International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
NAAS Rating (2026): 4.61
VET 2026; 11(7): 152-156

www.veterinarypaper.com
Received: 19-04-2026
Accepted: 23-05-2026

Tarun Nar Singh
MaxPetZ Hospital Pvt. Ltd, MaxPetZ Hospital, East of Kailash, New Delhi, India

Kunal Dev Sharma
MaxPetZ Hospital Pvt. Ltd, MaxPetZ Hospital, East of Kailash, New Delhi, India

Corresponding Author:
Tarun Nar Singh
MaxPetZ Hospital Pvt. Ltd, MaxPetZ Hospital, East of Kailash, New Delhi, India

Transfrontal craniotomy for surgical removal of frontal meningioma in a canine patient: A case study

Tarun Nar Singh and Kunal Dev Sharma

DOI: https://www.doi.org/10.22271/veterinary.2026.v11.i7c.3589

Abstract
Meningioma is the most commonly diagnosed primary brain tumor in dogs, originating from arachnoid cap cells of the meninges and frequently affecting middle-aged to older, large-breed dogs such as Golden Retrievers. This report describes the successful surgical management of a left frontal/olfactory meningioma in a 9-year-7-month-old neutered male Golden Retriever presented with a two-month history of recurrent seizures. Magnetic resonance imaging revealed an extra-axial cystic mass in the left olfactory and frontal region associated with perilesional edema. Computed tomography and an in-house three-dimensional printed skull model generated from CT-DICOM data were utilized for preoperative planning and identification of surgical landmarks. A transfrontal craniotomy was performed under partial intravenous anesthesia using fentanyl, lidocaine, and propofol continuous rate infusions, enabling complete gross resection of the mass. Histopathological examination confirmed a cystic meningioma, microcystic variant, consistent with a World Health Organization Grade I equivalent tumor. Postoperative recovery was uneventful, with complete resolution of seizures and normal neurological status observed at one-month follow-up. This case highlights the effectiveness of transfrontal craniotomy combined with advanced preoperative planning using three-dimensional printing for the treatment of accessible frontal meningiomas in dogs, demonstrating that early surgical intervention, appropriate anesthetic management, and continued anticonvulsant therapy can result in an excellent short-term outcome.

Keywords: Canine meningioma, transfrontal craniotomy, brain tumor, PIVA, intracranial surgery, Golden Retriever, 3D printing, veterinary neurosurgery

1. Introduction

In recent years, brain tumors in pets have gained more attention in the veterinary world, largely due to advancements in diagnostic imaging, surgical techniques, and post-surgery care. When it comes to dogs, primary brain tumors (PBTs) are typically categorized into two types: extra-axial tumors, which form outside the brain's parenchyma, and intra-axial tumors, which develop from within the brain tissue itself. The most common primary brain tumor found in dogs is meningioma, which originates from the arachnoid cap cells that cover the brain. This tumor type makes up about 34–50% of all canine intracranial tumors [1]. Meningiomas are primarily seen in middle-aged to older dogs, with larger breeds like Golden Retrievers, Labrador Retrievers, and Boxers being notably more affected [2]. Unlike cats, canine meningiomas are often more aggressive at the cellular level, showing a wider variety of subtypes such as meningothelial, transitional, psammomatous, and microcystic variants [1]. Because meningiomas are located outside the brain tissue, they create a natural surgical pathway, making it possible to achieve gross total resection (GTR) when the tumor is located on the periphery and is accessible.

The clinical signs in dogs with these tumors can really differ, largely depending on where the tumor is, how big it is, and the amount of swelling around it. For example, forebrain meningiomas often present with seizures, changes in behavior, circling, and shifts in consciousness [3]. We usually diagnose these tumors using magnetic resonance imaging (MRI), which is the go-to method for spotting intracranial lesions because it provides much clearer images of soft tissues than computed tomography (CT). On an MRI scan, meningiomas

typically show up as bright, contrast-enhancing masses that sit outside the brain, with a broad base on the dura, and they often come with surrounding swelling and pressure effects [4].
There are several treatment options for canine meningioma, including palliative medical management with corticosteroids and anticonvulsants, surgical resection, stereotactic radiotherapy (SRT), or a combination of surgery followed by radiation therapy. Studies indicate that median survival times can vary: with palliative therapy alone, dogs typically survive for about 1 to 6 months; after surgery, they may live around 7 to 10 months; and when surgery is combined with radiotherapy, survival can extend to 16 to 30 months [5, 6]. A recent multicenter retrospective study by Geiger *et al.* [7], which looked at 285 dogs, highlighted the effectiveness of surgical intervention as a primary treatment for intracranial meningiomas in dogs. The transfrontal craniotomy approach is particularly effective, providing direct access to the olfactory bulb and frontal lobe, making it the go-to technique for rostral forebrain meningiomas [8]. This report details the clinical presentation, diagnostic process, surgical management using the transfrontal approach, anesthetic protocol, and the one-month outcome for a Golden Retriever diagnosed with a cystic frontal meningioma at MaxPetZ Hospitals. It also showcases the innovative use of in-house 3D printing from CT-DICOM (Computed Tomography- Digital Imaging and Communications in Medicine) data for preoperative surgical planning.

2. Case Report

2.1 Signalment and History

Juno, a 9-year-7-month-old neutered male Golden Retriever (28 kg), was presented to the Department of Orthopaedics and Neurology, MaxPetZ Hospital, New Delhi, India, with a two-month history of recurrent seizures, totaling four episodes. Between seizures, he remained clinically normal, exhibiting only mild postictal disorientation. There was no history of head trauma, toxin exposure, or significant systemic illness. Prior to referral, seizure management had been initiated with phenobarbital, and levetiracetam was subsequently added to improve seizure control.

2.2 Physical and Neurological Examination

General physical examination was unremarkable, and the dog was bright, alert, and responsive with normal vital parameters. Neurological examination revealed no deficits, with normal mentation, gait, postural reactions, and cranial nerve function. Given the absence of interictal neurological abnormalities, combined with the patient’s age and breed predisposition, a structural forebrain lesion, particularly intracranial neoplasia, was considered the most likely cause of the seizures. Neuroanatomical localization was consistent with the prosencephalon (forebrain), and the primary differential diagnoses included intracranial neoplasia, idiopathic epilepsy (considered less likely because of the late onset), and autoimmune or inflammatory encephalitis.

2.3 Diagnostic Imaging

The dog had a complete blood count (CBC) and serum biochemistry panel done, and everything came back within the normal ranges, which helped rule out any metabolic or systemic reasons for the seizures. The orthogonal thoracic radiographs were also clear, showing no signs of pulmonary metastasis. After that, the dog went through a computed tomography (CT) scan and magnetic resonance imaging (MRI) of the brain. MRI was preferred because it offers better soft tissue resolution. The T_1-weighted post contrast MRI sequences revealed a well-defined, extra-axial cystic mass in the left olfactory and frontal region. This area also showed T_2 hyperintensity, which is consistent with cystic changes, fat, CSF-like fluid, and some surrounding edema and post contrast the lesion showed active contrast uptake suggesting intra axial mass/tumor. The mass was compressing the nearby frontal lobe tissue but didn’t invade it directly. These imaging characteristics were highly suggestive of a meningioma. After discussing various treatment options, such as palliative care with corticosteroids and anticonvulsants, as well as the possibility of surgery alone or in combination with postoperative radiotherapy, the owner decided to go ahead with the surgical resection.

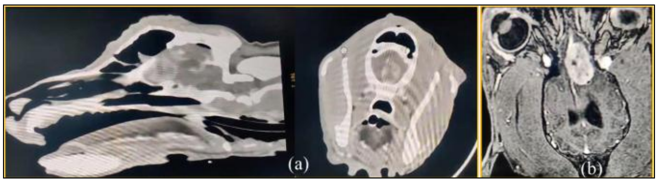

Fig 1: (a) CT scan images (sagittal and axial views) of Juno's skull demonstrating the frontal/olfactory region mass. The left panel shows a sagittal reconstruction; the right panel shows an axial cross-section revealing the extent of the lesion. (b) T_1-weighted post contrast MRI demonstrating the extra-axial cystic mass in the left olfactory/frontal region (hyperintense on T_1 post contrast), with perilesional edema and compression of adjacent frontal lobe parenchyma without parenchymal invasion

2.4 Preoperative Surgical Planning

Preoperative planning was done with great attention to detail, using the patient's MRI images to identify the right surgical site and define important anatomical landmarks. In a creative approach, we imported CT DICOM data into 3D slicing software and printed a life-sized anatomical model of Juno's skull in-house with our dedicated 3D printer. This model was crucial for the surgical team, allowing them to simulate and verify the exact dimensions and positioning of the planned craniotomy window before the procedure, which greatly enhanced our surgical accuracy. We marked the surgical landmarks on the skull model and outlined the diamond-shaped craniotomy window over the frontal bone area.

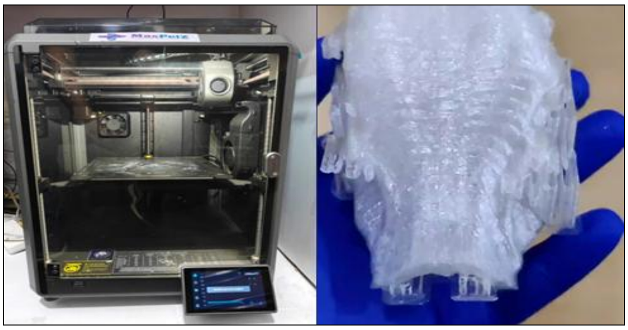

Fig 2: Left: In-house 3D printer used at MaxPetZ Hospitals to fabricate the patient-specific skull model. Right: 3D-printed anatomical skull model derived from CT DICOM data, used for preoperative landmark planning and craniotomy window simulation

2.5 Anesthesia Protocol

Preoperatively, the patient received maropitant, dexamethasone sodium phosphate, cephalexin, fentanyl, and lidocaine. Anesthesia was induced with intravenous midazolam and propofol and maintained using PIVA with fentanyl, lidocaine, and propofol infusions, supplemented with sub-MAC isoflurane to minimize intracranial pressure effects. Lactated Ringer's solution (5 mL/kg/hr) was administered, and mechanical ventilation maintained $EtCO_2$ between 33–40 mm Hg. Body temperature was maintained at 97–100°F, and the patient was continuously monitored for signs of increased intracranial pressure.

Fig 3: Juno positioned in sternal recumbency with head elevated prior to anesthetic induction and surgical preparation

2.6 Surgical Technique

The patient was positioned in sternal recumbency with the head elevated to promote venous drainage and reduce intracranial pressure. Following aseptic preparation, a midline frontal incision was made, and a diamond-shaped craniotomy was created using a sagittal oscillating saw, guided by preoperative imaging and the 3D-printed skull model. Hemostasis was maintained with bone wax, surgical patties, and bipolar electrocautery. After irrigation of the frontal sinus and removal of the internal frontal bone table, the dura mater was incised and reflected, exposing the cerebral cortex and the cystic extra-axial mass.

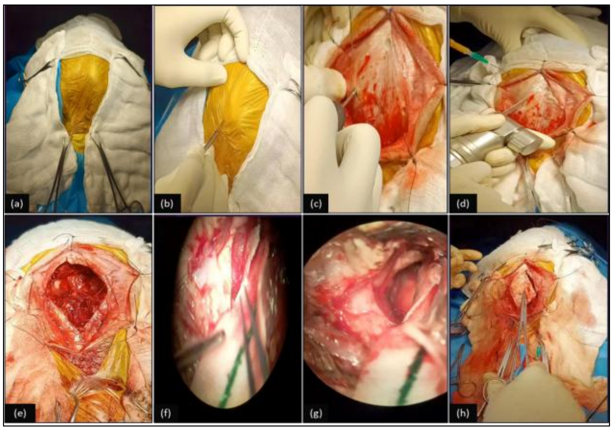

Fig 4: (a) Aseptic draping of the cranial operative field using iodine-impregnated adhesive film (Ioban). (b) Midline frontal skin incision exposing the subcutaneous tissues and frontal bone. (c) Frontal craniotomy with dural exposure and reflected dural flap revealing the frontal lobe. (d) Creation of a diamond-shaped frontal craniotomy using a sagittal saw under continuous irrigation. (e) Intraoperative exposure of the meningioma following craniotomy and dural opening. (f) Magnified view showing tumor–brain interface dissection and bipolar coagulation of feeding vessels. (g) Tumor bed after near-total/gross-total meningioma excision with preserved adjacent neural structures. (h) Layered wound closure following dural repair and bone flap replacement.

The meningioma appeared as a clearly defined, shiny, reddish-tan cystic mass situated in the left olfactory and frontal region, attached to the dura but without invading the brain tissue. With the help of a surgical loupe for better visibility, the tumor was meticulously dissected from the surrounding neural tissue and removed almost completely. Throughout the procedure, careful hemostasis was maintained. The dura mater was closed primarily where feasible, and the bone flap was repositioned before the surgical wound was stitched up in anatomical layers.

2.7 Histopathology

Tissue samples collected from the resected mass were submitted for histopathological examination. Microscopic evaluation revealed a cystic meningioma, microcystic variant, classified as Grade I under the human WHO grading system (the only available reference, as no established veterinary-specific grading system exists for canine meningiomas). The tumor was well-demarcated with a compressive but non-invasive growth pattern. Cystic change was observed in up to 50% of the tumor volume. Mitotic figures were rare and inflammatory infiltrate was minimal, features consistent with a low-grade, benign meningioma.

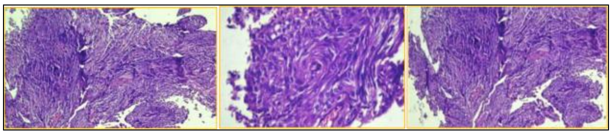

Fig 5: Histopathological sections (H&E stain) of the resected meningioma. Top: low-power view showing the well-demarcated cystic meningioma with characteristic whorling pattern and microcystic change affecting up to 50% of the tumor volume. Bottom panels: higher magnification demonstrating meningothelial cell nesting, minimal mitotic activity, and absence of parenchymal invasion, consistent with WHO Grade I (microcystic variant) meningioma.

2.8 Postoperative Care and Outcome

Following surgery, Juno was maintained on ventilator support, then gradually weaned off and extubated once adequate spontaneous respiration was confirmed. The patient was transferred to the ICU for continuous monitoring. Postoperative analgesia was provided initially with fentanyl/lidocaine CRI, transitioned to buprenorphine. Anti-inflammatory therapy consisted of dexamethasone-SP in the immediate postoperative period, followed by a tapering prednisone course at discharge. Anticonvulsant medications (phenobarbital and levetiracetam) were continued throughout. No postoperative seizures were observed. Juno was discharged from the hospital two days after surgery.

Fig 6: (a) Juno at 12 hours post-surgery voluntarily eating (left) and standing ambulatory in the ICU with Elizabethan collar in place (right), demonstrating rapid neurological recovery with no postoperative seizures. (b) Juno at one-month post-operative follow-up demonstrating strong ambulatory status with normal gait, no proprioceptive deficits, and no seizure recurrence. Anti-inflammatory, antibiotic, and analgesic medications were discontinued; anticonvulsant therapy was continued indefinitely.

3. Methodology

This case was managed at the Department of Orthopaedics and Neurology, MaxPetZ Hospital, following established veterinary neurosurgical standards with informed owner consent. Advanced imaging was performed using a 1.5T MRI unit and a multi-slice CT scanner. MRI included pre- and post-contrast T_1-weighted, T_2-weighted, and FLAIR sequences in multiple planes. CT DICOM datasets were processed using 3D reconstruction software, and patient-specific skull models were fabricated in-house using FDM 3D printing technology to assist preoperative planning and surgical template design.

The surgical team consisted of a board-certified chief surgeon, an associate surgeon specializing in veterinary orthopaedics and neurology, and dedicated anesthesia and nursing personnel. Standard neurosurgical instruments, including a sagittal oscillating saw, bipolar electrocautery, surgical patties, bone wax, retractors, and micro-dissection tools, were used, with surgical loupes providing magnification. Anesthesia was continuously monitored using ECG, blood pressure, SpO_2, $EtCO_2$, body temperature, and anesthetic depth parameters. Postoperatively, the patient was managed in a dedicated ICU with serial neurological assessments. Excised tissue was fixed in 10% neutral buffered formalin, processed routinely, stained with hematoxylin and eosin, and examined histopathologically. Tumor grading was performed according to the human WHO Classification of Tumors of the Central Nervous System, as a validated canine-specific grading system is not currently available.

4. Discussion

This case demonstrates the successful surgical management of a frontal meningioma in an elderly Golden Retriever using a transfrontal craniotomy, resulting in an excellent short-term neurological outcome. Notable features included the use of patient-specific 3D-printed models for preoperative planning, a carefully managed PIVA anesthetic protocol, and favorable postoperative recovery. Meningiomas are the most common primary intracranial tumors in dogs, accounting for approximately 34–50% of cases, and predominantly affect older, large-breed dogs. Their extra-axial and compressive nature often permits complete surgical excision, resulting in a more favorable prognosis than intra-axial tumors. Given the recognized predisposition of Golden Retrievers to intracranial neoplasia, meningioma should be considered a primary differential diagnosis in older dogs presenting with new-onset seizures.

MRI remains the preferred imaging modality for evaluating intracranial lesions in dogs, with T_2-weighted sequences providing excellent visualization of peritumoral edema and cystic changes. Emerging techniques such as dynamic contrast-enhanced MRI (DCE-MRI) have shown promise in differentiating meningiomas from other intracranial tumors through characteristic perfusion patterns. In the present case, the combined use of CT and MRI provided essential anatomical and surgical planning information. A notable feature was the application of in-house 3D printing to generate a patient-specific skull model from CT DICOM data, enabling preoperative surgical simulation and improved procedural accuracy. Recent veterinary studies have demonstrated the value of 3D-printed guides and models in intracranial surgery, including meningioma resection and stereotactic brain biopsy procedures. To our knowledge, this represents one of the first reported applications of patient-specific 3D printing for canine frontal meningioma surgery in the Indian veterinary setting.

The transfrontal craniotomy approach was selected because of the tumor's rostral, extra-axial location within the left olfactory-frontal region, providing direct access to the olfactory bulbs and ventral frontal lobe. This approach is particularly well suited for meningiomas arising in the anterior cranial fossa. In the largest reported series of canine meningioma resections (n = 101), the transfrontal approach was used in 57% of cases. Although a shorter median survival time was reported for transfrontal craniotomy compared with the rostrotentorial approach, the present case demonstrated an excellent short-term outcome, with complete resolution of seizures and no postoperative neurological deficits at one-month follow-up. These findings suggest that early gross total resection of accessible, low-grade frontal meningiomas can yield favorable clinical results.

The anesthetic protocol, consisting of PIVA with fentanyl, lidocaine, and propofol continuous-rate infusions supplemented with sub-MAC isoflurane, was consistent with current recommendations for veterinary intracranial neurosurgery. Maintaining isoflurane below MAC minimizes its dose-dependent cerebral vasodilatory effects and reduces the risk of increased intracranial pressure, while PIVA provides adequate analgesia and anesthetic depth. Lidocaine infusion may further contribute to analgesia and potential neuroprotective effects. Mechanical ventilation was used to maintain $EtCO_2$ between 33 and 40 mm Hg, ensuring normocapnia and helping to optimize cerebral perfusion while preventing both hypercapnia-induced cerebral vasodilation and hypocapnia-associated cerebral ischemia.

The histopathological analysis of the removed mass shows it to be a cystic meningioma, specifically the microcystic variant, which is classified as WHO Grade I. This indicates that it has low-grade, benign characteristics. The fact that there's no invasion into surrounding tissue and a low mitotic index both suggest a positive outlook for recovery. Since there isn't a specific grading system for dogs, the human WHO grading system has been commonly used in veterinary oncology literature [1]. After surgery, it's crucial to provide proper care, which includes a well-structured pain management plan, a gradual reduction of anti-inflammatory medications, ongoing anticonvulsant treatment, and close monitoring in the ICU. A study by Kocher *et al*., looked at the health-related quality of life (HRQOL) in 10 dogs who underwent craniotomy for meningioma removal and found that owners generally reported positive outcomes, highlighting how important supportive care is for enhancing HRQOL. In Juno's case, her quick return to eating and walking within 12 hours after surgery, along with her complete neurological recovery by the one-month mark, showcases an outstanding short-term result [9]. In a recent large-scale study by Geiger *et al*., researchers compared the effectiveness of surgery and radiotherapy in 285 dogs with suspected intracranial meningioma [7]. They found that both treatment methods offer significant survival advantages, with the extent of gross total resection (GTR) being a vital predictor of long-term outcomes [10]. This emphasizes the importance of pursuing surgical options when feasible to achieve GTR. It's also recommended to conduct long-term follow-ups with regular MRI checks to keep an eye out for any recurrence, given that canine meningiomas often have a tendency to regrow locally.

5. Conclusion

This case report details a successful transfrontal craniotomy and nearly complete excision of a Grade I cystic meningioma (microcystic variant) in a 9-year-7-month-old Golden Retriever at MaxPetZ Hospitals. It emphasizes that

meningioma should be a primary consideration when diagnosing older large-breed dogs that are experiencing new-onset seizures. Early advanced imaging techniques, like CT or MRI, are crucial for making a definitive diagnosis and planning the surgery. The use of in-house 3D-printed, patient-specific skull models created from CT data has proven to be a practical and valuable tool for improving surgical accuracy, marking a significant step forward in Indian veterinary neurosurgery. Additionally, the transfrontal craniotomy approach offered excellent access to the rostral extra-axial lesion, allowing for safe tumor removal when executed by a skilled neurosurgical team. A PIVA-based neuroanesthetic protocol that included fentanyl, lidocaine, and propofol constant-rate infusions, along with sub-MAC isoflurane, normoventilation, and careful management of intracranial pressure, ensured stable conditions throughout the operation.
The histopathological examination revealed a low-grade meningioma, highlighting how crucial tumor grading is for predicting outcomes. Generally, tumors classified as WHO Grade I have a good prognosis after complete surgical removal. After surgery, it's important to continue anticonvulsant therapy, have regular neurological check-ups, and conduct MRI scans to keep an eye out for any seizure recurrence or tumor regrowth. This case adds to the growing evidence that surgical treatment can significantly improve the quality of life for dogs with forebrain meningiomas. It also shows that advanced neurosurgical procedures can be successfully carried out at tertiary veterinary centers in India, achieving results that are on par with international standards.

Acknowledgements
The authors sincerely acknowledge MaxPetz Hospital for providing the facilities and support necessary for the successful management and documentation of this case.

Conflict of Interest
The authors declare no conflicts of interest.

Financial Support
Not available

References
1. Miller AD, Miller CR, Rossmeisl JH. Canine primary intracranial cancer: A clinicopathologic and comparative review of glioma, meningioma, and choroid plexus tumors. Front Oncol. 2019;9:1151.
2. Snyder JM, Shofer FS, Van Winkle TJ, Massicotte C. Canine intracranial primary neoplasia: 173 cases (1986-2003). J Vet Intern Med. 2006;20(3):669-675.
3. Kraft SL, Gavin PR. Intracranial neoplasia. Clin Tech Small Anim Pract. 1999;14(2):112-123.
4. Cherubini GB, Mantis P, Martinez TA, Lamb CR, Cappello R. Utility of magnetic resonance imaging for distinguishing neoplastic from non-neoplastic brain lesions in dogs and cats. Vet Radiol Ultrasound. 2005;46(5):384-387.
5. Axlund TW, McGlasson ML, Smith AN. Surgery alone or in combination with radiation therapy for treatment of intracranial meningiomas in dogs: 31 cases (1989-2002). J Am Vet Med Assoc. 2002;221(11):1597-1600.
6. Griffin LR, Nolan MW, Selmic LE, Randall E, Custis J, LaRue S. Stereotactic radiation therapy for treatment of canine intracranial meningiomas. Vet Comp Oncol. 2016;14(S1).
7. Geiger R, Mankin J, Volk HA, *et al*. Comparison of survival after treatment of presumed intracranial meningioma by radiotherapy or surgery in 285 dogs. J Vet Intern Med. 2025;39(2).
8. Bagley RS. Recognition and localization of intracranial disease. Vet Clin North Am Small Anim Pract. 1996;26(4):667-709.
9. Köcher C, Tichy A, Gradner G. Evaluation of the health-related quality of life in dogs following intracranial meningioma resection using a specifically developed questionnaire. Vet Comp Oncol. 2024;22(1):89-95.
10. Rossmeisl JH, Parker RL, Shinn RL, Garcia Mora JK, Cecere TE, Southard T, Robertson JL. Prognostic value of magnetic resonance imaging-defined extent of surgical resection in dogs with intracranial meningiomas. Vet Comp Oncol. 2026.

How to Cite This Article
Singh TN, Sharma KD. Transfrontal craniotomy for surgical removal of frontal meningioma in a canine patient: A case study. International Journal of Veterinary Sciences and Animal Husbandry. 2026;11(7):152-156.