DOI: 10.14744/cm.2025.16362
Compreh Med 2026;18(1):34-39

RESEARCH ARTICLE

Preoperative Challenges in Diagnosing Meningioma-like Dural-based Lesions: A Retrospective Dual-center Study

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ABSTRACT

Objective: This study aimed to evaluate the prevalence of meningioma-like dural-based lesions that were histopathologically diagnosed as non-meningioma tumors, characterize their underlying pathologies, and assess clinical–radiological correlations to improve diagnostic accuracy and patient management.

Materials and Methods: A retrospective dual-center study was conducted, including 210 patients with dural-based lesions resembling meningiomas on MRI between January 2020 and December 2025. Imaging features, histopathological diagnoses, and clinical data were analyzed. Statistical comparisons were performed using univariate and multivariate analyses.

Results: Among the 210 patients, 12.8% (n=27) of lesions initially suspected as meningiomas were histopathologically confirmed as non-meningioma tumors. Metastatic lesions were the most common mimics (63%), followed by high-grade glial tumors (14%), lymphomas (11%), schwannomas (7%), low-grade glial tumors (7%), and primitive neuroectodermal tumors (4%). Homogeneous contrast enhancement and dural tail signs were observed in both meningiomas and their mimics, complicating preoperative diagnosis. Advanced imaging techniques and histopathological examination were critical for accurate differentiation.

Conclusion: A significant proportion of dural-based lesions resembling meningiomas are non-meningioma tumors, with metastatic and high-grade glial neoplasms being the most prevalent. Careful evaluation of imaging features and a multidisciplinary approach, including advanced imaging and histopathological confirmation, are essential for accurate diagnosis and optimal patient management.

Keywords: Differential diagnosis, dural-based lesions, histopathology, intracranial tumors, meningioma, meningioma mimics, MRI

How to cite this article: Tekin A, Can E, Başkurt O. Preoperative Challenges in Diagnosing Meningioma-like Dural-based Lesions: A Retrospective Dual-center Study. Compreh Med 2026;18(1):34-39

INTRODUCTION

Meningiomas are among the most common primary intracranial tumors in adults, accounting for 20–30% of brain tumors.[1] These tumors arise from arachnoid cap cells, are typically dural-based, well-circumscribed, slow-growing, and most often benign in nature. Radiologically, meningiomas usually appear isointense on T1-weighted magnetic resonance imaging (MRI), hyperintense on T2-weighted MRI, and tend to enhance homogeneously after contrast administration. In addition, the "dural tail" sign—thickening of the dura surrounding the tumor following contrast enhancement—represents a characteristic imaging feature of meningiomas.[2–4] However, these classic radiological features may overlap with other intracranial pathologies. Metastatic lesions, high-grade superficially located glial tumors, lymphomas, solitary fibrous tumors (SFTs), hemangiopericytomas (HPCs), neurosarcoidosis, and granulomatous infections are among various dural-based lesions that may exhibit radiological findings similar to meningiomas.[5–10] These similarities can lead to misdiagnosis in the preoperative evaluation process and may cause significant clinical challenges in terms of surgical planning and patient counseling.

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Received date: 11.10.2025
Revised date: 03.11.2025
Accepted date: 22.11.2025
Online date: 23.01.2026

Although advanced imaging techniques (DTI, MR spectroscopy, PET-MR, and perfusion MRI) contribute to the differential diagnosis, in some cases a definitive diagnosis is only possible through histopathological examination.[11–13] Therefore, it is of great importance that every dural-based lesion is evaluated in detail and that the limitations of imaging techniques be kept in mind.

The purpose of this study was to determine the proportion of cases that exhibited classical MRI features of meningioma but were subsequently diagnosed with different histopathological entities, to characterize the non-meningioma pathologies identified, and to evaluate clinical–radiological correlations. The aim was thereby to increase awareness of differential diagnosis among surgeons and radiologists and to improve patient management strategies.

MATERIALS and METHODS

This retrospective, dual-center study included data from 658 patients who underwent surgery for intracranial masses between January 2020 and December 2025 at the Neurosurgery Departments of Kanuni Sultan Süleyman Training and Research Hospital and Memorial Bahçelievler Hospital. The imaging studies of all cases were reviewed to identify features suggestive of meningioma-like lesions. A total of 210 patients who demonstrated dural enhancement resembling the "dural tail" phenomenon adjacent to an extra-axial neoplasm on contrast-enhanced T1-weighted imaging were included in the analysis. For each patient, basic demographic data—including age at surgery, sex, and histopathological diagnosis—were collected from the hospital database.

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Kanuni Sultan Süleyman Training and Research (Approval No: 2025.09.238; Date: 25.09.2025). The requirement for written informed consent was waived due to the retrospective design of the study.

Image Assessment

Imaging was performed using 1.5T scanners, and T1, T2, FLAIR, and gadolinium-enhanced T1 sequences were evaluated. The lesions were assessed in terms of parameters such as size, location, signal characteristics, contrast enhancement pattern, presence of edema, dural tail sign, and bone invasion.

Histopathological Assessment

Pathological examination was performed using hematoxylin–eosin (H&E) staining, and, when necessary, immunohistochemical markers (GFAP, EMA, Ki-67, IDH1-R132H, ATRX, and CD34) were utilized. Glial tumors were graded according to the 2021 World Health Organization (WHO) Classification. In cases of metastatic lesions, the primary focus was identified based on clinical evaluation and systemic screening results.

Data Analysis

The radiological characteristics of the lesions, including size, location, contrast enhancement patterns, signal homogeneity, presence of edema, and bone invasion, were analyzed in detail. Radiological assessments were performed in a blinded manner by an independent radiologist.

Statistical Analysis

A standard descriptive analysis was performed. Where applicable, 95% confidence intervals were calculated using the binomial exact method.

RESULTS

A total of 210 patients with dural-based radiological imaging findings were included in our study. The prevalence of meningioma mimics was found to be 12.8%. The mean patient age was 45.1±20.4 years, and 59.3% of the patients (n=16/27) were female.

According to their locations, the lesions were distributed as follows: parietal region (n=10/27; 37%), frontal region (n=7/27; 26%), temporal region (n=5/27; 19%), posterior fossa (n=3/27; 11%), and occipital region (n=2/27; 7%).

Based on their anatomical classification, the lesions were categorized as convexity (n=17/27; 63%), parasagittal/parafalcine (n=5/27; 19%), skull base (n=2/27; 7%), cerebellopontine (n=2/27; 7%), and spheno-orbital (n=1/27; 4%) (Table 1).

The majority of meningioma-like dural-based masses were metastases (17/27; 63%), comprising 6 breast, 5 lung, 2 gastric, 1 malignant melanoma, 1 papillary thyroid, 1 prostate, and 1 chondrosarcoma. These were followed by lymphomas (3/27; 11%), high-grade glial tumors (4/27; 15%), low-grade glial tumors (2/27; 7%), schwannomas (2/27; 7%), and primitive neuroectodermal tumor (1/27; 4%).

In preoperative MRI imaging of patients with a pathological diagnosis of metastasis, homogeneous contrast enhancement was observed in 10 patients (10/17; 59%), and dural tail-like dural thickening was present in 6 patients (6/17; 35%). In preoperative MRI imaging of patients with a non-metastatic pathological diagnosis, homogeneous contrast enhancement was observed in 8 patients (8/10; 80%),

Table 1. Demographic and anatomical characteristics of patients with non-meningioma dural-based lesions

Variable	Non-meningioma lesions (n=27)	
	n	%
Age (years), mean±SD	45.1±20.4	
Sex, female/male	16/11	
Lesion location		
Parietal region	10	37
Frontal region	7	26
Temporal region	5	19
Posterior fossa	3	11
Occipital region	2	7
Anatomical classification		
Convexity	17	63
Parasagittal/parafalcine	5	19
Skull base	2	7
Cerebellopontine	2	7
Spheno-orbital	1	4

Data are presented as mean±standard deviation or n (%). SD: Standard deviation

Table 2. Radiological and histopathological characteristics of non-meningioma dural-based lesions

Parameter	Non-meningioma lesions (n=27)	
	n	%
Histopathological diagnosis		
Metastasis	17	63
High-grade glial tumor	4	14
Lymphoma	3	11
Schwannoma	2	7
Low-grade glial tumor	2	7
PNET	1	4
MRI characteristics		
Homogeneous enhancement	16	59
Dural tail sign	10	37
Bone invasion	4	15
Peritumoral edema	14	52
Irregular margins	12	44
Multiple lesions	6	22

Percentages are calculated based on the non-meningioma subgroup.
PNET: Primitive neuroectodermal tumor; MRI: Magnetic resonance imaging

dural tail-like dural thickening was present in 4 patients (4/10; 40%), and bone involvement was observed in 2 patients (2/10; 20%) (Table 2). Representative preoperative MRI images of a 37-year-old female patient with invasive ductal breast carcinoma are shown (Figs. 1, 2).

DISCUSSION

This study demonstrates that a significant portion of dural-based contrast-enhancing lesions resembling meningiomas on preoperative MRI are histopathologically non-meningioma tumors. The prevalence of meningioma-like lesions in our series was 12.8%, which is higher than the 7.2% reported by Yamaki et al.[11] This discrepancy may be attributed to our broader inclusion criteria encompassing all dural-based contrast-enhancing lesions, thereby reflecting a wider clinical spectrum.

Metastatic tumors represented the most common meningioma-like masses in our series, accounting for 63% of cases, which aligns with the predominance of breast and lung metastases described by Alali et al.[14] regarding dural invasion and meningioma-like appearance. Moreover, the ability of metastases to exhibit homogeneous contrast enhancement and dural tail signs in 44% of patients further complicates differential diagnosis.[15]

While Alali et al.[14] proposed a diagnostic scoring system to distinguish dural metastases from meningiomas based on imaging criteria, our dual-center design with histopathological confirmation provides real-world validation of these challenges, emphasizing the practical limitations of imaging-based differentiation. As noted by Laidlaw et al.,[16] such radiologic overlap can lead to significant diagnostic pitfalls during preoperative evaluation and surgical decision-making.

In our study, glioblastomas and other high-grade glial tumors were observed in 14% of dural-based masses. This rate is consistent with observations by Romano et al.,[17] who reported that superficially located glial tumors can contact the dura and mimic meningiomas. The potential for high-grade glial tumors, such as glioblastomas, to be mistaken for meningiomas is critically important for prognosis and treatment planning. The large sample size, dual-center design, and histopathological confirmation in our study support these observations, highlighting the importance of careful imaging evaluation and a multidisciplinary approach in clinical practice.

In practice, this multidisciplinary workflow can be implemented through regular joint reviews among radiologists, neurosurgeons, and pathologists for atypical dural lesions. Establishing standardized imaging checklists for meningioma mimics, ensuring histopathological confirmation in

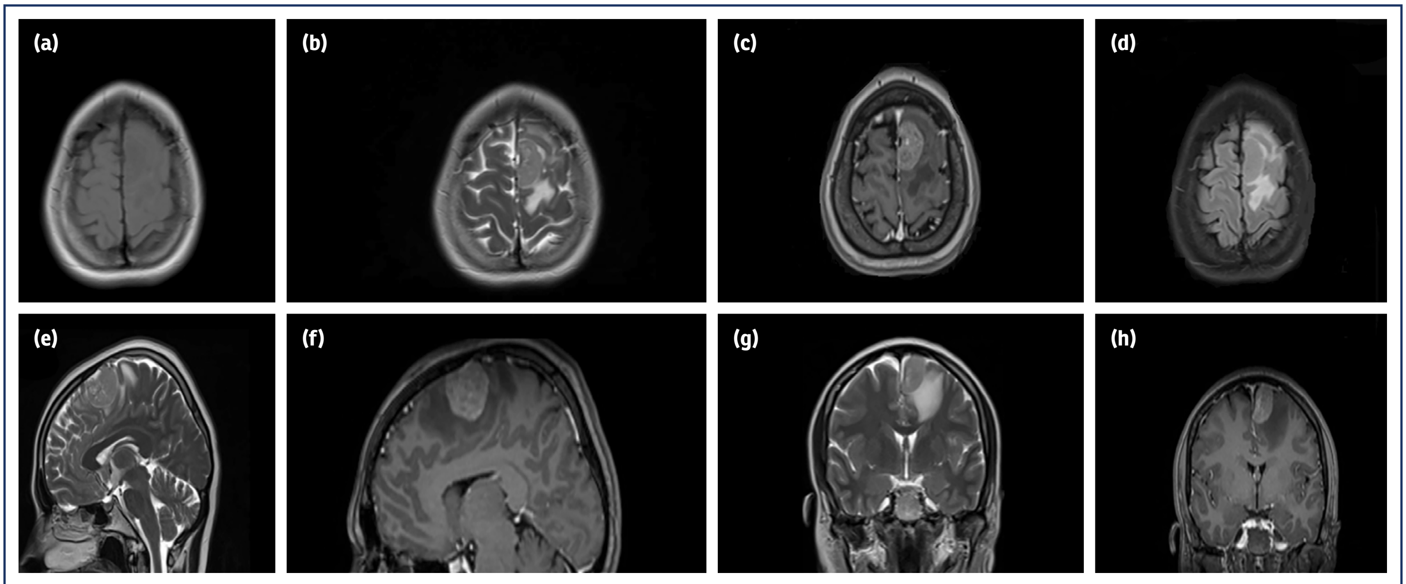

Figure 1. MRI characteristics of a dural-based metastatic lesion mimicking meningioma in a 37-year-old female patient with a history of invasive ductal breast carcinoma. **(a)** Axial T1-weighted image showing an isointense dural-based lesion. **(b)** Axial T2-weighted image demonstrating mild hyperintensity. **(c)** Contrast-enhanced T1-weighted axial image revealing homogeneous enhancement. **(d)** Axial FLAIR image showing perilesional edema. **(e)** Sagittal T2-weighted section displaying dural attachment. **(f)** Sagittal contrast-enhanced T1-weighted image showing a prominent dural tail sign. **(g)** Coronal T2-weighted image illustrating hyperintensity and dural continuity. **(h)** Coronal contrast-enhanced T1-weighted image confirming homogeneous enhancement

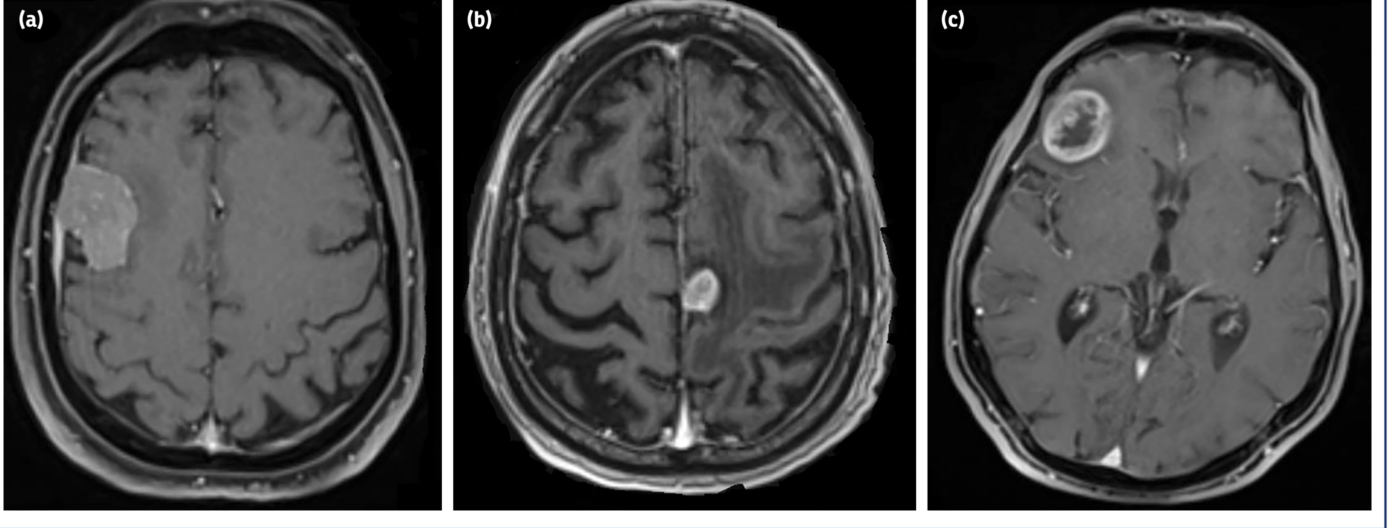

Figure 2. Representative MRI images of dural-based lesions mimicking meningioma. **(a)** Typical convexity meningioma showing a well-defined extra-axial mass with homogeneous contrast enhancement and a broad dural attachment. **(b)** Adenocarcinoma metastasis exhibiting focal dural involvement and intense enhancement, resembling meningioma on preoperative MRI. **(c)** Glioblastoma presenting with irregular ring enhancement, perilesional edema, and indistinct dural interface, mimicking meningioma radiologically

ambiguous cases, and conducting systemic screening when metastasis is suspected may further improve diagnostic accuracy and patient outcomes.

Lymphomas were represented by three cases in our series. As reported by Karschnia et al.,[18] primary central nervous system lymphomas can rarely present on the dural surface and be mistaken for meningiomas. In our series, cases preoperatively diagnosed as meningiomas but histopathologically confirmed as lymphomas were identified. This finding underscores the indispensable role of biopsy in establishing a definitive diagnosis.

Schwannomas and low-grade glial tumors constituted a smaller group (7%) in our study. Additionally, a single case of primitive neuroectodermal tumor was identified. Although rare, these tumors can mimic meningiomas.

Our study demonstrates that many lesions resembling meningiomas, particularly metastatic and glial neoplasms, receive different histopathological diagnoses. Therefore, MRI findings alone are insufficient. Careful evaluation of parameters such as contrast enhancement patterns, signal homogeneity, presence of edema, and bone involvement can enhance diagnostic accuracy. Additionally, advanced imaging techniques such as MR spectroscopy, diffusion tensor imaging, and PET-MR may provide potential contributions to distinguishing meningiomas from their mimics. However, real-world clinical adoption remains limited by availability, protocol variability, and lack of standardization. A pragmatic approach would prioritize MR spectroscopy and perfusion MRI when conventional features are equivocal, reserving PET-MR for cases with suspected receptor-positive meningioma or systemic disease.[5,19,20]

Strengths and Limitations of the Study

The strengths of this study include its dual-center design, large patient cohort, and histopathological confirmation of all cases. However, the retrospective design introduces certain limitations. In particular, the heterogeneous patient population and the lack of advanced imaging modalities in all cases were limiting factors in differential diagnosis. Incomplete follow-up data in some patients may have affected the longitudinal assessment of outcomes. In addition, the inclusion of surgically treated cases may have introduced patient selection bias, potentially inflating the proportion of aggressive or symptomatic pathologies. Heterogeneity in MRI scanner models and acquisition parameters across the two centers could also have influenced image interpretation and feature visibility. Finally, the distribution of histopathological subtypes was imbalanced, which may limit the precision of subgroup comparisons and the generalizability of our findings.

CONCLUSION

This study shows that a significant portion of dural-based contrast-enhancing lesions resembling meningiomas are histopathologically non-meningioma tumors. In our series, the prevalence of non-meningioma pathologies was 12.8%, with metastatic tumors and high-grade glial neoplasms being the most common. Many of these tumors exhibit classic meningioma features, such as homogeneous contrast enhancement and dural tail-like signs, which pose significant challenges in preoperative diagnosis. Adopting a multidisciplinary approach, particularly for metastatic and high-grade glial tumors, will improve patient management and contribute to accurate surgical planning and prognosis determination.

Future prospective multicenter studies are warranted to validate and expand upon these findings using standardized MRI protocols across sites. Such studies should incorporate quantitative scoring systems and perform external validation to assess diagnostic performance in independent cohorts. Evaluating clinical impact—such as changes in preoperative decision-making, time-to-treatment, and cost-effectiveness—will clarify how advanced imaging augments routine practice.

Disclosures

Ethics Committee Approval: The study was approved by the Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee (No: 2025.09.238, Date: 25/09/2025).

Informed Consent: The requirement for written informed consent was waived due to the retrospective design of the study.

Conflict of Interest Statement: There is no conflict of interest between the authors.

Funding: No funding was required to write this article.

Use of AI for Writing Assistance: No artificial intelligence–assisted technology was used in the design, analysis, or writing of this study. The entire manuscript was prepared and reviewed solely by the authors.

Author Contributions: Concept – A.T., E.C.; Design – A.T., E.C.; Supervision –E.C., O.B.; Data collection and/or processing – A.T., E.C., O.B.; Data analysis and/or interpretation – A.T., E.C.; Literature search – A.T.; Writing – A.T.; Critical review – E.C., O.B.

Acknowledgments: The authors thank the Radiology and Pathology Departments of Kanuni Sultan Süleyman Training and Research Hospital and Memorial Bahçelievler Hospital for their valuable assistance in data collection and interpretation.

Peer-review: Externally peer-reviewed.

REFERENCES

1. 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(Suppl 5):v1–100. [CrossRef]
2. Louis DN, Perry A, Reifenberger G, von Deimling A, Figarella-Branger D, Cavenee WK, et al. The 2016 World Health Organization classification of tumors of the central nervous system: A summary. Acta Neuropathol 2016;131:803–20. [CrossRef]
3. Cucu AI, Costea CF, Macovei G, Dumitrescu GF, Sava A, Blaj LA, et al. Clinicopathological characteristics and prognostic factors of atypical meningiomas with bone invasion: A retrospective analysis of nine cases and literature review. Rom J Morphol Embryol 2023;64:509–15.
4. Navarro-Ballester A, Aleixandre-Barrachina M, Marco-Doménech SF. Update on meningioma: Clinical–radiological and radio–pathological correlation. Radiologia (Engl Ed) 2023;65:458–72. [CrossRef]
5. Lyndon D, Lansley JA, Evanson J, Krishnan AS. Dural masses: Meningiomas and their mimics. Insights Imaging 2019;10:11. [CrossRef]
6. Chourmouzi D, Potsi S, Moumtzouoglou A, Papadopoulou E, Drevelegas K, Zaraboukas T, et al. Dural lesions mimicking meningiomas: A pictorial essay. World J Radiol 2012;4:75–82. [CrossRef]
7. Gajaria PK, Shenoy AS, Goel NA. Nonmeningothelial dural-based lesions: A histopathological analysis. Asian J Neurosurg 2023;18:484–91. [CrossRef]
8. Morrison Z, Yeh MY, Hughes J. Diffuse mass-like dural-based neurosarcoidosis with concurrent leptomeningeal involvement: An unusual case presentation and review. Quant Imaging Med Surg 2023;13:6343–6. [CrossRef]
9. Inami K, Tsutsumi S, Hashizume A, Yamataka M, Sugiyama N, Ueno H, et al. Dural-based large B-cell lymphoma masquerading as a tentorial meningioma. Radiol Case Rep 2024;19:1661–5. [CrossRef]
10. Garg S, Gude G, Chatterjee D, Tewari MK, Singla R, Ahuja C. Primary dural acute lymphoblastic leukaemia/lymphoma masquerading meningioma: Report of a case and review of literature. Neurol India 2023;71:987–90. [CrossRef]
11. Nagai Yamaki V, de Souza Godoy LF, Alencar Bandeira G, Tavares Lucato L, Correa Lordelo G, Fontoura Solla DJ, et al. Dural-based lesions: Is it a meningioma? Neuroradiology 2021;63:1215–22. [CrossRef]
12. Scola E, Del Vecchio G, Busto G, Bianchi A, Desideri I, Gadda D, et al. Conventional and advanced magnetic resonance imaging assessment of non-enhancing peritumoral area in brain tumor. Cancers (Basel) 2023;15:2992. [CrossRef]
13. Overcast WB, Davis KM, Ho CY, Hutchins GD, Green MA, Graner BD, et al. Advanced imaging techniques for neuro-oncologic tumor diagnosis, with an emphasis on PET-MRI imaging of malignant brain tumors. Curr Oncol Rep 2021;23:34. [CrossRef]
14. Alali AA, Aljaafary M, AlBaker K. A proposed imaging scoring system to differentiate dural-based metastasis from meningioma using MR and CT images. BMC Med Imaging 2025;25:163. [CrossRef]
15. Nayak L, Abrey LE, Iwamoto FM. Intracranial dural metastases. Cancer 2009;115:1947–53. [CrossRef]
16. Laidlaw JD, Kumar A, Chan A. Dural metastases mimicking meningioma: Case report and review of the literature. J Clin Neurosci 2004;11:780–3. [CrossRef]
17. Romano A, Moltoni G, Dellepiane F, Palizzi S, Romano A, Guarnera A, et al. Dural tail sign and middle meningeal artery hypertrophy in glioblastoma: A rarity? World Neurosurg 2023;176:e240–5. [CrossRef]
18. Karschnia P, Batchelor TT, Jordan JT, Shaw B, Winter SF, Barbiero FJ, et al. Primary dural lymphomas: Clinical presentation, management, and outcome. Cancer 2020;126:2811–20. [CrossRef]
19. Tamrazi B, Shiroishi MS, Liu CS. Advanced imaging of intracranial meningiomas. Neurosurg Clin N Am 2016;27:137–43. [CrossRef]
20. Purandare NC, Puranik A, Shah S, Agrawal A, Gupta T, Moiyadi A, et al. Differentiating dural metastases from meningioma: Role of 68Ga DOTA-NOC PET/CT. Nucl Med Commun 2020;41:356–62. [CrossRef]