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Clinical and epidemiological aspects of meningiomas among intracranial brain tumors

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Abstract. The global literature presents heterogeneous data on the prevalence of meningiomas among intracranial neoplasms. A number of studies indicate that the most common intracranial tumours are meningiomas, gliomas, or metastatic brain lesions. This paper presents the experience of the institution in the treatment of patients with intracranial neoplasms and a comparison of the results obtained with the data published in the literature. The purpose of the study was to evaluate the relative incidence of intracranial meningiomas among all intracranial neoplasms in the Kyrgyz Republic. A retrospective analysis was conducted of 151 consecutive patients treated at the Neurosurgery Clinic of the National Hospital of the Ministry of Health of the Kyrgyz Republic over a 12-month period. All patients underwent neurosurgical intervention, and all tumour samples taken during surgery were subjected to histological examination for a final diagnosis. The study included patients with histologically verified intracranial neoplasms. The authors presented their own experience of diagnosis, treatment, and outcome analysis in patients with meningiomas. In addition, postoperative morbidity and mortality, and the frequency of relapses, were assessed. Given the predominantly benign histological nature of meningiomas, the success of treatment was largely determined by the specific features of the course of the postoperative period. Significant importance was attached to adequate postoperative follow-up of patients. The

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most frequently identified histological types of tumours were meningiomas, gliomas, and pituitary tumours. During the follow-up period, intracranial meningiomas were histologically confirmed in 48 patients (31.8%), pituitary adenomas in 35 (23.2%), and gliomas in 32 (21.2%). The average age of the patients was 43 years, the ratio of women to men was 1.3:1. The highest frequency of referrals occurred in the fifth (27.1%) and sixth (26.5%) decades of life. The maximum age range was in the age groups of 41-50 years and 51-60 years, which accounted for 27.1% and 26.5% of patients and corresponded to the fifth and sixth decades of life, respectively. With age, women account for a higher prevalence of brain tumours, while men account for a higher prevalence in childhood and younger age. The results indicate that meningioma is the most common type of tumour among intracranial neoplasms in the Kyrgyz Republic

Keywords: meningioma; intracranial neoplasm; prevalence; epidemiology

Introduction

Advances in neuroimaging have improved the diagnosis of intracranial neoplasms. This made the preoperative diagnosis of intracranial meningiomas almost reliable. Information about the prevalence of meningiomas in the structure of intracranial neoplasms remains ambiguous. A number of researchers point to the leading position of meningiomas in terms of frequency, while other studies consider gliomas or metastatic brain lesions to be the most common intracranial tumours. Simultaneously, it has been established that meningiomas, as a rule, are characterised by a slow growth rate and account for approximately one third of all primary intracranial tumours [1].

This pathology is more often diagnosed in women. The clinical symptoms of meningiomas are determined by their anatomical location, size, and growth rate. The main treatment method in most cases was surgical intervention, the effectiveness of which largely depends on the degree of radical removal of the tumour. Radiation therapy is used as an adjuvant or alternative treatment method. Radiosurgery using a gamma knife also occupies an important place in therapy, especially for small and/or slow-growing tumours localised in hard-to-reach areas, and in elderly patients [2].

Meningiomas are neoplasms originating from cells of the arachnoid membrane of the brain, and, according to epidemiological data, their proportion of all intracranial neoplasms ranges from 13 to 26%. Population-based studies show that the overall incidence of meningiomas is approximately 6 cases per 100,000 population, and it occurs in women about twice as often as in men. According to the results of large autopsy studies, meningiomas are detected in 1.4% of cases, which is probably due to the presence of clinically asymptomatic forms. In the vast majority of cases, intracranial meningiomas are detected in mature patients, mainly between 40 and 60 years of age, and are extremely rare among children. Multiple forms of the disease are diagnosed in less than 10% of patients [3].

The majority of meningiomas are classified as benign neoplasms and correspond to Grade 1 malignancy according to the World Health Organisation (WHO) histopathological classification. They are characterised by clear boundaries and slow infiltrative growth. Atypical meningiomas, classified as Grade 2 malignancy according to the WHO classification, account for about 5-7% of all cases. Their diagnosis is based on increased mitotic activity or the identification of at least three morphological features, such as high cellular density, the predominance of small cells with an increased nuclear-cytoplasmic ratio, the presence of pronounced nucleoli, leaf-like or continuous growth, and zones of spontaneous or geographical necrosis [4]. Anaplastic meningiomas (Grade 3 malignancy according to the WHO classification) show more pronounced signs of a malignant process, significantly exceeding the changes observed in atypical forms, including pronounced cytological atypia with signs of similarity to sarcomas or carcinomas and a high mitotic index. The proportion of such tumours ranges from 1-3%. In general, the long-term prognosis for meningiomas is considered relatively favourable: according to cancer registries, the five-year relative survival rate exceeds 80%, the ten-year is in the range of 74-79%, and the fifteen-year reaches approximately 70% [5].

The overall survival rates of patients vary depending on a number of clinical and pathological factors, which makes it advisable to separate the analysis of benign and malignant forms of the disease. Thus, the five-year survival rate for benign meningiomas is in the range of 70-90%, while for malignant variants it does not exceed 50%. A more favourable prognosis was noted in patients with a benign course of the tumour process, in women with a neoplasm size of less than 2.5 cm, and in patients who underwent radical surgical treatment without the need for subsequent adjuvant radiation therapy [6]. Therefore, this study examined the prevalence of meningiomas among intracranial neoplasms in Kyrgyzstan. The purpose of this study was to raise awareness about the prevalence of intracranial neoplasms in the Kyrgyz Republic, and to investigate the local neuroepidemiology of such tumours.

Materials and Methods

This was a prospective study conducted at the National Hospital of the Ministry of Health of the Kyrgyz Republic for 12 months. Permission to conduct the research was obtained from the Committee on

Bioethics of Research of the Kyrgyz State Medical Academy named after I.K. Akhunbayev (Protocol No. 12/25 dated 09.12.2025). The study included patients who were followed up at the neurosurgery clinic consistently for 12 months with histologically confirmed intracranial neoplasms.

A questionnaire compiled by the researcher was used to record the details of the patient's personal medical history and clinical data, and the results of relevant studies. Patients received informed consent and were registered in the questionnaire in order. Further, the patients were examined according to the standard protocol for detecting intracranial neoplasms using computed tomography and/or magnetic resonance imaging (MRI). Treatment was prescribed after clinical and X-ray evaluation.

All patients underwent neurosurgical intervention, and all tumour samples taken during surgery were subjected to histological examination for a final diagnosis. All neoplasms were brain tumours, and 11 patients included in the study were diagnosed with tumour recurrence because they had undergone previous surgery (prior to the study) for brain tumours and their histology was similar to the previous result. The authors presented their own experience in the diagnosis, treatment, and outcome analysis of meningioma patients. In addition, postoperative morbidity and mortality, and the frequency of relapses, were assessed. Given the predominantly benign histological nature of meningiomas, the success of treatment was largely determined by the specific features of the course of the postoperative period. Significant importance was attached to adequate postoperative follow-up of patients. In some cases, the tactics of dynamic observation ("wait-and-see") were considered a reasonable management option. The data obtained was analysed using SPSS 21.0. The data was presented in the form of frequency and percentages.

Results

During the 12-month study period, 151 patients with intracranial neoplasms were examined at the Neurosurgery Clinic of the National Hospital of the Ministry of Health of the Kyrgyz Republic. 48 (31.8%) patients had histologically confirmed intracranial meningiomas; 35 (23.2%) patients had glioma and 32 (21.2%) patients had pituitary adenoma (Fig. 1).

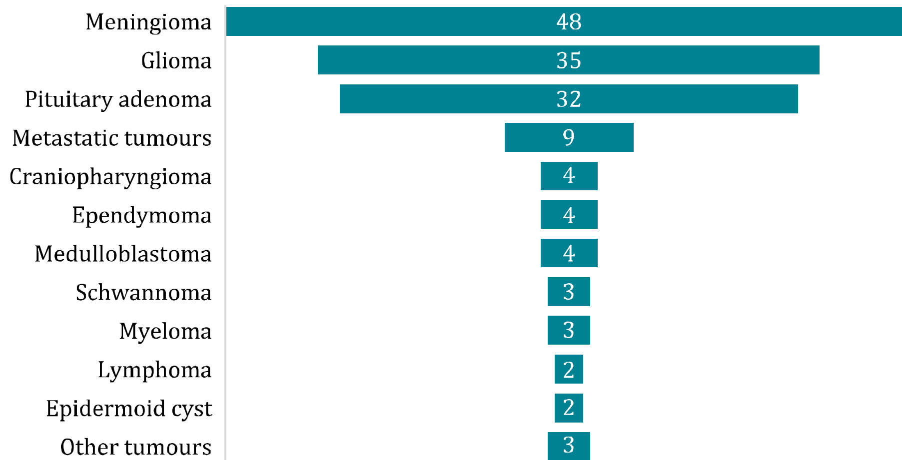

Figure 1. Distribution of brain tumours by occurrence

Source: compiled by the authors

84 (55.6%) patients were women, and 67 (44.4%) were men. The average age of male patients was 41.2 years, while the average age of female patients was 44.4 years. The average age of the patients was 43 years (Fig. 2). Figure 3 shows the distribution of recurrent tumours detected over the entire study period.

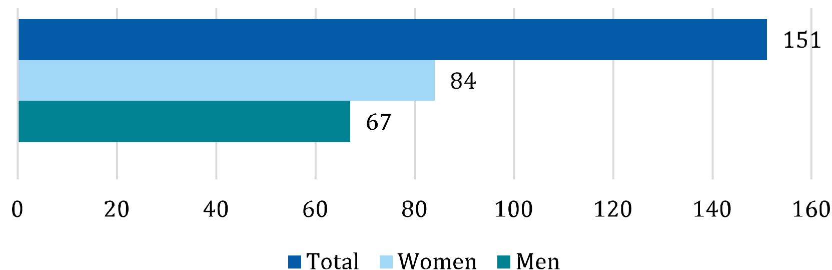

Figure 2. Gender distribution of patients with brain tumours

Source: compiled by the authors

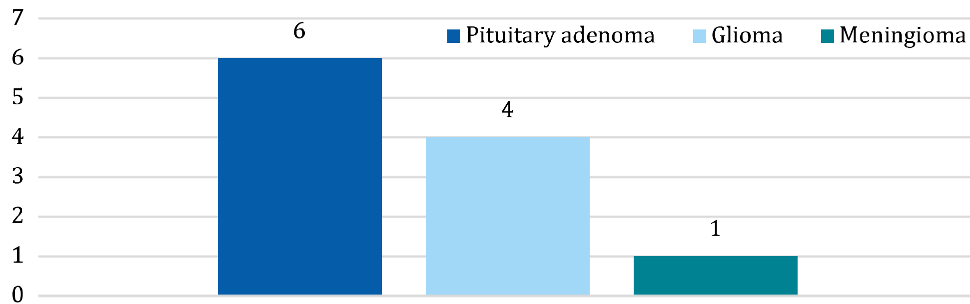

Figure 3. Distribution of patients with brain tumours by the number of relapses
Source: compiled by the authors

The highest representation of patients was observed in the age groups of 41-50 and 51-60 years, which accounted for 27.1% and 26.5% of cases, respectively, which corresponds to the fifth and sixth decades of life. With increasing age, there is an increase in the prevalence of brain tumours among women, whereas in childhood and at a young age, a higher detection rate is typical for men. Surgical intervention remains the main, and in some cases, radical method of treating meningiomas. The main objective of surgical treatment was to remove the tumour tissue as completely as possible while preserving the patient's neurological functions.

In many clinical situations, this is achieved by total resection. To assess the degree of radical tumour removal and predict the risk of recurrence, the Simpson classification, developed in the 1950s, was widely used, which retains its clinical significance to the present day. Simpson Grade 1 resection (S1) involved near-total tumour removal with excision of the adjacent dura mater and was associated with a recurrence rate of approximately 10% over a 10-year follow-up period. However, if the neoplasm is localised in functionally significant or anatomically inaccessible areas of the brain, radical removal may be limited or technically impossible. Simpson Grade 2 resection (S2) was characterised by complete tumour removal without coagulation of the dura mater. The Simpson Grade 3 (S3) approach was used in situations where total excision of the tumour was associated with a high risk of damage to critical anatomical structures such as the cavernous sinus or venous sinus junctions, while maintaining a minimal residual volume of the tumour, potentially suitable for adjuvant therapy. Simpson Grade 4 resection (S4), associated with the highest recurrence rate (up to 40% within 10 years), involved partial removal of the tumour, which, however, can help reduce intracranial pressure and increase the effectiveness of subsequent radiation or radiosurgical treatment (gamma knife, cyber knife) [7].

Simpson Grade 5, which involves performing a biopsy, is currently extremely rarely used and has lost its clinical significance due to the significant development of neuroimaging techniques over the past decades. Surgical treatment of meningiomas often allowed achieving a radical effect, especially in tumours of the first degree of malignancy according to the WHO classification, which were the most common histological variant. Prognostic factors affecting the risk of disease recurrence have been repeatedly analysed in various studies, while the age and gender of patients have not demonstrated statistically significant prognostic significance.

The role of the histological variant of the tumour in predicting recurrence remains controversial. The lack of well-established risk factors for recurrence is also reflected in clinical practice: currently, there are no unified recommendations for postoperative neuroimaging monitoring of patients after meningioma removal. An analysis of the available literature did not reveal any publications devoted to assessing the role of planned postoperative neuroimaging control in this category of patients. There is also no unified protocol for postoperative neuroimaging monitoring in the clinical practice of the organisation [8]. However, in everyday clinical practice, there is a tendency to regularly perform neuroimaging studies in the postoperative period, especially in the early stages of follow-up, regardless of the degree of malignancy of meningioma according to the WHO classification and the volume of surgical intervention determined by the Simpson scale.

The appearance of new clinical signs and symptoms indicating a possible recurrence of the tumour is an absolute indication for imaging, regardless of the degree of the performed resection. In the majority of patients included in the study cohort, postoperative neuroimaging examination was performed as part of routine follow-up, and not according to direct clinical indications. As a result, the recurrence of the tumour process in most cases was detected during routine radiological monitoring before the manifestation of clinical symptoms. Informal consultations with neurosurgeons from other specialised institutions of the republic indicate that similar tactics are widely used in clinical practice.

Discussion

It was estimated that meningiomas account for between 13 and 26% of primary intracranial neoplasms, although early combined results from several large brain tumour studies conducted in hospitals have

shown that the incidence of meningiomas was approximately 20% of all intracranial tumours. However, a recent report from the United States Central Registry of Brain Tumours showed that meningiomas account for approximately 20% of all intracranial tumours. There is a high incidence of meningiomas, which account for 35% of all brain tumours diagnosed in the United States in 2004-2008 [9].

Treatment of meningiomas is one of the key tasks of neuro-oncology, since early diagnosis and timely surgical intervention are necessary conditions for achieving optimal clinical outcomes. According to epidemiological studies, the annual incidence of meningiomas ranges from 2 to 6 cases per 100,000 population. A significant proportion of these tumours are characterised by an asymptomatic course, which causes discrepancies between the indicators obtained based on clinical observations and the results of pathoanatomic studies. The maximum detection rate of meningiomas is over the age of 45 years; at the same time, the disease is significantly more often diagnosed in women, with a sex ratio of about 2:1. However, several publications report a higher prevalence of malignant meningioma variants among males. According to various data, the proportion of meningioma cases in men ranges from 1 to 4%. In this study, meningiomas accounted for 31.8% of all intracranial neoplasms and were the most common tumour among intracranial neoplasms in the studied environment. They were followed in this order by pituitary adenomas, gliomas, and metastatic tumours. The high proportion of meningiomas identified in this study was comparable to the results of recent research performed in Ibadan (35%) and Lagos (30%), and data from the Central Registry of Brain Tumours in the United States, according to which meningiomas account for approximately 35% of all brain tumours and are the most common variant. The results are also consistent with data from a study conducted in Singapore, where meningiomas accounted for 35.1% and ranked first among symptomatic brain tumours in the study population [9,10].

Although there is a low incidence of intracranial tumours among the Japanese people. In a recent study conducted in Japan, meningiomas were the most common tumour. However, the present findings contradict other reports that have shown that gliomas are the most common tumour among intracranial neoplasms. In a recent study conducted in Osaka, Japan, over the last 10-year period from 1995 to 2004, from their 30-year study from 1975 to 2004, it was shown that the age-standardised incidence rates of meningioma decreased significantly, while glioblastoma did not [11]. However, they recommended caution in interpreting the results due to a number of limitations, one of which was the likelihood of underreporting of benign tumours. However, there are several older studies regarding the higher prevalence of gliomas among intracranial neoplasms compared to intracranial meningiomas, which indicate their higher prevalence. In a 55-year study conducted in Denmark, the researchers reported a 3.9-fold increase in the incidence of meningiomas from 1943 to 1997. In contrast, the incidence of gliomas increased only 1.7 times over the same period [12]. In their study, they noted that improved diagnostic methods for gliomas have reached their maximum. However, nothing like this has been observed with meningiomas, which may indicate that meningiomas have not been sufficiently reported until recently.

The low prevalence of recurrent meningiomas may reflect the short duration of the study, as these tumours grow slowly, although this may also reflect a tendency to cure with total tumour resection, since most tumours are histologically benign. However, even with complete tumour resection and the benign nature of these tumours, the recurrence rate of intracranial meningiomas ranges from 10-20% [13]. Metastatic brain tumour, which has also been reported to be the most common type of brain tumour, had a very low prevalence in this study. The low prevalence of metastatic tumours in the present study may be a reflection of the fact contained in most reports that resection of a metastatic brain tumour is usually prescribed to patients with stable systemic disease who are in good neurological condition [14]. Thus, the advantage of histological confirmation of metastatic brain tumours is overlooked in most cases. The results of the present study have shown that intracranial meningiomas are the most common among intracranial neoplasms in Kyrgyzstan, and this is consistent with reports that the incidence of intracranial meningiomas among Asians is high.

An analysis of the literature has not revealed convincing evidence substantiating the current practice of the frequency of postoperative neuroimaging monitoring in patients after surgical removal of meningioma. Surgical treatment of meningiomas is usually considered to be a complex surgical procedure, and therefore postoperative follow-up is of great clinical importance. Moreover, the results of the analysis indicate limited diagnostic effectiveness of regular short-term postoperative neuroimaging monitoring in patients with Grade 1 meningiomas according to the classification of the World Health Organisation (WHO), in whom macroscopically complete tumour removal was achieved (Grade 1-2 resection according to the Simpson scale).

For the majority of such patients, routine postoperative neuroimaging examination currently seems unreasonable [15]. Meningiomas are predominantly benign tumours of extraaxial origin, which, due to the specifics of their biological behaviour, usually do not pose an immediate threat to the patient's life. Morbidity and mortality rates in benign forms of meningiomas can vary under the influence of a number of factors, among which the localisation of the tumour, the degree of radical surgical removal, the patient's age, and the

presence of concomitant diseases play a key role [16]. A number of studies have demonstrated the existence of specific factors associated with the female sex that contribute to a higher incidence of meningiomas among women, which was also confirmed by the authors of the cohort analysis [17].

The clinical picture of meningiomas is largely determined by their location and size. However, a number of symptoms are non-specific and may mimic the manifestations of other diseases, making early diagnosis difficult. In the diagnostic algorithm, the initial examination, as a rule, begins with computed tomography, which allows identifying calcifications, the extraaxial nature of neoplasm growth, displacement of median structures, and intensive accumulation of contrast agent. Despite the high informative value of CT, magnetic resonance imaging with gadolinium contrast is still considered the "gold standard" for imaging meningiomas. MRI usually defines a clear boundary between the tumour and the unchanged brain tissue, which is unusual for malignant intracranial neoplasms and significantly increases the accuracy of diagnosis. In most cases, an arachnoid layer is preserved between the meningioma and adjacent structures, visualised as a cerebrospinal fluid layer, which facilitates surgical intervention. Cerebral angiography is of additional diagnostic importance, which allows assessing the relationship of the tumour with the main vessels and the features of its vascularisation; in a number of clinical situations, this method was also used for therapeutic purposes, in particular, for preoperative embolisation of the supply arteries, which helps reduce intraoperative blood loss.

Moreover, postoperative neuroimaging monitoring in patients with Grade 2 and 3 meningiomas according to the WHO classification seems to be more reasonable, especially in the first years after surgery, which is associated with a significantly higher recurrence rate in this group. Notably, such patients make up a relatively small proportion of the general population of patients with meningiomas, and therefore, the economic costs of subsequent dynamic follow-up in this cohort are significantly lower compared with patients with Grade 1 tumours. In the framework of the present study, the number of patients with Grade 1-3 meningiomas was limited, which does not allow formulating definitive conclusions regarding the optimal frequency of postoperative neuroimaging control [20]. To make sound recommendations, it is necessary to analyse data from a larger sample of patients in this category.

Conclusions

Although the present results may indicate a high prevalence of intracranial meningiomas in the Kyrgyz Republic, this may also be the result of increased detection rates due to increased availability of advanced diagnostic neuroimaging tools in the hospitals, such as CT and MRI. A larger multicentre and long-term study in different regions of the republic may help get a clearer picture of the prevalence of this tumour. The success of meningioma treatment is evidently associated with the extent of surgical resection.

Considering benign types of meningiomas (WHO 1), the authors argue that the lower the extent of resection, the greater the likelihood of tumour recurrence. Age and comorbidities may be other independent predictors of higher morbidity and mortality. However, surgery can also be associated with complications. Thus, the search for the optimal balance between the risk of early complications after surgery and the likelihood of delayed neurological deterioration using the "watch and wait" strategy remains one of the key tasks in choosing a rational treatment strategy for patients with meningiomas.

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Conflict of Interest

None.

References

[1] Bondy M, Ligon BL. Epidemiology and etiology of intracranial meningiomas: A review. J Neurooncol. 1996;29(3):197–205. DOI: 10.1007/BF00165649

[2] Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, Burger PC, Jouvet A, et al. The 2007 WHO classification of tumours of the central nervous system. Acta Neuropathol. 2007;114(2):97–109. DOI: 10.1007/s00401-007-0243-4

[3] Yrysov KB, Arstanbekov NA, Mamytov MM, Akmataliev A, Turganbaev B, Vityala Y. Postoperative complications in patients with intracranial meningiomas who underwent surgery. Biomedicine. 2023;43(3):1023–6. DOI: 10.51248/.v43i3.2886

[4] Mirimanoff RO, Dosoretz DE, Linggood RM, Ojemann RG, Martuza RL. Meningioma: Analysis of recurrence and progression following neurosurgical resection. J Neurosurg. 1985;62(1):18–24. DOI: 10.3171/jns.1985.62.1.0018

[5] Marks SM, Whitwell HL, Lye RH. Recurrence of meningiomas after operation. Surg Neurol. 1986;25(5):436–40. DOI: 10.1016/0090-3019(86)90081-9

[6] Lemée JM, Corniola MV, Meling TR. Benefits of re-do surgery for recurrent intracranial meningiomas. Sci Rep. 2020;10(1):303. DOI: 10.1038/s41598-019-57254-5

[7] Leistner T, Terrapon APR, Hostettler IC, Bozinov O, Zeitlberger AM, Neidert MC. Adverse events in meningioma surgery classified using the therapy-disability-neurology (TDN) grading system. J Neurooncol. 2025;176(2):125. DOI: 10.1007/s11060-025-05312-6
[8] Corell A, Thurin E, Skoglund T, Farahmand D, Henriksson R, Rydenhag B, Gulati S, et al. Neurosurgical treatment and outcome patterns of meningioma in Sweden: A nationwide registry-based study. Acta Neurochir. 2019;161(2):333–41. DOI: 10.1007/s00701-019-03799-3
[9] Ostrom QT, Cioffi G, Gittleman H, Patil N, Waite K, Kruchko C, et al. CBTRUS statistical report: Primary brain and other central nervous system tumors diagnosed in the United States in 2012-2016. Neuro Oncol. 2019;21(5):1–100. DOI: 10.1093/neuonc/noz150
[10] Duba M, Mrlian A, Rošková I, Smrčka M, Fadrus P, Duba J, et al. Neurosurgical treatment and outcome patterns in patients with meningioma in South Moravian region – a population-based study. Neurol Sci. 2024;45(5):2311–9. DOI: 10.1007/s10072-023-07244-3
[11] Oya S, Ikawa F, Ichihara N, Wanibuchi M, Akiyama Y, Nakatomi H, et al. Nation-wide brain tumor registry-based study of intracranial meningioma in Japan: Analysis of surgery-related risks. Neurol Med Chir. 2021;61(2):98–106. DOI: 10.2176/nmc.oa.2020-0304
[12] Lin MC, Li CZ, Hsieh CC, Hong KY, Lin BJ, Lin C, et al. Preoperative grading of intracranial meningioma by magnetic resonance spectroscopy (1H-MRS). PLoS One. 2018;13(11):e0207612. DOI: 10.1371/journal.pone.0207612
[13] Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: What it is and what it isn't. BMJ. 1996;312(7023):71–2. DOI: 10.1136/bmj.312.7023.71
[14] Rogers L, Zhang P, Vogelbaum MA, Perry A, Ashby LS, Modi JM, et al. Intermediate-risk meningioma: Initial outcomes from NRG Oncology RTOG 0539. J Neurosurg. 2018;129(1):35–47. DOI: 10.3171/2016.11.JNS161170
[15] Scheichel F, Popadic B, Kitzwoegerer M, Ungersboeck K, Marhold F. Fluorescence-guided resection in bone and soft tissue infiltrating meningiomas. Acta Neurochir. 2020;162(3):605–11. DOI: 10.1007/s00701-019-04179-7
[16] Wadiura LI, Millesi M, Makolli J, Wais J, Kiesel B, Mischkulnig M, et al. High diagnostic accuracy of visible 5-ALA fluorescence in meningioma surgery according to histopathological analysis of tumor bulk and peritumoral tissue. Lasers Surg Med. 2021;53(3):300–8. DOI: 10.1002/lsm.23294
[17] Dincer A, Morales-Valero SF, Robert SM, Tabor JK, O'Brien J, Yalcin K, et al. Surgical strategies for intracranial meningioma in the molecular era. J Neurooncol. 2023;162(2):253–65. DOI: 10.1007/s11060-023-04272-z
[18] Brastianos PK, Galanis E, Butowski N, Chan JW, Dunn IF, Goldbrunner R, et al. Advances in multidisciplinary therapy for meningiomas. Neuro Oncol. 2019;21(1):18–31. DOI: 10.1093/neuonc/noy136
[19] Gousias K, Schramm J, Simon M. The Simpson grading revisited: Aggressive surgery and its place in modern meningioma management. J Neurosurg. 2016;125(3):551–60. DOI: 10.3171/2015.9.JNS15754
[20] Nanda A, Bir SC, Maiti TK, Konar SK, Missios S, Guthikonda B. Relevance of Simpson grading system and recurrence-free survival after surgery for World Health Organization Grade I meningioma. J Neurosurg. 2017;126(1):201–11. DOI: 10.3171/2016.1.JNS151842