SHORT PAPER

Microcystic cerebral neoplasia in a Nilgai antelope (*Boselaphus tragocamelus*) – presumed microcystic meningioma

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Summary

Tumours of the nervous system are rare in wild and captive mammals. An intracranial, solid, space-occupying lesion originating from the meninges is described. Histologically, the tumour had a conspicuous microcystic appearance with features similar to the histological subtype of microcystic meningioma described in humans. This is the first such tumour described in a Nilgai antelope.

Keywords: Neoplasia; microcystic meningioma; Nilgai antelope (*Boselaphus tragocamelus*); artiodactyls

Spontaneous neoplasms originating in the nervous system are "relatively rare in most domestic animal species with the exception of the dog and, to a lesser extent, the cat", and

rare in mice and rats (Krinke *et al.*, 2000; Higgins *et al.*, 2017). Although extensive literature research on systematic studies of neoplasms in wild and captive mammals yields a number of articles, only a few mention tumours originating from the nervous system (Newman *and* Smith, 2006; Junginger *et al.*, 2015; Madsen *et al.*, 2017; Pesavento *et al.*, 2018). In contrast, case reports on this type of tumours can be found in greater number (e.g. Akin *et al.*, 2013; Chien *et al.*, 2013). To the authors' knowledge, lymphosarcoma and uterine fibroma are the only types of tumour described in the nilgai antelope (Ratcliffe, 1933; Blake *et al*., 1990). The present study reports a microcystic neoplasia in this species.

A 17-year-old female nilgai antelope (*Boselaphus tragocamelus*) was euthanized because of abnormal behaviour (circling) for one week and loss of weight. Post-mortem examination revealed a space-occupying lesion of grey colour, tightly adhering to the skull vault over an area of approximately 2.5 × 2.5 cm. After separation from the skull vault, the tumour presented as a lesion of the dimensions 5.5 × 4.5 × 3 cm, displacing the adjacent left frontal lobe of the brain (Fig. 1 A). After removal from the brain, and following macroscopic dissection, the cut surface showed a homogenous centre and a peripheral radial pattern (Fig. 1 B). Additional findings at post-mortem included bilateral coxarthrosis and a small chondroma at the left ear.

The tumour was fixed in 10% buffered formalin for 48 hours and processed through graded alcohols and xylene into paraffin, for routine histological investigation. 4 µm sections were prepared and stained with haematoxylin-eosin (H&E), Congo red, von Kossa and periodic acid-Schiff (PAS). Frozen sections were prepared at 14 µm thickness and stained with Sudan red.

The most conspicuous histological finding in this tumour was the formation of a widespread network of cysts (Fig. 1 C). These cysts were lined by elongated flat cells (Fig. 1 D, H&E) and contained finely granular and faintly eosinophilic material (not stained in PAS). In areas of solid growth, the tumour cells formed lobules of rudimentary meningothelial whorls.

Occasional microcalcifications were present across the tumour. Tumour-cells showed a bland nuclear morphology, with small, round or elongated nuclei and granular chromatin with occasional intranuclear vacuoles, and an eosinophilic cytoplasm. Some cells had cytoplasmic vacuoles (not stained with Sudan red), which occasionally merged to larger void spaces. Mitotic figures could not be identified. There was a widespread invasion of adjacent brain tissue by tumour lobules (Fig. 1 E).

The histological features of the present tumour are consistent with descriptions of the "microcystic meningioma", a rare variant of meningioma both in domestic animals and man (Ng *et al*., 1989; De Jesus *et al*., 1995; Montoliu *et al*., 2006; Matano *et al*., 2013; Velázquez Vega *and* Rosenberg, 2015, Higgins *et al*., 2017). Several of differential diagnoses were considered. Both the macroscopic presentation as space-occupying lesion adherent to the dura and skull, displacing the brain tissue, and the histologic features exclude intrinsic/primary tumour types such as pilocytic astrocytoma and (anaplastic) oligodendroglioma with possible cystic or microcystic histological appearance (Engelhard *et al*., 2002; Collins *et al*., 2015; Higgins *et al*., 2017). Angiomatous meningioma can occasionally present with cystic changes, but the current tumour did not have a prominent vasculature (Higgins *et al*., 2017; Yang *et al*., 2020).

Microcystic meningioma is classified as a neoplasm with low risk of aggressive growth/recurrence, i.e. corresponds to World Health Organization (WHO) grade I (Perry *et al*., 2016; Higgins *et al*., 2017). However, meningiomas with brain invasion, such as the present tumour, are reported as atypical meningioma with brain invasion, WHO grade II, due to the fact that brain-invasive meningiomas show a higher recurrence rate. Importantly, recent advances in molecular characterisation of human meningiomas have now identified genetic and epigenetic changes that predict growth pattern and recurrence risk much more reliably than classical histology, requiring additional molecular workup with genomic and epigenetic test methods (Sahm *et al*., 2017; Nassiri *et al*., 2019). However, the epigenetic classification,

based on changes in methylation of sequences of DNA with elevated levels of cytosine-phosphate-guanine dinucleotides (CpG islands), determined with bead chips and classified using machine learning tools, is only established for human tumours and cannot be applied for tumours arising in other species (Capper *et al*., 2018). Such risk stratification has become of increasing relevance for the prognostication of tumours, including meningiomas, in human patients and can on some occasions supersede the histological grading.

Conflict of Interest Statement

The authors declare no conflict of interest with respect to publication of this manuscript.

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Figure legends:

Fig. 1: Macroscopic and microscopic findings: A, Macroscopic view of the tumour overlying the left frontal lobe. B, Cut surface of the tumour showing a homogenous centre and a peripheral radial pattern. C, Low power magnification of the tumour, showing widespread cystic changes. D, High power magnification of the tumour shows meningothelial elements, characteristic of meningioma, and thin-walled cysts, lined by elongated flat cells. E, Brain invasion of the tumour, with brain parenchyma on the left upper part and tumour on the right

lower part. All histological sections stained with haematoxylin and eosin. Scale bar corresponds to 500 µm (C), 50 µm (D), and 100 µm (E).