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# Feline meningioma with extensive nasal involvement

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## Abstract

**Case summary** A 9-year-old male neutered domestic longhair cat was presented with a 3 week history of lethargy and pain of unknown origin. A large extra-axial mass was demonstrated on MRI of the head, with cribriform plate destruction, extensive nasal invasion and intracranial expansion, producing a severe mass effect. The mass was isointense on T1-weighted imaging, predominantly hypointense with some hyperintense areas on T2-weighted imaging and fluid attenuation inversion recovery, markedly contrast enhancing, and caused transtentorial and cerebellar herniation. Histopathological evaluation confirmed a transitional (mixed) meningioma.

**Relevance and novel information** To our knowledge this is the first report of a meningioma with extensive nasal involvement in a cat. Based on this case, meningioma should be considered as a differential diagnosis for tumours involving the nasal cavity and frontal lobe with cribriform plate destruction.

**Keywords:** Frontal; intracranial; meningioma; nasal; osteolysis

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## Case description

A 9-year-old male neutered domestic longhair cat was presented with a 3 week history of lethargy and pain of unknown origin. Physical examination was unremarkable and neurological examination revealed alert mentation, markedly low head carriage and hypometria in all limbs, with mild ambulatory monoparesis of the right thoracic limb. Cranial nerves and spinal reflexes were normal. There were mild proprioceptive deficits in the right thoracic limb and severe hyperesthesia was elicited upon cranial cervical palpation. A right C1–C5 myelopathy was suspected, but a brainstem lesion lateralised to the right could not be ruled out. The main differential diagnoses considered included neoplastic (primary or metastatic), degenerative (intervertebral disc disease), and inflammatory or infectious conditions. Haematology and serum biochemistry were unremarkable.

The cat received pre-anaesthetic intramuscular doses of dexmedetomidine (0.005 mg/kg), butorphanol (0.2 mg/kg) and ketamine (1 mg/kg). Intravenous (IV) alfaxalone was used as the induction agent (0.8 mg/kg)

and anaesthesia was maintained with isoflurane (1–2%) and oxygen 100% (1–2 l/min) after intubation.

MRI of the cervical area and brain was performed using a 1.5 Tesla magnet (Philips Intera). All slices were 3 mm thick. Turbo spin echo T1-weighted (T1W), fluid attenuation inversion recovery (FLAIR) were acquired in the transverse plane. Turbo spin echo T2-weighted (T2W) images were acquired in transverse, sagittal and dorsal planes. T1W images after IV administration of gadoteridol (0.1 mmol/kg [Prohance; Bracco Diagnostics]) were acquired in sagittal, dorsal and transverse planes.

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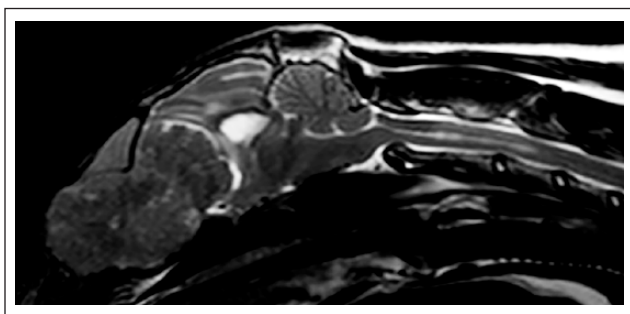
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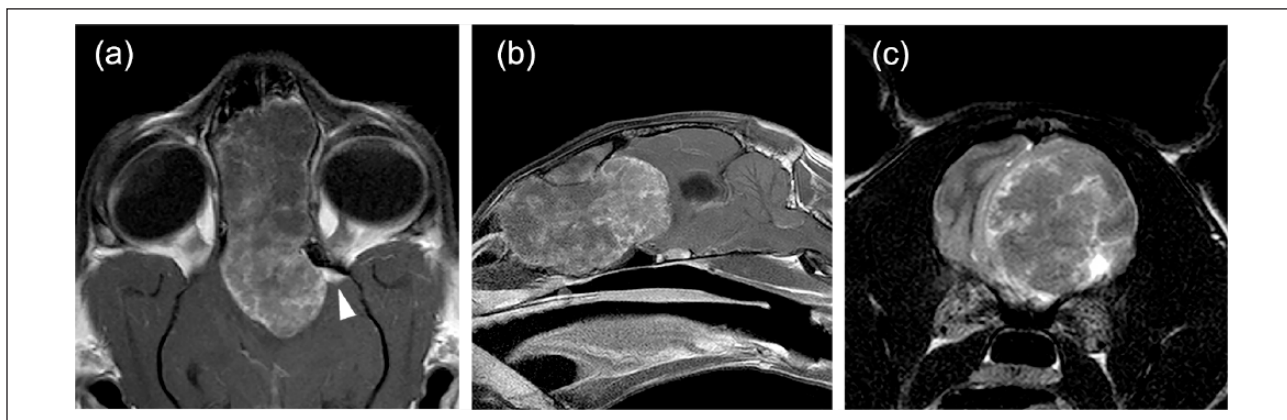
MRI revealed a single large (4.8 cm × 1.7 cm × 2.7 cm) space-occupying mass of extra-axial origin, centred slightly left of midline over an obliterated cribriform plate (Figures 1 and 2). The mass had a lobular appearance (Figure 2). Rostrally, the mass showed extensive nasal invasion, crossing the septum to involve the dorsal nasal passages of both sides, more extensively on the left, and invading the rostral portion of the left frontal sinus. The residual volume of the left frontal sinus contained an accumulation of fluid. There was no orbital involvement. Despite extensive infiltration of the nasal cavity, the periosteal surfaces of the cranial bones appeared smooth and the tumour margins were



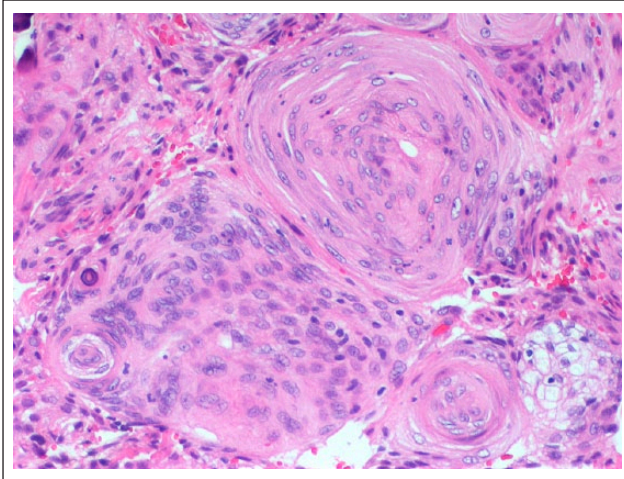
**Figure 1** Sagittal T2-weighted (T2W) MRI of the head and cervical area illustrating a large mass with extensive nasal invasion, destruction of the cribriform plate and intracranial expansion in a cat. The mass was predominantly hypointense with some hyperintense areas on T2W images compared with the grey matter. Note a linear T2W hyperintense lesion throughout the mid-cervical spinal cord, consistent with syringomyelia, which continued caudally to the thoracic spinal cord segments

well defined. Within the cranium, the mass showed a broad base, with destruction of the cribriform plate and marked intracranial expansion, producing a mass effect. The lesion was isointense on T1W images compared with the grey matter, predominantly hypointense with some hyperintense areas on T2W and FLAIR images, and was markedly contrast enhancing. A dural tail bordering the intracranial portion of the mass at its rostral aspect on the left was visible on T1W post-contrast sequences (Figure 2a). A focal area of thickening of the right frontal bone adjacent to the region of meningeal enhancement was suspected to represent an area of hyperostosis. There were moderate perilesional oedema and marked caudal displacement of the brain with midline shift towards the right, resulting in transtentorial and cerebellar herniation (Figure 2b). All ventricles of the brain were moderately and asymmetrically dilated, indicative of an obstructive hydrocephalus. Also, a linear T2W hyperintense lesion throughout the mid-cervical and thoracic spinal cord, consistent with syringomyelia, was observed (Figure 1). The imaging findings were consistent with an expansile neoplastic process centred on the cribriform plate. The main differential diagnoses included olfactory neuroblastoma, lymphoma and soft tissue sarcoma. However, meningioma was also considered owing to the presence of a dural tail sign and local hyperostosis.

Given the extensive nature of the lesion and the poor prognosis, euthanasia was discussed with the owners, but they elected to continue with further investigations owing to the lack of intracranial signs prior to the anaesthesia. Methadone was administered (0.1 mg/kg IV) and nasal biopsies were collected from both nasal cavities blindly using forceps, and were



**Figure 2** Brain MRI T1-weighted post-contrast sequences. (a) Dorsal view. The mass was centred slightly left of midline over an obliterated cribriform plate. The intracranial portion of the mass filled the rostral cranial fossa, and extended into the middle cranial fossa. A dural tail bordering the intracranial portion of the mass at its rostral aspect on the left was visible (arrowhead). (b) Midline sagittal view. The mass displayed extensive nasal, frontal sinus and intracranial invasion, cribriform plate destruction, hydrocephalus and transtentorial and cerebellar herniation. (c) Transverse view. Note the severe displacement of the frontal lobes by the mass, centred left of midline



**Figure 3** Histopathology image illustrating microscopic characteristics of the mass. The nasal mucosa was replaced by a population of spindle-shaped-to-occasionally polygonal cells. Foci of mineralisation were present within them. The infiltrating cells had large, ovoid nuclei, reticulate-to-clumped chromatin, prominent eosinophilic nucleoli and hyaline, and granular or vacuolated eosinophilic cytoplasm with indistinct borders. This was consistent with a transitional (mixed) meningioma. Haematoxylin and eosin stain,  $\times 40$  objective

submitted for histopathological analysis in 10% neutral buffered formalin saline.

The cat's vital signs remained stable throughout the anaesthetic procedure (heart rate 120 beats per min [bpm], mean arterial pressure  $>70$  mmHg). After recovery from anaesthesia, the cat exhibited bradycardia (100 bpm), hypertension (systolic blood pressure 178 mmHg, oscillometric method) and anisocoria. An increase in intracranial pressure was suspected. Intravenous (IV) mannitol (1 g/kg) and an IV anti-inflammatory dose of dexamethasone (0.1 mg/kg) were administered. The cat subsequently recovered, but experienced an epileptic seizure 24 h later. The cat was euthanased at the owners' request; consent for a post-mortem examination was not given.

The biopsies of the nasal cavity revealed infiltration and replacement of the nasal mucosa and turbinates by irregular sheets, intertwining bundles and whorls of spindle-shaped-to-occasionally-polygonal cells. Foci of mineralisation were present within the lesion. The infiltrating cells had large, ovoid nuclei, reticulate-to-clumped chromatin, prominent eosinophilic nucleoli and hyaline, granular or vacuolated eosinophilic cytoplasm with indistinct borders. Mitotic figures were uncommon ( $<1$  mitosis per 10 high-power fields) and occasional apoptotic cells were visible. There were small numbers of neutrophils in some areas (Figure 3). Findings were consistent with a transitional (mixed) meningioma.

## Discussion

Meningiomas are slow-growing, extra-axial, well-defined tumours typically arising from the cells of the arachnoid layer of the leptomeninges. They are the most common intracranial neoplasm in cats,<sup>1</sup> and the rostral tentorial location appears to be most frequent in this species (92.4%).<sup>1</sup> On MRI, they are usually presented as a space-occupying mass lesion, heterogeneously hyperintense on T2W images and iso- or hypointense on T1W images, with homogeneous or heterogeneous contrast enhancement.<sup>2</sup> To our knowledge, this is the first report to describe the MRI features of a feline meningioma with severe destruction of the cribriform plate and extensive involvement of the nasal cavity.

This case presented a diagnostic challenge. According to the literature,<sup>2</sup> it is difficult to predict the histological tumour type for extra-axial masses with these features affecting the frontal lobes. However, nasal tumour and olfactory neuroblastoma are considered to be the most likely differential diagnoses.<sup>2</sup> Despite the marked sino nasal invasion and cribriform plate destruction, the surrounding smooth periosteal surfaces and well-defined margins of the mass suggested a non-aggressive lesion. In addition, the intracranial location of the mass, the presence of calvarial hyperostosis and a dural tail were suggestive of a meningioma. Feline intracranial meningiomas have not been previously reported to cause destruction of the cribriform plate,<sup>1,2</sup> or to occupy the nasal cavity.

Osteolytic behaviour, such as cribriform plate destruction, is rarely described in meningiomas of humans or veterinary species but was a prominent feature of the tumour in this cat. The pathophysiology of meningioma-associated osteolysis is unknown. Invasion by tumour cells, production of proteolytic enzymes, focal necrosis of the bone by pressure atrophy and ischaemia are considered to be possible mechanisms for this change.<sup>3</sup>

Typical MRI characteristics observed in meningiomas include dural tail sign and hyperostosis of the calvarium.<sup>2</sup> The dural tail sign represents an area of contrast enhancement on T1W images extending along the meninges beyond the lesion margins. This has been considered highly suggestive of meningioma;<sup>2,4</sup> however, this imaging feature is not exclusive of this tumour. In veterinary medicine, dural tail sign has been seen in cases of histiocytic sarcoma,<sup>5</sup> adenocarcinoma,<sup>4</sup> lymphoma,<sup>2</sup> leptomeningeal oligodendrogliomatosis,<sup>6</sup> inflammatory fibrosarcoma<sup>7</sup> and choroid plexus tumour,<sup>8</sup> as well as fungal<sup>9,10</sup> and protozoal<sup>11</sup> granulomas.

Meningiomas encountered outside the calvarium are referred as extracranial. They have been described only rarely in the human and veterinary literature, with a reported incidence of 1–2% of all meningiomas in people.<sup>12</sup> Also, there are reports of sinonasal meningiomas with connection to the central nervous system, although they are considered to be rare in humans.<sup>13–16</sup>

When diagnosed, they often display osteolytic and locally invasive behaviour,<sup>14</sup> and appear histologically identical to intracranial meningiomas. There are few reported cases of meningiomas associated with transcalvarial extension through osteolytic skull defects in small animals.<sup>3,17</sup> In the present case, given the typical location of meningiomas in the calvarium, the tumour could represent nasal invasion from an intracranial meningioma. However, a sinonasal meningioma expanding into the calvarium cannot be ruled out.

The clinical signs observed in this patient were likely to be secondary to compression of the motor neuron tracts in the brainstem and possibly a central myelopathy caused by the cervical syringomyelia. The formation of syringomyelia has been described in dogs and cats with brain masses and disturbance of cerebrospinal fluid flow.<sup>18,19</sup> In dogs, syringomyelia has commonly been associated with herniation of the foramen magnum, whereas in cats it is associated with either herniation of the foramen magnum or caudal transtentorial herniation, as in this case.<sup>20</sup> Cats with primary brain tumours are commonly presented with non-specific clinical signs (lethargy, inappetence and anorexia; signs not obviously referred to neurological dysfunction), occurring in 20% of cases in one large study population.<sup>1</sup> In humans and dogs, the frontal, olfactory and piriform lobes have been described as brain 'silent areas'. Growth of a tumour in these locations could result in minimal or no clinical signs,<sup>21</sup> hampering neurolocalisation.

The clinical worsening noted after the anaesthetic recovery might have been related to the anaesthetic procedure. Premedication or certain maintenance agents in animals with intracranial disease might cause blood pressure changes, slow recovery, or excessive sedation and respiratory depression, which can contribute to increased intracranial pressure or clinical deterioration.<sup>22</sup> Also, an increase in intracranial pressure can precipitate brain herniation, which can alter brain haemodynamics. A recent study failed to show a directly attributable association between brain herniation and anaesthetic complications in dogs and cats.<sup>23</sup>

In this case report, the lack of a complete post-mortem examination might have resulted in underestimation of the histological grade of the tumour. Also, a post-mortem examination may have helped to elucidate the anatomical origin of the mass. In humans, histopathology demonstrating exclusive involvement of the outer layer of the dura in a tumour for which the main mass is extracranial, and documenting tumour growth directed from outside to inside the dura, are features considered to be suggestive of a primary extracranial meningioma.<sup>24</sup>

## Conclusions

Although rare, meningioma should be considered as a differential diagnosis for tumours in cats involving the

nasal cavity and frontal lobe with cribriform plate destruction.

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