



CLINICAL AND SURGICAL CHARACTERISTICS OF POSTERIOR FOSSA TUMORS IN ADULTS – SINGLE-CENTER EXPERIENCE OF SURGICAL MANAGEMENT

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SUMMARY – In contrast to tumors in children, between 6% and 20% of all brain tumors in adults arise solitary in the posterior cranial fossa. Given their rarity in adults, as well as the importance and complexity of their treatment, this paper reviews and discusses the clinical and surgical characteristics of such tumors. In a retrospective single-institution observational study, adult patients with posterior fossa tumors treated surgically over a ten-year period were analyzed. The characteristics observed were age and gender distribution, clinical symptoms, histopathologic tumor type, tumor size, location and extent of surgical resection, tumor recurrence and postoperative complications, as well as surgical outcome. Sixty-six patients who underwent surgical treatment were diagnosed with a tumor in the posterior fossa. The mean age was 63 years, and patients were evenly distributed by gender. The most common histopathologic type was metastatic tumor (59.1%), whereas meningioma was the most common primary brain tumor (16.6%) recorded. Most patients presented with vegetative and cerebellar symptoms in general and cranial nerve palsy, especially in the occurrence of vestibular schwannoma. In conclusion, posterior fossa tumors grow in a confined space and therefore may directly threaten vital centers in their immediate vicinity. Thus, it is crucial to schedule an appropriate surgical intervention as soon as possible, as it can significantly improve treatment outcome and prognosis of the disease. If possible, meticulous total tumor resection should be the treatment of choice. In the case of hydrocephalus, a ventriculoperitoneal shunt should be considered as an alternative surgical option after tumor resection.

Key words: *Cranial fossa, posterior; Outcome; Surgical management; Symptoms; Tumor, infratentorial*

Introduction

Tumors of the central nervous system (CNS) represent a heterogeneous group of pathologic entities with diverse histologic features and clinical symptoms. It is important to note that their incidence rate has

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increased in recent decades¹. The incidence rate of primary brain tumors in adults in the United States is 23.79/100,000 persons². The age-standardized incidence rate of malignant CNS tumors in Western Europe is 5.6/100,000, while the age-standardized mortality rate is as high as 4.0/100,000³.

Although half of pediatric CNS tumors are localized in the posterior fossa, they rarely occur in adults⁴, and they can be localized in any part of the posterior fossa. Given the limited space and volume of the posterior fossa, symptoms are highly dependent on tumor location within the fossa. However, their incidence also depends on the patient's age and tumor type. Due to the risk of brainstem compression posed by the tumor, and due to the possibility of hydrocephalus development, these tumors often require urgent surgery⁵. Current advances in surgical techniques are aimed at more complete and safer tumor resection, which may improve the outcomes and prolong the survival period⁶.

In this paper, we present our case series, discussing the clinical and surgical features of adult posterior fossa tumors in correlation with treatment outcomes. It is based on our ten-year experience in the management of such tumors.

Material and Methods

This was a retrospective observational study conducted at a university hospital in eastern Croatia over 10 years (between January 1, 2005 and December 31, 2015). All adult patients (18 years and older) with a newly diagnosed tumor of the posterior fossa who were treated surgically were included in the study. The following data from medical records were evaluated: demographic data (age, gender), neurological symptoms at admission, tumor size, location and histopathologic type, extent of tumor resection, postoperative complications including hydrocephalus, intraoperative blood loss, tumor recurrence, and treatment outcome. Clinical symptoms are classified into 6 main groups, as follows: increased intracranial pressure (headache, nausea, vomiting), cerebellar signs (balance, coordination and gait disorders, vertigo, nystagmus), cranial nerve deficits (facial nerve palsy, visual disturbances, hearing impairments), motor deficits (mild, moderate, severe), psychosomatic signs (behavioral changes), and disturbance of consciousness.

Preoperative and postoperative performance status was assessed by the Karnofsky Performance Index (KPI). Treatment outcome was assessed by the

Glasgow Outcome Score (GOS) and by the KPI at hospital discharge and at a 3-month follow-up.

Statistical analysis

Category data were presented as absolute and relative frequencies. Numerical data were described by median and interquartile range (IQR). Normality of the distribution of numerical variables was tested using the Kolmogorov-Smirnov test. Comparison between different groups of numerical variables was tested using the nonparametric Kruskal-Wallis test. The correlation of numerical variables with ordinal variables was tested with Kendall's tau coefficient. Differences or correlations between categorical variables were tested with the χ^2 -test or Fisher exact test when necessary.

All p values were two-sided, and the significance level was set at $\alpha=0.05$. MedCalc Statistical Software, version 15.11.4 (MedCalc Software bvba, Ostend, Belgium) was used on statistical analysis.

Data collection and analysis were approved by the local Ethics Committee.

Results

The study included 66 adult patients diagnosed with posterior fossa tumor. Out of the total number of patients, 34 were male and 32 were female (χ^2 -test, $p=0.862$). The median age at diagnosis was 63 (IQR 56.0-70.0) years, with the youngest patient being 22 years old and the oldest 87 years old (Table 1).

Headache was the most common clinical symptom, and it was recorded in 36 (54.5%) patients. Vertigo was present in 34 (51.5%) patients. Other cerebellar symptoms were gait disturbances, which occurred in 27 (41%) patients, and coordination disturbances were observed in 25 (38%) patients. Hearing impairments were recorded in 5 (8%) patients, thus being the most common symptom among cranial nerve deficits (Fig. 1).

A statistically significant deviation in the distribution of the frequency of specific symptoms for each histopathologic tumor type when compared to the distribution of the frequency of total symptoms, was present for metastatic tumor (Fisher exact test, $p=0.039$) and vestibular schwannoma (Fisher exact test, $p=0.028$).

The most common histopathologic tumor type was metastatic tumor, which was observed in 39 (59.1%) patients. Among primary brain tumors, meningioma was found in 9 (13.6%) patients, followed by heman-gioblastoma in 6 (9.1%) and vestibular schwannoma in 5 (7.6%) patients. Other histopathologic tumor types were relatively rare (Table 1).

Table 1. Baseline demographic and clinical characteristics

Gender	
Male	52%
Female	48%
Age, yrs (median [IQR])	63 [56.0-70.0]
Histopathologic tumor type (n)	
Metastasis	39
Meningioma	9
Hemangioblastoma	6
Vestibular schwannoma	5
Ependymoma	2
Pilocytic astrocytoma	2
Medulloblastoma	1
Oligodendroglioma	1
Anaplastic astrocytoma	1
Tumor size (cm)	
Median [IQR]	4.0 [3.0-4.5]
Extent of tumor resection (n)	
Total resection	58
Subtotal resection	8
Ventriculoperitoneal shunt (n)	6
Postoperative complication (n)	
Meningitis	3
Pneumonia	2
Cardiorespiratory arrest	2
Pneumocephalus	2
Urinary tract infection	1
Mortality	3.03%

IQR = interquartile range

Out of 39 patients with metastatic tumors, lungs were the primary tumor site in 25 (64.1%) of them, whereas colon was the primary tumor site in five (12.8%) patients. Other primary sites were relatively rare. Among patients with primary tumor in the lungs, men slightly predominated. Among women, breast cancer was found in 6 (18.7%) patients. Breast was the most common primary tumor site besides lungs, detected in 16 (50.0%) female patients (Fig. 2).

The median tumor size was 4.0 cm in diameter (IQR, 3.0-4.5 cm). The minimum tumor size was 1.2 cm, while the maximum size was 6.0 cm. No statistically significant correlation existed between the histo-

pathologic tumor type and average tumor size. On average, the largest tumors were meningiomas (4.0 cm) and the smallest were neurinomas (3.0 cm).

A statistically significant positive correlation was found between tumor size and treatment outcome assessed by GOS and KPI scores (Kendall Tau=-0.171, $p=0.041$) (Fig. 3).

A relatively strong positive correlation was observed between preoperative Glasgow Coma Scale (GCS) and KPI scores, which was statistically significant ($p<0.001$) (Fig. 4).

There was no statistically significant difference in age, tumor size, GCS, GOS, and KPI scores between patients with and without tumor recurrence.

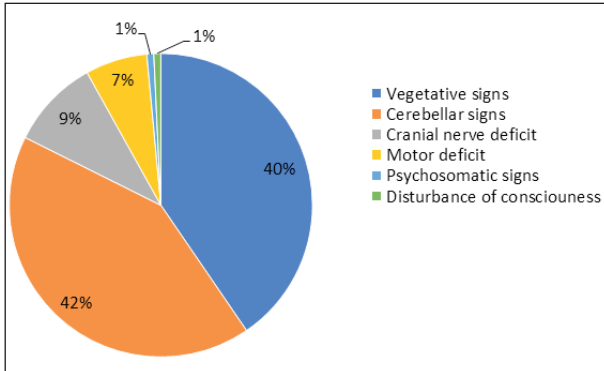


Fig. 1. Distribution of clinical symptoms and signs.

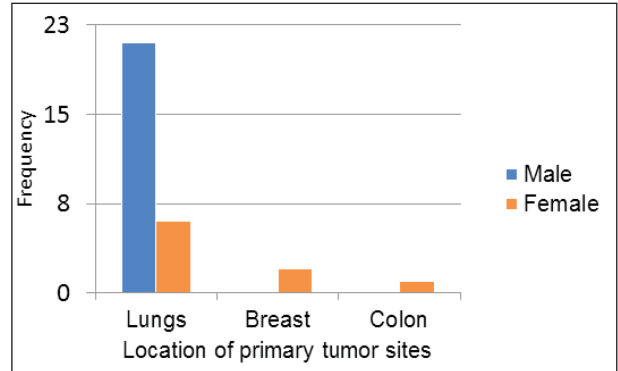


Fig. 2. Gender distribution of primary sites of metastatic brain tumors.

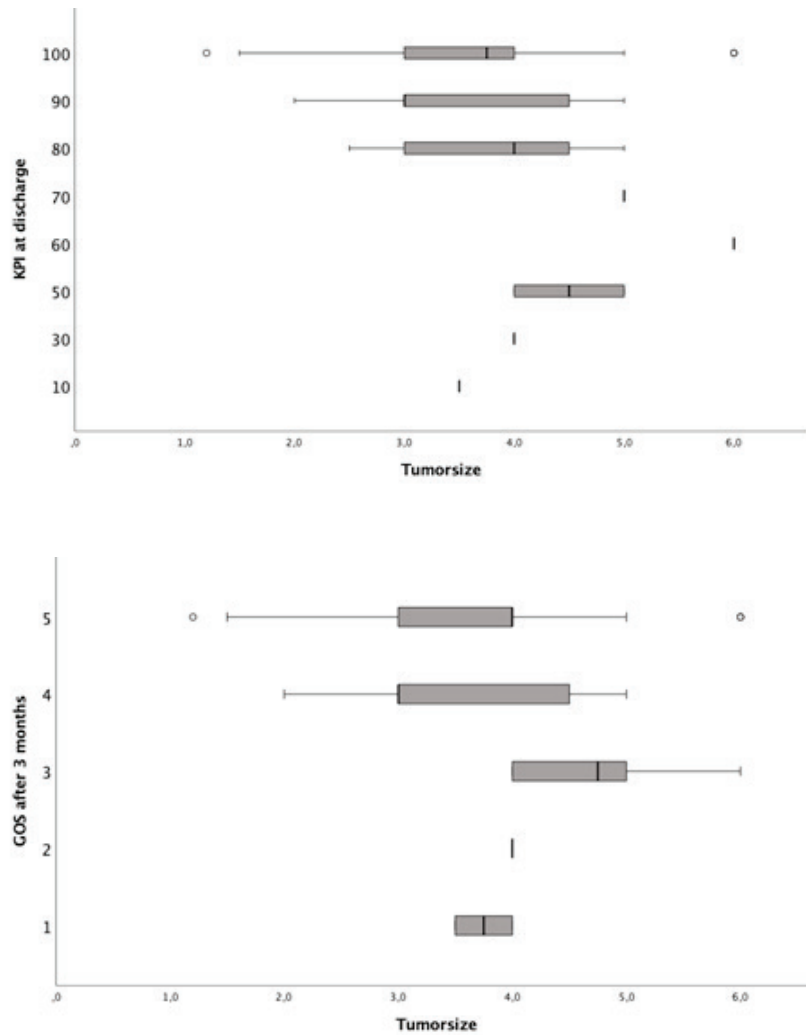


Fig. 3. Correlation between tumor size and KPI (A), and between tumor size and GOS (B).

KPI = Karnofsky Performance Index; GOS = Glasgow Outcome Score

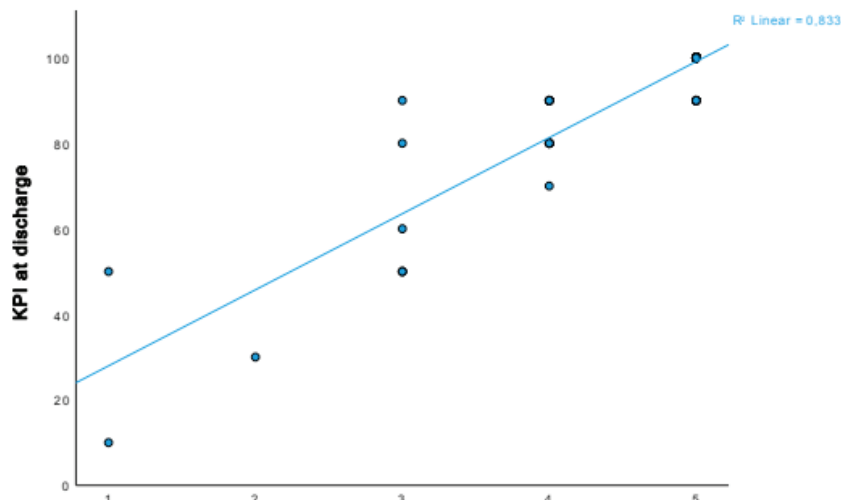


Fig. 4. The Kendall tau correlation coefficient between GOS and KPI.

KPI = Karnofsky Performance Index; GOS = Glasgow Outcome Score

Various postoperative complications occurred in 10 (15.1%) patients. Meningitis was observed in 3 (4.5%) patients, followed by pneumonia and pneumocephalus that occurred in 2 (3.03%) patients each. Two patients suffered fatal cardiorespiratory arrest resulting in a mortality rate of 3.03% (Table 1). The average blood loss was 400 mL, but it was measured in 4 patients only.

Discussion

Although tumors of the posterior cranial fossa are most common in childhood, they can also occur in adults, with adult brain metastases being the most common intra-axial malignancy in this region⁷, along with vestibular schwannoma as the most common extra-axial lesion⁸.

In this case series, 66 adult patients presented with posterior fossa tumors. Histologically, the most common tumor was metastatic tumor, while lung cancer was the most common primary tumor site, regardless of gender. Metastatic tumor was found in cerebellar hemisphere in almost 95% of patients, while in the remaining 5% of cases it was located intraventricularly. This generally coincides with the reported results stating that metastases account for only 6% of intracranial neoplasms intraventricularly and have been reported most commonly with lung and renal carcinoma⁹.

Regarding the primary posterior fossa tumor, in our cohort meningioma was most common, followed by hemangioblastoma. In contrast, Shih and Smirni-

otopoulos report that hemangioblastoma is the most common primary tumor of the posterior fossa, due to a strong predilection for the cerebellum¹⁰. Approximately 25% of these tumors are associated with von Hippel-Lindau disease, an autosomal dominant inherited disease characterized by the development of the CNS and retinal hemangioblastoma^{7,11}.

Despite advances in chemotherapy and immunotherapy in recent decades, surgical resection remains the first choice in the treatment of symptomatic tumor masses in the posterior fossa. In our case series, complete resection was achieved in 88% of patients. In the remaining 12%, subtotal resection was performed because the tumor was located in the proximity of critical cerebellar vessels and nerve structures.

According to some authors, the incidence of symptomatic obstructive hydrocephalus due to posterior fossa tumor is 7.6%⁵. To the best of our knowledge, there are no guidelines for the treatment of obstructive hydrocephalus in adult patients with posterior fossa tumors. The indication for hydrocephalus treatment is based on neuroradiological diagnosis and the presence of symptoms of elevated intracranial pressure after surgery. In our series, 17% of patients had neuroradiologically documented hydrocephalus before surgery, which is a higher incidence than previously reported. Three patients received external ventricular drainage because of radiological signs of ventricular enlargement before tumor resection. Hydrocephalus can also develop after surgery secondary to subtotal tumor resection or increased cerebral edema¹². Prior studies have reported

a rate of hydrocephalus after posterior fossa surgery to be 2% to 7% in adult patients¹³.

Saad *et al.* report that tumor features associated with ventriculoperitoneal (V-P) shunt requirement included intra-axial location, larger size, and presence of multiple infratentorial lesions¹⁴. In our cohort, 10% of patients received V-P shunt postoperatively because of worsening of their neurological symptoms, which were common but not specific, although hydrocephalus was not confirmed in these patients. However, in the early postoperative period after tumor resection, a neuro-radiological diagnosis should be made urgently if clinical deterioration occurs to rule out acute hydrocephalus and other possible complications.

With further development of such tumor diagnostics, as well as with the use of neuronavigation and new surgical techniques, significant progress has been made in reducing the incidence of complications and postoperative mortality. Surgical treatment can lead to complications because tumor can be difficult to approach and can involve cranial nerves and vessels¹⁵.

The potential complications of posterior fossa tumor surgery include lower cranial nerve palsy, cerebrospinal fluid (CSF) leakage, deep vein thrombosis, systemic and local infections, and V-P shunt disruption. Cerebellar mutism syndrome occurs less often compared to the pediatric population¹⁶. To date, only 21 cases of cerebellar mutism syndrome in adults in the postoperative period have been published¹⁷.

The incidence of complications in our series was ~15%, whereas 28-day mortality was 3.03%, which was lower than previously reported^{5,18,19}.

The 30-day failure rate of V-P shunts may be a better indicator of surgical outcome and should be used as a separate outcome measure²⁰. Although shunt placement is associated with a risk of infection (with a revision risk of 13%), especially after posterior cranial fossa surgery, the most common complication in our case series was meningitis, followed by pneumonia, which is consistent with the literature^{18,21}. Infratentorial surgery is also associated with an increased likelihood of CSF leakage, leading to a higher incidence of postoperative meningitis^{22,23}. Bharati *et al.*²⁴ also report a correlation between postoperative complications and adverse neurological outcomes.

Our study showed that KPI ≥ 70 was an independent significant prognostic factor (Fig. 4). In addition, there was also a correlation between tumor size and GOS and KPI scores (Fig. 3). Comparing the 12-month overall

survival rate of metastatic lesions in our case series with previous studies, the results were similar^{25,26}.

This study had several limitations. First, we performed a retrospective study at a single center with a limited number of patients. A certain number of patients were lost to follow up, so the data on complications were somewhat incomplete. Nevertheless, we believe that our study can provide a solid basis for further multicenter prospective research.

In conclusion, since posterior fossa tumors grow in a limited space, they may directly threaten the adjacent vital centers. Therefore, it is crucial to perform the appropriate surgical intervention as soon as possible, which can significantly improve the treatment outcome and prognosis. If possible, total tumor resection should be the treatment of choice. In the case of hydrocephalus, a V-P shunt should be considered as an alternative option after surgery.

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Sažetak

KLINIČKE I KIRURŠKE ZNAČAJKE TUMORA STRAŽNJE LUBANJSKE JAME U ODRASLIH –
INSTITUCIJSKO ISKUSTVO KIRURŠKOG LIJEČENJA

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Za razliku od tumora u djece, samo 6% do 20% svih tumora mozga u odraslih nastaje u stražnjoj lubanjskoj jami. S obzirom na njihovu rijetkost, ali i složenost i važnost liječenja tumora stražnje lubanjske jame u odraslih, ovdje raspravljamo i osvrćemo se na kliničke i kirurške značajke takvih tumora. U opservacijskoj retrospektivnoj studiji analizirani su odrasli bolesnici s tumorom stražnje jame koji su kirurški liječeni tijekom desetogodišnjeg razdoblja. Ispitivane su značajke bile dob i spolna distribucija, histopatološki tip tumora te klinički simptomi, veličina tumora, lokacija i opseg kirurške resekcije, recidiv tumora i poslijeoperacijske komplikacije te uspješnost kirurškog liječenja. Tumor stražnje jame dijagnosticiran je u 66 bolesnika koji su podvrgnuti kirurškom liječenju. Prosječna dob bila je 63 godine, a bolesnici su bili ravnomjerno raspoređeni prema spolu. Najčešći histopatološki tip bio je metastatski tumor (59,1%), dok je meningiom bio najčešći primarni tumor mozga (16,6%). Većina bolesnika imala je vegetativne i cerebelarne simptome te ispad vestibularnog živca u slučaju vestibularnog švanoma. U zaključku, budući da tumori stražnje jame rastu u ograničenom prostoru i stoga mogu izravno ugroziti vitalne centre smještene u njihovoj neposrednoj blizini, ključno je što prije započeti s odgovarajućim kirurškim liječenjem, što može značajno poboljšati uspješnost liječenja i prognozu bolesti. Ako je moguće, precizna i potpuna resekcija tumora treba biti metoda izbora u kirurškom liječenju. U slučaju hidrocefalusa, ventrikuloperitonejska likvorska drenaža može biti alternativa u nadopuni tumorske resekcije.

Ključne riječi: Kirurško liječenje; Lubanjska jama, stražnja; Simptomi; Tumor, infratentorijski; Uspješnost liječenja