https://doi.org/10.1590/0004-282X-ANP-2020-0441

ARTICLE

Epidemiological features of meningiomas: a single Brazilian center's experience with 993 cases

Características epidemiológicas de meningiomas: experiência de um centro único brasileiro com 993 casos

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ABSTRACT

Background: Meningiomas are the most frequent primary central nervous system (CNS) tumors. Their geographical and ethnic characteristics need to be known, in order to enable rational treatment. Objective: To investigate clinical and epidemiological aspects in a series of patients with meningiomas. **Methods**: Retrospective analysis on the demographic profile, location and histopathology of 993 patients with meningiomas (768 operated and 225 not operated). **Results**: Meningiomas represented 43.8% of the primary CNS tumors; 6.8% were multiple tumors (14.7% with neurofibromatosis 2) and 0.6% were radiation-induced tumors. The mean ages were 53.0 and 63.9 years for operated and non-operated patients and the female/male ratios were 3.2:1 and 6.3:1. Diagnosis was made later among females. The peak incidences were in the 6th and 7th decades respectively for operated and non-operated patients. The incidence was low at early ages and higher among patients aged 70+ years. The meningiomas were intracranial in 96.5% and most were WHO grade I (88.9%) and transitional. In the spinal canal (3.5%), they occurred mainly in the dorsal region (all grade I; mostly transitional). The racial distribution was 1.0% in Asian-Brazilians, 87% in Caucasians and 12% in African-Brazilians. 83.4% and 51.6% of the patients were estimated to be recurrence-free at 10 and 20 years, and the mortality rate was 3%. **Conclusions**: Most of the demographic data were similar to what has been observed in other western centers. Differences were higher incidence of meningiomas, female and older predominance in non-operated patients, predominance in Caucasian, and higher association with neurofibromatosis 2.

Keywords: Meningioma; Demographic Data; Pathology; General Surgery; Risk Factors; Neoplasm Recurrence, Local.

RESUMO

Antecedentes: Meningiomas são os tumores mais frequentes do sistema nervoso central (SNC). Suas características étnicas e geográficas precisam ser conhecidas para o seu tratamento racional. **Objetivo**: Investigar aspectos clínicos e epidemiológicos de uma série de pacientes com meningiomas. **Métodos**: Análise retrospectiva demográfica de 993 pacientes com meningiomas (768 operados e 225 tratados conservadoramente). **Resultados**: Meningiomas constituíram 43.8% dos tumores primários do SNC. 0.8% deles eram múltiplos (14,7% com neurofibromatose 2) e 0,6% eram radioinduzidos. A idade média e o índice mulheres/homens foram respectivamente 53,0 e 63,9 anos e 3.2:1 e 6.3:1 para pacientes operados e não operados. O diagnóstico foi mais tardio em mulheres. Ocorreram picos de incidências na 6ª e na 7ª décadas respectivamente para pacientes operados e não operados. A incidência foi menor na infância e maior após 70 anos. Meningiomas predominaram no crânio (96.5%), a maioria grau I da OMS, subtipo transicional. Do total, 3.5% ocorreram no canal raquídeo, principalmente na região torácica, todos grau I, a maioria transicional. Em relação à distribuição racial, 1.0% dos meningiomas ocorreu em amarelos, 87% em brancos e 12% em negros. As taxas de sobrevida sem recorrência foram 83.4% e 51.6% em 10 e 20 anos e a mortalidade operatória foi 3%. **Conclusões**: A maioria dos dados demográficos observados foi similar aos de outros centros ocidentais. As diferenças observadas foram maior incidência, predominância em mulheres e idosos nos pacientes não operados e em caucasianos, e maior associação com neurofibromatose 2.

Palavras-chave: Meningioma; Dados Demográficos; Patologia; Cirurgia Geral; Fatores de Risco; Recidiva Local de Neoplasia.

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Conflict of interest: There is no conflict of interest to declare.

Authors' contributions: BOC: conceptualization, investigation, data curation, writing; HRM, CGCJ, JAAJ: conceptualization, investigation (supporting); RSO, GGPG: data curation, investigation, writing original raft, writing-review (supporting); ACS, LN: investigation, validation (supporting).

Received on September 21, 2020; Received in its final form on October 26, 2020; Accepted on November 04, 2020.

INTRODUCTION

Meningiomas arise from meningothelial cells of the arachnoid layer, which covers the brain. They occur primarily at the base of the skull in the parasellar regions and over the cerebral convexity[1]. Meningiomas have become the most common type of all primary central nervous system (CNS) tumors over the last decade[1,2,3]. They account for 35.8% of all CNS tumors and for more than 53% of all benign CNS tumors diagnosed, with a prevalence of approximately 97.5/100,000 and were histopathologically confirmed in 170,000 individuals diagnosed in the United States in 2009-2010 (CBTRUS Statistical Report)[3].

Although meningiomas are very common tumors in the CNS, data on their epidemiology, clinical characteristics and therapeutic management remain poor. This lack of data can be explained, to some extent, by the benign and frequently silent course of most meningiomas[3]. Meningiomas are more common in females, and their incidence increases with advancing age[1]. In addition to differences in incidence among intracranial tumors in several parts of the world, meningioma patients have distinct geographical and ethnic characteristics, such as the regional and racial incidences at a given age at which the diagnosis is made[3,4,5,6,7]. Characterization of the demographic and biological aspects of meningioma patients in different regions of the world can provide paths towards understanding the etiology and behavior of these tumors.

We present a cohort of 993 patients with 1104 meningiomas from a single-center institution. These cases were retrospectively analyzed with the purpose of evaluating their clinical and epidemiological factors.

METHODS

Patient population

The medical charts of a series of 993 patients with a radiological and/or histopathological diagnosis of CNS meningioma who were consecutively registered at Hospital das Clínicas, Ribeirão Preto Medical School, University of São Paulo (HCFMRP-USP), between May 1984 and December 2019, were retrospectively reviewed. This study was approved by the Research Ethics Committee of our institution. Neuroradiological examinations (computed tomography [CT] and/or magnetic resonance imaging [MRI]) were performed on all the patients, and for those who underwent surgery, histological examinations were added for making the diagnosis. Tumor locations were determined based on CT, MRI and surgery. The histological classification of tumors was carried out in accordance with the WHO criteria[8]. The demographic data were presented as medians, means, frequencies and percentages and the outcomes as survival rates and as overall survival (OS) and recurrence-free survival (RFS) curves. Patients with grade I meningiomas were followed up yearly, with MRI at one month after surgery and then yearly, and patients with grades II and three were followed up every six months.

The statistical analysis consisted of the chi-square and Fisher exact tests and nonparametric t tests, using the GraphPad Prism 8.0 software. Statistical significance was assumed when $\alpha = 0.05$.

RESULTS

Demographic profiles

During the 35-year study period, 993 consecutive patients diagnosed with 1104 meningiomas were followed up at our hospital, representing 43.8% of all patients with primary brain tumors. Among these, 768 patients underwent surgical treatment. For 225 patients, surgery was not indicated (because the tumors were incidental, non-progressive or calcified; or because the patients were of older age or refused treatment) and these patients did not receive any other kind of treatment. Adjuvant radiotherapy was used in eleven patients (five WHO grade I, three grade II and three grade III), and in sixteen patients after recurrence/regrowth (six grade I and ten grade II). Sixty-eight patients (6.8%) had two or more tumors (9.3% of non-operated and 6.5% of operated patients). Patients with multiple tumors underwent one or more surgical procedures, totaling 795 operations for 840 tumors. The distribution of patients according to year over the study period is presented in Figure 1.

Figure 2 presents the distribution of patients according to sex and age. The overall female/male incidence rate for meningiomas was 3.7:1. It was 6.3:1 for the non-operated patients and 3.2:1 for the operated patients ($p = 0.0271$ using paired t test). Females presented meningiomas at an older age than males, among all the patients (mean 55.6 ± 14.7 vs. 51.0 ± 16.4 years; $p < 0.001$ using unpaired t test). and among the operated patients. (53.0 ± 13.5 vs. 50.0 ± 16.3 years, $p = 0.0102$ using unpaired t test).

A peak of meningioma incidence was observed in the 50 to 59-year age group (30.6%) for both sexes among the operated patients, and 71.5% of the meningiomas were presented in the 5th and 7th decades of life. For the non-operated patients, there was predominance (68%) in the 7th and 9th decades of life (operated vs. non-operated patients; $p = 0.0304$ using paired t test), with a peak between 60 and 69 years old (23.1%). Meningioma occurred in the 1st decade in 0.2% (0.5% for males and 0.13% for females) and in 1.8% (4.2% for males and 1.15% for females) in the 2nd decade, totaling 2.0% for these two decades, with predominance among males (1:0.8). The frequency among patients over 70 years old was 16.4% (36.0% for non-operated and 10.7% for operated patients; $p < 0.0001$ using Fisher's exact test) with higher predominance among females (5.8:1), (37.1% vs. 11.6%; $p < 0.0001$ using

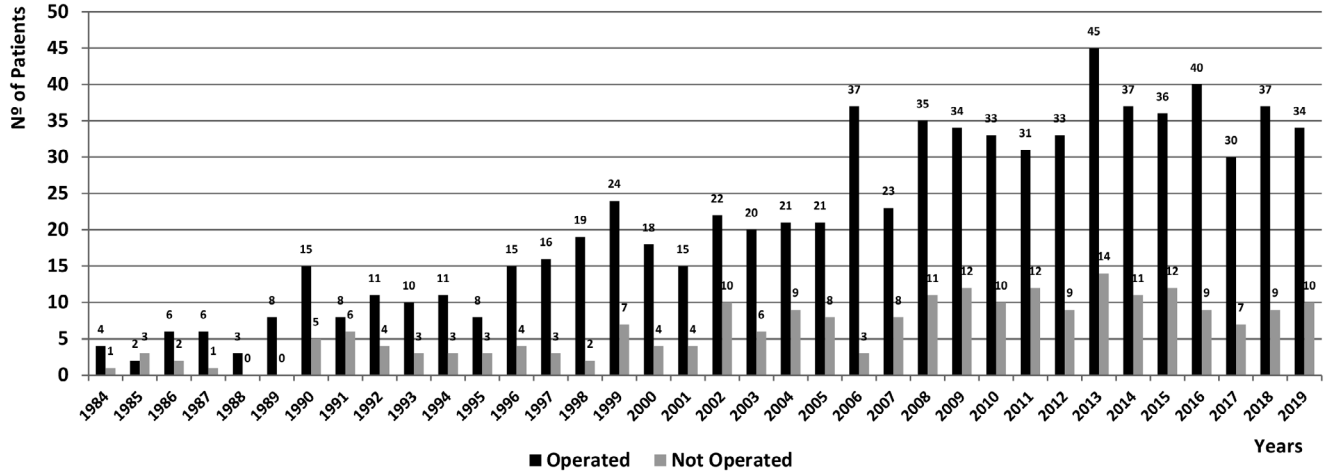

Figure 1. Distribution of patients with a diagnosis of meningioma (993) treated per year at HCFMRP-USP, from 1984 to 2019.

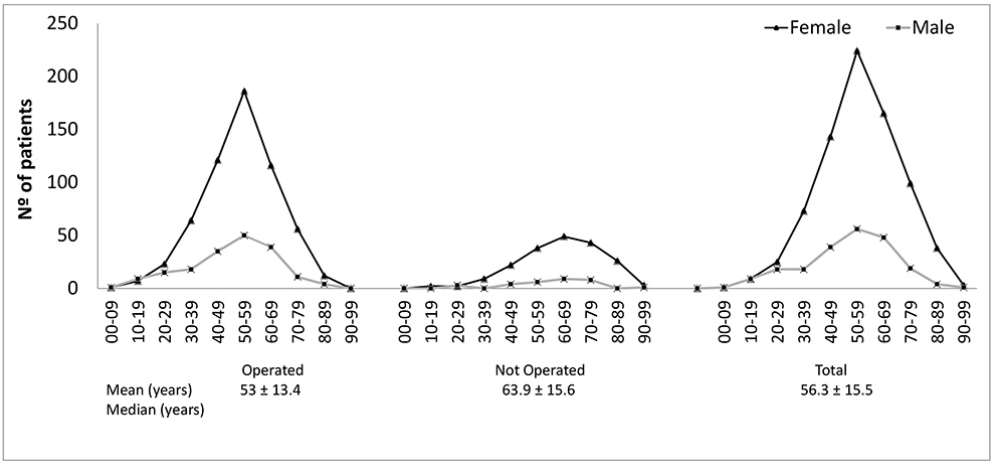

Figure 2. Distribution of patients with a diagnosis of meningioma (993) treated at HCFMRP-USP from 1984 to 2019, according to age and sex. Operated patients: mean age = 53 ± 13.5 years; median = 54 years. Non-operated patients: mean age = 63.9 ± 15.6 years; median age = 64.5 years. All patients: mean age = 56.3 ± 15.5 years; median age = 57 years.

Fisher's exact test; and 29.0 vs. 8.2%; p < 0.0087 using Fisher's exact test, respectively).

Overall, 87% of the meningiomas occurred in Caucasians, 12% in African-Brazilians and 1% in Asian-Brazilians, with similar distribution between operated and non-operated patients (87% vs. 85.3% for Caucasians; 12.1% vs. 13.3% for African-Brazilians; and 0.9% vs. 1.3% for Asian-Brazilians, respectively). Based on the racial distribution of the population of the state of São Paulo in 2019 (Brazilian Institute for Geography and Statistics, IBGE, 2010)[9], meningiomas predominated among Caucasians, compared with African-Brazilian and Asian-Brazilian patients (p < 0.0001, using chi-square test).

Tumor location

Table 1 summarizes the anatomical distribution of these 1104 meningiomas in 993 patients. Meningiomas were located in the cranial cavity in 96.6% (22% in the cerebral convexity, 18.3% in the parasagittal region, 1.2 % in the ventricles and 58.5% in the skull base). We did not find any association between sex and topographic location (convexity vs. skull base and parasagittal region vs. skull base; p = 0.0834 using chi-square test with Yates' correction; and p = 0.2179 using Fisher's exact test respectively). Spinal canal meningiomas were observed in 3.5% of the patients, with predominance in females (4.4:1), and most were located in the dorsal region (65.8%).

Histopathological features

The histopathological distribution of the operated meningiomas is summarized in Table 2. WHO grade I occurred in 88.9%, grade II in 9.9% and grade III in 1.2%. Females predominated among the WHO grade I patients (3.8:1), and there was no predominant sex with regard to patients with grades II (1.02:1) and III (1:1) (p = 0.001 and p = 0.0411, respectively, using Fisher's exact test).

The most frequent grade I histological subtypes were transitional (39.3%) and meningothelial (28.8%); 91.5% of grade II cases were atypical and 50% of grade III cases were anaplastic. In the spinal canal, all the tumors were grade I; most of

them were transitional (44.4%), followed by psammomatous and meningothelial tumors.

Treatment and outcome

The treatment of the 840 meningiomas (surgical or surgical + adjuvant treatment), the OS/RFS curves and the mortality rates are shown in Table 3 and in Figure 3. There was no significant difference in the OS/RFS curves between the patients with intracranial and spinal meningiomas. There was no significant difference in the OS curves between patients who underwent total or Simpson's grades I and II resection vs. subtotal or Simpson's grades III-IV resection. The RFS curves were better for patients who underwent total or Simpson's grades I and II resection than for those who underwent subtotal or Simpson's grades III-IV resection ($p < 0.0001$ using Mantel-Cox log-rank test, for both). There was no difference between the supratentorial and skull base locations (Figure 4). There were significant differences in OS/RFS between WHO grades I vs. II vs. III (Figure 5).

Risk factors

Meningiomas occurring after radiotherapy to treat other tumors were observed in six patients (0.6% of the total number of tumors and 0.78% of the operated patients), of whom five were male and one was female. Two patients (33.3%) had multiple tumors. These patients were diagnosed 8 to 16 years after radiotherapy. Four of these patients were classified as WHO grade II and two as grade I.

Table 4 summarizes the association between meningiomas and neurofibromatosis type 2 (NF2). NF2 was detected in 3.1% of the patients with meningiomas, with similar distribution between the operated and non-operated patients, and

Table 1. Distribution of meningiomas (1104) in 993 patients treated at HCFMRP-USP from 1984 to 2019, according to the location in the central nervous system and sex.

Location	Operated patients			Non-operated patients			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Intracranial									
Convexity	114	40	154	71	9	80	185	49	234 (21.9%)
Superior sagittal sinus	87	42	129	25	5	30	112	47	159 (14.9%)
Falx	16	6	22	10	4	14	26	10	36
Ventricles	7	4	11	2	0	2	9	4	13
Skull base									
Sphenoid wing	91	21	112	24	4	28	115	25	140 (13.1%)
Tentorial	58	14	72	20	2	22	78	16	94
Tuberculum sellae	55	15	70	12	1	13	67	16	83
Olfactory groove	35	8	43	15	2	17	50	10	60
Petrous	29	7	36	7	2	9	36	9	45
Spheno-orbital	30	4	34	4	0	4	34	4	38
Foramen magnum	18	3	21	5	0	5	23	3	26
Petroclival	11	8	19	3	2	5	14	10	24
Sphenopetroclival	15	4	19	6	4	10	16	8	24
Cavernous sinus	12	5	17	11	2	13	23	7	30
Middle fossa	10	4	14	0	0	0	10	4	14
Optic Nerve/Canal	12	4	4	1	1	2	6	5	11
Others	18	4	22	6	0	6	24	4	28
Total skull base	387	101	488	116	20	136	503	121	624 (58.4%)
Total intracranial	611	193	804	224	38	262	835	221	1066 (96.6%)
Spinal canal									
Cervical	6	3	9	0	0	0	6	3	9
Cervicodorsal	2	0	2	1	0	1	2	0	3
Dorsal	20	3	23	0	0	0	20	3	23
Dorsolumbar	2	0	2	0	0	0	2	0	2
Not specified	0	0	0	0	1	1	1	0	1
Total spinal	30	6	36	1	1	2	31	6	38 (3.4%)
Total intracranial (+ spinal)	641	199	840	225	39	264	866	228	1104 (100%)

Table 2. Histopathological subtypes of meningiomas in 840 tumors among 768 operated patients at HCFMRP-USP from 1984 to 2019.

Location	Intracranial			Spinal canal			Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Grade I									
Transitional	227	60	287	13	3	16	240	63	303
Meningothelial	163	49	212	6	2	8	169	51	220
Fibroblastic	58	12	70	2		2	60	12	72
Psammomatous	28	5	33	9		9	37	5	42
Meningioma	23	6	29				23	6	29
Syncytial	19	2	21				19	2	21
Angiomatous	16	4	20				16	4	20
Microcystic	13	1	14				13	1	14
Mixed	9	2	11				9	2	11
Secretory	8	2	10				8	2	10
Lymphoplasmacyte-rich	1	1	2				1	1	2
Metaplastic	1	0	1		1	1	1	1	2
Lipoblastic	0	1	1				0	1	1
Total grade I	566	145	711	30	6	36	596	151	747
Grade II									
Atypical	37	39	76				37	39	76
Chordoid	2	2	4				2	2	4
Clear cell	3	0	3				3	0	3
Total grade II	42	41	83				42	41	83
Grade III									
Anaplastic	2	3	5				2	3	5
Papillary			1					1	1
Rhabdoid	3	1	4				3	1	4
Total grade III	5	5	10				5	5	10
Total	613	191	804	30	6	36	643	197	840

Table 3. Treatment and outcomes among 840 meningiomas treated at HCFMRP-USP from 1984 to 2019.

Treatment	Nº (%)
Extent of resection	
Gross total resection	634 (75.5%)
Subtotal resection	180 (21.4%)
Partial	24 (2.9%)
Biopsy	2 (0.2%)
Simpson grade I	480 (57.3%)
Simpson grade II	149 (17.7%)
Simpson grade III	6 (0.7%)
Simpson grade IV	201 (23.9%)
Simpson grade V	3 (0.4%)
Adjuvant conventional radiotherapy	11 (1.3%)
Follow-up	
Range	1-426 months
Mean	84 ± 73.1 months
Median	67 months

Table 3. Cont.

Treatment	Nº (%)
Outcome	
Survival rates	
5 years	91.2%
10 years	82.9%
15 years	78.2%
20 years	72.5%
30 years	40.4%
Recurrence	
Recurrence rate (all follow-up)	135 (16.1%)
Recurrence-free estimates	
5 years	94.5%
10 years	83.4%
15 years	64%
20 years	51.6%
30 years	30.7%
Mortality	
Overall (over the follow-up period)	127 (15.1%
1 month (mortality due to operation)	32 (3.8%)
2nd - 12th months	13 (1.5%)
13th - 180th months	73 (8.7%)
181st - 426th months	9 (1.1%)

Table 4. Distribution of patients with neurofibromatosis 2 among patients with a diagnosis of meningioma who were treated at HCFMRP-USP from 1984 to 2019.

Treatment	Non-operated		Operated				Total		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Number of tumors/NF2									
One	5	5	6 (2.9%)	7 (0.7%)	8 (4.6%)	15 /721 (2.1%)	12	9	21 /925 (2.3%)
Multiple	1	0	1 (4.7%)	5 (10.4%)	9/47 (19.1%)	9/47 (19.1%)	6/53	4/15	10 / 68 (14.7%)
Total	6	1	7/225 (3.1%)	12 (2.5%)	12 (6.6%)	24/768 (3.1%)	18/780*	13/213*	31 / 993 (3.1%)

* Significant difference, p = 0.0121, using Fisher's exact test.

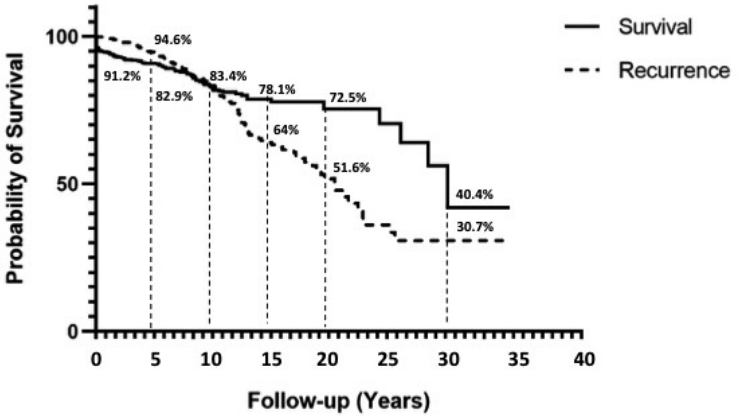

Figure 3. Survival curve for patients with meningiomas who underwent surgical treatment (840 cases) at HCFMRP-USP. Percentages represent the estimates for overall survival and survival free recurrence rates after 1, 10, 15, 20 and 30 years of follow-up.

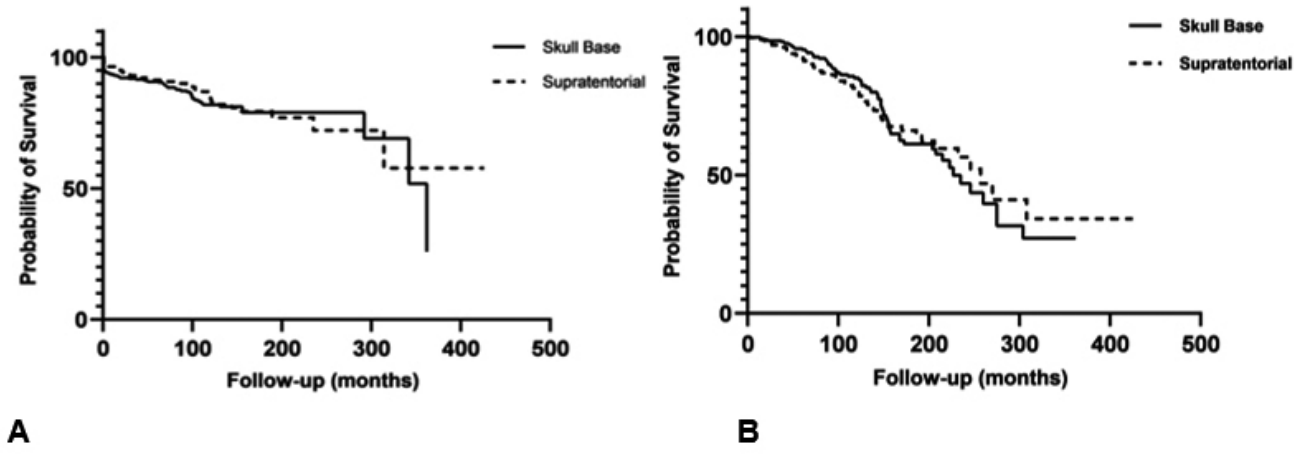

Figure 4. Overall survival (A) and recurrence-free survival (B) curves for patients with meningiomas who underwent operations (840 cases) according to the location: supratentorial vs. skull base (follow-up: 1-426 months; mean = 77 months; median = 61.5 months). No significant differences (p = 0.4163 and p = 07866, using Mantel-Cox log-rank test, respectively).

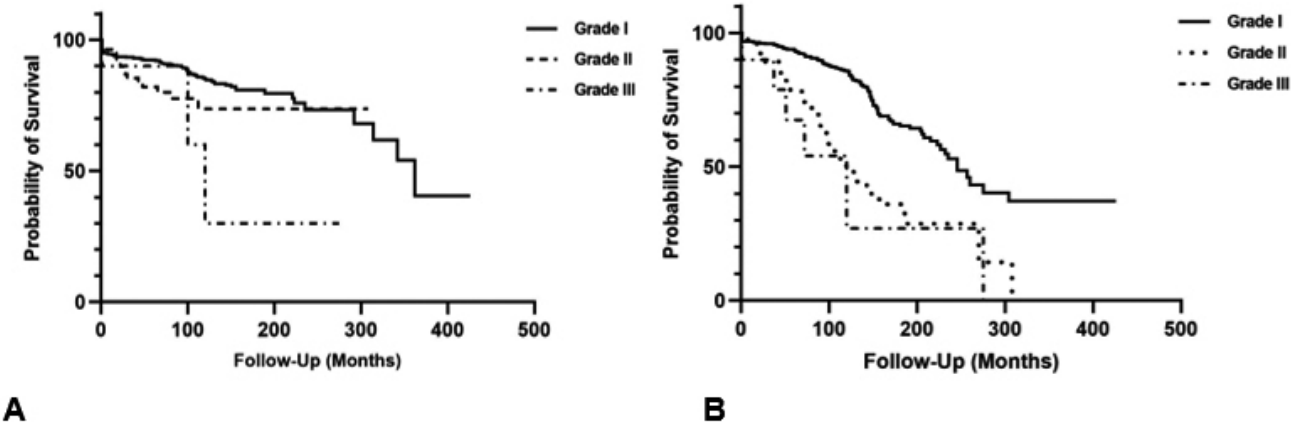

Figure 5. Overall survival (A) and recurrence-free survival (B) curves for patient with meningiomas who underwent operations (840 cases) according to WHO grades (follow-up: 1-426 months; mean = 77 months; median = 61.5 months). Significant differences for I vs. II vs. III (p = 0.0301 and p = 0.0001, using Mantel-Cox log-rank test, respectively); for I vs II (for OS curves, p = 0373, using Mantel-Cox log-rank test); and for I vs III and II vs III (for RFS curves, p = 0.0008 and p = 0.0001, using Mantel-Cox log-rank test, respectively).

with predominance among males (6.1% in males vs. 2.3% in females). NF2 was observed in 31.8% of the patients with multiple meningiomas, with predominance among males (25% in males vs. 10.9% in females).

DISCUSSION

Demographic profiles

Meningiomas are the most common intracranial extra-axial neoplasms. Population-based studies have shown that the prevalence of histopathologically confirmed meningioma cases per year per 100,000 inhabitants was estimated to be approximately 97.5 in the United States (CBTRUS Statistical Report)[3]. The incidence of meningiomas among CNS tumors in the United States is 36.8%, and the incidence is more than twice as high in females as in males (8.36/100,000 and 3.61/100,000 people, respectively, per year). Among these meningiomas, 79% of them were located in the skull, 4.2% were in the spinal canal and 16% did not have a specified location[3]. Meningioma lesions are common[1,8], with incidences ranging from 5.4% to 8.9% according to the origin of the series analyzed (population, surgical, CT or autopsy)[8,10-13]. We observed that 7.0% of the patients in our cohort had multiple tumors, predominantly among the non-operated patients (9.8% vs. 6.2%).

Due to the lack of prospective databases, the epidemiology of meningiomas in developing and underdeveloped countries is based on retrospective analysis on data from hospitalized operated patients or from autopsy series. Therefore, these data do not reflect the actual situation of this type of

tumor in the population. From the scarce epidemiological information, meningiomas had lower incidence in China than in Japan or in Western countries[2,14-16]. In addition, some characteristics were common to many regions. For example, meningiomas were always the most or second most frequent CNS tumor, occurred predominantly in women, had higher incidence in the 4th to 6th decades of life and consisted mostly of benign tumors[4-6], in South America[17,18], Asia[15,16], Europe[19,20] and the Middle East[21,22].

In Brazil, two studies, one using a surgical/necropsy series and the other using data from neurosurgical centers, showed meningioma incidences of 19% and 22.6% respectively among primary intracranial tumors, with mean ages of 40 and 45.8 years. Cases occurred predominantly between 20 and 50 years of age (peak in the 5th decade of life) and predominantly among females (2.2:1). 96.7% were located in the intracranial region and 3.29% in the spinal canal[17,18].

Our series was from a single-center public tertiary-level hospital in the state of São Paulo affiliated to the Brazilian National System Health (SUS), which is responsible for treating a population of approximately 5,000,000 inhabitants. To obtain a better approximation of the population data, this series was divided into two groups: patients who underwent surgical treatment and patients with a radiological diagnosis of meningioma who remained non-operated for several reasons, such as older age, small tumor size, incidental tumors with no edema in the adjacent nervous tissue, poor clinical conditions and the patient's refusal of treatment.

The incidence of this tumor progressively increased from 1984 until it stabilized in recent years. This can be explained by better access to SUS and improving access to neuroradiological investigations, which has led to an increased rate of diagnosis of incidental meningiomas, especially in the past two decades. Additionally, the Division of Neurosurgery of HCFMRP-USP has acquired expertise for treatment of patients with CNS meningiomas and has become a recognized regional reference center for treating these patients from SUS.

The incidence of meningiomas increases with age, and their occurrence is predominantly in the 5th to 7th decades of life[3,6,7,18,19,23]. In some countries, such as China[15], South Africa[5] and other parts of Brazil[17,18], higher incidences among younger patients were observed. In agreement with most other authors, meningiomas predominated in our patients between the 5th and 7th decades of life (67% of cases), with a peak in the 6th decade (18.2%). Among the non-operated patients, the cases occurred predominantly between the 6th and 8th decades (68%), with a peak in the 7th decade (25.2%). The discrepancy observed in relation to other regions of Brazil can be explained by the different ethnic composition in distinct parts of the country. Improved access to neuroradiological investigations has resulted in an increasing number of diagnoses of intracranial meningiomas in older patients with no symptoms or stable minimal symptoms, which do not need surgical treatment.

The occurrence rates of meningiomas in the 1st and 2nd decades of life were low and similar to what has been reported in the literature[2,3,8,17], with predominance among males. Over the age of 70, the incidence was 16.4%, with a 5.8:1 predominance among females. A trend towards reduction and even inversion of the female/male ratio during childhood and towards an increase of male patients in old age has been reported in the literature[3,24]. We observed that the female/male ratio was twice as large among the non-operated patients (6.3:1), and that the male patients had their meningiomas diagnosed earlier (six years earlier) than the females, which was also observed in South Africa[6].

Higher frequency of meningiomas among black Africans and individuals of African-American descent has been reported in the literature[3-6]. Other authors reported similar distribution[1], while others observed that the annual incidence was lower among individuals of African-American descent than among Caucasians, and that Hispanic patients had their tumors diagnosed at a younger age than Caucasians[7]. Based on the ethnic distribution of the population of the state of São Paulo from the last Brazilian census (2010)[9], meningiomas predominated among Caucasians, compared with African-Brazilians and Asian-Brazilians ($p < 0.0001$ using chi-square test).

Location

Meningiomas are more frequently found in the intracranial compartment (80.7 to 96.7%)[3,8,18,21,23,25,26]. They occur predominantly in the convexity, parasagittal region and sphenoid wing, and this last region harbors more than half of them[8,20,21,25,26]. In the spinal canal, the incidences of meningiomas have ranged from 4.2 to 19.3%[3,18,21,25,26], and most of them have been found in the dorsal region (69.6%)[8,15,23,26], with predominance among females[8,26]. Our observations are in agreement with data from the literature, which have shown predominance of the transitional subtype among intracranial tumors. We did not find any significant difference in intracranial tumor location according to sex (convexity vs. skull base; and parasagittal region vs. skull base). We observed higher incidence of tumors in the skull base (58%) than what was observed by others[21,23], and this can be explained by the fact that our institution is a reference center for these tumors.

Histopathological features

Most meningiomas are benign tumors of WHO grade I (79-95%), and a smaller number are grade II and III tumors (20-30%). Predominance of grade I tumors in females (female/male ratios ranging from 2:1: to 13;1:) has commonly been reported in the literature[1,3,4,6-8,14,15,17-21,26,27]. However, the incidence becomes equal between the sexes at WHO

grades II and III[3,8,26] and in patients under 20 years old[26], and the difference increases among patients over 70 years old[27]. Meningothelial and transitional histological subtypes predominate among tumors located in the intracranial compartment; and the meningothelial subtype, followed by the psammomatous subtype, predominates in the spinal canal[21,26]. Our data are in agreement with the literature regarding histopathological distribution (88.9% of our patients had grade I tumors) and the female/male ratios for grade I (3.7:1), grade II (1.02:1) and grade III (1:1) tumors, and with predominance of the transitional subtype among intracranial tumors and among tumors of the spinal canal.

Treatment and outcomes

Meningiomas are generally treated with surgery. The extent of resection and histopathological grade are the strongest prognostic factors for meningioma treatment. Age, sex and tumor location are other more debatable factors. Total resection or Simpson I and II ranges are achieved in 77 to 84% of the cases and subtotal resection or Simpson III and IV in 15 to 87%[19,20,24,25,28-30]. Patients undergoing more extensive resections and with WHO grade I tumors have better survival rates and lower recurrence rates[20,24,25,28-31]. Mortality due to the operation ranges from 2 to 16% and the overall mortality rate after 15 years of follow-up ranges from 20 to 29%[19,20,24,28,29]. The 5 and 10-year survival rates vary from 79 to 90% and 78 to 81%, respectively; beyond 15 years of follow-up, the rates range from 23 to 69%[19,20,24,29]. The recurrence rates after 5 years and after 15 years range respectively from 7 to 31% and 19 to 32%[19,28-31]. Our resection and mortality rates were in agreement with the literature and our survival (78.2%) and RFS (64%) rates at 15 years were better than the levels reported in the literature. We found that there was no difference in survival in relation to the extent of resection, as also reported in a recent study using data from CBTRUS (United States)[23].

Risk factors

The most important risk factors for meningiomas are exposure to ionizing radiation, hormones, genetic changes and head trauma[1,2,8]. Exposure to ionizing radiation increases the risk of developing intracranial tumors and, specifically for meningiomas, ionizing radiation increases the risk six to tenfold[1,2,32]. These radiation doses might consist of low doses such as irradiation for tinea capitis treatment[33], panoramic dental radiographs[34] or radiotherapy for intracranial tumors,[35] and going up to the radiation produced by the atomic bomb[36]. Meningiomas occurring after intracranial tumor irradiation are often multiple and more aggressive, with higher histopathological grades and recurrence rates, and are associated with complex cytogenetic aberrations[8-36]. There is also evidence that radiotherapy causes or accelerates the progression of meningiomas from less severe to more aggressive grades[37,38]. Our data corroborated these findings; 33.3% of our patients had multiple tumors, and 66.7% of these tumors were atypical and were predominantly in males (5:1).

People with specific mutations in the NF2 gene are at increased risk of developing meningiomas, and tend to develop them at an earlier age[2,3,8]. It is also well known that patients with meningiomas develop classic NF2[39]. Multiple meningiomas are associated with NF2 in 0 to 20% of patients[8,11,12]. The association of multiple meningiomas with NF2 that we observed in this series (3.1%) was similar between the operated and non-operated patients, and was predominantly in males. These data were similar to what has been reported in the literature; however, the association of NF2 with multiple meningiomas (31.8%) and the predominance in males were much higher than previous reported.

In conclusion, although meningiomas are the most common brain tumor, only a few epidemiological studies have been published. An increase in the incidence of primary brain tumors in general, and of meningiomas in particular, has been observed in the past decades in several countries. Our study showed higher incidence of meningiomas in a regional population in the state of São Paulo, Brazil, than in the literature. Among the non-operated patients, predominance in females and older age were significant factors. There was predominance in Caucasian patients, compared with African-Brazilian and Asian-Brazilian patients. The association with NF2 among patients with multiple meningiomas was higher than previous reported, and the predominance in males among these patients was not previously reported in the literature. The differences observed between our data and those of other Brazilian studies can be attributed to the different ethnic compositions of the populations in different regions of Brazil.

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