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Changing Trends of Brain Tumors at Kenyatta National Hospital in Kenya: A 12 Year Picture

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Abstract

Introduction: Brain tumors are a multifaceted disease with about fifty different pathological kinds. These tumors are becoming more common over the world. Gliomas are the most prevalent histological type of brain tumor, accounting for more than 70% of all cases. Recent studies, on the other hand, suggest that global trends are shifting. As a result, this study examines recent data from a tertiary referral center in Kenya, compares current trends to past trends reported from same location, and highlights changes that have occurred. **Methodology:** Data from the University of Nairobi's Department of Pathology's cancer database for a period of 12 years (2005-2016) was reviewed. **Results:** Brain tumors were found in 5.8% of the population. The most common age categories for diagnosis of brain tumors were 0-5 years and 51-55 years, both at 8.8%. Female patients (58.2%) presented with more brain tumors than male patients. Meningiomas were the most common histological diagnosis (44.8%), followed by gliomas (34%). **Conclusion:** The frequency of various histological types of brain tumors, as well as their gender and age distribution, are changing over time in this region. Meningiomas are now more prevalent than gliomas. More efforts should be put toward the identification, diagnosis, and treatment of these tumors, as well as a constant evaluation of overall patterns and trends in brain cancers.

Keywords: *Brain tumors, Kenya, Sub-Saharan Africa, meningioma, glioma, patterns*

Introduction

Tumors of the brain are a group of complex diseases that comprise over 50 pathological entities and are diverse with reference to their locations, morphology, molecular biology, and clinical behavior (1). The tumors variably result in different morbidity and mortality outcomes depending on the site, tumor grade and treatment given (1). The severity of brain tumors can be explained by the functional consequences of neuronal loss as the brain plays a vital role (2).Brain tumors have an annual incidence of 1.8% of all new cancer cases and mortality is 2.3% of all cancer deaths worldwide (3). The lowest distribution of brain tumors is in Africa and the highest incidence rates occur in North America, Western Europe and Australia (1).

The overall incidence of brain and central nervous system tumors was 2.2/100,000 and 1.9/100,000 in Kenya for males and females respectively for the period 2004-2008 and is still rising at a rapid rate (4). However, this is still lower than incidences seen in developed nations (5).The World Health Organization (WHO) in 2016 reclassified brain tumors based on molecular parameters in addition to histological characteristics of the tumor (6). This led to a major restructuring of the current existing entities and incorporation of new entities that were not present in its 2007 predecessor (6,7).

Gliomas account for more than 70% of brain tumors and of those, glioblastoma (GBM) is the most frequent histological type (8). Studies since the 1980's show that gliomas are the most common brain tumors followed by meningiomas despite five reclassifications and revisions by WHO of the classification of brain tumors (9–13). High-grade gliomas represent 60-75% of all cases and include

grade III anaplastic oligodendroglioma, mixed anaplastic oligoastrocytoma, and grade IV glioblastoma (3,13). The incidence of gliomas is between five to ten per 100,000 general population (2,14).

Males have a higher risk of brain and CNS tumors than females with the highest incidences occurring among adults 60 years and older; children 0-4 years old, and adolescents (1). Gliomas account for 70-80% of all brain and CNS malignancies in adults. The most common histological types in children are pilocyticastrocytomas, medulloblastomas, and germ cell tumors.

A description of the patterns and the changing trends in this region is lacking. In this paper, we describe the commonest histological patterns identified in this region, and the age and sex distribution of these patterns and thus provide a reference point for future predictions of disease trends in this region. An evaluation of the current trends is important in identifying new risk factors and improving current diagnostic methods. To clinicians this may assist in selecting appropriate sample sizes for their clinical studies and to public health officials this is a resource on which they can have empirical data to base resource allocation (15).

Methodology

The study data is taken from the Kenyatta National Hospital in Nairobi, Kenya, which is the largest teaching and referral hospital in East and Central Africa, with over 1800 beds. When tumors are excised, the resected material is sent to the Department of Pathology for histological analysis. The department identifies the tissue and then inputs the histological type and other details into a database that the department maintains. The database is routinely updated as new cases are added, and it is also being backdated to cover data dating back to 1967. The data is now available for a 12-year period from 2005 to 2016.

The permission to conduct the study was obtained from the Departments of Pathology and Surgery at the University of Nairobi. The key search word *brain* was entered into the database, and data for the above period was retrieved. The data was subsequently sorted, coded and entered into Statistical Packages for the Social Sciences (SPSS) Version 20 for analysis.

Results

Demographic data

During the study period, a total of 13,624 neoplasms were seen, and 792 (5.8 percent) individuals were diagnosed with brain tumors. The youngest patient with a brain tumor was 2 months old, and the oldest was 83 years old. The age group 6 to 10 years was the most prevalent to be diagnosed with a brain tumor, accounting for 9.6 percent, followed by the age group 41-45 years, accounting for 9.2 percent (Table 1). Females were more likely to be diagnosed with brain tumors. 461 of the 792 patients were female. This equates to 58.2% for females and 41.8% for males.

Histologic classification

Meningiomas were the most frequent tumor, accounting for 44.8% of all cases, followed by gliomas (glioblastoma, astrocytoma, ependymoma, and oligodendroglioma), which accounted for 34% of all cases (Table 2). Medulloblastomas made up 6.9% of the total, whereas primitive neuroectodermal tumors (PNET) comprised 3.4%. Brain metastases accounted for 3.0 percent of all tumors.

Comparison between Histologic type and gender

Female patients were three times more likely than male patients to be diagnosed with a meningioma. Other female-prevalent tumors included schwannoma, PNET, and teratoid/rhabdoid tumors. Glioblastoma, medulloblastoma, ependymoma, craniopharyngioma, oligodendroglioma, and hemangioblastoma were the most prevalent histological diagnosis among men. (Table 3).

Comparison between histologic type and age

Meningiomas were most common in people aged 41-45, followed by those aged 36-40.

Table 1: A table summarizing the prevalence of brain tumors in various age groups

Age group	n	Valid Percent
0-5	63	8.8
6-10	69	9.6
11-15	62	8.6
16-20	48	6.7
21-25	39	5.4
26-30	51	7.1
31-35	60	8.3
36-40	59	8.2
41-45	66	9.2
46-50	58	8.1
51-55	63	8.8
56-60	34	4.7
61-65	24	3.3
66-70	15	2.1
71-75	4	.6
76-80	3	.4
81-85	2	.3
Total*	720	100.0

*-72 missing records

Table 2: Frequencies of various histological diagnosis of brain tumors

Histologic type	n	%
Meningioma	355	44.8
Astrocytoma	139	17.6
Glioblastoma	103	13.0
Medulloblastoma	55	6.9
Craniopharyngioma	30	3.8
PNET	27	3.4
Bran metastases	24	3.0
Schwannoma	18	2.3
Ependymoma	17	2.1
Oligodendroglioma	10	1.3
Hemangioblastoma	6	.8
Hemangiopericytoma	2	.3
Teratoid/rhabdoid tumor	2	.3
Pineal Tumor	1	.1
Malignant melanoma	1	.1
Neurocytoma	1	.1
Osteogenic sarcoma	1	.1
Total	792	100.0

Among the 305 meningioma patients, 208 (68.2%) were between the ages of 30 and 50. Glioblastoma was most frequently diagnosed between the ages of 51 and 55. Two of the glioblastoma patients were younger than five years old, while one was older than 81 years old. Astrocytomas were the most prevalent tumors in children under the age of five, accounting for 40% of all tumors. The majority of metastatic cancers appeared after the age of 45. The majority of craniopharyngiomas were discovered before the age of 25, with only two cases diagnosed after the age of 50.

Table 3: Comparison between histologic type and gender

Histological diagnosis	Gender		Total
	Male	Female	
Glioblastoma	63	40	103
Meningioma	81	274	355
Medulloblastoma	32	23	55
Schwannoma	7	11	18
Astrocytoma	75	64	139
Ependymoma	12	5	17
PNET	12	15	27
Craniopharyngioma	19	11	30
Hemangiopericytoma	1	1	2
Metastatic Cancer	16	8	24
Oligodendroglioma	7	3	10
Pineal Tumor	0	1	1
Hemangioblastoma	4	2	6
Teratoid/rhabdoid tumor	0	2	2
Malignant melanoma	1	0	1
Neurocytoma	0	1	1
Osteogenic sarcoma	1	0	1
Total	331	461	792

Discussion

The prevalence of brain tumors is increasing. In the United States two decades ago, the average annual rate of newly diagnosed primary brain tumors was 14.4 per 100,000 people. In the 1970s, the male incidence rate for malignant brain tumors was 5.9 per 100,000, while the female incidence rate was 4.1 per 100,000.

In 2003, these figures grew to 7.0 per 100,000 men and 5.2 per 100,000 women(9). These figures are comparable to the incidence rates in Kenya, which were 2.2/100,000 for males and 1.9/100,000 for females from 2004 to 2008(4). The magnitude of brain tumors varies greatly over the world, with a 5-fold difference between the highest rates in Europe and the lowest rates in Asia(16). Thus, while the prevalence of brain tumors in Africa is lower than in developed areas (North America, Europe, New Zealand, and Australia), it is fast increasing(17). This is similar for other non-caucasian races when compared to Caucasians (18).The low prevalence in of brain tumors in developing nations may be due in part to underestimation, but it is expected to rise as diagnostic tools advance in these areas.

Mwangombe et al. found only 214 histologically confirmed malignancies at the Kenyatta National Hospital between 1984 and 1993.(19). The current study spans 12 years and includes 792 tumors seen at the same facility, indicating that the occurrence of brain tumors is on the rise. Gliomas were the most prevalent histological type of brain tumor, accounting for 45.8% of all cases between 1984 and 1993, followed by meningiomas (34.4%). Meningiomas are now the most common tumor, accounting for 44.8% of all cases, followed by gliomas, which account for 34%. In the study of Mwangombe et al., the male to female ratio in the presentation of brain tumors was 1.4:1.(19). In this study, more females presented with brain tumors than their male counterparts at 58.2%.

When compared to other studies of brain tumor epidemiology around the world, this study demonstrates that, while gliomas are the most common histological kind of brain tumor elsewhere, meningiomas are the most common in this Kenyan single center study. This is unusual, and the change has occurred over time, as a prior study by Mwangombe et al found that gliomas were the most common. This feature is also similar for sex distribution of brain tumors in this study. The data from this study is similar to findings in the CBTRUS (Central Brain Tumor Registry of the United States) Statistical Report: Primary Brain and Central Nervous System Tumors Diagnosed in the United States in 2007-2011 whose findings indicate that meningiomas are the commonest tumors at 36.1% and followed by glioblastoma at 15.4%. Females are also more commonly affected than males 58% versus males at 42% (20). This prevalence is similar to the one in the current study.

Recent studies conducted on patients within sub-Saharan Africa reveal that meningiomas may be the most common intracranial neoplasms. Studies by Idowuet. al in Ibadan, Idowu and Apeyime in Lagos and Ibebuike et. al reveal that meningiomas account for 30-35% of brain tumors and points out that they were the most common intracranial neoplasms in their settings(21–23). Studies in Singapore and Japan also showed that meningiomas ranked among the highest symptomatic brain tumors in their region (21,24,25).

Medulloblastoma is the most common malignant paediatric brain tumor (26). It is most common in the posterior fossa in children and occurs more commonly in males. This is similar to our findings, in which 32 male patients were diagnosed with craniopharyngioma compared to 23 female cases. Craniopharyngiomas are the most prevalent type of nonneuroepithelial tumor in children, with a significant recurrence rate following first treatment (27-29). They were detected in 3.8% of the patients in this study, and 83% of these tumors were found in individuals under the age of 25. Craniopharyngioma was also discovered in two patients in the 51-55 age range. In this study, 77.4% of craniopharyngiomas and 66.7 percent of medulloblastomas were found in children under the age of 15.

Primitive neuroectodermal tumors (PNET) refer to an assemblage of tumors that occur principally in children and adolescents. They show poor differentiation phenotypically and may show divergent differentiation along neuronal, astrocytic and ependymal lines(7).

They show similar features to medulloblastomas however are differentiated by the side of the tentorium on which they occur. In our study, they accounted for 3.4% and 92% of them were found below age 25.

Other tumors histologically identified included; hemangiopericytoma, pineal tumor, hemangioblastoma, teratoid/rhabdoid tumor, malignant melanoma, neurocytoma, and osteogenic sarcoma which all showed prevalences of less than 1% in this current study. This illustrates that these tumors occur in this region, albeit rarely and may increase in incidence and it is essential that clinicians are aware of them.

Metastatic tumors accounted for 3.0% of the brain tumors in the study period. Thyroid, breast, prostate, and colonic tissues were the origins of metastatic cancers. Non-small cell lung cancers (NSCLC), breast cancer, and melanoma are all known to cause brain metastases (30). Surgery and radiotherapy are currently used for treatment; however, these offer modest benefits and systemic therapies are being incorporated so as to get better outcomes (30).

The limitations of this study included; some data was missing from the database and the outcomes of the tumors post resection could not be accessed. It is hoped that the database will become more robust over time with further revisions. It is recommended that the outcome post resection is included in future entries in the database so as to increase the impact of the data available.

Conclusion

The epidemiology of brain tumors is varied worldwide with different localities exhibiting their own unique occurrences in the epidemiology of brain tumors. As shown, there are changing trends in the frequency of presentation of the histological type of brain tumors and age and sex distribution in this region. This study has shown that less common tumors previously have become more common currently and more efforts need to be focused on finding the root cause of these changes.

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References

1. Piñeros M, Sierra MS, Izarzugaza MI, Forman D. Descriptive epidemiology of brain and central nervous system cancers in Central and South America. Cancer Epidemiol. 2016 Sep;44:S141–9.
2. Behin A, Hoang-Xuan K, Carpentier AF, Delattre J-Y. Primary brain tumours in adults. The Lancet. 2003;361(9354):323–331.
3. Barciszewska A-M. MicroRNAs as efficient biomarkers in high-grade gliomas. Folia Neuropathol. 2016 Dec 27;369–74.
4. Korir A, Okerosi N, Parkin M. Nairobi Cancer Registry Report 2004- 2008 [Internet]. 2014 [cited 2016 Jul 7]. Available from: http://afcrn.org/attachments/article/85/Nairobi%20CR%20Report%202004-8.pdf

5. Bondy ML, Scheurer ME, Malmer B, Barnholtz-Sloan JS, Davis FG, Il'yasova D, et al. Brain Tumor Epidemiology: Consensus from the Brain Tumor Epidemiology Consortium (BTEC). Cancer. 2008 Oct 1;113(7 Suppl):1953–68.
6. Louis DN, Perry A, Reifenberger G, von Deimling A, Figarella-Branger D, Cavenee WK, et al. The 2016 World Health Organization Classification of Tumors of the Central Nervous System: a summary. Acta Neuropathol (Berl). 2016 Jun;131(6):803–20.
7. Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, Burger PC, Jouvet A, et al. The 2007 WHO Classification of Tumours of the Central Nervous System. Acta Neuropathol (Berl). 2007 Aug;114(2):97–109.
8. Ohgaki H. Epidemiology of Brain Tumors. In: Verma M, editor. Cancer Epidemiology [Internet]. Humana Press; 2009 [cited 2017 Mar 6]. p. 323–42. (Methods in Molecular Biology). Available from: http://dx.doi.org/10.1007/978-1-60327-492-0_14
9. Fisher JL, Schwartzbaum JA, Wrensch M, Wiemels JL. Epidemiology of Brain Tumors. Neurol Clin. 2007 Nov;25(4):867–90.
10. El-Zein R, Bondy M, Wrensch M. Epidemiology of Brain Tumors. In: DSc FA-O, editor. Brain Tumors [Internet]. Humana Press; 2005 [cited 2017 Mar 6]. p. 3–18. (Contemporary Cancer Research). Available from: http://link.springer.com/chapter/10.1385/1-59259-843-9%3A003
11. Ae W, M R, Fd W. Epidemiology of brain tumors: the national survey of intracranial neoplasms. Neurology. 1985 Feb;35(2):219–26.
12. Scheithauer BW. Development of the WHO Classification of Tumors of the Central Nervous System: A Historical Perspective. Brain Pathol. 2009 Oct 1;19(4):551–64.
13. Pereira MS, Klamt F, Thomé CC, Worm PV, de Oliveira DL. Metabotropic glutamate receptors as a new therapeutic target for malignant gliomas. Oncotarget [Internet]. 2017 [cited 2017 Mar 8]; Available from: https://www.ncbi.nlm.nih.gov/pubmed/28212543
14. Hanif F, Muzaffar K, Perveen K, Malhi SM, Simjee SU. Glioblastoma Multiforme: A Review of its Epidemiology and Pathogenesis through Clinical Presentation and Treatment. Asian Pac J Cancer Prev APJCP. 2017 01;18(1):3–9.
15. Deorah S, Lynch CF, Sibenaller ZA, Ryken TC. Trends in brain cancer incidence and survival in the United States: Surveillance, Epidemiology, and End Results Program, 1973 to 2001. Neurosurg Focus. 2006;20(4):E1.
16. Miranda-Filho A, Piñeros M, Soerjomataram I, Deltour I, Bray F. Cancers of the brain and CNS: global patterns and trends in incidence. Neuro-Oncol. 2017 Feb 1;19(2):270–80.
17. Parkin DM, Bray F, Ferlay J, Pisani P. Global Cancer Statistics, 2002. CA Cancer J Clin. 2005 Mar 1;55(2):74–108.
18. Darefsky AS, Dubrow R. International variation in the incidence of adult primary malignant neoplasms of the brain and central nervous system. Cancer Causes Control. 2009 Nov 1;20(9):1593–604.
19. Mwang'ombe NJ, Ombachi RB. Brain tumours at the Kenyatta National Hospital, Nairobi. East Afr Med J. 2000;77(8):444–447.
20. Ostrom QT, Gittleman H, Farah P, Ondracek A, Chen Y, Wolinsky Y, et al. CBTRUS Statistical Report: Primary Brain and Central Nervous System Tumors Diagnosed in the United States in 2006-2010. Neuro-Oncol. 2013 Nov;15(Suppl 2):ii1-ii56.
21. Ibebuike K, Ouma J, Gopal R. Meningiomas among intracranial neoplasms in Johannesburg, South. Afr Health Sci. 2013 Mar;13(1):118–21.
22. IDOWU O, Akang EEU, MALOMO A. Symptomatic primary intracranial neoplasms in Nigeria, West Africa. J Neurol Sci Turk. 2007;24(3):212–218.
23. Idowu OE, Apemiye RA. Delay in presentation and diagnosis of adult primary intracranial neoplasms in a tropical teaching hospital: A pilot study. Int J Surg. 2009;7(4):396–8.
24. Das A, Chapman C, Yap W. Histological subtypes of symptomatic central nervous system tumours in Singapore. J Neurol Neurosurg Psychiatry. 2000 Mar;68(3):372–4.
25. Nakamura H, Makino K, Yano S, Kuratsu J-I, Kumamoto Brain Tumor Research Group. Epidemiological study of primary intracranial tumors: a regional survey in Kumamoto prefecture in southern Japan--20-year study. Int J Clin Oncol. 2011 Aug;16(4):314–21.
26. Northcott PA, Korshunov A, Witt H, Hielscher T, Eberhart CG, Mack S, et al. Medulloblastoma Comprises Four Distinct Molecular Variants. J Clin Oncol. 2011 Apr 10;29(11):1408–14.
27. Lubuulwa J, Lei T. Pathological and Topographical Classification of Craniopharyngiomas: A Literature Review. J Neurol Surg Rep. 2016 Jul;77(3):e121–7.
28. Bao Y, Qiu B, Qi S, Pan J, Lu Y, Peng J. Influence of previous treatments on repeat surgery for recurrent craniopharyngiomas in children. Childs Nerv Syst. 2016 Mar 1;32(3):485–91.
29. Clark SW, Kenning TJ, Evans JJ. Recurrent ectopic craniopharyngioma in the Sylvian fissure thirty years after resection through a pterional approach: A case report and review of the literature. Nagoya J Med Sci. 2015 Feb;77(1–2):297–306.
30. Chamberlain MC, Baik CS, Gadi VK, Bhatia S, Chow LQM. Systemic therapy of brain metastases: non–small cell lung cancer, breast cancer, and melanoma. Neuro-Oncol. 2017 Jan 1;19(1):i1–24.