

Posterior fossa meningiomas: Correlation between site of origin and pathology

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Abstract

Aim: to identify the possible correlation between demographic data of the patients, site of tumor origin, and pathological characteristics of each subgroup of the posterior fossa meningiomas as the anatomical location of these tumors is a critical determinant of the operative approach that will be chosen.

Materials and Methods: We analyzed medical records of 35 patients with posterior fossa meningiomas who underwent surgery between January 2005 and December 2009 at Neurosurgery Department, Iași. The analysis included: age and gender of the patients, tumor location, and pathologic findings. According to the anatomical relationship with posterior fossa structures, these 35 meningiomas were classified into 5 types: cerebellar convexity, cerebellopontine angle, petroclival, foramen magnum, and unclassified tumors. According to the classification scheme of WHO 2007 (19), all cases were classified into three histopathological groups: benign, atypical,

and malignant meningiomas, and every histopathological subtype was noted.

Results: Posterior fossa meningiomas have a 3.33:1 female-to-male ratio with a mean age of 51.6 years. 29 patients had anatomically distinct attachment to the dura of the 4 chosen compartments of the posterior fossa (cerebellar convexity – 14.28%, cerebellopontine angle – 48.57%, petroclival – 11.42%, and foramen magnum – 8.57%) and 6 patients (17.14%) had giant tumors with broad attachment in multiple areas of the posterior fossa. Grade I meningiomas encountered in majority of cases (82.85%), whereas grade II meningiomas were diagnosed in 11.42% of the operated case, and anaplastic meningiomas (grade III) accounted only 5.71%. The most common benign histological subtypes among posterior fossa meningiomas were fibrous (37.79%) and psammomatous (24.13%).

Petroclival meningiomas accounted a higher incidence than that presented in other studies (11.42% of all posterior fossa meningiomas). The mean age for female patients was older (55 years) than in other

studies. There were various benign histological subtypes (psammomatous, meningothelial, and secretory) and even an atypical one that was diagnosed in a male patient. Foramen magnum meningiomas affected only females with a mean age of 52.66 years. All tumors were benign (grade I) with psammomatous subtype being the most common histological subtype (66.66%). Cerebellar convexity meningiomas presented a female to male ratios of 4:1. Female patients were older (64.25 years) than the mean age of patients with posterior fossa meningiomas. In cerebellar convexity location, all meningiomas presented only benign histology (fibrous subtype, 100%) that made us thinking to a different tumorigenesis for this tumors comparative with other locations.

Cerebellopontine angle meningiomas presented a strong preponderance of female patients (5:1). Though majority of cerebellopontine angle meningiomas had grade I of malignancy, they exhibited a large variety of histological subtypes.

Conclusion: In our series, posterior fossa meningiomas are clearly various tumors in their histology and demographic data. We identified a significant association between age and gender of the patients, histology of posterior fossa meningiomas, and their site of origin.

Keywords: posterior fossa, meningioma, histopathological subtypes, age, gender, anatomical location

Meningiomas account for approximately 20-30% of all intracranial tumors, depending of the series (3). In clinical practice, meningiomas are most commonly classified according to site of origin. Cushing and Eisenhardt established in 1938

the modern classification of meningiomas by site of origin. Cushing's cumulative experience of 313 cases published in 1938 very closely resembles our contemporary understanding of the frequency of meningiomas by location (23).

There are many different classification schemes for meningiomas. Since the work of Cushing and Eisenhardt, there have been some other classifications of meningiomas according to their site of origin on the dura. These classification systems offer no insight into the biology of the tumors, but neurosurgeon can get important information about the challenges of surgical treatment (13).

The posterior fossa, deeply concave, is formed by the occipital, the petrous and mastoid portions of the temporal. It is separated from the middle fossa in the median line by the basilar suture and on each side by the superior border of the petrous portion of the temporal bone. This serves for the attachment of the tentorium cerebelli, is grooved externally for the superior petrosal sinus, and at its inner extremity presents a notch, upon which rests the fifth nerve. Its circumference is bounded posteriorly by the grooves for the lateral sinuses. In the centre of this fossa is the foramen magnum, bounded on either side by a rough tubercle, which gives attachment to the odontoid ligaments; and a little above these are seen the internal openings of the anterior condyloid foramina. In front of the foramen magnum is the basilar process, grooved for the support of the medulla oblongata and pons Varolii, and articulating on each side with the petrous portion of the temporal bone, forming the petro-occipital suture, the anterior half of which is grooved for the inferior petrosal sinus, the posterior half

being encroached upon by the foramen lacerum posterius or jugular foramen. Above the jugular foramen is the internal auditory foramen. Behind the foramen magnum are the inferior occipital fossae, which lodge the lateral lobes of the cerebellum, separated from one another by the internal occipital crest, which serves for the attachment of the falx cerebelli, and lodges the occipital sinuses. These fossae are surmounted, above, by the deep transverse grooves for the lodgment of the lateral sinuses (15).

Posterior fossa meningiomas have been usefully classified by Sekhar et al into six groups: Type I: Cerebellar convexity - lateral tentorial (tentorium, transverse sigmoid sinuses); Type II: Cerebellopontine angle (petrous ridge, internal acoustic conduct); Type III: Jugular foramen (cerebellomedullary angle, internal jugular vein, extracranial); Type IV: Petroclival (upper 2/3 clivus, cavernous sinus, Meckel's cave, petrous ridge); Type V: Foramen magnum (lower 1/3 clivus, C1-2 area); Type VI: Unclassified (entire clivus, mid and lower clivus, other types) (16).

Subsequently, different nomenclatures have been proposed by several authors. Bradac et al (7) subdivided posterior fossa meningiomas into four groups: 1. Tentorial meningiomas are those located under the surface of the tentorium cerebelli; 2. Clival meningiomas proceed from upper third of the clivus bone in the direction of the middle cranial fossa or the direction of the brainstem; 3. Cerebellopontine angle meningioma arise from the medial portion of the petrous bone; 4. Foramen magna meningiomas arise at or near the anterior rim of the foramen.

The present study analysed the posterior fossa meningiomas initially classified on their site of origin by CT, IRM and surgical observation, in order to identify the possible correlation between demographic data of the posterior fossa meningiomas patients, site of tumor origin, and pathological characteristics of each subgroup as the anatomical location of the meningioma is a critical determinant of the operative approach that will be chosen.

Materials and Methods

Emergency Clinical Hospital "Prof. Dr. N. Oblu" Iași admits neurosurgical patients from Moldova region that has a population of almost 5 million people. Taking into account this large addressability, we analyzed medical records of 35 patients with posterior fossa meningiomas who underwent surgery between January 2005 and December 2009 at Neurosurgery Department. The analysis included: age and gender of the patients, tumor location, and pathologic findings.

According to the anatomical relationship with posterior fossa structures, these 35 meningiomas were classified into 5 types: cerebellar convexity (tentorium cerebelli, transverse sigmoid sinuses), cerebellopontine angle (petrous ridge, internal acoustic conduct), petroclival (upper 2/3 clivus, foramen jugular), foramen magnum (lower 1/3 clivus, C1-2 area), and unclassified (broad dural attachment in multiple areas of the posterior fossa) tumors (Figure 1).

According to the classification scheme of WHO 2007 (19), all cases were classified into three histopathological groups: benign, atypical, and malignant meningiomas, and every histopathological subtype was noted.

Results

There was no great variation in the annual number of PF meningiomas, excepted 2008, when we observed a maximum of the operated cases (10 patients) (Figure 2).

In our series, meningiomas have a 3.33:1 female-to-male ratio. Of the 35 cases of posterior fossa meningiomas, 27 cases (77.14%) were females with an age ranging between 36-73 years, and a mean age of 52.8 years, and 8 cases (22.86%) were males with an age ranging between 35 – 57 years, and mean age of 47.1 years.

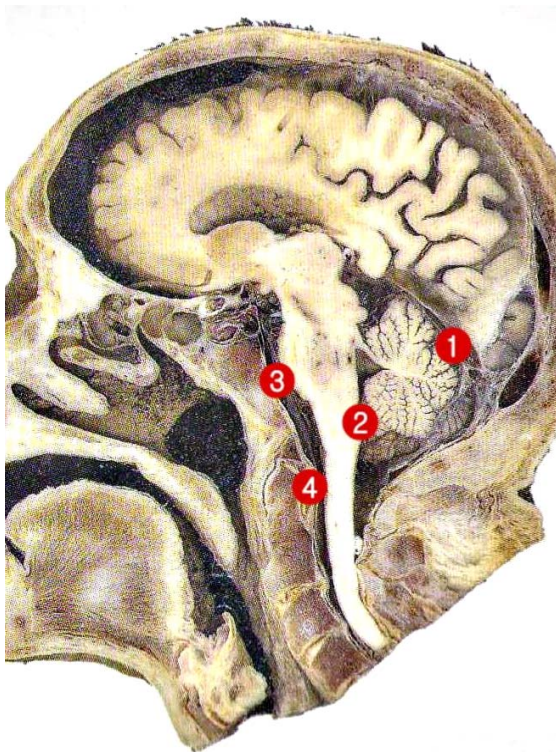


Figure 1 Anatomical location of posterior fossa meningiomas: Cerebellar convexity (1); cerebellopontine angle (2); petroclival (3); and foramen magnum (4)

Mean age for all posterior fossa meningiomas was 51.6 years. Giant meningiomas affecting a great part of posterior fossa encountered in male patients younger than mean age (43.33 years). Female patients were older than mean age when meningiomas were located in cerebellar convexity location (64.25 years) (Table 1).

Grade I meningiomas encountered in majority of cases (82.85%), whereas grade II meningiomas were diagnosed in 11.42% of the operated case (Figure 6), and anaplastic meningiomas (grade III) accounted only 5.71%. The atypical meningiomas (grade II) were diagnosed in cerebellopontine angle and in the petroclival location. The malignant meningiomas couldn't be located in one specific compartment of the posterior fossa as they were of great dimensions at the moment of diagnosis (Table 2).

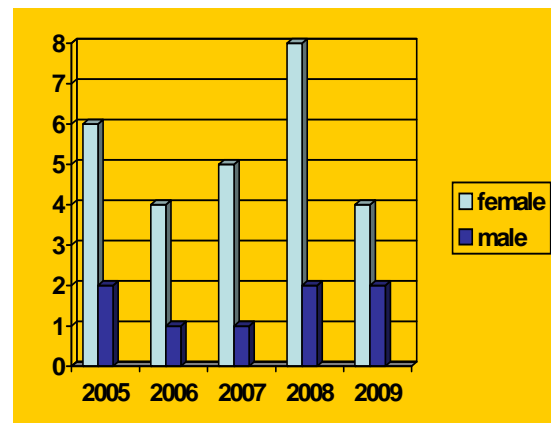


Figure 2 The annual distribution of PF meningiomas correlated with gender of the patients

Tabel 1
Posterior fossa meningiomas: sites of origin, gender, and mean age of the patients

Tumor location	Unclassified		Cerebellar convexity		Cerebellopontine angle		Petroclival		Foramen magnum	
Patient gender	F	M	F	M	F	M	F	M	F	M
Patient mean age (years)	52	43.33	64.25	49	50.93	49.33	55	50	52.66	-

Tabel 2
Posterior fossa meningiomas: sites of origin, gender and histological degree of malignity

Histological degree of malignity	Unclassified		Cerebellar convexity		Cerebello-pontine angle		Petro-clival		Foramen magnum		No. cases (%)
	F	M	F	M	F	M	F	M	F	M	
Grade I	1	2	4	1	13	3	3		3	-	29 (82.85%)
Grade II	1				2			1			4 (11.42%)
Grade III	1	1									2 (5.71%)

Tabel 3
Posterior fossa meningiomas: sites of origin and histological subtypes

Histological type	Un-classified	Cerebellar convexity	Cerebello-pontine angle	Petro-clival	Foramen magnum	No. cases (%)
Fibrous	1	5	5			11 (37.79%)
Psammomatous	2		2	1	2	7 (24.13%)
Meningothelial			3	1		4 (13.79%)
Secretory			2	1	1	4 (13.79%)
angiomatous			3			3 (10.34%)
atypical	1		2	1		4 (11.42%)
anaplastic	2					2 (5.71%)
Total	6 (17.14%)	5 (14.28%)	17 (48.57%)	4 (11.42%)	3 (8.57%)	35 (100%)

Twenty nine patients had anatomically distinct attachment to the dura of the 4 chosen compartments of the posterior fossa (cerebellar convexity – 14.28%, cerebellopontine angle – 48.57%, petroclival – 11.42%, and foramen magnum – 8.57%) and 6 patients (17.14%) had giant tumors with broad attachment in multiple areas of the posterior fossa (Table 3).

The most common benign histological subtypes were fibrous (37.79%) and psamomatous (24.13%). There were only few cases (10.34%) of angiomatous subtype

meningiomas. Atypical and anaplastic meningiomas represented 17.13% of all PF meningiomas. Taking into consideration the histological subtype, cerebellar convexity location was associated only with fibrous meningioma (Figure 3). The unique location of angiomatous subtype was cerebellopontine angle. Psamomatous subtype prevailed in the foramen magnum location (Figure 4). Cerebellopontine angle exhibited all the histological subtypes of meningiomas, inclusive the secretory meningioma (Table 3, Figure 5).

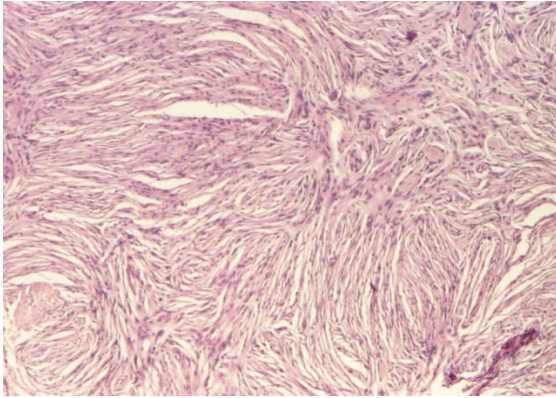


Figure 3 Female patient, 73 years: fibrous meningioma of the cerebellar convexity (Hematoxylin-eosin, original magnification x100)

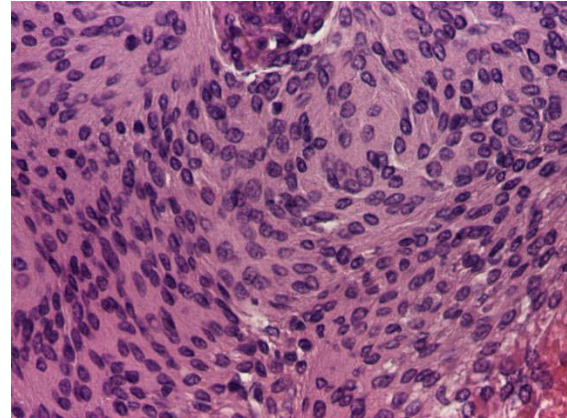


Figure 6 Male patient, 50 years-old: atypical meningioma of the petroclival area (Hematoxylin-eosin, original magnification x100)

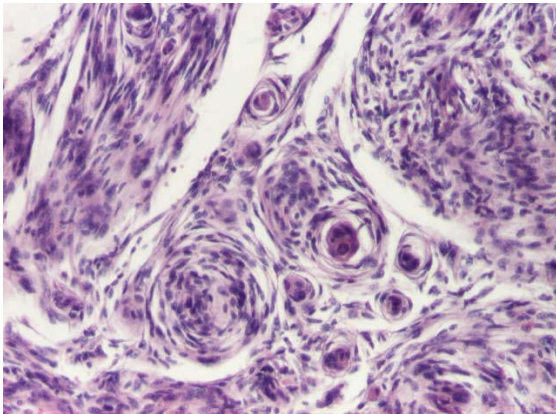


Figure 4 Female patient, 44 years – old: meningotheial meningioma of the cerebellopontine angle (Hematoxylin-eosin, original magnification x100)

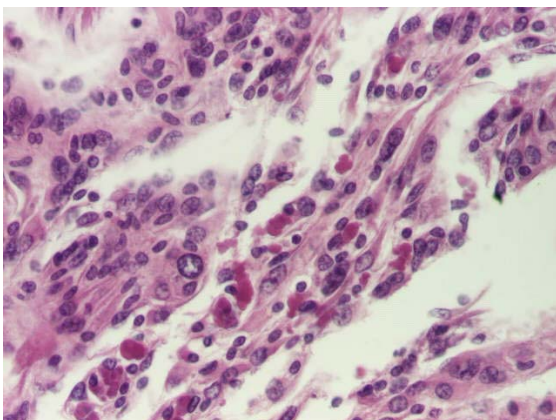


Figure 5 Female patient, 53 years-old: secretory meningioma of cerebellopontine angle (Hematoxylin-eosin, original magnification x100)

Discussion

Harvey Cushing was the first to use the term “meningioma” in 1922, although this tumor was known under various names since the 17th century (16). In 1614, Felix Plater, Professor of Medicine from the University of Basel, made the first report to a lesion that is most comparable with a meningioma. He described the symptoms as well as the autopsy findings of a “noble knight” intracranial tumor which he described as: “a round fleshy tumor, like an acorn. It was hard and full of holes and was as large as a medium –sized apple. It was covered with its own membrane and was entwined with veins. However, it was free of all connections with the matter of the brain, so much so that when it was remove by hand, it left behind a remarkable cavity” (23).

The first documented report of a tumor resembling a meningioma was published in 1774 by French surgeon Antoine Louis, who called it fungus durae matris. Various description and terms followed: in 1834 Cruveilhier depicted them in a pathology atlas; in 1847, they were named

psammomas (sandlike) by Virchow, who was the first to note the presence of granules; in 1864, Bouchard named them epitheliomas; and in 1869, Golgi named them endotheliomas (4). Although the first pictures of a meningioma were published in 1730, the earlier work that dealt with these tumors was written in 1774 by Antoine Louis in *Mémoires de l'Académie Royale de Chirurgie*. He called them *tumeurs fongueuses de la dure-mère*. Virchow, who noted the presence of small hard granulations in meningiomas, called them psammomas (tumors like sand) in 1859 and considered that they are related to the sarcomas. Golgi, on the other hand, called them endotheliomas in 1869, indicating a benign histology (4).

Meningiomas are now known to arise from arachnoidal cap cells of the leptomeninges. Arachnoidal granulations were first described by Antonio Pacchioni in Rome in 1705, believing them to be nervous system counterpart to lymph glands. In 1846, Rainey suggested that arachnoidal or pacchionian granulations arose from the meninges. This association was confirmed by Luschka in 1852 and later by Meyer in 1859. It was not until John Cleland in 1864, however, that the association between pacchionian granulations and meningeal tumors was drawn. Working in Glasgow, Cleland described two leptomeningeal tumors at autopsy and deemed them “villous tumors of arachnoid”, as he was able to separate the growths from the dura. He hypothesized their origin as from the pacchionian granulations. In 1915 Harvey sided with Cleland and considered that meningeal tumors arose from arachnoidal cap cells. Seven years later, Harvey Cushing proposed the term “meningioma” for these

tumors and the term achieved global acceptance. Working together with his student, Percival Bailey, at the Peter Bent Brigham Hospital, he adopted a histopathological classification system that listed four variants: meningothelial, fibroblastic, angioblastic and osteoblastic. Later, Bailey and Bucy expanded the initial histopathological classification scheme of meningiomas in such a manner as the new WHO histological classification 2007 is almost the same despite new discoveries made by molecular biology, biochemistry and technology from the last years (23).

Posterior fossa meningiomas have presented a formidable challenge throughout the history of neurosurgery and many, especially those arising from petroclival region, were considered “inoperable” up until the 1970s. However, with the advent of the operating microscope, CT and MR imaging, microsurgical techniques and the development of various skull base approaches, it became possible to safely resect the majority of posterior fossa meningiomas.

Tumor location is the single most important feature regarding therapy since it practically defines the terms of surgical interventions. They occur most commonly along the tentorium, cerebellar hemispheres, and cerebellopontine angle, but they can also be found along the clivus and the anterior margin of the foramen magnum (17).

Considering the location frequency, it is conceivable that true meningiomas tend to occur where meningothelial cells and arachnoid cap cells are most numerous. The arachnoid granulations or villi have large number of cap cells and therefore are common sites of origin for meningiomas, especially along the dural venous sinuses

where the villi are mostly concentrated, or along the cranial sutures where arachnoid granulations or rests of arachnoid cells are often present (12).

The frequency of meningiomas at various intracranial sites varies from study to study. According to some studies, posterior fossa meningiomas represent 6-15% cerebellar convexity meningiomas account for approximately 5%, cerebellopontine angle meningiomas for 2-4%, clivus less than 1% from all intracranial meningiomas (12).

Meningiomas of the cerebellopontine angle are the most common posterior fossa meningiomas. Foramen magnum meningiomas are uncommon. Clival meningiomas are less common (19). Bernstein reported the same percentages: 50% of posterior fossa meningiomas are located in the cerebellopontine angle, 40% occur around the tentorium or cerebellar convexity, 9% are at the clivus, and 6% occur in the vicinity of the foramen magnum (9).

Roberti et al. found some other different percents for posterior fossa meningiomas. In their report there were 68.32% petroclival meningiomas, 13.04% foramen magnum meningiomas, 8.69% cerebellar convexity meningiomas, 5.59% cerebellopontine angle meningiomas, and 4.34% jugular foramen meningiomas (25).

In our study, the most common site of posterior cranial fossa meningiomas was cerebellopontine angle as 48.57% of them were found to have dural attachment in this area. Only 8.57% of posterior fossa meningiomas were situated at the foramen magnum.

Intracranial meningiomas predominantly affect patients in the 5th to 7th decades of life with various female-to-male ratios that

range from 1.4:1 to 2.7:1 (16, 23), but posterior fossa meningiomas presented even a greater preponderance of female patients. García-Navarrete and Sola presented 26 successive patients with posterior fossa meningiomas treated at Servicio de Neurocirugía in Hospital Universitario de la Princesa from Madrid, Spain. There were 24 women and two men (14). Roberti et al. reported 161 consecutive cases of PF meningiomas operated on between 1993 and 1999 at the George Washington University Medical Centre. The ratio F:M were 3.9:1 (mean age 47 years, range 10-81 years) (25), almost similar values with the ratio found in our study as the mean age was 51.6 years (range 35-73 years) with a female:male ratios of 3.3:1.

The vast majority of intracranial meningiomas (92%) have a benign histology, whereas 8% show atypical or malignant features. For all meningiomas, the most common histopathological subtype is the meningotheliomatous type (63%), followed by transitional (19%), fibrous (13%), and psamomatous (2%) meningiomas (23). Fewer than 10% of meningiomas are malignant (24).

In the present study, the most common benign histological subtypes among posterior fossa meningiomas were fibrous (37.79%) and psamomatous (24.13%). Atypical and anaplastic meningiomas represented 17.13% of all posterior fossa meningiomas, but this series contained too small number of cases to draw a pertinent conclusion.

Petroclival meningioma accounts for approximately 3%-10% of all PF meningiomas (13, 32, 29). These rare, slowly growing tumors arise from the area of the synchondrosis of the sphenoid and

occipital bones on the clivus. Originating in the clivus and petrous apex region, the tumor may involve the medial part of the tentorium, Meckle's cave, cavernous sinus and parasellar region and, as a consequence, poses a great technical challenge to neurosurgeons because of its location (32).

Petroclival meningiomas present a slight female preponderance, and reported female:male ratios range from 1.4:1 to 2.8:1 (13). The mean age at presentation in patients with petroclival meningiomas is the mid-40s with a very wide range (29).

In 5 years, Zhu et al. operated 25 patients with petroclival meningiomas. Of the 25 patients there were 4 men and 21 women, aged 28-67 years (average 47.2 years) (32). 109 consecutive patients operated during a 12-years period by Couldwell included 40 men and 69 women ranging in age from 25 to 75 years (mean 51 years). Four recurrent cases demonstrated histological compatibility with malignant meningioma (10).

In our study, petroclival meningiomas accounted a higher incidence than that presented in other studies (11.42% of all posterior fossa meningiomas). The mean age for female patients was older (55 years) than in cited studies and for male patients it was 50 years. Petroclival meningiomas included various benign histological subtypes (psammomatous, meningothelial, and secretory) and even an atypical one that was diagnosed in a male patient.

Among the meningiomas of the posterior fossa, foramen magnum (FM) meningiomas deserve special consideration as they have the worst outcome in terms of surgical results and operative morbidity (29).

Due to their unique characteristics and challenges, foramen magnum meningiomas

were separated from other posterior fossa meningiomas and recently have received more attention, due to great improvement in the surgical approach during the last decade (21). Foramen magnum meningiomas are rare and account for only 0.3% to 3.2% of all meningiomas, and between 4.2% and 20% of all posterior fossa meningiomas (1, 9, 5). The first case description of a meningioma arising at the foramen magnum was provided by Hallopeau at Lariboisiere Hospital in 1872 (21). In their monograph on meningiomas, Cushing and Eisenhard divided foramen magnum meningiomas into two groups: craniospinal and spinocranial tumors. The craniospinal type arose above the foramen magnum ventral to the neuraxis and projected downward, displacing the medulla and cervical spinal cord. The spinocranial type was found dorsal or dorsolateral to the spinal cord and projected upward into the posterior fossa cisterns (5, 30). Welling et al (30) reported a definite female predominance for meningiomas of foramen magnum, with ratios from 2:1 to 3.6:1. They become symptomatic in the fourth through decades of life.

Marin Sanabria et al. reviewed 492 intracranial and spinal meningiomas treated at Kobe University Hospital between 1972 and 2001. Seven patients of 492 were identified as foramen magnum meningioma. The seven patients were five women and two men aged 39 to 66 years (mean 53.3 years). They found a female preponderance (2.5:1) (21).

Over a 5-year period, Borba et al. operated 15 patients presenting with meningiomas of the foramen magnum. Fourteen patients were females, and one was male, ranging in age from 42 to 74 years (mean 55.9 years) (6). In recent

literature there are a number of cases which appeared to children. Mahx Bracho et al. reported a 3-year-6-month-old boy with chordoid meningioma of foramen magnum (20). Due to the rarity of the published cases, there is only limited information about the histology of these meningiomas. Tsao et al. presented the histopathology of a foramen magnum meningioma as meningotheial type (28). On the other hand, Avninder et al. presented a case of a lymphoplasmacyte-rich meningioma arising at the foramen magnum (2).

In the present study, foramen magnum meningiomas affected only females being in the fourth through sixth decades of life (mean age = 52.66 years). All foramen magnum meningiomas were benign (grade I) with psammomatous subtype being the most common histological subtype. This presentation is similar to spinal meningiomas which are mainly psammomatous in appearance (66%) (26) probably because both tumoral location are in close vicinity.

Cerebellar convexity meningiomas are rare. A small number of series reported in the literature are often included in the wider coverage of posterior fossa meningiomas, and therefore, an accurate metanalysis is not possible. Nevertheless, it may be assumed that they account 6%–18% of the posterior fossa meningiomas and represent about 1.5% of all meningiomas (11, 9). In their surgical series of meningiomas from 1938, Cushing and Eisenhard encountered only three cases of pure cerebellar convexity meningiomas (about 1% of their entire series) (11).

In the present study, 14.28% of all 35 cases of posterior fossa meningiomas were located on cerebellar convexity. Female to male ratios was 4:1. Female patients with

cerebellar convexity meningiomas were older (64.25 years) than mean age of patients with posterior fossa meningiomas. In cerebellar convexity location, all meningiomas presented only benign histology (fibrous subtype, 100%) that made us thinking to a different tumorigenesis for this tumors comparative with other locations.

Although less than 20% of all meningiomas occur in the posterior fossa, half of these are located in the cerebellopontine angle (22). In our study, cerebellopontine angle meningiomas represented 48.57% of all 35 cases. There was a strong preponderance of female patients (5:1). The mean age, irrespectively of gender, was close to mean age for all posterior fossa meningiomas. 11.74% of cerebellopontine angle meningiomas had grade II of malignancy, and the remaining 88.23% exhibited benign histology. Though majority of cerebellopontine angle meningiomas had grade I of malignancy, they exhibited a large variety of histological subtypes (fibrous, meningotheial, secretory subtypes). Only in this location could be find the angiomatous subtype as the posterior petrous surface of temporal bone is relatively unique in its relationship to the venous sinuses because the sigmoid, superior petrosal, inferior petrosal, and cavernous sinuses form a ring surrounding the posterior face of the petrous bone and the meningiomas located in this region have a very close relationship with the four aforementioned sinuses (31).

On the other hand, Chung et al. gave another explication for histopathological variations of meningiomas as he considered that meningiomas arise from polyblastic and functionally multipotent arachnoid cells (8).

Taking into account the histology of normal leptomeninges, Lee et al. explained the existence of so many subtypes of meningiomas. The outer layer of the arachnoid membrane is formed by the arachnoid cap cells, whereas the trabecular cells form the inner layers, which are separated by basal lamina. Histologically, fibrous and transitional meningioma subtypes have features similar to the fibroblast found in the deeper layers of the arachnoid close to the subarachnoid space, whereas meningothelial subtype resemble the arachnoid cap cells of the outer layers. So, Lee considered that differential leptomeningeal embryogenesis may result in the predominance of one cell type (cap cells of the outer layer of the arachnoid membrane as opposed to trabecular fibroblast of the inner layer) in certain location (18).

Conclusion

In our series, posterior fossa meningiomas are clearly various tumors in their histology and demographic data. We identified a significant association between age and gender of the patients, histology of posterior fossa meningiomas, and their site of origin. There was a predominance of female patients with a mean age situated in the sixth decade of life. Benign meningioma was the unique histological category for cerebellar convexity and foramen magnum, but there were different subtypes (i.e. fibrous versus angiomatous) characteristic for every location.

This study establishes a foundation for future basic, clinical, and public health research to examine specific histologies (i.e. meningiomas) in specific location (i.e. posterior fossa) and incidence over times.

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