Descriptive Profile of Surgically-confirmed Adult Central Nervous System Tumors in Puerto Rico

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***Introduction*: Published studies regarding the incidence of central nervous system (CNS) tumors in Puerto Rico (PR) are exceedingly rare. The general understanding is that the incidence of these tumors in Puerto Rico is similar to the one found in the United States of America (USA). The objective of this study is to describe the specific profile of all the CNS tumors that are surgically intervened in Puerto Rico, through the creation of a database.**

***Methods*: A retrospective analysis of all the surgical procedures from January 1, 2002 to May 31, 2006 for adult CNS tumors in Puerto Rico was performed. Each case was evaluated for demographic information, operative procedure, lesion description and official pathological report. Recurrent lesions were excluded. The information was organized to form a database of all the CNS neoplasms.**

***Results*: A total of 1,018 procedures for CNS tumors were performed on 1,005 patients. The incidence rate of surgically intervened CNS tumors in Puerto Rico is 6 per 100,000 people. CNS tumors were more common in women than in men (58% vs. 42%), respectively. The mean age was 52.4 years. The most common histological type found was meningioma WHO I (24%), followed by pituitary adenomas (16%), and glioblastoma multiforme (14%).**

***Conclusions*: Our results reflect a unique histopathological distribution of operated CNS tumors in Puerto Rico. In this series, primary tumors are more common than metastatic tumors. Benign histological tumors were more frequent than more malignant variants. Although this study reflects only the histologically diagnosed tumors, it is headway towards diagnosing the incidence of all CNS tumors in Puerto Rico.**

Key words: CNS tumors, Tumor incidence, Puerto Rico, Neurosurgery, Neuro-oncology

The incidence rate of central nervous system tumors in the USA is 14.8/100,000 people per year.1 Within these, the malignant CNS tumors are accountable for at least 12,760 deaths for the year 2005 (1). The CNS tumors incidence in the USA is associated with male gender, Caucasian race, metropolitan area residents, and the elderly population (2). CNS tumor incidence in the USA has been studied and reported using centralized databases and registries. The Central Brain Tumor Registry of the United States (CBTRUS), the Surveillance, Epidemiology and End Results (SEER) Program and the North America Association of Central Cancer Registry (NAACCR) are among the most important sources of information available in the USA (3). They have been widely utilized for epidemiologic and cancer research studies (4-7).

Regarding CNS tumors, the general assumption in Puerto Rico is that the incidence and epidemiological profile is similar to those found in the USA. However, the demographical, ethnic and geographic characteristics of Puerto Rico may point towards a unique histopathological distribution of CNS tumors. It has been suggested in the literature a difference in the incidence rate of CNS tumors in different countries (2, 8-11), However, there is a lack of medical statistics, literature, or documented epidemiologic information to substantiate any assumption regarding CNS tumors in PR. Moreover, it is important to note that there are only few studies of brain tumors available for Latin American, and Caribbean countries, including Puerto Rico (12-15). The authors are only aware of only one published study regarding the incidence, risk factors and survival of CNS tumors in Puerto Rico (15).

Puerto Rico has only one centralized cancer registry. In the past, this registry only collected information regarding malignant tumors. Since 2004, the Puerto Rico Central Cancer Registry (PRCCR) has been collecting data on

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Table 1. Puerto Rico Central Cancer Registry: Number of New Cases for Brain and Other Nervous System by Histologic Type, Sex and Age Group for 2002-2003*

Histology	2002						2003					
	Male and Female		Male		Female		Male and Female		Male		Female	
	<=18	>18	<=18	>18	<=18	>18	<=18	>18	<=18	>18	<=18	>18
Tumours of neuroepithelial tissue	29	85	14	46	15	39	15	89	8	48	7	41
Gliomas	17	85	7	46	10	39	13	86	7	46	7	40
Astrocytic tumors	11	75	5	41	6	34	11	71	6	42	5	29
Oligodendroglial tumors and mixed gliomas	0	3	0	3	0	0	0	5	0	3	0	2
Ependimal tumors	4	4	2	2	2	2	2	6	1	0	1	6
Gliomas of uncertain origin	2	3	0	0	2	3	0	4	0	1	0	3
Embryonal tumors	12	0	7	0	5	0	2	3	1	2	1	1
Medulloblastoma	1	0	0	0	1	0	1	1	1	1	0	0
Other	6	0	3	0	3	0	2	2	1	1	1	1
Other neuroepithelial tumors	0	0	0	0	0	0	0	0	0	0	0	0
Tumours of Cranial Nerves	0	0	0	0	0	0	0	1	0	0	0	1
Tumors of meningial and related tissue	0	6	0	4	0	2	0	4	0	2	0	2
Meningioma	0	5	0	3	0	2	0	2	0	1	0	1
Soft tissue	0	0	0	0	0	0	0	1	0	0	0	1
Melanoma	0	1	0	1	0	0	0	1	0	1	0	0
Germ cell tumors	0	0	0	0	0	0	0	1	0	0	0	1
Germinoma	0	0	0	0	0	0	0	1	0	0	0	1
Other germ cell tumors	0	0	0	0	0	0	0	0	0	0	0	0
Sellar region	0	0	0	0	0	0	0	0	0	0	0	0
Pituitary tumors	0	0	0	0	0	0	0	0	0	0	0	0
Craniopharyngioma	0	0	0	0	0	0	0	0	0	0	0	0
Unspecified tumors	1	23	1	15	0	8	0	6	0	1	0	5
Other specified tumors	0	0	0	0	0	0	0	0	0	0	0	0
Total	30	114	15	65	15	49	15	101	8	51	7	50

*Source: Preliminary Data, Puerto Rico Central Cancer Registry

benign tumors as well, but still no official reports are available. In addition, the brain or spine metastases are not categorized as secondary CNS tumors. Instead, these neoplasms are incorporated to the primary tumor statistics (lung, breast, etc.). Thus, this registry only includes primary malignant tumors (Table 1) (16).

Since all CNS tumors, in spite of their histology, may have a devastating impact in the morbidity and mortality of the patients, it is imperative to have a database that encompasses all of the CNS tumors and their characteristics. The goal of this study is to obtain a complete profile of all CNS tumors operated in Puerto Rico. The analysis of these valuable sets of data may lead to the improvement of current public health policies and better allocation of human, technical and economical resources to address this health problem for the island population. To the best of the author's knowledge, this is the first study of its kind in Puerto Rico.

Materials and Methods

Retrospective analysis was performed of all adult surgical procedures from January 1st, 2002 to May 31, 2006 for CNS tumors in Puerto Rico. Adult age was defined as 18 years or older. In Puerto Rico, there were a total of 24 active neurosurgeons during the study period. All of the neurosurgeons were contacted by phone or personally; 23 neurosurgeons participated in the study, 1 neurosurgeon did not provide information. The totalities of the cases were reviewed for 21 of the neurosurgeons. Two

neurosurgeons practice at the San Juan Veterans Hospital (SJVA), and cases performed at that hospital were not included in this study due to institutional policy.

For the surgical procedures performed at the University of Puerto Rico (UPR), the cases were retrieved through the computerized database of the Neurosurgery Department. Pathology reports of these patients were obtained directly from the Pathology Department at the same institution. For the procedures done outside the UPR, neurosurgeons were contacted and list of their cases for the study period was obtained. Then, each medical record was reviewed individually for the data gathering. All the diagnoses were confirmed by the official pathological report.

Demographic information (age and gender) was collected from all the patients. Information about the specific operative procedure and the year of the surgery were recorded as well. Each lesion description included the location of the lesion within the CNS. The official pathological report was noted in every case and was required in order to be included in the study. Then, the data was gathered to create a database that included all the adult CNS neoplasms in Puerto Rico. This study was approved by the University of Puerto Rico Medical Sciences Campus and School of Medicine Institutional Review Board (A5420108). Statistical analyses were done using Microsoft Excel®.

Only two excluding criteria were considered for this study. First, patients that underwent surgery prior to January 2001 and had subsequent surgery during the study period for the same lesion were not included. Second, patients who were operated within the study period more that once for the same tumor were not considered.

Results

Between January 1st, 2002 and May 31st, 2006 there were 1,018 surgically treated CNS tumors in 1,005 adult patients. These cases represent the information collected from a total of 23 neurosurgeons and nine hospital centers (Table 2). Nine patients had two or more CNS tumors. Of these patients, 7 patients underwent a total of two surgeries for two different lesions, one patient had 3 surgeries for three Neurofibromas in different locations and one patient underwent a total of 5 procedures, 4 for different Schwannomas and 1 for a Neurofibroma. More than 200 cases were performed each year, except for 2006, when 109 cases were reported until May 31st, 2006. There was an average of 235 new cases per year (Figure 1 and Table 3) (17).

The general incidence rate of the operated CNS tumors in Puerto Rico is 6 /100,000 person-years. Yearly incidence rates were calculated based on the number of cases per year in relation to the population census estimates for that corresponding year. The population estimates are published by the US Census Bureau (17). For the year 2006, an estimated was done for the cases in that year in proportion to the cases performed in the first 5 months. The mean of all these yearly incidence rates was used as our total incidence rate (Table 3).

Table 2. Distribution of hospitals per geographical area

Hospitals	Number of Cases (%)
University of Puerto Rico, Metropolitan Area	601 (59%)
Other Hospitals:	
Metropolitan Areas (n=5)	299 (29%)
Non-Metropolitan Areas (n=3)	118 (12%)

During the study period, 770 craniotomies (total or subtotal) for lesion resection 146 transsphenoidal approaches, and 101 biopsies were performed. There was one case were the exact procedure was not clearly specified. Biopsy group included open, stereotactic or endoscopic procedures (Figure 2).

The CNS tumors were more commonly found in females than in males, 58% vs. 42%, respectively (Table 4). The mean age of diagnosis for both sexes was 52.4 years, 52.7 years for females and 51.9 years for males. The number of cases increased over the fourth decade, reaching a plateau during the 5th, 6th and 7th decades and decreased thereafter (Table 4).

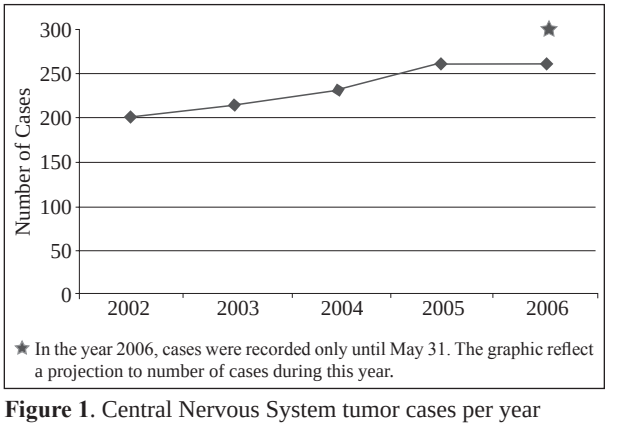

Figure 1. Central Nervous System tumor cases per year

In terms of location, spinal tumors were less frequently operated, accounting for 14% of the cases. The CBTRUS organizes the location of the lesions by site categories (1). Figure 3 shows our data series organized in a similar manner and Table 5 depicts the different sites of these lesions. Frontal lobe and the sellar region were the most common individual sites. Within the spine, the thoracic area was the most frequent site for neoplastic lesions.

Table 3. Distribution of cases by year

Year	Number of Cases	Annual Estimates of Population of Puerto Rico
2002	202	3,859,606
2003	214	3,877,881
2004	232	3,895,101
2005	261	3,911,810
2006*	109	3,927,776

Annual Estimates of the Population of the United States, Regions, and States and for Puerto Rico: April 1, 2000 to July 1, 2007. Source: Population Division, U.S. Census Bureau Release date: December, 2007. *Only includes cases from January 1, 2006 through May 31, 2006.

The official pathological report was reviewed in all the cases. The organization of the cases by histologic group is shown in Table 6. Primary tumors were more commonly encountered than secondary tumors, 88.5% vs. 11.5% respectively. Within the primary tumors, the neuroepithelial cell tumors were the most numerous histologic group.

When the cases are classified by histological type, the most frequent type was the meningioma WHO I with 249 cases. The menigioma WHO I represented 24% of all cases reviewed. They were found more frequently in women than in men (77% vs. 23%) and were more common in the 7th decade.

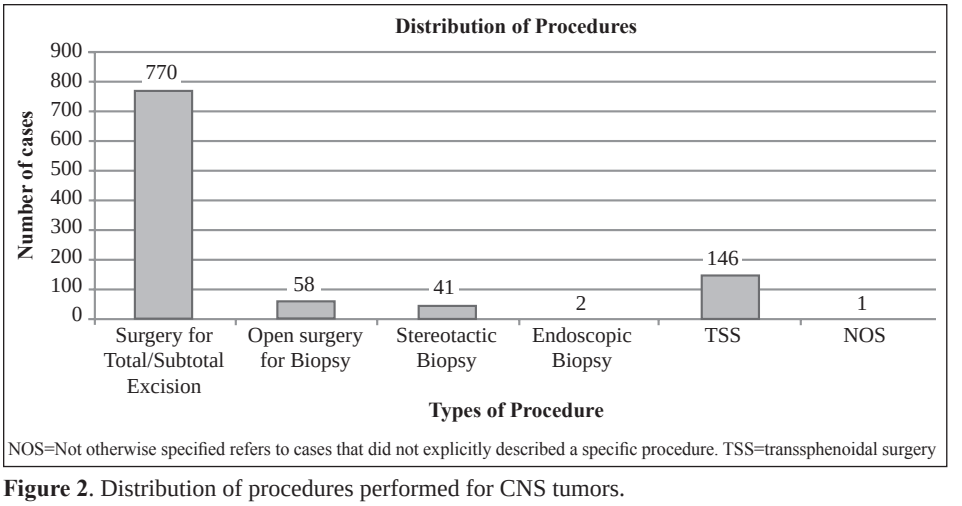

Figure 2. Distribution of procedures performed for CNS tumors.

The second most frequent histological type found was the pituitary adenoma. A total of 161 cases for pituitary adenomas were observed. The information about the functionality of these tumors was only available in the pathological reports of 23 specimens. Glioblastoma multiforme was found in 147 of the studied pathological samples of the 1,018 cases. Metastases accounted for 11% of our population with 117 cases. Metastasis from primary cancer of breast, lung and gastrointestinal system were the most frequent identified with 18, 17, and 16 cases respectively. For 40 cases of metastasis, the pathology report did not identify the origin of the primary tumor. Of the total of 138 spine tumor cases, the most common neoplasm was schwannoma. The histopathology of all of these lesions is shown in Table 8 and Figure 4.

In terms of histological distribution by age groups, meningioma WHO I was the most prevalent tumor in the age groups between 30 to 79 years of age (Table 8). After age 80, the same number of cases (N=6) was found for meningiomas, gliobastomas and metastatic lesions. The 2nd most common tumor in the mid age groups (30-59 years) is consistently the pituitary adenoma.

Discussion

CNS Tumor Incidence

The information about the incidence and the epidemiology of central nervous system tumors in Puerto Rico is limited. Until 2004, the Central Cancer Registry of Puerto Rico collected only primary malignant tumors.16 The information that is currently available is prior to 2004 and reflects that in 2002 and in 2003, the number of cases registered were 114 and 101 per year, respectively (Table 1). However, now as a result of this study, it can be established that at least 6 of every 100,000 Puerto Ricans underwent a surgical procedure in Puerto Rico for a Central Nervous System tumor during the study period. Moreover, approximately 235 surgical procedures per year were performed in Puerto Rico for CNS tumors. During the study period, the results suggest that there were an increasing number of tumor cases operated per year. However, longer study periods are required to further determine the significance and validity of this trend and/or to determine if any particular tumor histology is associated with this presumptive increased rate.

One of the purposes of this study is to serve as a database of the surgically diagnosed adult CNS tumors in Puerto Rico. The information collected served as a reliable source of the surgically diagnosed CNS tumors in Puerto Rico for various reasons. More than 90 % of the neurosurgeons in Puerto Rico cooperated with this study. We included all the

Table 4. Demographic Characteristics of Patients with CNS Tumors in Puerto Rico.

	Number of Cases (%)
Gender	
Male	426 (42.4)
Female	579 (57.6)
Age	
18-19	11 (1.1)
20-29	80 (7.9)
30-39	132 (13)
40-49	211 (20.7)
50-59	218 (21.4)
60-69	215 (21.1)
70-79	127 (12.4)
>80	24 (2.4)

cases from the UPR, the largest center for neurosurgery in the country. In addition, this investigation also included eight more centers across Puerto Rico (Table 2). Furthermore, this includes different surgical procedures; it does not only included open surgeries but stereotactic and endoscopic biopsies. For the above reasons, the sample number in this database is a representation of all the surgeries carried out in Puerto Rico for CNS tumors.

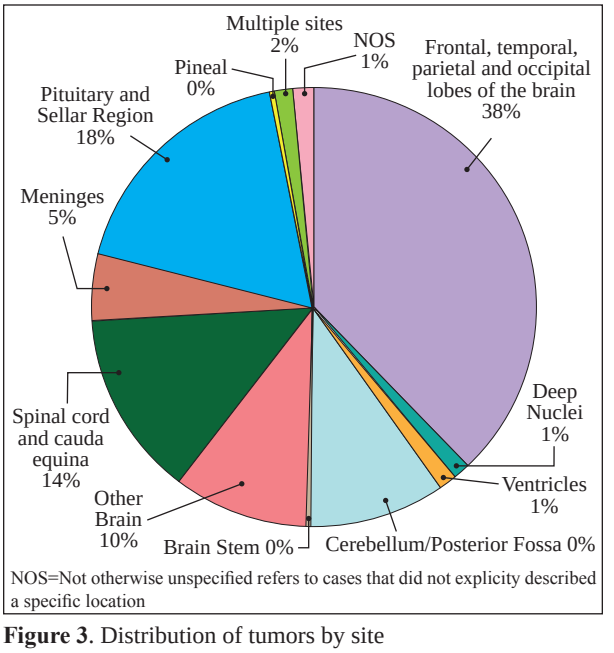

Figure 3. Distribution of tumors by site

Even though this study compromises most of all the histologically diagnosed CNS tumors in Puerto Rico, the incidence for these neoplasms can not be stated. First, this research is a retrospective study and relies in adequate documentation and filing of cases. Second, the patients operated in the SJVA were not included in this study. In addition, patients without histologically confirmed diagnosis were excluded from this study. If we take into consideration that radiosurgery has been readily available in Puerto Rico since 1999, there is a group of patients that may have undergone radiosurgery treatment as the initial management for their cancer without histological diagnosis, especially those with known metastatic disease or primary skull base tumors, like meningiomas or shwannomas. In addition to the above, there are an undeterminable number of Puerto Rican residents that travel to the USA for cancer treatment. These cancer cases may have not been registered in Puerto Rico.

Surgical Procedures

Of the total of 1,018 procedures, there were 770 cases of total or subtotal open surgical resections. This type of procedure was far more common than the biopsies. The advantages of open surgeries over biopsies has been well studied (18). The benefits of surgical excisions include decreasing the mass effect, diminishing the tumor burden, possible complete disease removal depending of the tumor histology and increased survival (19-20). These reasons might likely influenced the surgeons towards this type of procedure in the more than 75% of the cases. On the other hand, biopsies are performed in the cases when the surgery is not a treatment option for the type of cancer (e.g. CNS lymphoma), inaccessible location of tumor and/or when the overall health condition of the patient precludes a major surgery (18, 21-22). The decision between biopsy vs. open resection should take in consideration the risks and the benefits . Also the results of this type of study might be modified by the neurosurgeons decision "bias" toward which patients are recommended surgical procedures. Therefore, it is possible that the true incidence of CNS tumor in the adult population in Puerto Rico and elsewhere, could be quite different for the surgically treated. The complications of these procedures were not tabulated since they were outside the scope of this study. However, it is fundamental to know the complication rate encountered for these procedures in order to improve surgery decision making and furthermore, to be able to create recommendations of treatment within the resources and technology available at our health system (23).

Demographic Characteristics

In general, this cohort showed unexpected demographic characteristics. It is well established in the literature that CNS tumors are more common in males than in females, with the classic exemption being meningiomas (24-25). In contrast to the above, the results reflect that in Puerto Rico CNS tumors were more commonly operated in women than in men. It can be theorized that the overall incidence

Table 5. Site of Lesions

Site	Number of Patients
Cranial	**880 (86)**
Skull	28
Frontal lobe	142
Cingulate gyrus	3
Olfactory groove	18
Orbital area	7
Parietal lobe	82
Temporal lobe	94
Sphenoid bone	28
Sylvian fissure	3
Occipital lobe	27
Parasagittal/falx	22
Multilobar	51
Convexity	3
Basal Ganglia	2
Thalamus	10
Cavernous sinus	5
Sella Turcica	156
Suprasellar region	26
Optic Chiasm	1
Pineal region	3
Cranial Nerve V	1
Clinoid	4
Brain Stem	2
Tentorium	12
Cerebellopontine Angle	47
Cerebellar/ posterior fossa	52
Petrous bone	2
Jugular Foramen	1
Clivus	2
Ventricular	14
Foramen Magnum	2
Multiple brain lesions	15
Unspecified brain lesions	15
Spine	**138 (14)**
Cervical region	27
Thoracic region	53
Thoraco-Lumbar region	4
Lumbar region	24
Sacral region	2
Filum terminale/Conus medullaris	6
Vertebral body	22

of CNS tumors in Puerto Rico is higher in woman due to unknown genetic, environmental and racial factors. It also might be a result of the higher prevalence of meningiomas in this study. Gender difference in the patterns of seeking health care and even in the type of treatment has been documented in the literature but it is unknown the presence of these differences among the Puerto Rican population (26-28). Another possible hypothesis for the results in this study is that women in Puerto Rico may be willing to undergo surgery more often than men. These results most likely reflect a combination of the above factors. This gender distribution must be further investigated since gender has been associated with incidence of CNS tumors, and more importantly, with survival (29-30).

Tumor Location

Location of the CNS tumors has a pivotal influence in treatment of the tumor, prognosis and survival of the patient (20, 31-34). It has been documented that the cerebral hemispheres are a popular location for many CNS tumors (32, 35). The most common locations for CNS tumors of this study were cerebral lobes (40%), followed by sellar region (18%) and spinal cord (14%). Least common places were brain stem, pineal area and basal ganglia (less than 1% combined). This study's percentage is similar to the results of the site distribution in the USA published in CBTRUS (2005) (1).

The decision of surgery for a CNS tumor and the extent of its resection are influenced by the location of the lesion (36-37). In this study, the feasibility of resection due to tumor location, the eloquence of the adjacent tissues and the post operative neurological deficits related to the location of the tumor may have prompted the surgeons to perform surgery or to pursue a non surgical treatment. Our results show that cerebral hemispheres, cerebellum, and spine were more frequent locations than thalamus and brainstem not only because they are common tumors sites but may also be more frequent because of the feasibility of resection and relative decreased eloquence.

CNS Histology

In our series, primary CNS neoplasms were more common than secondary CNS neoplasms. This results contrasts to what has been the general consensus regarding secondary CNS tumors: that they are the most common tumor in the Central Nervous System in adults (2, 38). However, it is important to note that the statistics of this study resulted from a surgical series, and that the decision to perform surgery for metastatic disease is multifactorial (39). It involves the patient's overall health, the number of brain lesions, the brain lesion itself, as well as the staging of the patient's cancer and the patient's Karnofsky scale (39). Also, patient's personal preferences regarding cancer and its treatment may have had an impact on the final decision of treatment in these patients (40). Thus, surgical treatment could have been deferred in the patients with metastatic disease in Puerto Rico for all these factors. In addition, the use of radiosurgery for treatment of a metastatic lesion has gained acceptance among surgeons and patients (41-43). Since this treatment option is readily available in Puerto Rico, many patients with new metastatic lesions might had prefer this treatment before surgery and no tissue diagnosis would be obtained. The primary tumors of the metastases in this series were lung, breast, and GI, all of similar frequency, followed by melanoma in 4th place. These results are parallel to what has been published elsewhere (44).

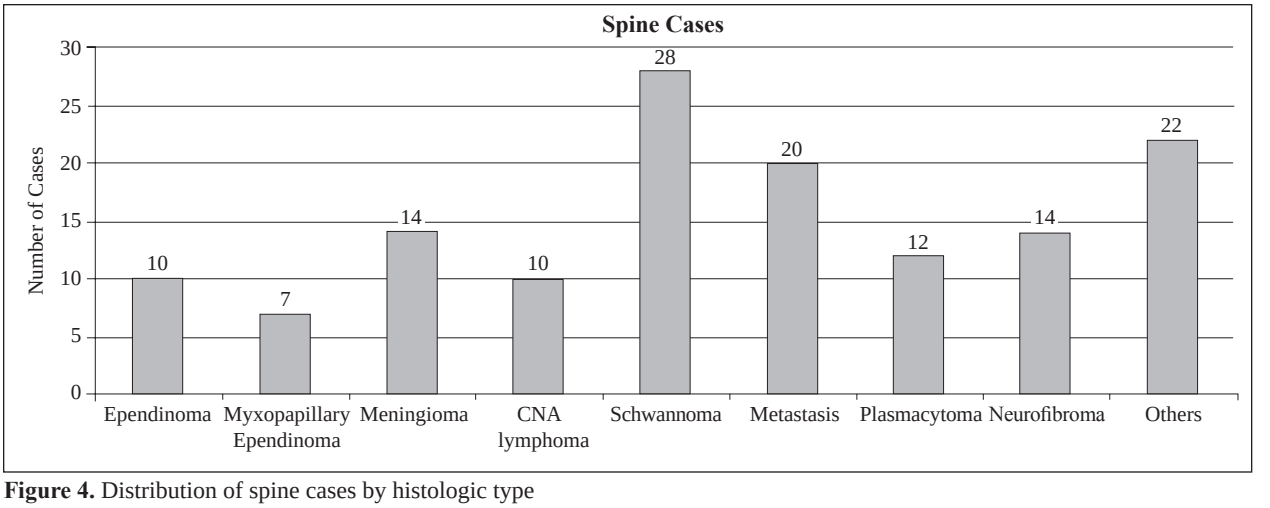

Figure 4. Distribution of spine cases by histologic type

In terms of primary CNS tumors, this series demonstrated a very diverse number of histologies. Meningioma WHO I was the most common histological type and represented 28.7% of all newly diagnosed primary CNS tumors. In the United States, meningiomas represent 20-25% of all intracranial tumors (24, 44-45). France recently published the implementation of an ingenious systematic format to register the incidence of histologically diagnosed CNS tumors with clinical, radiological and histological description of each newly diagnosed lesion (46). Their results show that meningioma was the single most common tumor comprising 30.9% and was followed by GBM with 24% and peripheral nerve sheath tumors with 8.7%. In Japan, the brain tumor registry also had Meningioma WHO I as the most frequent primary tumor with 23.8% (47). In Japan, pituitary adenomas were the second most common tumor with (16.8%), followed by GBM (9.5%), and astrocytomas (9.5%) and neurinoma (9.4%) (47). In the USA, the incidence of the meningiomas documented by the CBTRUS was 30.1% and was the CNS tumor with the highest incidence (Table 9).

The results of the incidence of menigiomas in this study are similar to the ones published in the USA and France. However, little is known about the exact epidemiology and risk factors associated with this frequently encountered tumor in Puerto Rico. Menigiomas are associated with female gender and increasing age (24). Females are known to be affected up to 80% more than males (48). The high percentage of females in this cohort may be associated with the large amount of meningiomas in this study; however, further investigations are needed to establish a valid relationship. Other known risk factors is ionizing radiation, which has been seen to increase the risk of meningiomas in the atomic bomb survivors, children who were given radiation for scalp ringworm and, more recently, has been associated with dental radiographs (24, 45). Hormones are another factor strongly associated with this neoplasm. The increase prevalence in woman, the presence of estrogen and progesterone receptors and the association with breast cancer and pregnancy connect hormonal exposure with menigioma (49). Other environmental and ethnic risk factors are not clearly elucidated. In the USA, African Americans and Caucasians share equal incidence of meningiomas and Hispanics compared to Non-Hispanics had a similar incidence rate (1). In Puerto Rico, further epidemiologic research is needed to define how these elements play a role in the incidence of meningiomas in the Puerto Rican/ Hispanic population.

Table 6. Distribution of cases by histology groups

Histologic Groups	Number of Cases (%)
Primary	901 (88.5)
Neuroepithelial	282
Meningiomas	259
pituitary adenomas	161
crania/spinal nerve tumors	88
Lymphomas and hematopoietic tumors	40
other	71
Secondary	
Metastasis	117 (11.5)
Total	1018

Pituitary adenomas were the second most common primary tumor, accounting for 17.9% of all the primary CNS tumors. In the literature, the pituitary adenomas are reported to represent the approximately the 15% of the intracranial neoplasm (50). However, the true incidence

and prevalence of pituitary adenomas has been difficult to determine since there are a number of pituitary adenomas that are asymptomatic and never diagnosed (51). For instance in 1994, Hall et al. studied brain MRI of 100 asymtpomatic healthy volunteers and he concluded that 10% of the normal asymptomatic adult population have pituitary abnormalities that were highly compatible with pituitary adenomas (52). Moreover, in a systematic meta-analysis of the prevalence of pituitary adenomas it was found that the presence of pituitary adenomas was at an estimated 14.4% in autopsies and 22.5% in radiologic studies in asymptomatic patients (51). Thus, a significant number of pituitary adenomas are incidentally found in radiographic studies done to patients due to other medical problems or, even more, there are only found in autopsies. In view of the above, the incidence of pituitary adenomas is difficult to determine since patient may have developed an adenoma may not be aware of it. Therefore, our results are an underestimation of the real incidence of pituitary adenomas in Puerto Rico, since these represent only the new cases pituitary adenoma which were properly diagnosed and surgically managed.

Table 7. Histologically Confirmed Primary Origin of CNS Metastasis

Primary Tumor	Number of Cases
Lung	17
Breast	18
GI	16
Melanoma	5
Ovary/Reproductive	3
Kidney/Bladder	8
Prostate/Testicules	5
Thyroid	4
Leiomyosarcoma	1
Undetermined	40

In spite of our results being lower than the true incidence, it was the second most common primary CNS tumor and was more commonly encountered (in order) than glioblastomas, schwannomas and diffuse astrocytomas WHO II. In the USA, the CBTRUS collected information of the incidence of CNS tumors that included surgical and non histological diagnoses.1 In their results, the newly diagnosed pituitary adenomas represented the 6.3% of all CNS tumors and were the 6th most common tumor (Table 9). The CBTRUS documented that the pituitary adenomas followed in frequency the meningioma, glioblastoma, nerve sheath tumors, and astrocytomas. The validation and explanation for this difference is, at the moment premature since these are two independent studies. Nevertheless, it is surprising that an exclusive surgical series reflected a higher percentage of adenomas. This is particularly different from other CNS tumors, where medical treatment, and not surgery, plays a primordial role in the management of prolactinomas, the most common type of pituitary adenomas (53).

The increased incidence of pituitary adenomas in this study cannot be attributed to any specific factor since there is no available information regarding the epidemiology of this neoplasm in Puerto Rico. The pituitary adenomas have been associated with the aryl hydrocarbon receptor-interacting protein (AIP) gene and other genetic disorders like multiple endocrine neoplasia type 1 (MEN1) (54-56). The authors are not aware of any study that examined the prevalence of these genes or diseases in the Puerto Rican population. In a recent publication of the University of Liege in Belgium, researchers performed a methodical cross sectional study to determine the prevalence of pituitary adenomas in certain specific counties of Belgium (57). In addition, for those patients that they found diagnosed with pituitary adenomas, they performed screening for MEN1 and familial isolated pituitary adenoma (FIPA). Their results reflected a prevalence of pituitary adenomas of 94 per 100,000 people. The authors stated that this prevalence of pituitary adenomas in the study population was more than 3.5-5 times that previously reported (57). These results encourage further local studies to determine incidence and prevalence of the pituitary adenoma in Puerto Rico. Furthermore, the additional investigations regarding the functionality of these pituitary adenomas are warranted since it has been suggested that certain adenomas, particularly GH producing, may be accounted for increase cardiovascular mortality (58).

Glioblastoma multiforme was found in 147 cases being the third most common of the primary CNS tumors. Since surgery continues to play a primordial role in treatment of this glioma WHO IV, it is not surprising that this tumor was the third most common in this surgical series (18). In general, there are not many published studies describing the incidence of GBM by specific population groups or ethnicities (59). Others have reported similar incidence rates for brain tumors among different ethnicities (59). One of the few publications reporting differences in the rate of malignant CNS tumors is the Cancer Incidence in Five Continents, Volume VII (60). It describes the incidence rates in specific ethnic subpopulations. For example, they compared populations from different regions in Europe (Poland, Austria and Yugoslavia) and Africa and found that these populations have elevated rates for malignant brain tumors. Also, in their analysis they found that for the Canadian population, there was

a higher rate of mortality due to brain tumors in the immigrant population from European nations (60). This finding seems to be consistent with others that have reported that the rates of brain tumors are higher among immigrants than in native populations (60).

Table 8. Most Common Histological Subtypes per Age Group

	Histology (Num. of Cases)		
AGE	**Most common**	**2nd most common**	**3rd most common**
19-29	Pituitary (16)	Schwannoma (15)	Astrocytoma II (7)
30-39	Meningioma (26)	Pituitary (24)	Schwannoma (14)
40-49	Meningioma (56)	Pituitary (41)	GBM = Metastasis (19)
50-59	Meningioma (54)	Pituitary (37)	GBM (35)
60-69	Meningioma (66)	GBM (40)	Metastasis (34)
70-79	Meningioma (39)	GBM (33)	Metastasis (21)
>80	Meningioma=GBM=Metastasis (19)		

The commonly accepted incidence of gliomas is around 5 to10 per 100,000 a year in the general population and patients are usually diagnosed in the fifties (34). Also true is a higher incidence of malignant gliomas in the elderly population (34). This study revealed that the brain tumor incidence in PR after the age of 80 is different from the current literature since in this group the same number of cases (N=6) was found for meningiomas, glioblastomas and metastatic lesions. Among the reasons hypothesized to explain this finding are that brain tumors in this study are more common in women than in male which makes the population at this age at higher risk for meningiomas than for GBM. Classification and grading of astrocytomas by WHO organization is based on specific histological features, been GBM the most frequent subtype of astrocytomas (34). Specific histopathologic features for high grade gliomas includes nuclear atypia, mitoses, microvascular proliferation and necrosis (34). Prognosis is poor even with aggressive intervention that includes resection, radiotherapy and chemotherapy (18). Pathophysiology and genetics studies of GBM show that tumor origin could be primary or secondary (34). In the case of primary GBM these are more common than secondary and patient tends to be older. Primary GBM arise from glial cell without previous evidence of neoplastic process while secondary GBM develop from previous low-grade astrocytomas. Risk factors for development of gliomas are been considered, including genetic factor, but no conclusive evidence is available to validated this conclutions (34). The high frequency of GBM in this study and the high mortality associated with GBM should prompt immediate action (61). Adequate health care and public health polices are needed that encompass the multimodal treatment for GBM that combines surgery, chemotherapy and radiotherapy (62). Although the survival of the GBM patients was not recorded in this series, additional investigation regarding the rate of survival as well as the presence of long term survivors, genetic variants and response to treatment are important to determine GBM profile that predominates in Puerto Rico. This information could help design treatment algorithms within Puerto Rico's health system that suits best.

Overall, the number of spine tumor cases was 138 of a total of 1,018 CNS tumors. Schwannomas were the most common spinal neoplastic lesion (20%), followed by metastases (15%), meningiomas (10%) and neurofibromas (10%). Schwannomas and neurofibromas can occur sporadically but also occur as a part of Neurofibromatosis (NF) 1 or 2 and Schwannomatosis (63). There were 3 patients with two or more neurofibromas or meningiomas or combination of both. However, no recent data is available regarding the prevalence of these diseases in Puerto Rico (64). It is of great importance to know the prevalence of these diseases in Puerto Rico since they are associated with multiple CNS tumors as well as other pathologic manifestations in the rest of the body (65-66).

Table 9. Distribution of All Primary CNS Tumors by Histology in Comparison to CBTRUS (2005-2006)* ^

Histology	**Our study (%)**	**CBTRUS (%)**
Glioblastoma	16.3	20.3
Other astrocytomas	7.7	9.8
Ependymoma	2.8	2.3
Embryonal	0.7	1.7
Meningioma	28.7	30.1
Pituitary adenoma	17.9	6.3
Craniopharyngioma	1.1	0.7
Nerve Sheath	9.8	8.0
Lymphoma	2.4	3.1
All Other	12.6	13.9

* CBTRUS: Central Brain Tumor Registry of the United States.
^ See Reference 8

In 2005, the CBTRUS published the results of their registry for the years 1998-2002.1 This registry included all the new cases of primary CNS tumors in the United States (Table 9). There are differences between the CBTRUS and this collection of cases. The main one, is that the data collection of new cases in CBTRUS is not limited to pathologically diagnosed neoplasm but also included the new cases diagnosed clinically or by imaging studies. In contrast, in this study, the histological diagnosis was an essential requisite. Nevertheless, when the two cohorts of adult primary CNS tumors are compared some differences are observed. The most striking of these is the

three-fold increase in the proportion of pituitary adenomas in Puerto Rico. The factors associated with increase incidence of pituitary adenomas within the population of newly diagnosed CNS tumors are unknown and the reasons of the difference between Puerto Rico and USA are uncertain. Additional studies are needed to evaluate the validity of this difference. The one fact that is certain and most important is that this study questions the general assumption that the incidence of CNS tumors in Puerto Rico is equal to the one in the United States.

Conclusion

The incidence of CNS tumors in Puerto Rico remains unknown. The goal of this study is to obtain a complete profile of CNS tumors and characteristics that are operated by neurosurgeons in Puerto Rico. The result is a unique profile of surgical cases of central nervous system tumors. Cultural, genetic, racial and environmental factors in the island may have contributed to the surgical incidence of these tumors. Further studies are imperative in order to evaluate how all these factors coalesce to create this distinct distribution of CNS tumors in Puerto Rico. Finally, although, this study reflects only the histological diagnosed tumors, it is headway towards diagnosing the incidence of CNS tumors in Puerto Rico.

Resumen

Introducción: Los estudios publicados acerca de la incidencia de los tumores del sistema nervioso central (SNC) en Puerto Rico son escasos. En general, se ha pensado que en Puerto Rico la incidencia de estos tumores es similar a la que se ha encontrado en los Estados Unidos. El objetivo de este estudio es describir el perfil específico de los tumores del sistema nervioso central que se diagnostican a través de procedimientos quirúrgicos en Puerto Rico. Métodos: Se realizó un análisis retrospectivo de todas las cirugías que se realizaron en Puerto Rico para tumores del sistema nervioso central desde el 1 de enero de 2002 hasta el 31 de mayo de 2006. En cada caso se evaluó las características demográficas, el procedimiento quirúrgico, descripción de la lesión y el reporte patológico oficial. Los casos de lesiones recurrentes fueron excluidos. Los datos obtenidos se organizaron para formar una base de datos de todos los casos de tumores del SNC. Resultados: Un total de 1,018 procedimientos para tumores de SNC fueron realizados en 1,005 pacientes. La tasa de incidencia de los tumores operados del SNC es de 6 por cada 100,000 personas. Los tumores del SNC fueron más frecuentes en mujeres que en hombres (58% vs. 42%, respectivamente). La edad promedio de los pacientes fue 52.4 años. Las histologías más frecuentes fueron meningioma WHO I (24%), seguido por adenoma de pituitaria (16%) y glioblastoma multiforme (14%). Conclusión: Los resultados de este estudio demuestran una distribución única histopatológica de los tumores de SNC operados en Puerto Rico. Los tumores primarios fueron más frecuentes que los secundarios predominando los tumores con patologías benignas. A pesar de que este estudio sólo demuestra la incidencia de tumores mediante diagnosticos histopatológicos, entendemos que es un paso de avance en la búsqueda de la incidencia de los tumores de sistema nervioso central en Puerto Rico.

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