	2 (0.3)	0	2 (1.3)	2	0	NA
tumours of the pineal region	3 (0.6)	2 (0.4)	1 (0.6)	1	2	NA
Pinealoblastomas	3 (0.6)	2 (0.4)	1 (0.6)	1	2	NA
Germinal tumors	1 (0.2)	0	1 (0.6)	1	0	NA
Other neuroepithelial tumors	1 (0.2)	0	1 (0.6)	0	1	NA
Astroblastome	1 (0.2)	0	1 (0.6)	0	1	NA
Total	657	499 (100)	158 (100)	328	329	0.99:1

Abbreviations: DNET: dysembryoplastic neuroepithelial tumor; F: female; M: male; NA: not applicable; PNET: primitive neuroepithelial tumor; SEGA: subependymal giant cell astrocytoma

Table-2: Repartition of histological types according to location

Histological types	intracranial tumors n (%)	Medullar tumors n (%)
Astrocytic tumors	174 (35.2)	6 (14.6)
Meningeal tumors	98 (19.8)	10 (24.4)
Oligodendroglial tumors	46 (9.3)	0
Embryonal tumors	59 (12)	1 (2.4)
Metastatic tumors	39 (7.9)	6 (14.6)
Ependymal tumors	24 (4.9)	7 (17.1)
Schwannomas	11 (2.2)	9 (22)
neuronal and mixed neuronal-glial tumors	10 (2)	0
craniopharyngiomas	12 (2.5)	0
lymphomas and heamolymphoid neoplasm	7 (1.4)	2 (4.9)
SEGA	5 (1)	0
choroid plexus tumours	4 (0.8)	0
pinealoblastomas	3 (0.6)	0
Germinal tumors	1 (0.2)	0
Astroblastoma	1 (0.2)	0
Total	494 (100)	41 (100)

Abbreviations: SEGA: subependymal giant cell astrocytoma

Table-3: Comparison of demographic and topographic characteristics of CNS tumors in the present study with previous series

	El Madhi [5]	Jaffrē [8]**	Chen [6]	Materljan [10]	Nibhoria [11]	Ghanghoria [7]	Askari [2]	Ostrom [12]**	Schmidt [13]**¤	Coll [4]**¤	Afif [1]**¤	Present study
SR M/F	1.22*	0.84*	1.01*	-	1.2	1: 0.86	0.93*	0.72*	-	-	-	0.99
Mean age (y)	35	-	-	-	40	-	41.1	-	-	-	-	38
Most frequent decade	-	-	-	-	-	-	5th, 6th 7th	-	-	-	-	6th, 5th 1st
- M	5th, 3d 6th	-	5th, 6th 4th	-	-	4th, 5th	-	-	-	-	-	1st, 6th 2nd
- F	5th, 3d 4th	-	5th, 6th 4th	-	-	-	-	-	-	-	-	4th,5th 6th
C & T %	16.72 (0-15y)	-	10.4* (0-19y)	-	12.3 (0-19y)	-	-	6 (0-19y)	-	-	-	24 (0-18y)
SR M/F C & T	-	-	-	-	1 :1 (0-19y)	-	-	-	1.2	0.95 (<15y)	0.89* (≤16y)	1.4
IC tumors	85.50%	91.3%*	-	88.4%	95.5%	-	80%*	-	-	-	-	92.3%
- ST :	- 77.09%		-	-	-	-	-	-	-	-	-	- 73.7%
-IT :	- 22.79%	-	-	-	-	-	-	-	-	-	-	- 26.3%
Med Tumors	14.50%	8.7%*	-	11.6%	4.5%	-	20%*	-	-	-	-	7.7%
Total	903	1149	27802	175	89	65	365	368,117	3983	240	131	657

*Result that we have calculated based on the number or the percentage given in the article.

**Article including only primitive tumors

¤ Article including only pediatric tumors

Abbreviations: C: children; F: female; IC: intracranial; IT: infratentorial; M: male; Med: medullar; SR: sex-ratio; ST: supratentorial; T: teenagers; y: years.

Table-4: comparison of histopathological characteristics of CNS tumors in the present study and previous series

	Nibhoria [11]	Ghanghoria [7]	Askari [2]	El Madhi [5]	Present series
Astrocytic tumors	39.32%	24.61%	29.6%*	32.53%*	30%
Pilocytic astrocytomas	0%	1.53%*	0.8%	NS	5.5%
Diffuse astrocytomas	34.3% ¤	0%	NS	NS	4.1%
Anaplastic astrocytomas	45.7%¤	16.92%*	NS	NS	2.3%
Glioblastomas	20%¤	6.16%*	NS	9.32%	17.6%
Pleomorphic astrocytomas	0%	0%	0.3%	NS	0.5%
Meningeal tumors	34.8%	46.15%*	32.5%*	20.29*	26.7%
Meningiomas	30.3%	41.54%	27.1%	19.04%	24.8%
Heamangioblastoma	1.1%	3.07%	1.9%	0.77%	1.9%
Mesenchymal, non-meningothelial tumors	3.4%	1.54%*	2.2%*	0.24%	0%
Melanocytic lesion	0%	0%	0%	0.12%	0%
Haemangiopericytoma	0%	0%	5 (1.3%)	0.12%	0%
Oligodendroglial tumors	6.8%*	0%	2.4%*	1.94%	9.5%
Oligodendrogliomas	4.5%	0%	1.9%	1.94%	7.3%
Oligoastrocytomas	2.3%	0%	0.5%	0%	2.2%
Embryonal tumors	1.1%	6.15%	3.5%*	5.18%	9.2%
Medulloblastomas	1.1%	6.15%	2.7%	5.18%	8.6%
PNET	0%	0	0.8%	0%	0.6%
Ependymal tumors	2.3%	7.7%	3%	3.10%	6.7%
tumours of the cranial and paraspinal nerves	4.5%	7.69%*	9.6%	6.21%	3.5%
Schwannomas	0%	6.15%	9.6%	6.21%	3.5%
Neurofibroma	4.5%	1.54%	0	0%	0
neuronal and mixed neuronal-glial tumors	0%	0%	0.8%	0.25%	2%
Craniopharyngiomas	2.3%	6.15%	0.8%	1.90%	1.8%
lymphomas and heamolymphoid neoplasm	1.1%	0%	3.4%	4.38%	1.5%
SEGA	0%	0%	0%	0%	0.7%
choroid plexus tumours	2.3%	1.54%	0.3%	0.12%	0.6%
Pineal tumors	0%	0%	0%	0.77%	0.6%
Germinal tumors	0%	0%	0%	0.12%	0.1%
Astroblastome	0%	0%	0%	0%	0.1%
Hypophysal pituitary adenoma	0%	0%	6.3%	7.64%	Not included
Other tumors	0%	0%	4%*	5.25%*	0%
Metastatic tumors	5.6%	0%	3.8%	10.23%	7.2%
Total	89	65	365	903	657

*Result that we have calculated based on the number or the percentage given in the article.

¤ Percentage relative to total astrocytic tumors

¤¤ Percentage relative to total meningiomas

Abbreviations: NS: not specified; PNET: primitive neuroepithelial tumor; SEGA: subependymal giant cell astrocytoma

DISCUSSIONS

Tumors of the CNS are a heterogeneous group with a variable frequency and a steady increase in the incidence [2, 3, 7]. In Morocco, as we do not have a national register of CNS tumors, we thought it was necessary to have, in our hospital, a demographic and histopathologic study of these tumors, which would give us a general view of the regional characteristics, as our department receives the majority of CNS tumors of the region.

In this study, CNS tumors were seen equally in both sexes. A review of various studies has shown variable results with a male predominance in some studies [4, 6, 8], a female predominance in others [4, 8] and sometimes no gender predominance [3]. We found

a male predominance in children and teenagers and a female predominance in adults. In Nordic Countries, CNS tumors were slightly higher in males than in females in children 0–14 years of age, with a ratio of 1.2:1 [9]. In contrast, G. Coll showed, in a study including 240 CNS tumors recorded in children under 15 years, a slight female predominance with a sex ratio of 0.95 (117/123) [10]. The same result was reported by another Moroccan study which found a slight female predominance (52.7%) in children with age less than or equal to 16 years [11]. Sarita Nibnhoria showed an equal male to female ratio (1:1) in children and teenagers [8]. The mean age at the time of diagnosis was 38 years overall. It was lower for males (36.7 years), compared to females (39.2 years). This overall mean age was close to overall mean age reported in other published series that report a slightly older [2, 8] or younger age [6] (table 2). According to the CBTRUS data [12], about 6% of primitive CNS tumors occurred in children and adolescents age 0–19 years. Chen [3] and Nibhoria [8] reported a percentage of 10.4% and 12.3% respectively in the same age range. This percentage was higher in the present study (24%).

The distribution by age showed, in the present series, that the peak age was the sixth, the fifth and the first decades of life. In Askari report [2], most diagnosed cases were in their 5th, 6th and 7th decades of life. Our female tumors peak at an older age in comparison to males. The same result has been observed by Chen [3]. This author found a peak proportion within the age range from 30 to 60 in males, with another proportional peak from 10 to 19 years. Comparison of age and gender data in our series with those of previous study is provided in table 3. Regarding location, studies around the world noticed that the most common locations were intracranial. Medullar location was less frequent. Among intracranial locations, supratentorial location was more frequent than infratentorial location [2, 6, 8, 13, 14]. These results are in accordance with ours (table 3).

Gender distribution according to location showed a male predominance for intracranial tumors and female predominance for spinal cord tumors. In contrast, Askari [2] reported a different result. In fact, of the 292 patients reported with a diagnosis of brain tumor, 154 cases were females (52.7%) and 138 cases were males (47.3%), and of the 73 cases of spinal cord tumors, 35 cases were in females (47.9%) and 38 were male patients. Topographic distribution according to age showed that supratentorial tumors are more frequent in adults compared to children and teenagers. On the other hand, subtentorial tumors are more frequent in children and teenagers. El Madhi [6] found the same distribution: supratentorial tumors were more frequent in adults than in children (83.77% and 50% respectively). In contrast, infratentorial tumors were more prevalent in children than in adults: 50% and 16.67% respectively.

On histopathological analysis, the top two categories found in this series were astrocytic tumors and meningiomas. In literature, many studies share the same histological distribution, such as another Moroccan study [6], a French [14], an Indian [8] and an Iranian studies [2]. In contrast, other publications indicated meningiomas as the most prevalent, followed by astrocytic tumors such as an indian report [4] and the american data from CBTRUS with the proportions of 36.6% and 20.5% of primary CNS tumors [12]. The proportion of metastatic tumors was slightly higher in the present study in comparison with others [2, 6, 8]. Among the astrocytic tumors, anaplastic astrocytomas have been shown to be the most common in Nibhoria [8] and Ghanghoria [4] researches. In the present survey, as in CBTRUS Data [10], glioblastomas were the most prevalent among astrocytomas. Comparison of the frequency of all tumors in this series and in the literature is shown in table 4.

When the histological distribution of CNS tumors in adults and children and teenagers was compared in the literature, the tumor spectra were different between publications and according to age ranges. Concerning adults, as found in the present study, meningothelial tumors were frequently reported as the most frequent [3, 6]. For children and teenagers, astrocytic tumors taked a lead in the present research, which is consistent with most reports [3,6,8,12].

Gender distribution according to histological type showed, in this report, a male predominance for astrocytic, ependymal and oligodendroglial tumors and medulloblastomas. In contrast, meningiomas and schwannomas were more frequent in females. A review of previous studies around the world showed the same result. Indeed, according to a French brain tumor database, gliomas and medulloblastomas are most frequent in male patients with a sex-ratio of 1.37 and 1.49 respectively. However, in females, meningiomas are almost three times more frequent than in males (sex-ratio= 0.34) [7]. Another French register of CNS tumors in Gironde showed that meningiomas affect females more than males [14]. A Chinese publication share the same gender distribution with a male/female ratio of 1.47 in neuroepithelial tumors and a female/male ratio exceeding 1.7 in meningeal tumors [3]. Similar finding was observed in an Indian report of Ghanghoria [4]. Another Iranian found that approximately 36.5% of the female patients suffered from meningiomas and 24.3% from astrocytomas. In contrast 33% of the male cases were affected by astrocytomas and 17% were affected by meningiomas [2]. In a Croatian publication, meningiomas were, contrary to these findings, slightly more frequent in males. This report found, however, a male predominance of astrocytic and metastatic tumors

and a female predominance of tumors of cranial and spinal nerves [13].

Concerning histological repartition according to location, Askari described astrocytic tumors and meningiomas as the most prevalent brain tumors (34.6% and 28.8%, respectively). The proportion of metastatic tumors in this location was 2.7% [2]. In this survey, we shared the same result. However, we noted a higher proportion of metastatic tumors (7.9%). These latter were the most frequent intracranial tumors in the report by Materljan [13], followed by astrocytic tumors and meningeal tumors. Among intraspinal tumors, meningeal tumors and schwannoma were the most frequent (24.4% and 22% respectively) in the present research. Metastatic tumors represented 14.6%. Askari indicated schwannoma as the most common type in this location (30.1%), followed by the meningioma (20.6%). He reported a lower rate of metastatic tumors in comparison to this survey (8.2%) [2].

CONCLUSION

In summary, characteristics of CNS tumors in the region of Fez were in accordance with those of other studies around the world. However, it's important to point out a higher proportion of children and teenagers. Other larger regional and national studies are necessary to confirm these results.

ABBREVIATIONS

Astrob: astroblastoma; CBTRUS: Central Brain Tumor Registry of the United States; CP: choroid plexus; DNET: dysembryoplastic neuroepithelial tumor; epend: ependymal; F: female; GT: germinal tumors; HL: haemolymphoid neoplasm; IARC: International Agency for Research on Cancer; L: lymphoma; M: male; N: neuronal; NA: not applicable; NG: neuroglial; ODG: oligodendroglial; pinealob: pinéoloblastoma; PNET: primitive neuroepithelial tumor; schw: schwannoma; SEGA: subependymal giant cell astrocytoma; CNS: central nervous system; WHO: world health organization.

DECLARATIONS

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interest

All authors declare that they have no competing interest.

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Authors' contributions

NH, AM, LC and HE performed the histological examination of the tumors. MM interpreted radiological data. EMC performed surgical excision and biopsies. SE performed statistical analysis. All authors read and approved the final version of the manuscript.

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REFERENCES

1. Louis, D. N., Ohgaki, H., Wiestler, O. D., Cavenee, W. K., Burger, P. C., Jouvet, A., ... & Kleihues, P. (2007). The 2007 WHO classification of tumours of the central nervous system. *Acta neuropathologica*, *114*(2), 97-109.
2. Askari, K., Janeshin, S., Mashouf, M., Taherzadeh-Amlashi, M., & Seyed-Saadat, S. M. (2015). Central Nervous System Tumors in Guilan, Iran: Epidemiological Features Over 10 Years. *Caspian Journal of Neurological Sciences*, *1*(1), 19-26.
3. Chen, L., Zou, X., Wang, Y., Mao, Y., & Zhou, L. (2013). Central nervous system tumors: a single center pathology review of 34,140 cases over 60 years. *BMC clinical pathology*, *13*(1), 14.
4. Ghanghoria, S., Mehar, R., Kulkarni, C. V., Mittal, M., Yadav, A., & Patidar, H. (2014). Retrospective histological analysis of CNS tumors-A 5 year study. *Int J Med Sci Public Health*, *3*(10), 1205.
5. Ferlay, J., Bray, F., Pisani, P., & Parkin, D. M. (2002). GLOBOCAN: Cancer incidence, mortility and prevalence worldwide.
6. El Madhi, T., Zentar, A., El Azzouzi, M., & El Khamlichi, A. (1996). Profil épidémiologique descriptif des tumeurs du système nerveux central: a propos de 903 cas (1983–1992). *Med Maghreb*, *59*, 6-14.
7. Zouaoui, S., Rigau, V., Mathieu-Daudé, H., Darlix, A., Bessaoud, F., Fabbro-Peray, P., ... & Taillandier, L. (2012). Recensement national histologique des tumeurs primitives du système nerveux central: résultats généraux sur 40 000 cas, principales applications actuelles et perspectives. *Neurochirurgie*, *58*(1), 4-13.
8. Nibhoria, S., Tiwana, K. K., Phutela, R., Bajaj, A., Chhabra, S., & Bansal, S. (2015). Histopathological Spectrum of Central Nervous System Tumors: A Single Centre Study of 100 Cases. *International Journal of Scientific Study*, *3*(6), 130-134.
9. Schmidt, L. S., Schmiegelow, K., Lahteenmaki, P., Träger, C., Stokland, T., Grell, K., ... & Schüz, J. (2011). Incidence of childhood central nervous

system tumors in the Nordic countries. *Pediatric blood & cancer*, *56*(1), 65-69.

10. Coll, G., Combes, J. D., Isfan, F., Rochette, E., Chazal, J., Lemaire, J. J., ... & Kanold, J. (2015). Incidence and survival of childhood central nervous system tumors: A report of the regional registry of childhood cancers in Auvergne-Limousin. *Neurochirurgie*, *61*(4), 237-243.
11. Afif, M., Khalil, J., Kouhen, F., Elmajjaoui, S., Kebdani, T., & Benjaafar, N. (2015). Profil clinique et histologique des tumeurs du système nerveux central chez l'enfant à l'institut national d'oncologie de Rabat, Maroc. *Journal Africain du Cancer/African Journal of Cancer*, *7*(2), 111-114.
12. Ostrom, Q. T., Gittleman, H., Xu, J., Kromer, C., Wolinsky, Y., Kruchko, C., & Barnholtz-Sloan, J. S. (2016). CBTRUS statistical report: primary brain and other central nervous system tumors diagnosed in the United States in 2009–2013. *Neuro-Oncology*, *18*(suppl_5), v1-v75.
13. Materljan, E., Materljan, B., Sepcic, J., Tuskan-Mohar, L., Zamolo, G., & Erman-Baldini, I. (2004). Epidemiology of central nervous system tumors in Labin area, Croatia, 1974-2001. *Croatian medical journal*, *45*(2), 206-212.
14. Ménégoz, F., Martin, E., Danzon, A., Mathieu-Daude, H., Guizard, A. V., Macé-Lesec'h, J., ... & Colonna, M. (2006). Incidence et mortalité des tumeurs du système nerveux central en France: évolution de 1978 à 2000 et influence des pratiques d'enregistrement sur les resultants. *Revue d'épidémiologie et de santé publique*, *54*(5), 399-406.