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Original Article

Outcomes in spinal ependymoma: A retrospective analysis of 38 patients

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ABSTRACT

Background: Spinal ependymomas are rare central nervous system tumors with an incidence of approximately 1 in 100,000. They comprise 2–6% of CNS tumors, and up to 60% of intramedullary tumors. In this study, we retrospectively analyzed prognostic factors affecting progression-free survival (PFS) and postoperative outcomes for 38 patients.

Methods: Clinical and histological data were collected for 38 patients treated at a single neurosurgical center (2012–2021). Data included presenting symptoms, tumor grade and location, type of management (gross total resection [GTR], subtotal resection [STR], or conservative), use of adjuvant therapy, and outcomes such as PFS and functional status.

Results: Patients averaged 55 years of age, and there was an equal gender distribution. Tumors most commonly occurred in the lumbar spine (58%), and 47% were classified as the World Health Organization Grade II. Pain was the most frequent presenting symptom (79%). GTR was achieved in 58% of patients, STR in 36%, and 13% were managed conservatively. GTR significantly reduced tumor progression compared to STR ($P = 0.008$); no progression was observed in the GTR group. Functional outcomes were better with GTR; 58% of patients showed improvement postoperatively versus 50% in the STR group. Adjuvant therapy was utilized in 18% of cases and showed no significant impact on PFS or functional outcomes ($P > 0.99$). The overall 5-year PFS rate was 75%.

Conclusion: This study underscores the importance of GTR in reducing progression while preserving functional outcomes in spinal ependymoma. Adjuvant therapy remains controversial, with limited evidence supporting its benefit.

Keywords: Ependymoma, Intradural, Outcomes, Spine

INTRODUCTION

Spinal ependymomas have a reported incidence of approximately 1 in 100,000 and account for 2–6% of all central nervous system (CNS) tumors and 30–60% of all intramedullary tumors.[2-5] These tumors typically present with symptoms such as progressive back or neck pain, motor or sensory deficits, gait instability, and bowel or bladder dysfunction. Imaging studies, primarily magnetic resonance imaging (MRI), reveal well-demarcated, contrast-enhancing intramedullary lesions. There are three histological grades of ependymoma based on the World Health Organization CNS fifth version (WHO CNS-5) classification

scheme; pathological analysis requires excision or biopsy to confirm the diagnosis. Treatment typically involves total/subtotal resection (STR), often complemented by adjuvant radiotherapy and/or chemotherapy (i.e., for STR or recurrences).[2,3,5-8] The aim of this study was to investigate the impact of the extent of resection on functional and clinical postoperative outcomes.

MATERIALS AND METHODS

Clinical data

We retrospectively identified 38 adult patients treated for spinal intradural ependymoma at a single neurosurgical center (2012 and 2021). We evaluated 38 patients, with an average age of 55 years. Half were females, and half were males. The median follow-up period was 35 days (range: 6 days–42 months). The most common location being the lumbar region (58%), followed by thoracic (18%), cervical (13%), and 11% were spread across multiple regions. Pain was the most common presenting complaint (79%), followed by paraesthesia (39%), autonomic symptoms (26%), weakness (21%), and paraplegia (5%).

Aims of multidisciplinary meeting (MDT) data analysis

Data from MDT meeting records and operative notes were analyzed to investigate predictors of functional outcome and progression-free survival (PFS). We assessed multiple clinical and histological (i.e., classification WHO CNS-5 grading system)[2] variables. Our evaluation includes tumor location, grade of ependymoma, type of management, surgery (GTR, STR, or biopsy), use of radiotherapy or chemotherapy, and posttreatment functional outcome (McCormick scale Grade I to Grade V). In addition, we looked at MRI findings (no changes, recurrence, or progression) and 5-year PFS rates.

Statistical evaluation

All statistical analysis was conducted using Microsoft Excel (Office 365, Microsoft, Seattle, USA) and RStudio (version – 2022.02.1+461 "Prairie Trillium" Release). Fisher's tests were used to see the effect of the variable on postoperative functional outcome. Kaplan–Meier analysis was performed using the "*survival*" package in R (version 3.3-1) to illustrate the probability of progression of ependymoma over a 5-year period.[8] Pairwise comparisons between the time to progression for each variable were conducted using multiple log-rank tests through the "*survdiff*" function in the "*survival*" package in R (version 3.3-1).[8] $P < 0.05$ was considered statistically significant.

RESULTS

Grade of ependymomas

The most common grade of ependymoma was Grade II (47%), followed by Grade I/myxopapillary (29%) [Table 1]. One patient (3%) presented with both Grades II and III ependymomas. Eight patients (21%) had ungraded ependymomas (i.e., managed conservatively, had passed away before surgery, or their ependymoma grade could not be found in patient records).

Table 1: WHO CNS classification of ependymomas.

Grade	Subtype	Location	Clinical features	Radiological hallmarks	Histological hallmarks
Grade I	Myxopapillary subependymoma	Typically, peripheral or outside the spinal cord	Usually asymptomatic or mild symptoms, such as localized pain - Rarely metastasize	Well-defined lesions, often at the terminal filum (myxopapillary) or intramedullary (subependymoma), with low contrast uptake	Myxopapillary: Papillary structures with a myxoid background Subependymoma: Small, bland nuclei in a fibrillary matrix
Grade II	Classic Clear cell Papillary Tanycytic	Thoracic and cervical regions of the spinal cord	Progressively worsening back pain Neurological deficits (e.g., motor weakness, sensory changes) Rare metastases	Well-demarcated, isointense or hypointense on T1-weighted MRI, hyperintense on T2 with strong contrast enhancement	Classic: Perivascular pseudorosettes Clear cell: Clear cytoplasm Papillary: Papillary architecture Tanycytic: Spindle-shaped cells
Grade III	Anaplastic	Spinal cord (any location, less common overall)	Rapid progression of motor/sensory deficits Higher likelihood of metastasis	Irregular margins, heterogeneous contrast enhancement, often with necrosis and hemorrhage	High mitotic activity, nuclear atypia, necrosis, microvascular proliferation

Summary of ependymoma grades according to the WHO CNS classification, including subtypes, typical locations, clinical features, radiological hallmarks, and histological characteristics. Tumor grades range from Grade I (low grade with limited progression) to Grade III (highly malignant with aggressive behavior)
WHO: World Health Organization CNS: Central nervous system

Table 2: Patient demographics, treatment strategies, and outcomes in spinal ependymoma patients

Variable	Number, *n*=38
Mean age (range)	55 (23–88)
Gender (%)	
Male	19 (50)
Female	19 (50)
WHO grade (%)	
I	11 (29)
II	18 (47)
II/III	1 (3)
Unknown	8 (21)
Ependymoma location (%)	
Cervical	5 (13)
Thoracic	7 (18)
Lumbar	22 (58)
Multiple	4 (11)
Symptom (%)	
Pain	30 (79)
Paraesthesia	15 (39)
Weakness/mobility issues	8 (21)
Paraplegia	2 (5)
Autonomic	10 (26)
Treatment (%)	
Gross total resection	19 (50)
Sub-total resection	12 (32)
Biopsy	1 (3)
Conservative	5 (13)
Unknown	1 (3)
Adjuvant therapy (%)	
Radiotherapy only	6 (16)
Radiotherapy and chemotherapy	1 (3)
Neither	27 (71)
Unknown	4 (11)
Latest scan findings (%)	
No changes	34 (89)
Progression	3 (8)
Recurrence	0 (0)
Unknown	1 (3)
Posttreatment functional status (%)	
Improved	19 (50)
Static	12 (32)
Declined	5 (13)
Unknown	2 (5)
Deceased (%)	
Yes	3 (8)
No	35 (92)

This is a summary of the characteristics, management, and outcomes observed in a cohort of 38 patients with spinal ependymoma (likely referring to anaplastic ependymoma, based on a matching study in the literature)
n: Number, WHO: World Health Organization

Extent of tumor resection and use of adjuvant treatment

Five patients (13%) were treated conservatively without surgery, but the remaining 33 patients were evaluated for the extent of resection, which was classed as GTR in 19 (58%) and STR in 12 (36%) [Table 2]. The majority of patients (71%) received neither adjuvant radiotherapy nor chemotherapy. Of 16% received only radiotherapy and 3% received both radiotherapy and chemotherapy, we could not identify what type of adjuvant therapy was received in 11% of cases. For those receiving radiotherapy, three had undergone GTR and three STR.

Outcome and results

Following surgical treatment, 89% of patients did not experience progression or recurrence of the ependymoma. 8% had progression of the ependymoma, all of which had been treated surgically, and no follow-up progression.

Three out of five conservatively treated patients had progression at last imaging follow-up.

50% of patients who had surgical intervention had improved functional status posttreatment. 32% experienced no changes, and 13% had a decline in functional state following surgery. Posttreatment functional status was unknown in 5% of cases.

Tumor grade had no impact on the improved posttreatment functional outcome (Table 3, $P > 0.99$), postresection.

Outcomes for tumors in different locations

Ependymoma location significantly affected posttreatment outcomes ($P = 0.01$), with patients with ependymoma located in the lumbar region experiencing the most improvement postsurgery.

Outcomes for single versus multiple lesions

There is also a significant difference between patients when separated into single versus multiple site lesions ($P = 0.01$). None of the patients with thoracic ependymomas had improvements.

Outcomes for GTR versus STR

Patients who had GTR did not experience a decline postsurgery, unlike those treated through STR or conservatively, with 8% and 25% having a poorer postoperative function, respectively. However, there was no statistically significant difference in functional outcome with respect to treatment modality ($P = 0.35$).

Outcomes with adjuvant therapy

Adjuvant therapy also did not appear to have a significant impact on functional outcome ($P = 0.15$). Patients who

Table 3: Statistical analysis of patient demographics, treatment strategies, and outcomes in spinal ependymoma patients (as measured by the modified McCormick scale).

Variable	Improvement, *n*=38	*P*-value
Mean age (range)		
Gender (%)		
Male	10/19 (53)	>0.99
Female	9/19 (47)	
WHO grade (%)		
I	8/11 (73)	>0.99
II ".	7/18 (34)	
II/III	1/1 (100)	
Unknown	3/8 (38)	
Ependymoma location (%)		
Cervical	2/5 (40)	0.01*
Thoracic	0/7 (0)	
Lumbar	14/22 (64)	
Multiple	3/4 (75)	
Treatment (%)		
Gross total resection	11/19 (58)	0.35
Sub-total resection	6/12 (50)	
Biopsy	1/1 (100)	
Conservative	1/5 (20)	
Unknown	0/1 (0)	
Adjuvant therapy (%)		
Radiotherapy only	3/6 (50)	0.15
Radiotherapy and chemotherapy	11 (100)	
Neither	15/27 (56)	
Unknown	0/4 (0)	
Latest scan findings (%)		
No changes	17/17 (34)	>0.99
Progression	2/3 (66)	
Recurrence	0/0 (0)	
Unknown	0/1 (0)	

n: Number, *: Significant result, WHO: World Health Organization

were treated with adjuvant therapy did not decline in function posttreatment. 19% of those who received neither radiotherapy nor chemotherapy had poorer function after treatment of their ependymomas.

The overall 5-year progression-free survival (PFS) rate was 75.4% [Figure 1]. Three patients experienced progression of their disease.

Grade and location did not appear to have significant impacts on the progression of ependymoma, [$P = 0.80$ for both]. The average PFS time for Grade I was 49.8, for Grade II was 52.6, and for Grade III was 49.2.

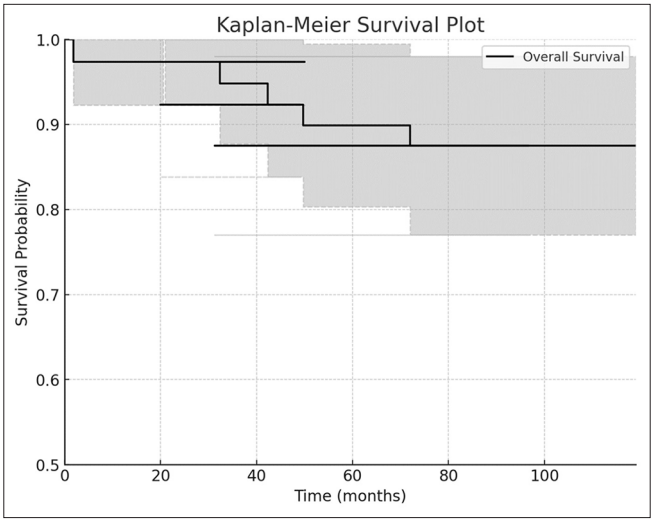

Figure 1: 5-year progression-free survival for all patients. The solid line represents the overall survival probability over time, whereas the dashed lines indicate the confidence intervals. The X-axis represents the time in months, and the Y-axis shows the proportion of patients who remained progression-free. The plot illustrates a decline in PFS over time, with the majority of events occurring within the first 60 months, followed by a stabilization phase.

The only treatment modality with progression was the STR, in which 25% of patients had advancement of the tumor. Indeed, there was a significant difference between GTR and STR with respect to progression ($P = 0.008$). Adjuvant therapy revealed no discernible pattern in relation to the progression of ependymoma ($P > 0.99$).

DISCUSSION

This study evaluated outcomes for intradural spinal ependymomas, rare CNS tumors that typically present with pain (79%), weakness, and are most often Grade II (47%) and lumbar spine (59%) lesions.[1-7] We analyzed the impact of surgical resection and adjuvant therapy, achieving a comparable 5-year PFS of 75%[5-9]

Benefit of surgical GTR

Gross total resection (GTR) demonstrated a clear prognostic benefit over STR, significantly reducing the chance of tumor progression without increasing postoperative functional deficits, aligning with findings from other studies.[2-5]

Role of adjuvant radiotherapy

The role of adjuvant radiotherapy remains unclear. We found no definitive correlation between adjuvant therapy and reduced ependymoma progression. This aligns with literature suggesting that post-GTR radiotherapy does not significantly

impact survival, particularly for Grade II tumors.[10] Guidelines (EANO) recommend postoperative radiotherapy mainly for WHO Grade III or incompletely resected Grade II lesions, indicating a limited benefit in other cases.[6]

These references cover several key aspects related to these tumors:

1. **Diagnosis and Treatment Guidelines:** Reference #6 provides **EANO guidelines** for the diagnosis and treatment of ependymal tumors.
2. **Recent Advances:** Reference #1 discusses **recent advances in intradural spinal tumors** generally.
3. **Surgical Outcomes and Prognostic Factors:** References #2, #4, #5, #7, and #9 examine the **surgical outcome**, **long-term outcomes**, and **prognostic factors** for spinal or intramedullary ependymomas in adults.
4. **Specific Tumor Subtypes/Focus:** References #3 and #7 focus on **intramedullary ependymomas** (those within the spinal cord tissue).
5. **Adjuvant Therapy:** References #5 and the final, unnumbered reference discuss the role of **adjuvant radiation therapy** (or observation) after surgical resection.
6. **Statistical Software:** Reference #8 is a citation for the **R package for Survival Analysis** (survival), which is a statistical tool often used in studies analyzing prognosis and survival (like in references #2, #5, and #9).

CONCLUSION

Our single-center retrospective study showed that ependymomas were most likely to appear in the lumbar region, present with pain, and be histologically classified as WHO Grade II. GTR is associated with a reduced incidence of tumor progression without significantly impacting postoperative functional outcome. The importance of adjuvant therapy remains unclear.

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