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Laterality of Brain Tumors

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Key Words

Brain cancer · Brain tumors · Laterality · Glioma · Meningioma · Acoustic neuroma · Epidemiology

Abstract

Tumor laterality was evaluated with respect to presenting symptoms and demographic factors among 489 adults with histologically confirmed glioma (354 high-grade, 135 low-grade), 197 with meningioma, and 96 with acoustic neuroma. The ratio of left-sided to right-sided tumors did not differ significantly from 1.00 for any of the major tumor types. Low-grade glioma and meningioma occurred nonsignificantly more often on the left side, whereas high-grade glioma and acoustic neuroma occurred nonsignificantly more often on the right side. Aphasia or mental status changes were significantly more common among glioma patients with tumors on the left side than among those with tumors on the right side. Associations between tumor laterality and symptoms may influence the probability or timing of diagnosis, possibly differentially by marital status.

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Introduction

The epidemiologic literature concerning intracranial tumors of the brain and nervous system is largely silent on the matter of tumor laterality. Brain tumor laterality has recently received attention in the context of concerns about possible hazards associated with the use of hand-held cellular phones, with attention focusing on whether tumors among cellular phone users occur disproportionately often on the side of the head on which the phone handset is used [1–3]. The preponderance of evidence to date does not indicate such an association. Otherwise, laterality has not been reported in most epidemiologic studies, and published information about the relative frequencies of left- and right-sided tumors is largely confined to small clinical series. The Surveillance, Epidemiology and End Results database [4] includes information about laterality for high percentages of cancers of selected paired organs, such as the breast [5] and ovary [6], but not for brain cancer, and it does not include data for benign tumors of the nervous system at all.

Structural and functional differences between the left and right sides of the brain are well known [7–11]. For example, the right cerebral cortex was reported to be slightly (1.3%), but significantly, larger than the left cerebral cortex [12], and the amount of gray matter relative to white matter was found to be greater in the left hemi-

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sphere [13, 14]. The left hemisphere generally appears to be more important for language, speech and verbal memory, whereas the right hemisphere is more involved in visual-spatial perception [7, 15–18]. Handedness is a familiar manifestation of brain asymmetry.

Whether hemispheric asymmetries or the developmental processes that give rise to them are related to the risk of brain tumors is unknown and largely unstudied [10]. Even if such asymmetries prove to be of little relevance to the etiology of brain tumors, they might be related to the detection of tumors, as correlations have been reported between the location of brain lesions and specific functional deficits [7, 18–20]. The objective of this paper is to describe patterns of tumor laterality overall and according to demographic factors and presenting symptoms for cases of glioma, meningioma and acoustic neuroma enrolled in a case-control study [3, 21].

Methods

Cases of glioma and other neuroepitheliomatous tumors, meningioma and acoustic neuroma (ICD-O-2 morphology codes 9380-9473, 9490–9506, 9530–9538, 9560) [22] were enrolled between June of 1994 and August of 1998 at three hospitals in the United States: St. Joseph's Hospital in Phoenix, Ariz., Brigham and Women's Hospital in Boston, Mass., and Western Pennsylvania Hospital in Pittsburgh, Pa. Eligibility criteria included age ≥ 18 years, microscopic confirmation (glioma and meningioma) or radiological diagnosis (acoustic neuroma), diagnosis within the 8 weeks preceding the index hospital admission or visit, residence within 50 miles of the hospital at the time of diagnosis (or within the state of Arizona) and the ability to understand English. (All but 4 of the acoustic neuroma cases were histologically confirmed.) Ninety-two percent of eligible cases who were asked to participate agreed to do so. Apart from refusals, the case group represented an unselected and nearly consecutive series. Information on tumor location and size (maximum linear dimension) was abstracted from radiological (MRI and CT) and surgical reports. Information about tumor-related symptoms was obtained from hospital charts.

Information about education, marital status and handedness was collected through a standardized personal interview by a trained nurse interviewer. Most interviews were conducted directly with the patient, but death or disability necessitated proxy interviews for 16, 7 and 3% of glioma, meningioma and acoustic neuroma cases, respectively.

Tests for differences in proportions of left- and right-sided tumors were based on exact calculations using the binomial distribution with $p = 0.5$, after excluding tumors not assignable to one side or the other. Unconditional logistic regression (SAS Release 6.12, Proc Logistic) [23] was used to evaluate associations between tumor laterality and sex, age at diagnosis, marital status at diagnosis, education, income, hospital, handedness, and presenting symptoms. Least squares regression (SAS Proc Reg) [23] was used to estimate and test for differences in mean age at diagnosis and tumor size between left- and right-sided tumors. Tests and 95% confidence intervals for mean differences were calculated based on the t-distribution. All significance tests were two-sided ($\alpha = 0.05$).

For the analyses presented here, glioblastoma, anaplastic astrocytoma, other anaplastic gliomas and embryonal neuroepithelial tumors (medulloblastoma, primitive neuroectodermal tumors, neuroblastoma, astroblastoma) were classified as high-grade glioma and other gliomas as low-grade glioma [24, 25].

Results

A total of 489 cases of glioma and other neuroepithelial tumors (354 high-grade, 135 low-grade), 197 cases of meningioma and 96 cases of acoustic neuroma were included in the study. There were nearly equal numbers of low-grade glioma among men and women (67 versus 68), but a substantially greater number of high-grade tumors among men (210 versus 144; $p = 0.05$; table 1). Male:female ratios were 1.5 for high-grade glioma, 1.0 for low-grade glioma, 1.3 for all gliomas combined, 0.3 for meningioma, and 0.6 for acoustic neuroma. The proportion of gliomas that were of high grade increased sharply with age for both sexes. The average age at diagnosis was 57 years for high-grade glioma, 38 years for low-grade glioma, 55 years for meningioma and 52 years for acoustic neuroma.

Four hundred sixteen gliomas (85%), 169 meningiomas (86%) and 92 acoustic neuromas (96%) were assignable to one side of the brain or the other (table 1). Only cortical gliomas are classified by laterality in table 1. Gliomas involving the cerebellum, brain stem or ventricles are grouped in the 'other' category. Most of the gliomas that involved both hemispheres were bifrontal ('butterfly') gliomas. The four bilateral acoustic neuromas occurred in association with neurofibromatosis and appeared to represent multifocal tumors. The ratio of left- to right-sided gliomas (L:R) of all types combined was 0.99 (table 1). Low-grade glioma occurred nonsignificantly more often on the left side, and high-grade glioma occurred nonsignificantly more often on the right side, but this difference by grade was not significant ($p = 0.34$). A small, left-sided predominance was observed for meningioma, and a right-sided predominance for acoustic neuroma. Tumors of all types combined occurred slightly more often on the right side (50.8%) than on the left side (49.2%).

More than 70% of the gliomas were astrocytic tumors, and most of the other gliomas of specified type were oligodendroglioma (11%) or mixed glioma (mostly oligoastrocytoma) (6%) (table 2). L:R did not differ significantly from 1.00 for any subtype of glioma, but there was a marked, and significant, left-sided predominance of glioma of unspecified type (L:R = 12).

Table 1. Laterality of intracranial tumors of the nervous system, by histopathologic type and sex

Type of tumor	Sex	Number					L:R	p value[2]
		left	right	both	other[1]	total		
Glioma								
High-grade	female	62	62	10	10	144	1.00	1.00
	male	87	97	14	12	210	0.90	0.46
	total	149	159	24	22	354	0.94	0.57
Low-grade	female	27	23	1	17	68	1.17	0.58
	male	31	27	3	6	67	1.15	0.60
	total	58	50	4	23	135	1.16	0.44
Total	female	89	85	11	27	212	1.05	0.76
	male	118	124	17	18	277	0.95	0.70
	total	207	209	28	45	489	0.99	0.92
Meningioma	female	68	62	15	6	151	1.10	0.60
	male	20	19	6	1	46	1.05	0.87
	total	88	81	21	7	197	1.09	0.59
Acoustic neuroma	female	22	36	2	0	60	0.61	0.07
	male	16	18	2	0	36	0.89	0.74
	total	38	54	4	0	96	0.70	0.10
Total	female	179	183	28	33	423	0.98	0.83
	male	154	161	25	19	359	0.96	0.69
	total	333	344	53	52	782	0.97	0.67

[1] Includes centrally (medially)-located tumors (tumors of the cerebellum, brain stem, and ventricles), plus tumors of unknown laterality, of which there was one meningioma.
[2] Two-sided p value (mid p), based on binomial distribution with equal probability (p = 0.5) for left- and right-sided tumors, and number of 'trials' = number of left-sided tumors plus number of right-sided tumors.

Table 2. Laterality of intracranial gliomas, by histopathologic type

Histopathologic type	Number					L:R	p value[a]
	left	right	both	other	total		
Glioblastoma and gliosarcoma	99	114	17	11	241	0.87	0.31
Anaplastic astrocytoma	28	32	6	4	70	0.88	0.61
Other astrocytoma	13	13	0	8	34	1.00	1.00
Oligodendroglioma	23	21	2	0	46	1.10	0.77
Anaplastic oligodendroglioma	4	5	0	0	9	0.80	0.75
Mixed glioma[b]	16	13	1	0	30	1.23	0.58
Ganglioglioma[c]	9	7	0	2	18	1.29	0.63
Glioma of other specified type[d]	1	2	1	14	18	0.50	0.63
Embryonal tumors	4	3	2	0	9	1.33	0.73
Glioma, not otherwise specified	12[e]	1	0	1	14	12.0	0.00

[a] Two-sided p value (mid p), based on binomial distribution with equal probability (p = 0.5) for left- and right-sided tumors, and number of 'trials' = number of left-sided tumors plus number of right-sided tumors.
[b] Includes 14 low-grade tumors and 16 high-grade tumors.
[c] Includes 17 low-grade tumors and 1 high-grade tumor.
[d] Includes 7 ependymomas, 3 anaplastic ependymomas, 3 subependymomas, 4 neurocytomas, and 1 neuroepithelioma.
[e] Of the 12 left-sided gliomas of unspecified type, 7 were low-grade and 5 high-grade, 6 were from the Boston center, 7 were in males, and 8 were married. The median age at diagnosis was 44 years.

Table 3. Laterality of glioma, meningioma and acoustic neuroma, by sex, age, marital status and handedness

	Glioma				Meningioma		Acoustic neuroma	
	high-grade		low-grade					
	L	R	L	R	L	R	L	R
Total	149	159	58	50	88	81	38	54
Sex								
Male	87	97	31	27	20	19	16	18
Female	62	62	27	23	68	62	22	36
	p = 0.61[a]		p = 0.92[a]		p = 0.72[a]		p = 0.32[a]	
Age at diagnosis								
18–44 years	28	31	47	35	25	14	13	18
45–59 years	50	48	9	9	36	29	12	21
≥60 years	71	80	2	6	27	38	13	15
	p = 0.52[b]		p = 0.09[b]		p = 0.11[b]		p = 0.73[b]	
Marital status at diagnosis								
Married	106	118	43	32	68	52	23	38
Not married	43	41	15	18	20	29	15	16
	p = 0.72[a]		p = 0.08[a]		p = 0.14[a]		p = 0.26[a]	
Handedness								
Left	13	13	4	3	6	4	4	8
Right	130	141	53	43	74	72	31	46
Either	6	5	1	4	8	5	3	0
	p = 0.89[a]		p = 0.30[a]		p = 0.58[a]		p = 0.62[a]	

Tumors involving both left (L) and right (R) hemispheres or neither cortical hemisphere are excluded.

[a] p value for test of heterogeneity in the proportion of left-sided tumors, adjusted for age at diagnosis, sex and marital status.

[b] p value for test of trend in the proportion of left-sided tumors, adjusted for age at diagnosis, sex and marital status.

No significant associations were observed between tumor laterality and sex, although acoustic neuromas occurred relatively more often on the right side among women than among men (table 3). The proportion of right-sided tumors increased with age for glioma and meningioma. The trend was not significant for glioma or meningioma individually, but it was when these two categories of brain tumor were combined ($p = 0.02$). Laterality of meningioma and of low-grade glioma were associated with marital status at the time of diagnosis, though not significantly; left-sided tumors were relatively more common among married persons and right-sided tumors were relatively more common among unmarried persons. High-grade glioma did not show the same pattern. For meningioma, the association with marital status was similar for males and females, whereas, for low-grade glioma, it was more pronounced for males than females (data not shown). The association with marital status was in the opposite direction for acoustic neuroma; that is, married cases more often had right-sided tumors. Associations with handedness were not significant, but there were few non-right-handed cases (table 3).

The median duration of tumor-related symptoms prior to histological diagnosis was 1 month for high-grade glioma (mean, 1.9 months), 1 month for low-grade glioma (mean, 11.6 months), 2 months for meningioma (mean, 7.6 months) and 6 months for acoustic neuroma (mean, 13.4 months).

Symptoms at or shortly prior to tumor diagnosis, as determined from medical records, varied among the different types of tumor (table 4). Aphasia and mental status changes were most common among patients with high-grade glioma, whereas history of seizure was relatively more common among patients with low-grade glioma. A history of headache was reported in similar proportions of high- and low-grade glioma patients. A wider variety of

Table 4. Prevalence of selected symptoms at, or shortly before, the time of tumor diagnosis

	Prevalence[1], %			
	glioma		meningioma	acoustic neuroma
	high-grade	low-grade		
Aphasia or mental status changes[2]	37.0	11.9	16.8	1.0
Headache	26.8	26.7	32.0	7.3
Seizure(s)	20.9	48.5	18.3	0.0
Weakness, hemiparesis, numbness	17.9	2.8	0.0	12.0
Ataxia	9.3	11.9	12.7	21.9
Nausea	5.1	7.4	1.5	3.1
Impaired hearing, tinnitus	3.7	4.4	14.2	80.2
Impaired vision	8.5	8.2	18.8	2.1
Olfactory disturbances	1.1	0.7	3.1	0.0

1 Based on all cases.
2 Includes aphasia, confusion, impaired memory and personality change.

symptoms was reported by meningioma patients. Usual symptoms among acoustic neuroma cases related to hearing or balance disorders.

Aphasia and mental status changes were decidedly more common among glioma patients with left-sided tumors (table 5), whereas headache and visual impairment were nonsignificantly more common in patients with right-sided gliomas. Seizures and weakness were not significantly associated with laterality. Among acoustic neuroma patients, hearing impairment and ataxia were predictive of left-sided tumors. None of the symptoms considered was strongly associated with laterality of meningiomas.

Because of the possibility that ascertainment of symptoms was incomplete, owing to variable recording in the sections of the hospital charts examined, we repeated the preceding analysis including only those patients for whom at least one of the listed symptoms was noted. This had the effect of strengthening the observed associations. Associations with laterality of high-grade gliomas became significant for headache ($p = 0.04$) and nausea ($p = 0.04$) and nearly so for visual impairment ($p = 0.06$). The association with aphasia or mental status changes became significant for low-grade glioma ($p = 0.04$).

Among meningioma and low-grade glioma cases who were married at the time of diagnosis, the average age at diagnosis was 5–6 years younger for patients with left-sided tumors than for those with right-sided tumors, whereas, among unmarried persons, the mean age at diagnosis was similar for left- and right-sided tumors (table 6). High-grade glioma showed an opposite pattern: no appreciable difference in age at diagnosis by laterality among married persons, but a nonsignificantly earlier age for left-sided tumors among unmarried persons. Among unmarried persons, right-sided acoustic neuromas were diagnosed an average of 7.7 years earlier than left-sided tumors, but the difference was not significantly different from zero.

Quantitative information on tumor size was available from imaging reports for just 58% of the unilateral cases. The mean tumor diameter was significantly smaller for left-sided than right-sided high-grade glioma, but there was little or no difference in size by laterality for low-grade glioma, meningioma or acoustic neuroma (table 7). Thus, left-right differences in tumor size by marital status (table 7) did not parallel the patterns for age at diagnosis by marital status (table 6).

Discussion

There was no significant difference in the proportions of left- and right-sided gliomas, meningiomas or acoustic neuromas in the case series as a whole. High-grade glioma and acoustic neuroma occurred nonsignificantly more often on the right side, whereas low-grade glioma and meningioma occurred nonsignificantly more often on the left side. In this sense, the findings are not particularly remarkable, but still instructive, given the extremely limited information about tumor laterality available in the literature.

Table 5. Odds ratios (OR) and 95% confidence intervals (CI) for associations between laterality of tumor and history of symptoms at presentation

	Glioma high-grade L	Glioma high-grade R	Glioma low-grade L	Glioma low-grade R	Meningioma L	Meningioma R	Acoustic neuroma L	Acoustic neuroma R
Aphasia or mental status changes								
Yes	77	35	12	4	16	13	0	1
No	72	124	46	56	72	68	38	53
	OR = 3.8 (CI: 2.3–6.3)		OR = 3.0 (CI: 1.0–11)		OR = 1.2 (CI: 0.5–2.6)		OR = 0.0 (CI: 0.0–8.3)	
Seizures								
Yes	37	36	34	31	17	15	0	0
No	112	123	24	18	71	66	38	54
	OR = 1.1 (CI: 0.7–1.9)		OR = 0.7 (CI: 0.4–1.2)		OR = 1.1 (CI: 0.5–2.3)		– –	
Headache								
Yes	34	50	9	13	29	24	1	5
No	115	109	49	37	59	57	37	49
	OR = 0.6 (CI: 0.4–1.1)		OR = 0.5 (CI: 0.2–1.3)		OR = 1.2 (CI: 0.6–2.3)		OR = 0.3 (CI: 0.0–1.7)	
Weakness, hemiparesis, or numbness								
Yes	24	31	1	2	0	0	5	6
No	125	128	57	48	88	81	33	48
	OR = 0.8 (CI: 0.4–1.4)		OR = 0.4 (CI: 0.0–4.5)		– –		OR = 1.2 (CI: 0.3–4.3)	
Ataxia/balance disorder								
Yes	13	11	3	5	10	11	11	10
No	136	148	55	45	78	70	27	44
	OR = 1.3 (CI: 0.6–3.0)		OR = 0.5 (CI: 0.1–2.1)		OR = 0.8 (CI: 0.3–2.0)		OR = 1.8 (CI: 0.4–4.9)	
Hearing impairment								
Yes	4	5	3	3	12	13	34	40
No	145	154	55	47	76	68	4	14
	OR = 0.9 (CI: 0.2–3.3)		OR = 0.9 (CI: 0.2–4.8)		OR = 0.8 (CI: 0.3–1.9)		OR = 3.0 (CI: 1.0–11)	
Visual impairment								
Yes	7	16	1	3	18	13	1	1
No	142	143	57	47	70	68	37	53
	OR = 0.4 (CI: 0.2–1.1)		OR = 0.3 (CI: 0.0–2.2)		OR = 1.3 (CI: 0.6–3.0)		OR = 1.4 (CI: 0.1–37)	

An OR >1.0 indicates that the prevalence of the symptom was greater among patients with left-sided tumors, and an OR <1.0 indicates that the prevalence was greater for right-sided tumors.

There is limited evidence from other case series pointing to a right-sided excess of glioma and brain tumors overall, and a left-sided excess of meningioma. In a large, nationwide survey concerning patterns of care for brain tumor patients, Mahaley et al. [27] documented a significant right-sided predominance for supratentorial primary brain tumors of all types combined (L:R = 0.94; p = 0.002), the majority of which were glioma, but laterality was not described separately by tumor histology or grade. Nonsignificant right-sided excesses were reported for series of cases of supratentorial low-grade astrocytoma (L:R = 0.75; n = 56), oligodendroglioma (L:R = 0.86; n =

Table 6. Mean age at tumor diagnosis, by marital status and tumor laterality

Marital status	Age at diagnosis, years							
	glioma				meningioma		acoustic neuroma	
	high-grade		low-grade					
	L	R	L	R	L	R	L	R
Married	59.9	59.3	39.0	44.0	50.5	56.5	50.5	52.7
	p = 0.75[a]		p = 0.07[b]		p = 0.02[c]		p = 0.47	
Not married	49.4	54.1	29.8	30.5	62.1	59.4	56.3	48.6
	p = 0.24		p = 0.83		p = 0.51		p = 0.18	
Total	56.8	58.0	36.6	39.2	53.1	57.5	52.8	51.5
	p = 0.50		p = 0.28		p = 0.04[d]		p = 0.65	

[a] t test for difference in mean age at diagnosis for left- and right-sided tumors.
[b] Mean difference in age (left-sided minus right-sided) = –5.03 years (95% CI: –10.47 to 0.41).
[c] Mean difference in age (left-sided minus right-sided) = –5.96 years (95% CI: –10.83 to –1.09).
[d] Mean difference in age (left-sided minus right-sided) = –4.38 years (95% CI: –8.62 to –0.14).

Table 7. Mean size of tumor at diagnosis (maximum linear dimension), by marital status and tumor laterality

	Size, cm							
	glioma				meningioma (n = 126)[a]		acoustic neuroma (n = 74)[a]	
	high-grade (n = 189)[a]		low-grade (n = 68)[a]					
	L	R	L	R	L	R	L	R
Married	3.8	4.6	4.5	4.4	3.3	3.4	1.7	2.0
	p < 0.01[b]		p = 0.87		p = 0.82		p = 0.37	
Not married	3.8	4.3	3.8	4.3	3.5	3.1	2.3	2.0
	p = 0.29		p = 0.58		p = 0.44		p = 0.49	
Total	3.8	4.5	4.3	4.4	3.3	3.3	1.9	2.0
	p < 0.01[c]		p = 0.90		p = 0.81		p = 0.80	

[a] Information about tumor size was missing for the other cases.
[b] Mean difference (left – right) = –0.82 cm (95% CI: –1.38 to –0.25).
[c] Mean difference (left – right) = –0.76 cm (95% CI: –1.24 to –0.27).

82) and oligoastrocytoma (L:R = 0.70; n = 51) [28–30]. Other authors have reported a left-sided predominance for meningioma, but the sample size was small (L:R = 1.50; n = 65) [31] or not reported [10]. We observed a nonsignificant 1% excess of right-sided over left-sided glioma, and a 9% excess of left-sided over right-sided meningioma. We note, but have no explanation for, the significant 12-fold left-sided predominance of glioma of unspecified type.

The relative frequencies of mental status changes, headache, seizures and hemiparesis as presenting symptoms for high-grade glioma, low-grade glioma and meningioma that were observed in the present study were similar to those reported previously [26]. An added dimension of the present study is consideration of symptoms by tumor laterality. Gliomas were decidedly more likely to be on the left side when the patient presented with aphasia or mental status changes, including confusion, impaired memory or personality changes.

A longstanding hypothesis in the neuropsychological literature is that left-hemisphere lesions, whether of neoplastic, vascular or other origin, 'declare' themselves earlier than right-hemisphere lesions and that right-sided lesions, therefore, tend to be larger or more severe at the time of diagnosis [31, 32]. This is based on the presumption that effects on parts of the brain involved with language and speech are likely to produce symptoms more noticeable or upsetting to the individual or to family members, and thus lead to earlier diagnosis [31]. In the present study, the mean size of left-sided, high-grade glioma at the time of diagnosis was significantly smaller than the mean size of right-sided, high-grade glioma. This pattern was not seen for low-grade glioma, meningioma or acoustic neuroma. Curiously, however, left-sided, low-grade glioma and meningioma were diagnosed, on average, 5–6 years earlier than corresponding right-sided tumors among married persons but not among unmarried persons.

Earlier stage of cancer at time of diagnosis among married persons has been reported for prostate and breast cancer [33], and the involvement of a spouse was associated with a shortened interval from onset of symptoms to diagnosis for glioma [34]. A spouse might notice brain tumor-related symptoms unapparent to the affected person or prompt that person to seek medical care earlier than he or she otherwise would have. This could account for an overall association between brain tumor risk and marital status, but would not, in and of itself, explain an association between tumor laterality and marital status. However, together with differences in symptoms between left- and right-sided tumors, such as we observed, it could.

High-grade glioma and acoustic neuroma did not demonstrate the same association between laterality and marital status. For acoustic neuroma, this is not surprising, as presenting symptoms typically relate more to impaired hearing or balance than to cognitive function. Most high-grade gliomas are rapidly progressive, produce dramatic symptoms and are diagnosed within weeks or months of the onset of symptoms [25]. With the neurodiagnostic technologies available today, it is probable that most come to diagnosis, regardless of tumor laterality or marital status. This is in sharp contrast to meningioma and, to a lesser extent, low-grade glioma, which can remain asymptomatic for many years [35–39]. Because glioblastomas grow rapidly, it is possible that there would be detectable size difference between left- and right-sided tumors in the absence of an age difference.

That we did not observe similar associations between laterality, marital status and tumor size for low-grade glioma and meningioma as we did for age at diagnosis serves as reason for caution in interpretation. However, the information about tumor size was incomplete and approximate. Furthermore, tumor location is often a better predictor of neurological symptoms than is tumor size [40].

Data presented here do not demonstrate significant differences in the numbers of left- and right-sided glioma, meningioma or acoustic neuroma. However, they suggest possible variation in the rates at which left- and right-sided tumors of different types arise, or are detected, in different subgroups of the population. Associations with marital status and presenting symptoms raise the possibility of differential detection according to tumor laterality. These associations are based on small numbers of cases and may represent chance findings. Regrettably, the epidemiologic literature provides a limited basis for comparison. It would be helpful if data on laterality were reported in future epidemiologic studies and included in large, population-based cancer registries.

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