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Magnetic Resonance Imaging and Histological Findings of Paranasal Sinus Tumors and Surgical Outcomes in Dogs and Cats

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Abstract

Objective of this study was to report Magnetic resonance imaging (MRI) features of histologically confirmed paranasal sinus tumors and surgical outcomes. Totally 17 dogs and 3 cats were included in the study. Medical records of dogs and cats which were presented between January 2008 and November 2015 due to paranasal sinus tumors were reviewed. Dogs and cats were included if they have full clinical findings, diagnosed by MRI, confirmed histologically, and treated just surgically. Collected data for sex, breed, age, tumor stage, localisation, surgical outcomes, histological diagnosis, survival time and cause of death were included. Soft tissue mass within the nasal cavity replacing the nasal conchae and/or ethmoturbinates and mass invading to the frontal sinuses were determined in 80% (n=16) of the cases in MRI. Nasal and/or frontal bones were destructed in 65% (n=13) of the cases. In 7 dogs bone flap was created to expose and remove the tumor, and the flap was replaced wired after operation. In 10 dogs and 3 cats frontal and/or nasal bone was involved by the tumor, and closure of the defects was carried out with PMMA and wire. In this case series 50% of the tumors were sarcomas, and it was followed by adenocarcinoma (20%) and neuroesthesioblastoma (15%) in decreased rates. Dedicated MRI examination is crucial for diagnosis of paranasal sinus tumors, and surgical intervention as sole treatments looks acceptable for providing better quality of life for certain time.

Keywords: Cat; Dog; MRI; Paranasal sinus tumour

Introduction

Tumors of nasal cavity and paranasal sinuses in dogs comprise approximately 1-2% of all canine neoplasia and most of them are malignant, and have poor prognosis [1-3]. Also feline nasal and paranasal tumors are rare, approximately 1% of all feline tumors reported [4]. These tumors have a slow rate distant metastases, but they are locally invasive to bone and cartilage. Most of the nasal tumors in dogs occure in the caudal two-thirds of the nasal cavities and generally extend into frontal and paranasal sinuses. Epitelial tumors which are different type of carcinomas constitute 51 to 75% of nasal tumors. The remaining tumors mostly originate from connective tissue, cartilage or bone [5-8]. Dolichocephalic and mesocephalic breeds are more prone to nasal tumors [1].

Mucopurulent or hemorrhagic nasal discharge, epistaxis, nasal dyspnea, sneezing, epiphora, facial deformity and exophthalmos are the general symptoms of the nasal tumors. In addition to these sypmtoms if the tumor extends to the brain, neurologic signs may occur. Altered mentation, seizure and behavioral changes are the most common symptoms due to tumor invasion to the brain [9].

Diagnostic approach to paranasal tumors directed with history, physical and clinical examination, radiography, Computed Tomography (CT), MRI, rhinoscopy, cytology and histology [10-12]. CT is advantageous in detecting bone destruction and soft tissue involvement. MRI has advanced soft tissue contrast, multiplanar imaging capacity, and lack of radiation and bone beam-hardening artefact [13].

Therapy is based upon local disease control, and it involves surgery [14], chemotherapy [15], radiation therapy [3,16] and immunotherapy, or combination [9,17]. Although surgical approach to those tumors is not suggested by some authors, it still retains its place in selected cases [14]. The objective of this study is to report the clinical, MRI, histopathological findings and surgical outcomes of the paranasal sinus tumors of dogs and cats.

Materials and Methods

Animals

Medical records of dogs and cats which were presented to Ankara University Faculty of Veterinary Medicine Department of Surgery Clinic between January 2008 and December 2015 due to nasal and paranasal sinus tumors were reviewed. Dogs and cats were included if they have clinical examination findings, diagnosed by MRI, confirmed histologically, and treated with surgery as sole treatment, and the patients which were treated by combination of chemotherapy or radiotherapy with surgery were excluded. Records of the cases were reviewed for sex, breed, age, tumor stage, localisation, surgical outcomes histological diagnosis, survival time and cause of death.

Diagnostic imaging

MR scan was performed for each animal under general anesthesia which was achieved by medetomidine 80 µg/kg iv and ketamine HCl 5 mg/kg iv with a 1.5 Tesla MRI unit (Vision plus, Siemens, Erlangen, Germany). T1-weighted, T2-weighted and contrast-enhanced T1-weighted images of the nasal cavities and paranasal sinuses (Figure 1) were acquired in the dorsal, transverse and sagittal planes. Gadolinium diethylen-etriaminepentaacetic acid (Magnevist, Bayer, Germany) was

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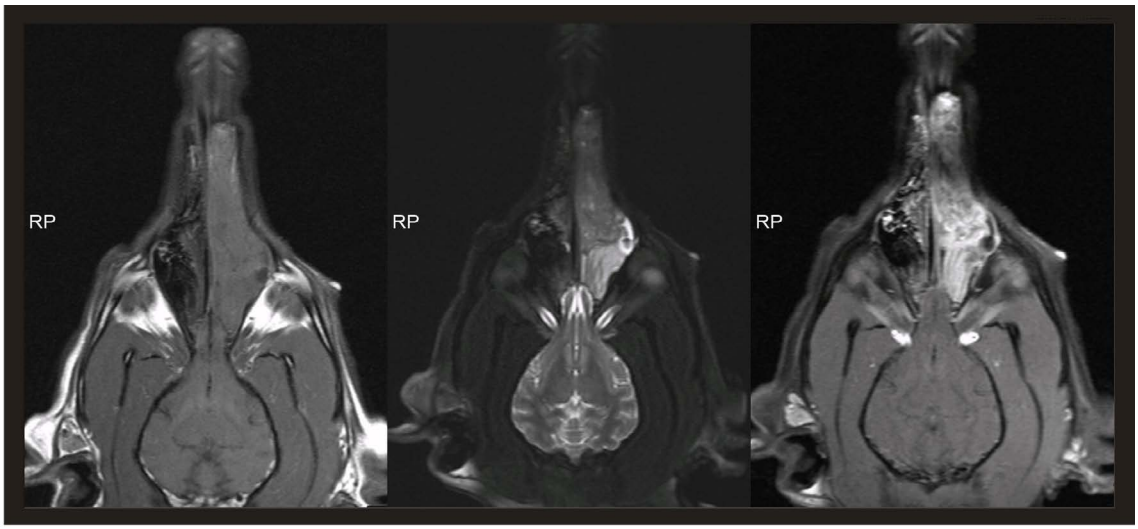

Figure 1: MRI features of the case 11. Dorsal T1-weighted and T2-weighted images of the nasal cavities show unilateral mass filling nasal cavity. T1-weighted postgadolinium images show extensive enhancement of tumor tissue. There is no any contrast enhancement in the brain suggesting with intracranial invasion.

used as the paramagnetic contrast medium, and was administered (dose: 0.2 mmol/kg) intravenously. All images were evaluated by board certified human radiologist and surgeons.

Tumor stage was determined based on the Modified World Health Organization Staging protocol by the evaluation of the MRI features. Dogs and cats were grouped into four clinical stages; T1-Confined to one nasal passage or paranasal sinus, with no bony involvement, T2 -Bony involvement, without evidence of orbital, subcutaneous, or submucosal mass, T3-Presence of orbital, subcutaneous, or submucosal mass, and T4-Tumor extension into nasopharynx or through cribriform plate. Tumors were also classified by location, on the basis of previously reported [13], into site 1 (unilateral nasal), 2 (unilateral nasal and sinus) and 3 (bilateral nasal). Staging and location of the tumors were based on the MRI images in three planes.

Clinical examination of the regional lenf nodes and chest X-ray were performed in order to assess metastasis before surgery. Surgery: Anesthesia was induced with propofol (Propofol, 10 mg/ml, Fresenius Kabi, Ltd., Sweden) and maintained with isoflurane-oxygen (Forane, Abbott Laboratories Ltd, Ireland). Perioperative analgesia was provided out using 0.5 mg/kg morphine-HCL (Morphine HCL, Galen, Turkey) in dogs and 0.1 mg/kg in cats. Tumor ablation was performed via dorsal approach under aseptic conditions. In the cases which frontal and nasal bones were involved by the tumor, the bone was removed totally and repaired by PMMA (polymetilmetacrilate) and wire (Figure 2). However in the cases which the frontal and nasal bone were not involved, a rectangle shaped frontonasal or nasal osteotomi was performed and tumor removed gross totally, then created nasal bone flap replaced and fixed with wire. Before replacing bone flap a gauze drain which rifampicine and bupivacain HCl-impregnated was placed into the nasal cavity. If the orbita was included in the tumor, it was extirpated. Postoperative analgesia was achieved with fentany patch (Duragesic® Janssen Pharmaceutica, Titusville, NJ; Cats and small dogs <10 kg: 25 µg/hr, Dogs 10-20 kg: 50 µg/hr, Dogs 20-30 kg: 75 µg/hr Dogs >30 kg: 100 µg/hr). Carprofen (Rimadyl, Pfizer, 3 mg/kg orally once daily) is used postoperatively for 7 days and antibiotherapy is maintained with amoxiciline (20 mg/kg orally twice daily) and metronidasole (20 mg/kg orally twice daily) for 10 days postoperatively.

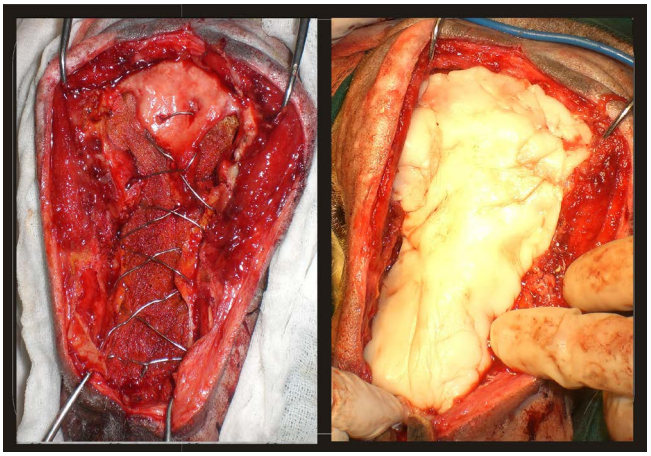

Figure 2: Repair of the bone defect with PMMA and wire (Case no. 1).

Collected samples of each mass were fixed 10% buffered formalin embedded in parafine and cut 5 µm-thick sections. All sections were stained according to Hematoxilen-Eosin (H&E).

Outcome assessment

The owner satisfaction and post operative survival time and cause of death (cardiac arrest during operation, euthanasia due to the tumor recurrence or infection and unrelated reasons) were recorded. Survival time was calculated due to the last day recieved report from the owner.

Statistical analysis

Mean survival time of the dogs was calculated due to Kaplan Meier Analysis, it wasn't calculated for cats because of the low case number. For data analysis, animals lost to followup and still alive were censored at their last known survival time. Dogs died during operation were not taken into account in estimating mean survival time.

Results

Twenty patients (17 dogs and 3 cats) have matched the inclusion

criteria. Sex distribution was 14 males (12 intact, 2 castrated) and 3 females (1 intact, 2 spayed) for dogs, 2 males (intact) and 1 female (intact) for cats. The mean age of dogs was 8.67 (range 1.5 to 16 years) years. Mix breed dogs were most commonly represented 5/17 (% 29.41) and all the cats were domestic short hair (DSH). In cats mean age were 9.66 years. Distribution of sex, breed, age, tumor stage, localisation, MRI findings, histologic diaognosis, survival time and cause of death are listed in Table 1.

Most common clinical complaint was mucopurulent or nasal discharge (n=14), following with facial deformity (n=10), sneezing (n=7), epiphora (n=7), nasal dyspne (n=6), neurologic signs including circling and/or seizure (n=5), epistaxis (n=3) and exophtalmus (n=3) were observed. In three cases only chief complainment was neurologic signs (Case no 5, 6 and 7).

Imaging findings

On MR images, soft tissue mass within the nasal cavity replacing the nasal conchae and/or ethmoturbinates and mass invading to the frontal sinuses were determined in 80% (n=16) of the cases. Nasal and/or frontal bones were destructed in 65% (n=13) of the cases. Retained secretions with or without mass lesion caudally in frontal sinuses were characteristic with a hyperintensity as like the fluids on T2-weighted images, and seen in 75% of the cases. Though meningeal hyperintensity on T2-weighted images around one or both olfactory bulbs was detected in 8 cases (40%), extension of mass into the cranial cavity affecting the brain was observed in 6 of these cases (30%). Both cases with meningeal hyperintensity and tumor extension to the brain were admitted obtundation, seizure, circling and some abnormal behavior. Detailed MRI findings were summarized on Table 2.

Frontal and nasal bones were intact in 7 dogs (Case no 2, 4, 6, 11, 14, 15, 16), in this context bone flap was created to expose and remove the tumor, and in these cases for the closure of the bone defect that occure due to the rhinotomy were closed by the replacing and wiring the flap. Rest of the cases (10 dogs and 3 cats) frontal and/or nasal bone was involved by the tumor, and closure of the defects were carried out with PMMA and wire. PMMA was well tolerated all the cases except for one case chondrosarcoma (Case no: 9) in which fistula was occured at 6th month, and tumor reoccured and displaced the PMMA. This case

	Case	Breed	Age (years)	Sex	Stage	MRI			Site	Histopathology	Survival	Cause of death
						T1W	T2W	Gd				
Dogs	1	Siberian Husky	1.5	F	T4	iso	hyper	++ H	3	neuroesthesiablastoma	11 m	Euth.
	2	Mix	13	MC	T4	iso	hyper	++ H	2	neuroesthesiablastoma	7 m	Euth.
	3	Rottweiler	4	M	T2	Hyper mild	hyper	++ Ht	3	Squamous cell carcinoma	1 m	Euth.
	4	Kangal	4	M	T2	hypo	hyper	++ H	2	chondrosarcoma	9,5 m	unrelated
	5	English Setter	14	M	T4	Hyper mild	Hyper mild	++ H	2	Squamous cell carcinoma	-	Died during op.
	6	Kangal	6	M	T4	iso	hyper	++ H	2	Neuroestesiablastoma	2 m	Euth.
	7	Mix	11	M	T4	iso	Hyper mild	++ H	2	Meningioma	8 m	Loss of follow up
	8	Labrador	6	M	T3	hyper	hyper	++ H	3	osteosarcoma	-	Euthanasia during op.
	9	Mix	11	M	T2	hyper	hyper	+ H	3	Chondrosarcoma	19 m	Euth.
	10	Mix	11	M	T3	iso	hyper	+ H	2	osteosarcoma	4 m	Euth.
	11	Golden Retriever	10	M	T1	hyper	Hyper mild	++ H	3	chondrosarcoma	6 m	Euth.
	12	Maltese Terrier	16	M	T4	hyper	hyper	++ H	3	adenocarcinoma	1 m	Euth.
	13	Mix	6	M	T3	iso	hyper	+ H	3	Osteosarcoma	3 m	Euth.
	14	Rottweiler	12	MC	T2	hyper	Hyper mild	+ H	2	chondrosarcoma	9 m	unrelated
	15	English Setter	5	FS	T1	iso	hyper	++ H	3	adenocarcinoma	10 m	still living
	16	Cocker	7	FS	T1	iso	hyper	++ H	1	adenocarcinoma	5 m	Still living
	17	Golden Retriever	10	M	T4	iso	hyper	++ H	2	fibrosarcoma	2 m	Still living
Cats	18	Domestic short hair	11	F	T3	iso	hyper	++ Ht	2	Cystic ductal adenocarcinoma	1 m	Loss of folllow up
	19	Domestic short hair	9	M	T3	iso	hyper	++ H	2	osteosarcoma	2 m	Loss of follow up
	20	Domestic short hair	9	M	T2	iso	hyper	++ Ht	3	angiosarcoma and polip	2 y	unrelated

Table 1: Detailed information of the all cases.

MRI features of the cases	Number/Percent of all cases
Soft tissue mass within the nasal cavity replacing the nasal conchae and/or ethmoturbinates	16/80.0
Destruction of nasal septum (predominantly middle portion)	10/50.0
Mass invading the maxillary recesses (predominantly unilateral)	8/40.0
Mass extending into the nasal caudal recesses (predominantly unilateral)	9/45.0
Retained secretions with or without mass lesion caudally in frontal sinuses	15/75.0
Mass invading to the frontal sinuses	15/75.0
Destruction of the nasal/frontal bones	13/65.0
Destruction of the cribriform plate	7/35.0
Extension of mass into the cranial cavity (not necessarily through the cribriform plate) affecting the brain	6/30.0
Meningeal (dural) hyperintensity on T2-weighted around one or both olfactory bulbs (predominantly unilateral and on the side of the mass)	8/40.0

Table 2: MRI findings of all cases.

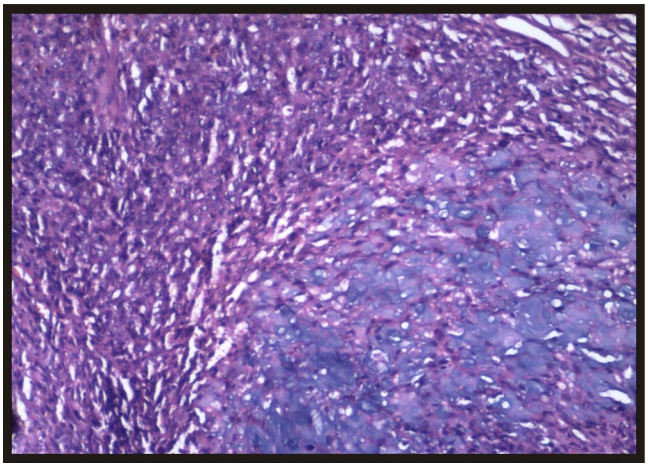

Figure 3: In differentiated round and/or spindle cartilage cells and condroid matrix, chondrosarcoma, HE, X100.

was reoperated, and survived for 19 months, and euthanaised due to owner request because of second time recurrence except 4 cases (Case no 3, 6, 12, 18) clinical complaints were roughly solved on 15 to 20 days after surgery. In four cases clinical complaints were not solved until one month postoperatively, which might be because of the tumor reoccurence, but further diagnostic workup was declined by the owner and animals were euthanaised.

Four chondrosarcoma (Figure 3), 4 osteosarcoma (3 dogs, 1 cat), 3 neuroesthesiablastoma, 1 cystic ductal adenocarcinoma (cat), 1 angiosarcoma and polip (cat), 2 squamous cell carcinoma, 1 meningioma, 1 fibrosarcoma and 3 adenocarcinoma were diagnosed histopathologically.

Mean survival time for dogs was found 7.95 ± 1.74 (95% confidence interval: 4.53-11.37). Estimated probabilty of survival was 78.6% at the 2nd month and it decreased to 38.6% at the 9th month postoperatively. Only 2 patients died spontaneously, rest of euthanized cases was performed over the request of owners.

Cause of death was euthanasia in 10 of the all cases due to tumor recurrence (n=8) and infection (n=1) and inability to remove tumor because of its more invasiveness (n=1). Three cases died with unrelated causes, and cardiac arrest was happened during operation in 1 cases. The cause of the death was unclear in 3 case because of lost to follow up (Case no: 7, 18, 19) and 3 of the cases are still alive.

Discussion

Characteristic MRI findings of paranasal sinus tumors and especially signs of affecting the frontal lobe of brain and histological findings according to WHO were represented in this case series. Surgical removal of paranasal tumor and repairement of created bone defect with PMMA and bone flap was found reliable and they were well tolerated by the dogs.

The mean age of the reported cases is similar with previous studies, which have reported a mean age of onset of nine to 10 years [5,8,14]. The prognosis for paranasal tumors without any treatment is poor and euthanasia is chosen in most animals as a result of progressive local invasion of tumor and related problems within three to six months of the onset of clinical signs [18]. The poor response of dogs with paranasal tumors to surgery is due to the advanced nature of most tumors at the time of diagnosis a propensity for this tumor to invade bones that are inaccessible or that can not be surgically removed, and lack of appreciable encapsulation; each of which makes it impossible to completely remove tumors [19]. Even though surgery is not recommended as a sole therapy, but it can be an option in selected cases like mesenchymal tumors and collecting biopsy specimens, and it can be accepted as an option for increasing the quality of life, not just for increasing survival time [14]. Most of the patients suffer from sneezing, nasal discharge, epistaxis and nasal dyspne, after surgery clinical signs in some dogs paliated by alleviating obstruction and epistaxis. The clinical signs in the presented 16 cases were solved after operation and this can suggest the usefulness of surgery for a certain time. Restoration of bone defect with PMMA and wire are well tolerated in this case series. PMMA was found as a suitable material to repair the bone defect after nasal and/or frontal osteotomy which is necessary for radical removal of the diseased tissues in most of the cases presented in this study.

Mean survival time for the present study was counted 7.95 months and same as compared to the previous study [14]. The presented cases in this study had minimaly 3 to 5 months history of clinical complaining and were treated before presentation to our clinic medically, and also 60% of the dogs were stage 3-4. In addition, obscured time of beginning clinical signs may have caused the lower mean survival time.

Mucoprulent/haemoragic nasal discharge, facial deformity and sneezing were reported previously as most common clinical signs [1,20,21]. These signs were the main clinical complainments in the presented cases, but also in 5 patients neurological signs were recorded and extension of the mass into the cranial cavity is detected all these patients. Although extension of mass into the cranial cavity was identified in six cases by the MRI, five of these cases showed neurologic signs. Hyperintense lesions in the brain were also seen in cases the tumors were extended to the caudal nasal recess. Those findings represent the diagnostic power of MRI in paranasal sinus. MRI has an excellent soft tissue resolution, on the other hand CT is a valuable diagnostic tool for identifying bone destruction, and combined with rhinoscopy was reported as sensitive diagnostic approach [12,20]. In this study, nasal septum destruction and nasal and/or frontal bone destruction were identified in 10 and 13 patients respectively by MRI features; these findings were also confirmed by the operation. These findings represent that MRI is a very convenient diagnostic modality of choice in evaluating of nasal and paranasal sinus tumors even the bone structures involved in tumor and can lead the surgeon. However, in one with osteosarcoma, the margins and invasiveness of the tumor were worse than MRI findings, and he was euthenaised after the owner permision during the surgery. In addition to MRI, CT can be considered in cases with osteosarcoma for being sure about the tumor margins and it will provide valuable informations in deciding surgical treatments.

Conclusion

In conclusion, reconstruction of the bone defect with PMMA and wire in the cases which the nasal and/or frontal bone is invaded by the tumor and unrepairable after the opration can be suggested. However, if is it possible creating bone flap to expose the tumor to remove and nasal and/or frontal bone is repairable, reconstruction with bone flap should be the approach of choice. MRI is an ideal diagnostic tool in the evaluating of paranasal sinus tumors extending to cranial cavity, and even in the cases with bony involvoment.

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