

Anatomic locations in high grade glioma

A. Oslobanu¹, St.I. Florian²

University of Medicine and Pharmacy, "Iuliu Hatieganu" Cluj-Napoca

¹Assistant Professor in Neurosurgery, ²Professor in Neurosurgery

Abstract: The treatment options and prognosis in gliomas could be determined by anatomic topographic location, beside different subtypes of glioma. The aim of this study is to find if any correlation between anatomical location of a glioma and the different subtypes of high grade glioma exist, and if this differences exists, does this influence the treatment options in terms of surgery. To do this, a representative group of 318 adults with high grade glioma was used. The most frequent subtypes of high grade glioma were glioblastoma (76,1%) followed by anaplastic astrocytomas (19,1%), anaplastic oligodendrogliomas (2,2), anaplastic ependymomas (1,2%), anaplastic oligoastrocytomas (0,9%), and anaplastic oligoastrocyomas (0,3%). The most frequent locations of gliomas were in the right frontal lobe in 11,95% of the cases, followed by left frontal in 9,12%, left temporal in 9,12%, right parietal in 8,18%, left parietal in 6,60%, right temporal in 5,66% for one lobe location. For multiple lobe locations the left fronto-parietal and left temporo-parietal (5,03%) were the most frequent locations. Deep-seated locations were present in 1,56% of the cases, and brain stem location was in 3,46%. No significant difference was observed between left or right predominance. Regarding the results among different subtypes of high grade glioma we noted that the anaplastic astrocytomas were more frequently located at the right frontal lobe in 18,03% compare to left frontal and left parietal lobe in 9,83%. In glioblastoma we found no significant differences in anatomical location as seen in anaplastic astrocytomas. These data results from our study could affect the therapeutic strategy regarding the extent of tumors resection.

Key words: brain tumors, location, high grade glioma, imaging.

Introduction

Incidence of glioma increased during the last 3-4 decades, and is around 5/100 000. They can develop at all ages, but the incidence is higher in the 5th and 6th decades of life. Few several causes could explain this increase in incidence, the advance in neuroimaging possibilities being one of them along with a better access to neurosurgical services. [1] According to the WHO high grade glioma comprises glioblastoma – grade IV, anaplastic astrocytoma – grade III, mixed anaplastic astrocytoma – grade III, and anaplastic

oligodendroglioma – grade III. [2] The tumor grade is considered to be the most important prognostic factor, and glioblastomas carrying the worst prognosis, oligodendroglioma tending to have the best outcome with higher response rates to chemotherapy and radiotherapy. Anaplastic astrocytoma and mixed anaplastic oligoastrocytoma have an intermediate prognosis between glioblastoma and anaplastic oligodendroglioma. [1]

Locations of the gliomas have an impact to the treatment options and prognosis but even that, a few large-scale study have been

published with detailed anatomic topographic locations of gliomas. [3]

Development of the gliomas in different lobes is believed to be relative to the volume of glial tissue, and revealing the differences in the anatomic location of gliomas could provide some details about gliomas etiology and pathogenesis. [4, 5, 6] For example, this can give clues in the role played by traumatic events or exposure to the electromagnetic radio-frequency fields from mobile phones to the development of gliomas. Also, another possible situation is related to the functional differences among cells and tissues in different areas of the brain, or the possibilities of the existence of physiologic stimuli to the adjacent glial tissue by anatomic structures in developing high grade gliomas. Some studies show the differences in the biologic characteristics in subsets of gliomas arising in different anatomic locations. [7, 8]

Using neuroradiological imaging we try to find some details about the possibilities of developing gliomas in specific anatomical locations.

Material and methods

All cases included in the study were from the database of Neurosurgical Clinic in Cluj-Napoca, and collecting the records of all patients diagnosed with high grade glioma during the period from January 2000 to December 2010. Inclusion criteria in the study were based on the age of the patient and surgical treatment. Those patients included in the study were required to be over 20 years, and all of them were treated by surgery. After surgical resection the Department of Pathology confirmed the diagnoses of high grade glioma for patients included in the study. The diagnosis of high grade glioma was made using the pathological criteria offered by WHO, and they were classified into the following subgroups: glioblastomas, anaplastic astrocytomas, anaplastic ependymomas, anaplastic oligoastrocytomas, and anaplastic oligodendrogliomas.

All patients or their family/relatives gave

their consent to enter the study, and their identity was not revealed during or after the study.

The topographic anatomic location of the glioma was specified using neuroradiologic imaging and the neuroradiologist indications.

For the age standardization the world standard population was used. [9]

The statistic analysis was done using the R project that provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering) and graphical techniques.

R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form.

To compare distribution of different histological subtypes, high grade gliomas were grouped in different categories: anaplastic astrocytomas, glioblastomas, anaplastic oligodendrogliomas, and anaplastic oligoastrocytomas.

Results

During the period of our study a number of 318 patients with high grade gliomas were diagnosed (Table I). The vast majority were glioblastomas with 76,10% of the cases. At a distance, on the second place was anaplastic astrocytomas in 19,18% cases, followed by anaplastic oligodendrogliomas (2,2%), anaplastic ependymomas (1,26%), anaplastic oligoastrocytomas (0,94%), and finally anaplastic oligodendroastrocytomas with 0,31% of the cases.

TABLE 1
Number and incidence of gliomas by histologic type

Pathology	No.	%
GBM	242.00	76.10
AA	61.00	19.18
ODGA	7.00	2.2
EA	4.00	1.26
OAA	3.00	0.94
ODAA	1.00	0.31

Over all, the most frequent locations of the high grade gliomas were in the cerebral lobes (Figure 1). Gliomas of the right frontal lobe in 11,95% of the cases, followed by left frontal in 9,12%, left temporal in 9,12%, right parietal in 8,18%, left parietal in 6,60%, right temporal in 5,66% for single lobe location. For multiple lobe locations the left fronto-parietal and left temporo-parietal (5,03%) were the most frequent locations. Deep-seated locations were present in 1,56% of the cases, and brain stem location was in 3,46%.

Lateralization of the gliomas showed a difference between right and left distribution with 47,16% of the case on the right, and 44,65% on the left. Location in the center of the brain (considered for locations at the corpus callosum, thalamus and lateral ventricles) was in 7,54% cases, and only in 2 cases it was situated bilateral in the frontal lobes, both of them being glioblastoma (Figure 2).

Between different lobes there were some

differences in tumor frequencies. For glioblastomas, the most frequent single lobe location was at the right frontal lobe in 26 cases (10,33%), followed by right parietal and left frontal lobe in 23 cases (9,5%). For the multiple lobes location the most frequent location was at the left temporo-parietal lobes in 14 cases (5,78%), right fronto-parietal lobes in 13 cases (5,37%), and left fronto-temporal lobes in 12 cases (4,95%)(Figure 3).

Anaplastic astrocytomas were most frequent located at the right frontal lobe in 11 cases (18,03%), followed by the left frontal, left parietal and left temporal lobes with 6 cases for each location (9,83%), and in multiple lobes location the left fronto-parietal lobes was the most frequent location with 6 cases (9,83%)(Figure 4). Involvement of the corpus callosum and bilateral frontal location was observed only in glioblastomas, but the location at the brain stem was more frequent for anaplastic astrocytomas then glioblastomas (5 vs. 3 cases).

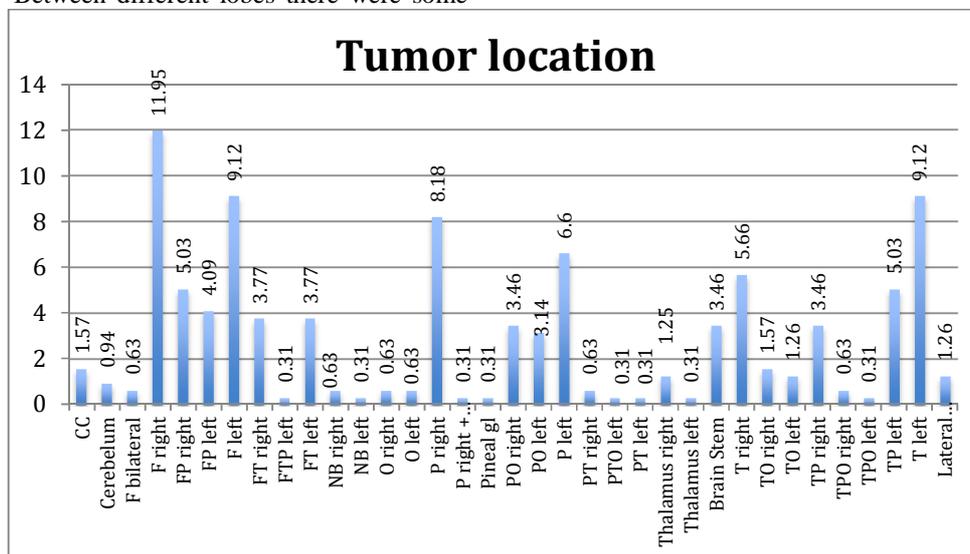


Figure 1 - Incidence by tumors location for high grade gliomas

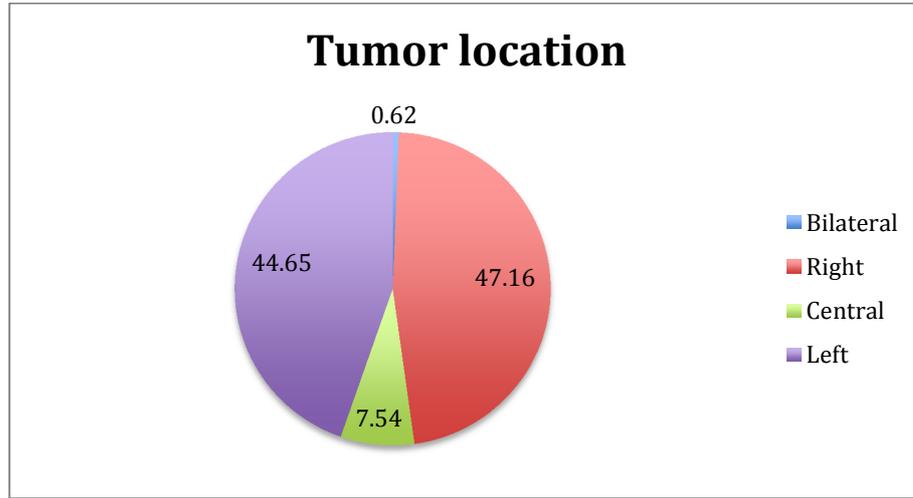


Figure 2 - Left-right tumor location for high grade gliomas

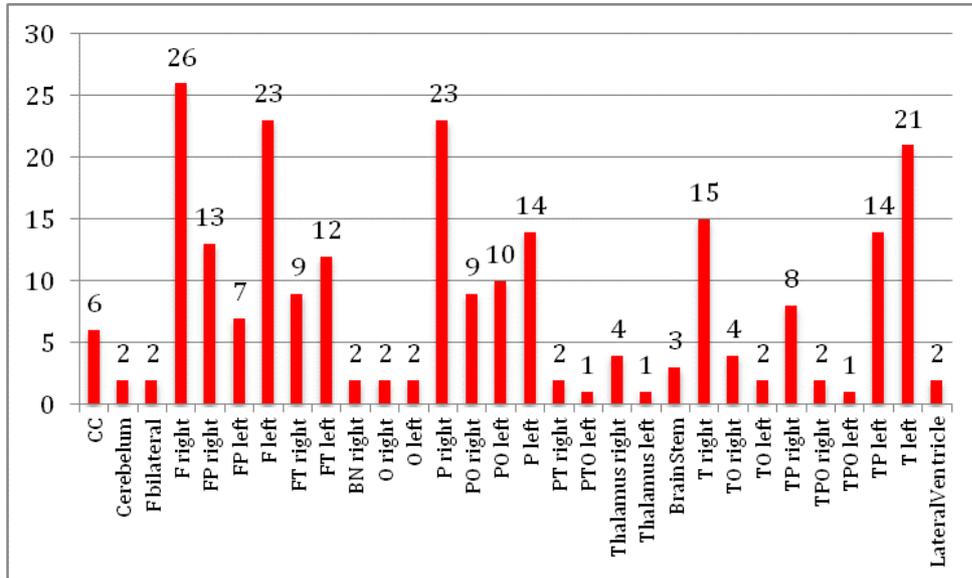


Figure 3 - Incidence by location in glioblastomas

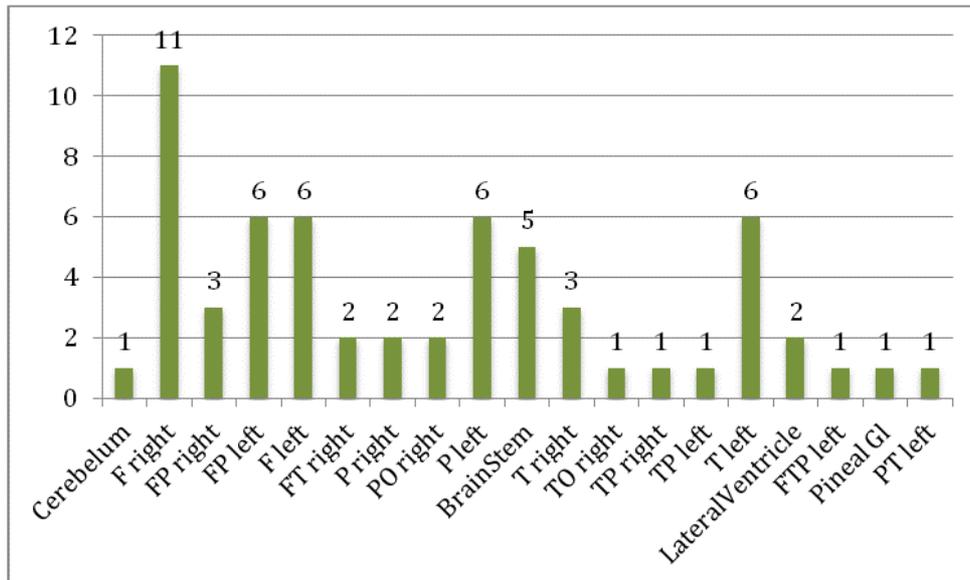


Figure 4 - Incidence by location in anaplastic astrocytomas

For the rest of the high grade gliomas there were no significant differences between locations in the cerebral lobes.

Discussion

According with the data presented in the Central Brain Tumor Registry of the United States, glioblastomas account for 51%, anaplastic astrocytomas for 8%, and oligodendrogliomas for 10% of all primary brain.[10] In our study, glioblastomas accounted for 76,10%, anaplastic astrocytomas for 19,18%, and oligodendrogliomas for 2,2% in high grade gliomas group.

The number of high grade gliomas was substantially higher for the frontal lobe (21%), but the frequency are even distributed between parietal and temporal lobes (14,78%) with no regards to the right or left locations.

At the frontal lobes the distributions of high grade gliomas shows a difference between right and left distribution with the

predominance for the right location (11,95%) compare to the left (9,12%).

At the other side, the occipital lobe was proved to be the location for high grade gliomas in only 0,63% of the cases.

A study made by Simpson et al. in 1993 found that 43% of glioblastomas were located in the frontal lobe, 28% in the temporal, 25% in the parietal, and 3% in the occipital lobe. [11] In our study, frontal location of glioblastomas was found in 20% of the cases, in the parietal and temporal lobes almost equally with 15%, and in the occipital lobe in 1% of the cases.

Bilateral occurrence of glioblastoma was found toward the frontal lobes, and the involvement more frequent on the right hemisphere as it has been reported in another study. [12, 13]

Anaplastic astrocytomas tend to have the same distribution in the cerebral lobes with the frontal lobe location in 28%, 14% in the temporal, 13% in the parietal lobe, and no pure

occipital location only by extension from adjacent areas.

The studies shows that tumors were distributed toward frontal subcortical areas. The subcortical areas contain the glial cells, whereas the cortical areas consist of gray material, and as gliomas develop from the glial cells, the difference between the cell types in separate areas partly could explain why tumors develop preferably from the subcortical sites.

Partly, involvement of developmental, neurochemical, or functional factors in the pathogenesis of gliomas could explain this nonuniform anatomical distribution of gliomas. In another study, allelic loss was commonly found in oligodendroglioma located in the same areas were was found the highest tumor frequency.[14] It also has been suggested that tumors located in different parts of the brain may arise from different precursor cells or involvement of structural and functional differences between different brain regions, including energy metabolism, architectonic arrangements of the tissues, and interaction between neuronal and glial cells, has been postulated.[15]

A slightly overestimated regarding the frequency of gliomas in some lobes is possible, because tumors in unspecific or deep brain location could be coded into the lobes. But all these issues could not explain the differences between gliomas distribution on cerebral lobes.

The anatomical distribution of gliomas differs between adults and children. [16] In these regard findings of this study apply only for the gliomas in adults.

Conclusions

The results of this study indicate that gliomas arise mainly from the anterior subcortical structures of the brain, with special regards for frontal lobes, followed by parietal and temporal lobes, and minor involvement of the occipital lobes. The predominance in the frontal lobes could not be explained only by

tissue volume alone. A detailed analysis of a large case series will consolidate the knowledge about localization of gliomas, and will provide details about the development of gliomas.

Even more, details about development preferences of gliomas to different location of the brain will provide technical notes about surgical strategies in dealing with different types and/or subtypes of gliomas.

Correspondence

Dr. Aurel Oslobanu

Str. Victor Babes Nr.43, Cluj-Napoca, Romania

Tel-fax: 0040-264-450023

E-mail: oslobanu@yahoo.com

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