Comparison of Survival Between Cerebellar and Supratentorial Glioblastoma Patients: Surveillance, Epidemiology, and End Results (SEER) Analysis

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BACKGROUND: Cerebellar glioblastoma multiforme (cGBM) is rare, and although there is a general belief that these tumors have a worse prognosis than supratentorial GBM (sGBM), few studies have been published to support this belief.
OBJECTIVE: To investigate the effect of cerebellar location on survival through a case-control design comparing overall survival time of cGBM and sGBM patients.
METHODS: The Surveillance, Epidemiology, and End Results (SEER) registry was used to identify 132 patients with cGBM (1973-2008). Each cGBM patient was matched with an sGBM patient from among 20 848 sGBM patients on the basis of age, extent of resection, decade of diagnosis, and radiation therapy using propensity score matching.
RESULTS: Within the cGBM, 37% were older than 65 years of age, 62% were men, and 87% were white. Most patients underwent surgery and radiation (74%), whereas only 26% underwent surgical resection only. The median survival time for the cGBM and sGBM matched cohort was 8 months; however, the survival distributions differed (log-rank $P = .04$). Survival time for cGBM vs sGBM at 2 years was 21.5% vs 8.0%, and 12.7% vs 5.3% at 3 years. Multivariate analysis of survival among cGBM patients showed that younger age ($P < .0001$) and having radiation therapy ($P < .0001$) were significantly associated with reduced hazard of mortality. Among all patients, multivariate analysis showed that tumor location ($P = .03$), age ($P < .0001$), tumor size ($P = .009$), radiation ($P < .0001$), and resection ($P < .0001$) were associated with survival time in the unmatched cohort.
CONCLUSION: Median survival time for cGBM and sGBM patients was 8 months, but cGBM patients had a survival time advantage as the study progressed. These findings suggest that cGBM patients should be treated as aggressively as sGBM patients with surgical resection and radiation therapy.

KEY WORDS: Case-control study, Cerebellar glioblastoma, Gross total resection, Overall survival time, Radiation, Supratentorial glioblastoma

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Patients with glioblastoma multiforme (GBM) have poor survival outcomes, generally totaling approximately 15 months median overall survival time despite maximal therapy.[1] The rare GBM tumors that are found in the cerebellum are generally perceived to be associated with more dismal prognoses than their supratentorial GBM counterparts.[2] To avoid undertreatment of cerebellar GBM patients and to ensure that appropriately aggressive therapeutic interventions are performed, it is important to identify the prognostic significance of cerebellar tumor location.

Although patient age, neurological performance, and resection status have been established as GBM prognostic factors in the literature, the influence of tumor location in the cerebellum has been obscured by conflicting reports.[3,4] The past 3 decades have yielded only a few, very small-scale studies of cerebellar GBM with often disparate results on the comparative survival time of cerebellar GBM (cGBM) and supratentorial

ABBREVIATIONS: GBM, glioblastoma multiforme; **cGBM,** cerebellar glioblastoma multiforme; **IQR,** interquartile range; **SEER,** Surveillance, Epidemiology, and End Results; **sGBM,** supratentorial glioblastoma multiforme

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GBM (sGBM) patients. Several larger scale studies in the past decade sought to elucidate the impact of various prognostic factors on overall survival time in GBM.[5-7] Unfortunately, their subgroup analysis of cGBM has been limited with small cohorts ranging from 21 to 45 patients.

Our Surveillance, Epidemiology, and End Results (SEER) registry–based study constitutes the largest study of cGBM to date. By matching 132 cGBM patients with sGBM patients with equivalent demographic and clinical characteristics, we aimed to evaluate the prognostic influence of cerebellar tumor location on overall survival time. Additionally, we analyzed the significance of GBM prognostic factors recognized in the literature and assessed their influence on survival time of cGBM.

PATIENTS AND METHODS

Study Design

To address issues of confounders in the design stage of this study, control patients (sGBM) were matched to cases (cGBM) by age, extent of resection, and radiation therapy. Pair matching was based on propensity scores and conducted using a nearest available pair-matching algorithm. A logistic regression model calculated the predicted probability that a patient in the sGBM cohort belonged to the cGBM group while adjusting for potentially confounding covariates. Once propensity scores were assigned to all patients, cGBM patients were ordered and sequentially matched to the nearest unmatched sGBM patient. If more than 1 unmatched sGBM patient was matched to a cGBM patient, then the sGBM patient was selected at random. Univariate analysis was used to confirm matching across the multiple variables between the cGBM and sGBM matched cohorts.

Setting

Patients were extracted retrospectively from the SEER registry data set. The SEER database is a population-based registry that tracks information about cancer from certain geographically defined areas in the United States. The database includes patient demographics, the dates and other characteristics of primary and subsequent cancer diagnoses, and follow-up on vital status. During the period from which our patients were identified, 9 cancer registries encompassing approximately 14% of the US population were covered by the SEER registry.[8]

Participants and Study Size

We identified patients diagnosed with GBM listed as the primary disease site. Patients were identified according to International Classification of Disease for Oncology, Third Edition histology code (ICD-O3: 9440) and site codes C716 (cerebellum) vs C710-C714 and C717-C719 (supratentorial) from 1973 to 2008. We excluded patient younger than 18 years of age and autopsy cases (ie, survival time 0 months). A total of 20 980 GBM patients met the inclusion criteria; of these, 132 and 20 848 had a diagnosis of cerebellar and supratentorial tumors, respectively.

Variables

Demographic characteristics extracted from the SEER registry included patient age, race, and sex. Clinical variables included tumor size, vital status, radiotherapy, extent of surgical resection, and treatment. For the purpose of this study, age was analyzed as a continuous and categorical variable (≤39 years, 40-64 years, and ≥65 years). Tumor size was categorized into 2 categories (≥4 cm and <4 cm); extent of resection was categorized into high (gross total resection) and low (biopsy, partial, surgery not otherwise specified) resection.

Statistical Methods

Overall survival time was compared between the cerebellar and supratentorial matched cohort via Kaplan-Meier estimates; log-rank and Wilcoxon tests were used to compare the survival distribution among these groups. The log-rank test is more sensitive to capturing long-term survival time differences, whereas Wilcoxon is more sensitive to capturing differences occurring early on. Interquartile ranges (IQR) for the medians were provided. Additional explorations of the unmatched cohort involved multivariate analysis to determine factors associated with survival time using a Cox proportional hazard model. A total of 20 980 patients of the unmatched cohort were included in our multivariate analysis. $P < .05$ was considered statistically significant. All analyses were conducted with SAS software (version 9.2; SAS Institute, Cary, North Carolina).

RESULTS

Participants and Descriptive Data

A total of 20 980 GBM patients were identified between 1973 and 2008. Of these, 132 patients had cGBM and 20 848 had sGBM (Table 1). In total, among all patients, fewer cerebellar patients were in the older cohort (65+) compared with sGBM patients (35.65% vs 46.4%, $P < .0001$). Most patients were white in the cerebellar and supratentorial cohorts (88.6% vs 91.5%, $P = .63$). A majority of patients had tumors 4 cm or larger in diameter in both the cGBM (63%) and sGBM (63%) cohorts ($P = .93$) Radiation rates in cGBM and sGBM cohorts were comparable (74% vs 71%, $P = .43$). No statistical differences were observed in terms of extent of resection in the cGBM vs sGBM cohorts, respectively, as well ($P = .34$). Within the matched cohort of 132 cGBM vs 132 sGBM patients, the covariates of age, race, tumor size, extent of resection, and radiation therapy were all comparable (P values ranging from .38 to 1.00) (Table 1). Tumor size was missing in 16.7% and 6.1% of cGBM and sGBM patients, respectively.

Outcome Data: Survival Time in cGBM

Among cGBM patients, median survival time was 8 months. Univariate survival analysis of cGBM patients demonstrated that age and radiotherapy were significant predictors of survival. For instance, patients 18 to 39 years of age had a median survival time of 13 months, whereas patients 40 to 64 years of age and those 65 years of age or older had median survival time of 9 and 4 months, respectively ($P < .001$). Additionally, cGBM patients receiving radiation had a median survival time 5 months longer than counterparts not receiving radiation ($P = .002$). Tumor size and extent of surgical resection were not associated with significant differences in median overall survival time within the cGBM cohort (Table 2). A multivariate analysis of survival time among cGBM patients showed that younger age (age 39 years and younger vs age 65 years and older; hazard ratio [HR]: 0.25, $P < .0001$) and having radiation therapy patients (HR: 0.60, $P = .03$) were significantly associated with reduced hazard of mortality.

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TABLE 1. Patient Demographics and Treatment for Cerebellar and Supratentorial Glioblastoma Patients According to the Surveillance, Epidemiology, and End Results Database, 1973 to 2008

	Unmatched Cohort			Matched Cohort		
	Cerebellar (N = 132)	Supratentorial (N = 20 848)	*P* Value	Cerebellar (N = 132)	Supratentorial (N = 132)	*P* Value
Age at diagnosis, y, no. (%)			<.0001			1.00
≤39	31 (23.5)	1532 (7.4)		31 (23.5)	31 (23.5)	
40-64	54 (40.9)	9635 (46.2)		54 (40.9)	54 (40.9)	
65+	47 (35.6)	9681 (46.4)		47 (35.6)	47 (35.6)	
Race, no. (%)			.63			.38
White	117 (88.6)	19,076 (91.5)		117 (88.6)	126 (95.5)	
Black	8 (6.1)	896 (4.3)		8 (6.1)	5 (3.8)	
Other	7 (5.3)	876 (4.2)		7 (5.3)	1 (0.8)	
Tumor size, cm, no. (%)			.93			.83
≥4	69 (62.7)	10,483 (62.6)		69 (62.7)	81 (65.3)	
<4	41 (27.3)	62,698 (37.4)		41 (37.3)	43 (34.7)	
Radiotherapy, no. (%)			.43			1.00
Radiation	98 (74.2)	148,226 (71.1)		98 (74.2)	98 (74.2)	
No radiation	34 (25.8)	6,022 (28.9)		34 (25.8)	34 (25.8)	
Surgery, no. (%)			.34			1.00
Biopsy	35 (26.5)	5,712 (27.4)		35 (26.5)	35 (26.5)	
Gross total resection	20 (15.2)	3,792 (18.2)		20 (15.2)	20 (15.2)	
Partial resection	31 (23.5)	3,685 (17.8)		31 (23.5)	31 (23.5)	
Surgery, not otherwise specified	46 (34.9)	7,659 (36.7)		46 (34.9)	46 (34.9)	

Main Results: Overall Survival Time in the Matched Cohort

Within the matched cohort, the median survival time was 8 months for cGBM (IQR, 18 months) and sGBM (IQR, 10 months); however, assessing long-term differences in the survival distributions rather that early on differences (Wilcoxon P = .28) between these cohorts showed that the sGBM cohort had a significant survival time advantage over the cGBM cohort (log-rank: P = .04) (Figure 1). For instance, survival at 6 months among cerebellar and supratentorial patients was 60.5% and 63.6%, whereas survival time among these 2 groups was 21.5%

TABLE 2. Median Overall Survival, 95% Confidence Intervals, and *P* Values for Cerebellar Patients According to the Surveillance, Epidemiology, and End Results Database, 1973 to 2008

	Cerebellar (n = 132), 95% Confidence Interval	*P* Value
Age, y		<.0001
≤39	13 (10-20)	
40-64	9 (8-11)	
65+	4 (3-5)	
Tumor size, cm		.08
≥4	8 (6-9)	
<4	8 (6-11)	
Radiotherapy		.0002
Radiation	9 (8-11)	
No radiation	4 (3-5)	
Extent of surgery[a]		.10
High resection	12 (8-15)	
Low resection	6 (6-8)	

[a]High resection corresponds to gross total resection. Low resection corresponds to either biopsy or partial resection.

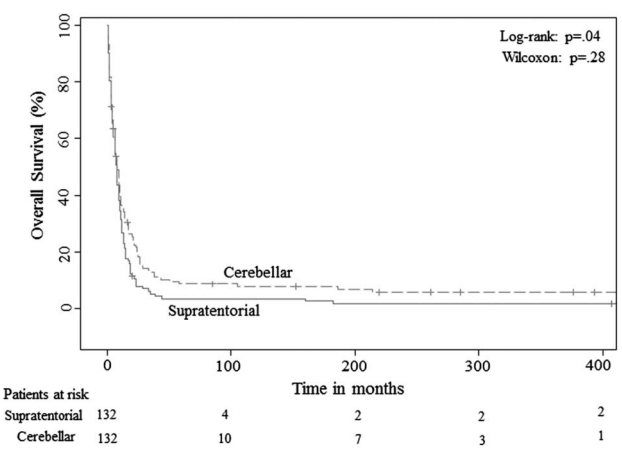

FIGURE 1. *Overall survival functions for 132 cerebellar glioblastoma multiforme (cGBM) patients who were matched to supratentorial glioblastoma multiforme (sGBM) patients according to age, extent of resection, and radiation. Kaplan-Meier estimates for overall survival time in months for sGBM (solid line) and cGBM (dashed line) patients. Wilcoxon and log-rank tests assessed differences in the survival distributions early on and long term, respectively.*

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and 8% at 24 months, respectively (Table 3). Greater evidence of differences in survival curves is shown in Figure 2 between the unmatched cGBM and sGBM cohorts (log-rank P = .0002) before adjusting for important confounders.

Secondary Results: Unmatched Cohort

In multivariate analysis of cGBM patients relative to unmatched sGBM patients, several covariates were found to be significantly associated with improved survival time. Age was a significant predictor of survival time, with patients between 18 and 40 years of age and between 40 and 64 years of age having 75% and 47% lower risk of death relative to counterparts 65 years of age and older ($P < .0001$). Radiation was also a significant predictor of survival time, with patients receiving radiation having 44% lower risk of death relative to those not receiving radiation ($P < .0001$). Patients undergoing gross total resection had 28% lower risk of death relative to those who had only biopsy or partial tumor resection ($P < .0001$). Patients with cerebellar tumors had a reduced mortality hazard (HR = 0.81, P = .02) relative to supratentorial tumors (Table 4).

The relationship between tumor location and survival was further explored in univariate analysis at multiple time intervals. The proportion of patients alive at 6, 12, 24, and 36 months was significantly higher in the cGBM cohort (60.5%, 36.5%, 21.5%, and 12.7%, respectively) relative to the unmatched sGBM cohort (52.7%, 31.1%, 9.9%, and 5.4%, respectively) (Table 3, Figure 2).

DISCUSSION

cGBM is rare in adults compared with its supratentorial counterpart. Given its rarity, the prognosis of this entity is uncertain, factors associated with prognosis have been unclear, and a standard of treatment has not been fully defined. Using the SEER registry database, we were able to identify 132 patients with adult cGBM among 20 980 patients with GBM between 1973 and 2008, corresponding to an incidence of 0.63%. This is in accordance with rates previously reported in the literature, with cGBM accounting for 0.4% to 3.4% of all GBM cases.[7,9-11]

This SEER series is the largest of cGBM cases to date with 132 patients treated between 1973 and 2008. Comparison of patient demographic and treatment factors between cGBM and sGBM cohorts demonstrated similar distribution of race, tumor size, and use of radiotherapy and surgical resection. However, we did observe that age at diagnosis was significantly lower for the cGBM group than the sGBM group. The significance of this difference is unknown. Weber et al[6] reported a median age of 50.3 years, while Tsung et al[5] reported a median age of 39.9 years in their cGBM cohort, although neither cohort had a comparative group of sGBM patients with which to compare this baseline demographic.

Some previous studies have alluded to the fact that cGBM may be a different entity in that it may demonstrate histology similar to secondary.[9,11] This may partly account for the younger age at diagnosis seen with cGBM patients, as secondary sGBMs tend to present earlier than primary GBM. Moreover, it may be possible that cGBM has a quicker onset of presentation compared with sGBM, possibly in part as a result of posterior fossa tumors presenting with more acute symptomatology with compression on the brainstem and other critical structures. Whether these 2 factors may be contributing to the younger age at diagnosis of cGBM requires further study.

Key Results and Interpretation

The overall median survival time among patients in the cGBM cohort was 8 months. This is comparable to the median survival time reported by other studies. Weber et al[6] reported a median overall survival of 9.9 months, whereas Djalilian and Hall[7] reported a median overall survival time of 11 months. Tsung et al[5] reported an even better overall survival time of 18.4 months for cGBM patients, possibly explained in part by the fact that the extent of resection performed in this cohort was very high with median extent of resection equaling 100%. Moreover, the Tsung et al cohort consisted of patients treated from 1990 to 2010, which may reflect more modern diagnostic and treatment approaches

TABLE 3. Survival Rates for Cerebellar and Supratentorial Matched Cohorts According to the Surveillance, Epidemiology, and End Results Database, 1973 to 2008[a,b]

	Matched Cohort		Unmatched Cohort
	Cerebellar (N = 132)	Supratentorial (N = 132)	Supratentorial (N = 20 848)
Median survival, mo	8 (6, 10)	8 (6, 9)	7 (3, 13)
IQR for median survival, mo	18	10	10
Overall survival rate, % (95% CI)			
6 mo	60.5 (51.6-68.3)	63.6 (54.8-71.1)	52.7 (57.3-58.6)
12 mo	36.5 (28.3-44.7)	31.4 (26.5-42.6)	31.1 (30.4-31.7)
24 mo	21.5 (14.9-29.0)	8.0 (4.0-13.6)	9.9 (9.5-10.3)
36 mo	12.7 (7.8-19.2)	5.3 (2.2-10.3)	5.4 (5.1-5.8)

[a]IQR, interquartile range. Log-rank P = .04; Wilcoxon P = .28 (matched cohort); log-rank P = .0002; Wilcoxon P = .08 (unmatched cohort).
[b]The values inside the parenthesis correspond to the 95% confidence intervals (95% CI) for the median estimate.

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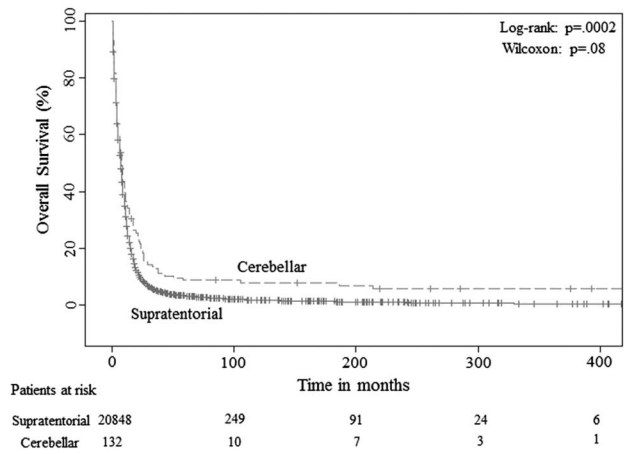

FIGURE 2. *Overall survival functions for 132 cerebellar glioblastoma multiforme (cGBM) and 20 848 supratentorial glioblastoma multiforme (sGBM) patients. Kaplan-Meier estimates for overall survival time in months for sGBM (solid line) and cGBM (dashed line) patients. Wilcoxon and log-rank tests assessed differences in the survival distributions early on and long term, respectively.*

compared with our cohort and those of Weber et al and Djalilian and Hall. A similar cohort of Johnson and O'Neill[12] that included giant cell glioblastoma (ICD-O3: 9441) and gliosarcoma (ICD-O3: 9442) reported a median survival of 8.1 (2000-2003) and 9.7 (2005-2008) months; the longer survival time reported by Johnson and O'Neill might be explained by the inclusion of the giant cell glioblastomas, which have been shown to have better survival than ordinary glioblastoma (ICD-O3: 9440). Our overall survival rate was less that that reported by Stupp et al[1] for sGBMs, with survival time totaling 14.6 months in their cohort of patients receiving both chemotherapy and radiation after resection. Again, this may reflect the fact that our patients dated back to the 1970s and not all of them received radiation and chemotherapy. Nonetheless, our internal comparison of survival within our cGBM cohort relative to our matched sGBM cohort showed that although the median overall survival time was essentially the same in both groups, cGBM patients seem to have a long-term survival advantage.

TABLE 4. Hazard Ratios, 95% Confidence Intervals, and *P* Values or Multivariate Survival Analysis of the Unmatched Cohort[a]

	Unmatched Cohort	
Characteristics	**HR (95% CI)**	***P* Value**
Tumor type (ref: supratentorial)		
Cerebellar	0.81 (0.66-0.98)	.03
Age, y (ref: 65+)		
≤39	0.25 (0.24-0.27)	<.0001
40-64	0.53 (0.51-0.55)	<.0001
Tumor size, cm (ref: <4)		
≥4	0.96 (0.93-0.99)	.009
Radiotherapy (ref: no radiation)		
Radiation	0.56 (0.54-0.58)	<.0001
Extent of surgery (ref: low resection)		
High resection	0.71 (0.68-0.74)	<.0001

[a]HR, Hazard ratio; CI, confidence interval. High resection corresponds to gross total resection, whereas low-resection includes biopsy and partial resection.

The impact of the cerebellar location of GBM on survival has remained uncertain, with some studies suggesting a worse prognosis for cGBM compared with sGBM.[2] This poorer prognosis has been attributed to the proximity of the cerebellum to the brainstem compared with supratentorial counterparts, as well as to the decreased tolerance of the posterior fossa to mass effect, which may restrict treatment. However, most of these studies are case reports or small case series. Levine et al[2] reported a median survival time of 3 months among 14 cases of cGBM reviewed. On the other hand, some larger series have demonstrated a similar prognosis between cerebellar and supratentorial glioblastoma.[6,7] Weber et al[6] reported a 10-month median survival among 45 cerebellar GBM patients documented in the Rare Cancer Network, which mirrored the survival of aggressively treated supratentorial patients in the literature. The analytic review of Djalilian and Hall[7] of 41 cGBM case reports showed an overall survival of 11 months, comparable to that of sGBM.[7] Finally, Tsung et al[5] reported a higher median overall survival of 18.4 months in their single-institution cohort of 21 cGBM patients. Interestingly, although overall median survival times were not different between the 2 cohorts of GBM patients explored in our study (8 months), the survival distributions seemed to significantly differ between cGBM and sGBM, especially after 12 months ($P = .04$). Our data show a trend toward longer survival time in the cGBM cohort compared with the sGBM cohort with a higher percentage of cGBM patients alive at 2 and 3 years. Some previous studies alluded to the fact that cGBM may be a distinct biological entity compared with its supratentorial counterpart.[9,11] Indeed, a histological analysis of 4 patients with cGBM by Utsuki et al[11] showed that these tumors had characteristics similar to secondary sGBM, including positivity for p53, negativity for epidermal growth factor receptor, and the presence of scant low-grade glioma histology. This relatively more indolent biology may potentially explain the better longer term survival time in cGBM patients. Given the relatively small sample size of the cGBM cohort, this trend of better survival time at 2 years and beyond in the cGBM cohort should be interpreted with caution.

Univariate analysis of our cGBM cohort revealed that age was significantly associated with overall survival time, consistent with the positive association found between older age and worse survival time in sGBM studies. Our categorization of patients in age brackets of younger than 40 years of age, 40 to 65 years of age, and older than 65 years of age is roughly the same categorization seen in previous studies. Tsung et al[5] did not find a significant association between age and overall survival time when using ages younger than 40 years of age and 40 years or age and older as age categories. Similarly, Weber et al[6] did not find an association between age and survival time using younger than 50 years of age and 50 years of age and older as age categories.[6] However, these were both relatively small series that did not include a comparative supratentorial GBM cohort.

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Radiation therapy was significantly associated with better overall survival time in our univariate analysis. This is in agreement with the univariate and multivariate analyses by Djalilian and Hall,[7] in which receiving external beam radiation therapy was associated with 23 months overall survival time compared with only 1 month overall survival time for those patients not receiving radiotherapy.[7] Utsuki et al[11] and Saito et al[9] suggested that the tendency for cGBM to be negative for epidermal growth factor receptor may have an impact on the radiosensitivity of these tumors. Weber et al[6] found patients that had undergone adjuvant therapy after surgery, including radiation with our without chemotherapy, had improved 2-year overall and progression-free survival time. Tsung et al[5] also reported a significant improvement in progression-free survival with the use of adjuvant chemotherapy, with most patients receiving temozolomide. The impact of concurrent or adjuvant chemotherapy along with radiation was unfortunately not able to be explored in this study due to limitations within the available data set.

Interestingly, extent of resection was not significantly associated with overall survival in our univariate analysis, despite this factor being associated with survival in sGBM.[13-15] Weber et al[6] found that extent of resection was associated with overall survival in both their univariate and multivariate analyses of cGBM patients. Similarly, Djalilian and Hall[7] found that median survival for patients undergoing surgical resection (partial or complete) was 30 months vs 1 month for patients not receiving surgery. Tsung et al,[5] on the other hand, reported no significant association between extent of resection and either overall or progression-free survival time in their univariate or multivariate analyses of patients with cGBM. The extent of resection variable in our study was classified into 2 categories: high resection signifying gross total resection and low resection corresponding to partial resection or biopsy. Although rates of gross total resection in this study seem low (<20%), Saito et al[9] and Ewelt et al[16] have reported rates of 22.3% and 4.7%, respectively. In fact, none of the 7 cGBM cases reported in Saito et al, underwent gross total resection. Volumetric analyses of resection to help differentiate the more specific degree of extent of resection between partial and gross total resection groups was not possible in this multisite study. It may be possible that patients receiving partial resection still had a high percentage of their tumor removed, thus potentially contributing to the lack of significant association seen between extent of resection and overall survival time in our study.

Limitations

There were several limitations to this study due to some intrinsic limitations of the SEER database. Clinical variables such as Karnofsky performance score, presence of leptomeningeal disease, location of tumor in the cerebellum, and brainstem invasion were not available for analysis. In addition, data on disease progression and information about treatments such as additional surgeries and treatments that are not part of the initial treatment are not recorded in the SEER database. To maximize our sample size, we included patients dating back to 1973. Given this fact, some patients within our cohort may have received more outdated modalities of treatment, which may have negatively affected our overall survival rates. Although this has been the largest series of cGBM patients to date, our sample size was still relatively small. This may limit the interpretation of the trend that we found in this review showing somewhat better survival in the cGBM cohort at 2 years and beyond compared with sGBM patients.

Generalizability

Glioblastoma of the cerebellum is rare, accounting for 0.63% of all intracranial glioblastomas analyzed in this study. The age at diagnosis of cGBM patients seems to be younger than that seen in patients with sGBM, possibly reflecting an underlying biological difference between these tumor locations. We found median overall survival time to be identical between our matched cGBM and sGBM cohorts, suggesting a similar prognosis between these 2 entities, at least early on in the study. However, over time, we found a significant survival advantage in the cGBM cohort. Future studies are needed to confirm this trend and to investigate potential biological differences between sGBMs and cGBMs.

Radiotherapy was additionally significantly associated with improved survival time in our univariate analysis. Given the similar prognosis seen between cGBMs and sGBMs within this multicenter longitudinal SEER cohort study, we recommend that cGBM be treated as aggressively as their sGBM counterparts, including the use of standard multimodality therapy including surgery plus radiation with concurrent and adjuvant chemotherapy.

CONCLUSION

The median overall survival time for cGBM and sGBM patients was 8 months. However, a benefit in survival was observed in the cGBM cohort as the study progressed. Although further studies may be needed to further elucidate factors that may be associated with the perceived survival benefit, these preliminary findings suggest that cGBM patients should be treated just as aggressively with surgical resection and radiation therapy as their sGBM counterparts.

Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENT

Cerebellar glioblastomas (cGBMs) are very rare compared with their supratentorial counterparts and hence there are only a few institutional cohort studies reported. This study was able to identify 132 patients form the SEER registry between 1973 and 2008 and matched them with sGBM patients. I agree with study conclusions despite its limitations that patients with cGBMs should be treated as aggressively as those with sGBMs with surgery and radiotherapy as cGBMs had a survival advantage over sGBMs as time progressed. In a single-institution cohort of 21 cGBM patients, Tsung et al[1] showed a median overall survival of 18.4 months. The presence or absence of brainstem invasion and or leptomeningeal disease, although not reported here, are important findings that may influence patient outcomes.

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1. Tsung AJ, Prabhu SS, Lei X, Chern JJ, Benjamin Bekele N, Shonka NA. Cerebellar glioblastoma: a retrospective review of 21 patients at a single institution. *J Neurooncol.* 2011;105(3):555-562.

CME QUESTIONS

1. What proportion of all intracranial glioblastomas originate in the cerebellum?
   a. 0-3%
   b. 3-6 %
   c. 6-9%
   d. 9-12%
   e. 12-15%
2. What characteristic differentiates cerebellar (cGBM) from supratentorial glioblastoma multiforme (sGBM)?
   a. Younger age at presentation of cGBM
   b. Positivity for p53
   c. Negativity for EGFR
   d. Overall median survival
3. An expanding body of evidence suggests that extent resection influences survival in patients with glioblastoma multiforme. Which of the following factors can influence the extent of resection?
   a. Age
   b. Gender
   c. Medical comorbidities
   d. Tumor location

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