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Clinical Presentation and Outcomes for Adult Ependymoma Patients

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Abstract

BACKGROUND: Outcomes projects can be a catalyst for determining disease- and treatment-related consequences for patients with rare tumors. The Adult Ependymoma Outcomes (AEO) survey uses self-reported experience to evaluate how this tumor affects patient groups throughout the illness trajectory.

METHODS: Patients completed the AEO survey via a Web-based portal. The survey included questions on treatment, tumor recurrence, and current health status; the MD Anderson Symptom Inventory Brain Tumor and Spine Tumor modules; and the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36).

RESULTS: The sample included 264 participants (57% female) with a median age of 46 years (range, 18–77 years). Radiation treatment was commonly used for patients who had brain involvement ($\chi^2(1) = 20.7$; $P < .001$), underwent a partial resection (43%; $\chi^2(3) = 15.4$; $P < .001$), or had a grade 3 tumor (41%; $\chi^2(2) = 18.8$; $P < .001$). Recurrence occurred in a small group (29%), with grade 1 tumor patients 2.6 times more likely and grade 3 tumor patients 2.5 times more likely to experience recurrence than those with grade 2 tumors. Spine tumor patients had a higher symptom burden (mean, 2.8; scale, 0–10) than brain tumor patients ($t(247) = -4.0$), and they reported more moderate to severe symptoms (rating ≥ 5; 29%) than their counterparts (18%). Within the physical health portion of the SF-36, spine tumor patients reported worse health with respect to bodily pain ($t(249) = 6.8$; $P < .001$), physical functioning ($t(252) = 4.1$; $P < .001$), and vitality ($t(202.2) = 3.0$; $P < .003$).

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AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST DISCLOSURES

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CONCLUSIONS: These results demonstrate the feasibility of implementing outcomes projects that report on the clinical and demographic characteristics of a rare patient population, and they underscore the importance of outcomes data in understanding disease-related issues.

Keywords

cancer treatment; central nervous system; ependymoma; quality of life; symptoms

INTRODUCTION

Ependymomas are rare tumors occurring in the central nervous system (CNS) and account for approximately 7% of all CNS gliomas.[1] Although ependymomas occur throughout the neuraxis, spinal cord tumors are more common in adults than the pediatric population,[2] with spinal cord tumors accounting for 21% of ependymomas diagnosed in patients who are 20 years old or older.[1] Most commonly, ependymomas are found in the filum terminale and central canal of the spinal cord and in the fourth ventricle within the brain, but they can occur anywhere within the CNS, and there are rare reports of ependymomas occurring outside the CNS.[3] The ependymoma grade is based on histopathologic criteria and the World Health Organization–based grading system (range, 1–3). Several publications discuss the difficulty of the existing criteria, which use morphologic features to determine the grade of an ependymoma; this has led to an ongoing debate regarding the significance of the grade in predicting the prognosis.[4] More recently, molecular markers have been reported for subclassifying ependymomas within anatomic compartments (supratentorial, infratentorial, and spinal cord) and thereby identifying differences in the underlying tumor biology and clinical course, including the prognosis.[4,5] However, despite the increasing recognition of the importance of these molecular markers, they currently are not routinely determined in clinical practice.

As with other CNS tumors, the extent of surgical resection affects the prognosis and provides essential diagnostic information.[6] Additional treatment generally consists of radiation or a combination of radiation and chemotherapy. Although there have been seminal molecular discoveries in ependymoma research, prospective clinical trials exploring the efficacy of treatment regimens are uncommon or are often limited to single-institution accrual or retrospective reviews. Overall, just as for many other rare cancers, we lack a full understanding of the disease presentation and patient experience for ependymoma.

The Adult Ependymoma Outcomes (AEO) project is an online questionnaire established in January 2009 by the Collaborative Ependymoma Research Network (CERN) Foundation. The primary aims of this project are to obtain self-reported data on treatment, symptoms, functional status, and quality of life for patients with ependymoma and to evaluate the relation between health status and disease and treatment characteristics for patients with tumors in the brain or spine. The preliminary results for the first 118 ependymoma participants from this survey were published in *Cancer* in 2011.[7] This early report indicated that patients were symptomatic for months before their diagnosis, and this was significantly longer for those with tumors located in the spine. In addition, for those patients currently under surveillance, the symptom burden remained high, and nearly half of the patients were

unable to return to work. Since this initial publication, an additional 146 patients (for a total of 264 participants) have self-registered for the AEO project. The purpose of this report is to provide a comprehensive update of the clinical presentations and outcomes for a large cohort of ependymoma patients, begin an exploration of factors associated with outcomes and current health status in patients with disease in the brain versus patients with spinal cord ependymomas, and thereby provide important clinical insights into this rare tumor population.

MATERIALS AND METHODS

This study was first reviewed and approved by the institutional review board of The University of Texas MD Anderson Cancer Center in 2009, and it was later reviewed and approved at The University of Texas Health Science Center at Houston in 2015. Participants were invited to complete the survey, although a majority registered on the Web site without being prompted. A variety of methods, including social media posts, monthly newsletters, and information sharing at annual events held by the CERN Foundation, were implemented to increase traffic to the Web site and encourage participation. Increasing weekly traffic to the site, social media announcements were deemed the most successful. Participants were invited to participate on the basis of the following criteria: 1) being diagnosed with an ependymoma or ependymoma variant; 2) being able to speak, write, and read English; and 3) being 18 years old or older. Participants completed the enrollment form found on the CERN Web site; this is a brief 5- to 10-minute questionnaire designed to capture registration information. The project coordinator received notification of completed enrollment forms and sent a unique identifying number and instructions to participants to complete the ependymoma outcomes survey. The project coordinator verified each patient's registration information with the study database before sending study identification numbers to prevent multiple registrations. Participants without Internet access were able to contact CERN to get a hard copy sent to a preferred address. The AEO project questionnaire consisted of 67 questions on treatment history, recurrence, current treatment, and demographic and social information. It included the following questionnaires: the MD Anderson Symptom Inventory Brain Tumor (MDASI-BT) module, the MD Anderson Symptom Inventory Spine Tumor (MDASI-SP) module, the Ependymoma Outcomes Questionnaire, and the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36).

Instrument Description

The symptom burden was measured with the MDASI-BT or MDASI-SP; patients completed the form that corresponded to the tumor location. Each version contains location-specific symptoms and interference items that focus on the impact of symptoms on different aspects of one's life. Symptoms experienced in the last 24 hours are measured on a 0 to 10 scale, with 0 indicating "not present" and 10 indicating "as bad as you can imagine." The MDASI-BT consists of 22 items and 6 interference items. The 6 constructs measured within this instrument are affect, cognition, focal neurological deficit, treatment-related symptoms, generalized disease status, and gastrointestinal-related symptoms.[8] The MDASI-BT has been used in the primary brain tumor population, and earlier studies have confirmed its validity.[8] The MDASI-SP consists of 18 items and 6 interference items (the same

interference items found in the MDASI-BT). Its 4 constructs are disease-related symptoms, autonomic function, constitutional/treatment-related symptoms, and emotions.[9] The Ependymoma Outcomes Questionnaire is a 21-item disease-specific instrument that explores the disease presentation and clinical course for participants with ependymoma tumors. This questionnaire was developed by the CERN investigators specifically for the AEO project, and it has been reported previously.[2] The SF-36 measures the awareness of current health within 8 dimensions that cover the areas of functional status, well-being, and overall health.[10] Participants completed questions on how they felt and how well they were able to perform their usual activities.

Statistical Analysis

All analyses were conducted with IBM SPSS Statistics for Windows (version 23).[11] The patient sample was portrayed with descriptive statistics, including frequencies, means, and standard deviations (SDs). Associations among patient demographics, tumor characteristics, and clinical details were evaluated with chi-square and Fisher exact tests. Independent sample *t* tests were used to determine significant differences between groups in terms of patient demographics, symptom severity, and health functioning. A logistic regression with backwards selection was used to investigate potential risk factors for tumor recurrence. Bonferroni and Holm test adjustments were made for multiple comparisons. All significant results were at the level of $P < .05$.

RESULTS

Participation

The sample consisted of 264 participants who completed the survey online from June 2009 to March 2015 with an average of 4.5 completions a month. A majority of the participants completed the survey without assistance (85%), whereas 38 (15%) required help or had someone complete it for them because of physical limitations.

Participant Characteristics

Table 1 presents the demographic characteristics for the sample. Participants primarily were female (57%), were married (65%), and had at least a college education (37%); they ranged in age from 18 to 77 years (median, 46 years) and on average were 39 years old at the time of diagnosis. Brain ependymoma patients on average were slightly younger at 44 years at the completion of the survey, whereas spine ependymoma participants were 47 years old on average. Participants could complete the survey at any point along the illness continuum. The median time to survey completion from diagnosis for participants with brain tumors was 52 months (range, 0–457 months), and the median time for participants with spine tumors was 66 months (range, 0–470 months). In addition, more than half of both patient groups reported a household income of $60,000 or more and reported living with someone who could help take care of them (brain tumor patients, 85%; spine tumor patients, 78%). Concomitant medication use was common in both groups and is outlined in Table 2. Spine and brain tumor patients reported similar use of antidepressants (brain tumor patients, 24%; spine tumor patients, 23%). More participants with spine tumors (39%) than brain tumors (21%) reported current use of pain medications ($\chi^2(1) = 10.01$; $P < .01$).

Tumor Characteristics

Disease characteristics are reported in Table 3. A majority of the sample reported uncertainty about the tumor grade (33%) or a grade 2 diagnosis (33%). Most brain ependymoma patients reported a grade 2 tumor (40%), whereas half of those with spine tumors reported uncertainty about their tumor grade.

Clinical Presentation

Overall, the most common presenting symptoms (Table 4) for the sample included numbness/tingling (49%), weakness (41%), and headaches (38%), but with respect to the tumor location, there was variation in symptoms before the participants' initial surgery. Brain tumor patients reported headaches (63%) as their most prevalent symptom, and they were followed by nausea/vomiting (40%), visual problems (38%), and weakness and sleepiness (28%). For spine tumor patients, the most commonly reported symptoms were numbness/tingling (67%), back pain (58%), and weakness (51%). In addition, participants reported experiencing depression (brain tumor patients, 19%; spine tumor patients, 15%), and this did not seem to be differ greatly between the 2 locations. The duration of time from symptom onset to diagnosis was evaluated and found to vary greatly between the 2 locations. Sixty-six brain tumor participants (61%) but only 31% of spine tumor participants were symptomatic for 6 months or less before the initial surgery ($\chi^2(1) = 21.6$; $P < .001$), whereas spine tumor patients were more likely to be symptomatic for more than 1 year before the diagnosis (58% vs 28% of brain patients; $\chi^2(1) = 23.8$; $P < .001$).

Treatment Course

For each of the locations, the majority of the patients reported that they underwent a complete resection during the first surgery. Overall, although more than half of the sample (59%) reported feeling better after their initial surgery, they noted postsurgery complications. For participants with spinal cord ependymomas, the most commonly reported issues were sexual dysfunction (23%), paralysis (19%), incontinence (19%), and an inability to urinate (14%). Patients with brain ependymomas reported a high rate of postoperative infections (11%), seizures (11%), paralysis (11%), and blood clots (6%). There was a general consensus among patients from both tumor groups that weakness (brain tumor patients, 34%; spine tumor patients, 44%) was the most common symptom after surgery.

The survey participants' initial treatment after surgery also highlighted the differences in the tumor locations. More patients with brain ependymomas received some form of treatment after their initial surgery in comparison with patients with spinal cord tumors (61% vs 30%; $\chi^2 = 22.4$; $P < .001$). Patients with brain ependymomas were more likely to undergo treatment after surgery, with 39% reporting radiation alone (39%) and 16% reporting a combination of radiation and chemotherapy. In contrast, patients with spinal cord tumors most commonly reported no additional treatment after the initial surgical resection (70%) or radiation only (23%). Receiving radiation as part of the initial treatment plan was associated with having a brain tumor versus a spinal cord tumor (62% vs 38%; $\chi^2(1) = 20.7$; $P < .001$), undergoing only a partial tumor resection versus a gross total resection (43% vs 21%; $\chi^2(3) = 15.4$; $P < .001$), and having a higher grade tumor versus a grade 1 or 2 tumor (41% vs 13%; $\chi^2(2) = 18.8$; $P < .001$).

Tumor Recurrence

Tumor recurrence occurred in 29% of the patients participating in the AEO survey, with 80% reporting that their tumor recurred in the same location. The majority of the participants who reported any recurrence had only 1 recurrence (57%) throughout the illness trajectory. As expected, symptoms at recurrence varied between tumor locations: for spine tumor patients, back pain was the most reported symptom (58%), and for brain tumor patients, headaches were (33%). Treatment at the time of recurrence included surgery only (25%), radiation only or radiosurgery (19%), and surgery plus radiation; surgery and radiosurgery or surgery, radiation and radiosurgery (18%). When we evaluated potential tumor characteristics that could influence the risk of recurrence, tumor grade was found to be associated with the likelihood of relapse ($\chi^2(2) = 9.8$; $P < .007$; $R^2 = 0.067$ [Cox and Snell] or 0.091 [Nagelkerke]). As anticipated, patients with grade 3 (anaplastic) tumors were 2.5 times more likely to have a recurrence. However, surprisingly, compared with patients with grade 2 tumors, patients with grade 1 tumors were 2.6 times more likely to have a recurrence. Recurrence information is outlined in Table 5.

Symptom Burden

Table 6 provides information on the symptom burden in this patient population. As measured by the MDASI-BT and the MDASI-SP, the overall symptom burden was higher for spine tumor patients (mean, 2.8; SD, 2.0) than brain tumor patients (mean, 1.9; SD, 1.7; $t(247) = -4.0$). Spine tumor patients endorsed a higher percentage of possible symptoms (57%) than brain tumor patients (44%). Furthermore, spinal cord tumor patients endorsed a higher percentage of moderate to severe symptoms (rating ≥ 5; 29%) than brain tumor patients (18%). The 5 symptoms reported most frequently as moderate to severe among brain tumor patients were fatigue (34%), difficultly with remembering (31%), disturbed sleep (29%), feeling distressed (27%), and feeling drowsy (27%). For spinal cord tumor patients, the symptoms were numbness/tingling (59%), fatigue (52%), weakness (47%), pain (46%), and sexual dysfunction (39%). Another problematic area for patients was the impact that these symptoms had on aspects of their life. Both groups specifically reported that work suffered the most interference (mean for brain tumor patients, 3.7; SD, 3.9; mean for spinal cord tumor patients, 4.7; SD, 3.4). However, patients with spinal cord tumors reported more interference in activity-related areas in general (work, activity, and walking; mean, 4.6; SD, 3.2) in comparison with brain tumor patients (mean, 3.4; SD, 3.4; $t(247) = -2.8$).

Current Health Status

An inability to work was common for patients completing this survey; overall, 118 (47%) reported this. Some participants reported good health (38%) in response to SF-36 questions about their current health, and the majority of the patients reported that their health was about the same as it had been a year ago (46%). In different dimensions of physical health, however, spinal cord tumor patients reported worse health than brain tumor patients, particularly with respect to bodily pain (mean, 49.1 [SD, 25.8] vs 72.1 [SD, 28.5]; $t(249) = 6.8$; $P < .001$), physical functioning (mean, 51.6 [SD, 29.7] vs 67.8 [SD, 33.1]; $t(252) = 4.1$; $P < .001$), and vitality (mean, 40.9 [SD, 21.6] vs 50.1 [SD, 26.1]; $t(202.2) = 3.0$; $P < .003$).

The survey also asked for participants to report any depressive symptoms within the past year that occurred for 2 weeks or more; overall, this was relatively uncommon (28%).

Follow-Up Care

When participants were asked to report the type of physician that they saw for follow-up, a majority reported a single physician for continuation of their care (70%): 53% reported a neurosurgeon, and much smaller percentages reported follow-up care provided by a neuro-oncologist (29%) or an oncologist (7%). Nearly 20% of spinal cord tumor patients followed up with a family physician for the ongoing evaluation of their tumors. The sample also reported on the frequency of magnetic resonance imaging scans with a variety of schedules; the most commonly reported included follow-up imaging every 6 months for brain ependymoma patients (26%) and every year for participants with spinal cord tumors (24%).

DISCUSSION

The Ependymoma Outcomes Project has demonstrated that it is feasible to collect self-reported information from adult ependymoma participants during the course of their illness. Inherent biases of this approach are worth noting; they include the potential bias of participants who were required to recollect information from earlier time points in the course of their illness because of the cross-sectional nature of this study. In addition, the limitation to participants who could learn of the study through access to the Internet may have resulted in a sample that is biased to those seeking out information about their diagnosis as a result of their ongoing health issues or disease status. However, our sample is not dissimilar to either national statistics or previous reports with respect to sex or age. Our sample does include a larger percentage of spinal cord ependymoma patients, and this may represent a survival bias for this group. Although the reported results are subject to a selection bias, the results provide guidance for the development of educational materials and interventions specific to symptoms that can generate research questions for future studies.

The results of this analysis demonstrate that patients with brain ependymomas and patients with spinal cord ependymomas do experience symptoms differently; this is particularly true for the length of time that patients are symptomatic before the diagnosis. More than half of the spine tumor patients experienced symptoms for a longer period of time before the initial diagnosis in comparison with brain tumor patients. In the preliminary analysis of the AEO survey by Armstrong et al,[7] 64% of spine tumor patients experienced symptoms for >6 months; this finding persists with the updated data in the current analysis. A longer symptom duration before surgery has been shown to be associated with a worse prognosis for both survival duration and functional outcomes in patients with spinal cord compression from other cancers, including B-cell lymphoma,[12] hepatocellular carcinoma,[13] and others.[12,14] The impact of earlier recognition and surgery for patients with spinal cord ependymomas warrants investigation.

As expected, the patients also experienced symptoms specific to their tumor location, and this allowed a comparison of commonly reported symptoms in this cohort. Several studies have reported common symptoms that can be helpful in pinpointing the tumor location; these include weakness, neck and back pain, sensory loss, abnormal gait, and bowel

dysfunction in the spine.[15] With intraventricular ependymomas, patients often experience nausea, vomiting, headaches, vertigo, and ataxia.[16] When the tumor is primarily in the brain parenchyma, patients often experience changes in behavior, memory loss, or focal neurological symptoms.[16] Lastly, patients with an ependymoma within the posterior fossa may have signs of ataxia, hydrocephalus, or dizziness.[16] The results of this study demonstrate that tumor-related symptoms over time can affect patients' overall sense of well-being, regardless of their disease status. Identifying the specific symptoms related to the location of the ependymoma can be a catalyst for primary care providers to educate patients about the importance of addressing the symptoms in a timely manner and to implement effective measures to control their symptoms. Understanding the reason that a gap exists between the 2 locations could fuel research and more outcomes projects focusing on patient and provider education.

The rarity of ependymomas underscores the need for involvement by health care providers with expertise in this disease. The AEO survey surprisingly showed that the majority of patients were receiving their medical follow-up from primary care physicians. This may contribute to gaps in patients' knowledge and understanding of the disease. For example, in our study, we found that over a third of the spine tumor participants and 28% of the brain tumor patients were uncertain of their tumor grade. Furthermore, prior studies raise concerns about the accuracy of the pathologic diagnosis if the evaluation does not involve a center with expertise. In this context, several studies have reported that up to 20% to 30% of ependymomas are misdiagnosed and that diagnosing an ependymoma is challenging.[2,17]

The current study results provide insights into the long-term consequences of surgery and other treatments and the need for further exploration of the long-term physiological impact of ependymoma and its treatment. Despite reporting a high number of postoperative complications, patients generally reported feeling better after the initial surgery. Weakness was a common symptom with both brain and spinal cord tumor locations. However, there were additional symptoms that were more location-specific such as sexual dysfunction, incontinence, and urinary retention for spinal cord tumors and seizures and cognitive problems for brain ependymomas.

Persistent pain was more common with spinal cord tumors, and as a result, more of these patients reported the use of analgesics in comparison with brain ependymoma patients. Overall, approximately 31% of the entire sample reported using analgesics; this highlights one of the long-term consequences of the disease and/or its treatment. Furthermore, when patients completed a second survey 6 months after the first, overall, 40% reported continued use of pain medication, but this rate was much higher (65%) for patients with spinal cord tumors even though they had completed active treatment for their ependymoma.[18] These data provide a framework for future analyses designed to better understand the need for the extended use of pain medication, the impact on the symptom burden, and the relation between disease location and treatment; we can learn about possible correlations with long-term symptoms, the type of medication, and the tumor location in future studies.

The data provided by the AEO survey provide important insights into a rarely studied population of adult cancer patients. Because the recurrence rate was low (29%) among the

patients participating, the outcomes data reflect issues of chronic disease. Not unexpectedly, there was a higher likelihood of disease relapse for grade 3 ependymomas versus lower grades. However, the relapse rate for grade 1 was greater than the rate for grade 2; this phenomenon has been demonstrated in other reports.[19] The reason for this apparent paradox is not known, but it has been speculated that patients with grade 1 tumors are less likely to receive additional therapy after surviving resection even if there is residual disease.

There are several limitations to the current study. The sample was self-selected, and only self-reported data were used without verification from the medical record. The sample was cross-sectional, with most patients having completed treatment before participation. There may have been a bias among the patients in reporting experiences and information that occurred months to years before participation. Also, the need for participants to have access to social media meant that some missed the opportunity to be recruited for the survey. Approximately 2000 patients are diagnosed each year in the United States with an ependymoma or an ependymoma variant, so this sample does represent only a fraction of those who are diagnosed. Because of the importance of understanding the natural history of the spectrum of this rare cancer, future studies should include prospective, longitudinal collection of data to evaluate the impact of the disease over the entire treatment trajectory.

In conclusion, this study represents the largest report to date of the impact of ependymoma in the adult population. Even though it is commonly classified as a low-grade tumor, significant symptoms and functional limitations are evident throughout the disease's trajectory. The use of an online survey has been proven to be a feasible method of collecting patient-reported information from persons with rare diseases. Furthermore, the current findings can be used to generate hypotheses for clinical interventions and to promote education for patients and clinical staff.

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TABLE 1.

Participant Characteristics

Characteristic	Brain	Spine	Sample
Sex, No. (%)[a]			
Female	61 (54)	88 (59)	149 (57)
Male	53 (47)	61 (41)	114 (43)
Current age, y			
Mean	44	47	46
Median	43	47	46
Range	18–77	23–76	18–77
Age at diagnosis, y			
Mean	37	40	39
Median	36	38	38
Range	0–72	12–70	0–72
Marital status, No. (%)			
Never married	29 (26)	24 (17)	53 (21)
Married	74 (67)	92 (64)	166 (65)
Divorced, widowed, or separated	8 (7)	25 (17)	33 (13)
Preferred not to say	-	2 (1)	2 (1)
Education, No. (%)			
Some high school	4 (4)	1 (1)	5 (2)
High school graduate and some college	32 (29)	37 (26)	69 (27)
College graduate	43 (39)	52 (36)	95 (37)
Any postgraduate work	32 (29)	54 (38)	86 (34)
Household income, No. (%)			
Preferred not to say	14 (13)	21 (15)	35 (14)
<$20,000	8 (7)	8 (6)	16 (6)
$20,000–$59,999	22 (20)	36 (26)	58 (23)
$60,000–$99,999	30 (27)	24 (17)	54 (21)
≥$100,000	37 (33)	54 (38)	91 (36)
Living with someone, No. (%)			
No	16 (15)	31 (22)	47 (19)
Yes	93 (85)	112 (78)	205 (81)

All data are from patient self-reports, and they have not been verified with medical records.

The number of patients varies from category to category due to missing data.

[a]Sex data were missing for 1 participant.

TABLE 2.

Follow-Up Care

	Brain, No. (%)	Spine, No. (%)	Sample, No. (%)
Concomitant medication			
Antiseizure	22 (19)	22 (15)	44 (17)
Antidepressant	27 (24)	35 (23)	62 (24)
Corticosteroid	6 (5)	5 (3)	11 (4)
Pain	24 (21)	59 (39)	83 (31)
Follow-up physician[a]			
Neurosurgeon	56 (49)	84 (56)	140 (53)
Neuro-oncologist	37 (33)	40 (27)	77 (29)
Oncologist	10 (9)	9 (6)	19 (7)
Radiation oncologist	20 (18)	15 (10)	35 (13)
Family physician	16 (14)	28 (19)	44 (17)
Other	15 (13)	19 (13)	34 (13)
Frequency of MRI			
Every 2 mo	15 (15)	10 (7)	25 (11)
Every 6 mo	26 (26)	26 (19)	52 (22)
Every year	24 (24)	33 (24)	57 (24)
Every 2 y	1 (1)	9 (7)	10 (4)
Only when there was a concern	4 (4)	2 (2)	6 (3)
>2 y since last MRI	2 (2)	12 (9)	14 (6)

Abbreviation: MRI, magnetic resonance imaging.

All data are from patient self-reports, and they have not been verified with medical records.

The number of patients varies from category to category due to missing data.

[a]Common physician combinations (2 or 3 physicians) included the following: family physician and neurosurgeon (34%); neurosurgeon, radiation oncologist, and neuro-oncologist (24%); family physician, neurosurgeon, and oncologist (19%); and neuro-oncologist, neurosurgeon, and family physician (24%).

TABLE 3.

Tumor Characteristics

Characteristic	Brain, No. (%)	Spine, No. (%)	Sample, No. (%)
Diagnosis			
Ependymoma	67 (59)	88 (59)	155 (59)
Anaplastic ependymoma	25 (22)	8 (5)	33 (13)
Myxopapillary ependymoma	-	37 (25)	37 (14)
Subependymoma	9 (8)	2 (1)	11 (4)
Tanycytic, mixed cell, or giant cell ependymoma	3 (3)	3 (2)	6 (2)
Did not know name	10 (9)	11 (7)	21 (8)
Grade			
1	9 (8)	39 (26)	48 (18)
2	45 (40)	42 (28)	87 (33)
3	28 (25)	14 (9)	42 (16)
Did not know grade	32 (28)	55 (37)[a]	87 (33)
Extent of surgery			
Biopsy	3 (3)	9 (6)	12 (5)
Partial resection	38 (33)	34 (24)	72 (28)
Complete resection	72 (63)	98 (68)	170 (66)
No surgery	1 (1)	3 (2)	4 (2)
Treatment throughout illness			
Radiation	75 (66)	54 (36)	129 (49)
Chemotherapy[b]	27 (24)	15 (10)	42 (16)
Treatment after initial surgery			
Chemotherapy	3 (3)	2 (2)	5 (2)
Radiation	39 (39)	29 (23)	68 (30)
Chemoradiation	16 (16)	6 (5)	22 (10)
Chemotherapy, radiation, and radiosurgery	2 (2)	-	2 (1)
Radiation and radiosurgery	1 (1)	-	1 (.4)
Radiosurgery	-	1 (1)	1 (.4)
None	39 (39)	90 (70)	129 (57)

All data are from patient self-reports, and they have not been verified with medical records.

The number of patients varies from category to category due to missing data.

[a]The value for the spine grade was initially 74 (50%). The grade was revised with the ependymoma variable and the grade variable.

[b]The chemotherapy regimens were as follows: 1) intravenous cisplatin and etoposide for 6 months; 2) vincristine, cisplatin, and a few others; 3) vincristine, Etoposide, and 2 others; 4) Temozolomide for 6 months (1 week every month); and 5) Temozolomide, etoposide, carboplatin, and Bevacizumab.

TABLE 4.

Clinical Characteristics

Characteristic	Brain, No. (%)	Spine, No. (%)	Sample, No. (%)
Presenting symptoms			
Numbness/tingling	27 (24)	101 (67)	128 (49)
Weakness	32 (28)	76 (51)	108 (41)
Headache	72 (63)	27 (18)	99 (38)
Back pain	6 (5)	87 (58)	93 (35)
Radiating back pain	3 (3)	69 (46)	72 (27)
Sleepiness	32 (28)	22 (15)	54 (21)
Memory loss	25 (22)	10 (7)	35 (13)
Nausea/vomiting	46 (40)	7 (5)	53 (20)
Trouble with speaking or writing	21 (18)	9 (6)	30 (11)
Personality change	20 (18)	13 (9)	33 (13)
Seizures	12 (11)	3 (2)	15 (6)
Problems with thinking or completing tasks	30 (26)	12 (8)	42 (16)
Problems with urinating	3 (3)	38 (25)	41 (16)
Visual problems	43 (38)	7 (5)	50 (19)
Sexual dysfunction	4 (4)	21 (14)	25 (10)
Duration of presenting symptoms			
No symptoms	3 (3)	2 (1)	5 (2)
<1 mo	22 (20)	11 (8)	33 (13)
1–2 mo	14 (13)	9 (6)	23 (9)
3–4 mo	17 (15)	14 (10)	31 (12)
5–6 mo	13 (12)	11 (8)	24 (9)
7–11 mo	13 (12)	15 (10)	28 (11)
1–4 y	19 (17)	49 (34)	68 (26)
≥5 y	11 (10)	35 (24)	46 (18)
Condition after initial surgery			
Better	70 (66)	78 (53)	148 (59)
Same	7 (7)	15 (10)	22 (9)
Worse	29 (27)	54 (37)	83 (33)
Postsurgery complications			
Infection	13 (11)	7 (5)	20 (8)
Blood clot	7 (6)	6 (4)	13 (5)
Bleeding in the brain	4 (4)	-	4 (2)
Seizure	13 (11)	2 (1)	15 (6)
Diabetes	2 (2)	5 (3)	7 (3)
Drug allergy	4 (4)	9 (6)	13 (5)
Weakness	39 (34)	66 (44)	105 (40)
Paralysis	13 (11)	29 (19)	42 (16)
Inability to urinate	6 (5)	21 (14)	27 (10)

Characteristic	Brain, No. (%)	Spine, No. (%)	Sample, No. (%)
Incontinence (urine or bowel movements)	2 (2)	28 (19)	30 (11)
Sexual dysfunction	7 (6)	34 (23)	41 (16)

All data are from patient self-reports, and they have not been verified with medical records.

The number of patients varies from category to category due to missing data.

TABLE 5.

Tumor Recurrence

	Brain, No. (%)	Spine, No. (%)	Sample, No. (%)
Recurrence			
No	77 (68)	109 (73)	186 (71)
Yes	36 (32)	40 (27)	76 (29)
Same location			
No	8 (23)	7 (18)	15 (20)
Yes	27 (77)	33 (83)	60 (80)
No. of recurrences			
1	20 (61)	21 (54)	41 (57)
2	9 (27)	6 (15)	15 (21)
>2	4 (12)	12 (31)	16 (22)
Recurrence treatment			
None	5 (14)	3 (8)	8 (11)
Surgery only	5 (14)	13 (34)	18 (25)
Radiation only or radiosurgery	7 (20)	7 (18)	14 (19)
Chemotherapy only	4 (11)	2 (5)	6 (8)
Radiation and chemotherapy	-	1 (3)	1 (1)
Surgery and radiation; surgery and radiosurgery; or surgery, radiation, and radiosurgery	7 (21)	6 (16)	13 (18)
Surgery and chemotherapy	4 (11)	2 (5)	6 (8)
Surgery; radiation and chemotherapy; or surgery, radiation, radiosurgery, and chemotherapy	2 (6)	4 (11)	6 (9)
Radiosurgery and chemotherapy	1 (3)	-	1 (1)
Recurrence symptoms			
Sleepiness	5 (14)	3 (8)	8 (11)
Headache	12 (33)	5 (13)	17 (22)
Memory loss	3 (8)	6 (15)	9 (12)
Nausea/vomiting	4 (11)	3 (8)	7 (9)
Trouble with speaking or writing	1 (3)	2 (5)	3 (4)
Personality change	2 (6)	3 (8)	5 (7)
Weakness	4 (11)	21 (53)	25 (33)
Seizures	2 (6)	1 (3)	3 (4)
Problems with thinking or completing tasks	4 (11)	5 (13)	9 (12)
Numbness/tingling	11 (31)	22 (55)	33 (43)
Visual problems	2 (6)	4 (10)	6 (8)
Back pain	3 (8)	23 (58)	26 (34)
Radiating back pain	1 (3)	15 (38)	16 (21)
Problems with urinating	1 (3)	11 (28)	12 (16)
Sexual dysfunction	-	8 (20)	8 (11)

All data are from patient self-reports, and they have not been verified with medical records.

The number of patients varies from category to category due to missing data.

TABLE 6.

Symptom Severity by Location

	Symptom	
	Brain	**Spine**
No.	104	145
Mean	1.9	2.8
Standard deviation	1.7	2.0
Median	1.5	2.4
Range	0.0–6.8	0.0–8.8
Symptoms endorsed, %		
Mean	44	57
Range	0–91	0–100
Symptoms endorsed as moderate-severe, %		
Mean	18	29
Range	0–82	0–100

All data are from patient self-reports, and they have not been verified with medical records.