

RESEARCH COMMUNICATIONS III:
Small Animals

ENDOSCOPIC BRONCHIAL ANATOMY IN THE CAT

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Purpose of the Study: The aim was to define the endoscopic bronchial anatomy of the cat and to adapt these findings to the bronchoscopic nomenclature previously described for the dog by Amis and McKiernan (1986). Then, the results obtained should be used to design a bronchoscopic map of the feline bronchial tree and to prepare a photographic bronchoscopic atlas of the healthy cat.

Materials and Methods: In this study the normal endoscopic bronchial anatomy was identified based on analysis of a combination of air-dried feline lungs, healthy anesthetized cats and 2 euthanized cats using either a rigid or a flexible endoscope. Endoscopic photographs were taken during the examinations in the anesthetized cats for a photographic atlas. Silicone cast models were prepared from the air-dried lungs to confirm the anatomy identified by bronchoscopy. All the lungs were examined in a systematic manner, moving through the bronchial tree in the same direction, from one specific lobe to the other.

Results: All endoscopically evaluated lungs had a generally consistent anatomical structure showing similarity to the endobronchial anatomy and nomenclature described for dogs (Amis and McKiernan, 1986). The cast models confirmed the origin and direction of the lobar, segmental and sub-segmental bronchi and in most cases corresponded with the findings of the bronchoscopic anatomy.

Lobar bronchi were identified on the basis of the principal bronchus (right or left) from which they originated. Segmental bronchi were designated on the basis of their origin from the lobar bronchus, and were almost always in a dorsal or ventral aspect and identified with the capital letter D or V (dorsal, ventral). The sub-segmental bronchi were visualized in some situations; in these cases the canine nomenclature was applied. Sub-segmental lobar identification was proposed on the basis of the order in which they originate from the segmental bronchus using small letter sequence with no reference to their position.

The results from each bronchoscopy were recorded using the endoscopic nomenclature, with identification of the principal, lobar, segmental and sub-segmental bronchi visualized. Finally, it was possible to draw a map of the normal feline bronchial tree as observed in this study and realize a photographic bronchoscopic atlas of the feline bronchial tree.

Conclusions: The understanding of the normal endobronchial anatomy is a necessary preliminary step to recognize abnormal anatomy and pathological changes that may be encountered. A standard examination procedure should be followed to evaluate all accessible airways. We recommend the evaluation of the entire right side first followed by the left side. Each lobar bronchus should be entered when possible. From this study it appears that the canine and feline bronchial anatomy is similar. However, the diameter of the feline airways does not permit entry into the distal airways. The endoscopic map developed from this study should improve bronchoscopy in cats.

VIRTUAL CT-ENDOSCOPY OF THE UPPER AND CENTRAL AIRWAYS OF SMALL ANIMALS AND AN INTRODUCTION TO VIRTUAL CT-ENDOSCOPY

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Subject: Conventional endoscopy is an indispensable tool to diagnose alterations of the upper and central airways. Particularly the detection of stenosis in the nasal cavity, nasopharynx, larynx, trachea and main-stem bronchi is most important in respiratory medicine. Typical diseases causing narrowing of airway diameter are brachycephalic syndrome and tracheal collapse.

Since the introduction of multirow detector CT, high-resolution virtual-endoscopic images of the airways can be reconstructed. Either surface rendering or volume rendering can be used for realistic depiction of the airways.

Aim of this presentation is the comparison of virtual CT-endoscopy with conventional endoscopy and with conventional two-dimensional CT-imaging in small animals with suspected stenosis of upper and/or central airways.

Methods: Investigations are performed using standard equipment for conventional endoscopy (rigid, fiberoptic and video endoscopy) and a helical multislice CT (PHILIPS Mx8000 Brilliance, 6-slice configuration). Scan protocols routinely used in our department are used.

Brachycephalic dogs and cats having severe impairment of breathing were examined. The degree of intranasal stenosis is determined. 3D surface rendering and multiplanar reconstruction are used to analyse the stenosis (primarily of the ventral conchae occluding the ventral meatus) anterograde from the vestibulum nasi and retrograde from the nasopharynx. The image data are compared with focus on their ability to determine a safe pathway for endoscopic intranasal laser surgery. Postoperatively the different endoscopic procedures are applied to determine the surgical results of laser surgery in respect of reopening the ventral nasal meatus.

Results:

Compared with conventional endoscopic techniques advantages of virtual endoscopy are

- non-invasiveness,
- the ability to visualize airway segments located behind a stenosis that can not be passed by a conventional endoscopic device,
- visualisation of airway and stenosis not only in cranio-caudal direction but also in caudo-cranial aspect, simulating a "turning around the endoscope by 180°",
- assessment of surgical results after endonasal lasersurgery and recanalizing the ventral meatus with less tissue damage than with conventional endoscopy.

Disadvantages are

- inability to depict mucosal colour and fine structure,
- inability to perform interventional maneuvers (biopsy, probe sampling, removal of foreign bodies),
- artefacts due to respiratory and/or cardiac movements may be difficult to recognize and mimic structural changes of wall confirmation.

Compared with two-dimensional CT-images, virtual endoscopy provides a view along the main axis of an airway and therefore gives a more realistic endoluminal impression. The ability of modern CT-software, to navigate freely as well inside the air-conducting structures as at the same time being able to "leave" the airway and visualize respiratory structures from angles normally being occupied by body tissue, gives new and impressing information. But the planning of save endonasal surgical pathways is more reliable with axial CT-images then with any form of 3D reconstruction.

Virtual CT-Ectoscopy

The ability of modern CT-software, to navigate freely as well inside the air-conducting structures as at the same time being able to "leave" the airway and visualize respiratory structures from "ectopic" angles normally being occupied by body tissue. Therefore we created the term "Ectoscopy" for this exciting way of visualising air-filled cavities and structures.

Conclusions: Virtual endoscopy of the upper and central airways produces endoluminal images similar to those of fiberoptic endoscopy. In particular, it is useful for the assessment of endoluminal stenosis. Virtual endoscopy of the airways can be used before laser surgery, stent implantation and for postoperative follow-up. In the future, virtual airway endoscopy will be increasingly applied for interactive virtual reality guidance of airway procedures as tracheo-bronchoscopy and endoluminal surgery.

EVALUATION OF THE BIOAVAILABILITY AND PHARMACOKINETICS OF AN EXTENDED RELEASE THEOPHYLLINE PRODUCT IN CATS

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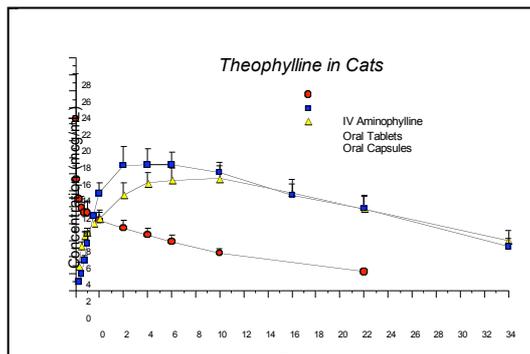
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Purpose: Theophylline has been used extensively in the United States to treat obstructive airway disease in cats and dogs. Previous studies have determined the pharmacokinetics of various products but the extended release products shown to have acceptable pharmacokinetics in dogs and cats are no longer available. This study was undertaken to determine the pharmacokinetics of the Inwood Laboratories brand of extended release theophylline in healthy cats.

Methods: Six mixed breed adult cats were studied. The cats were determined to be healthy based on history, physical examination and a complete CBC, chemistry profile and urinalysis. A randomized 3-way crossover study design was utilized with each cat being treated with extended release theophylline capsules, extended release theophylline tablets and IV aminophylline with two week washout period allowed between treatments. EDTA plasma samples were collected throughout a 36hr period post dosing using pre-placed, indwelling central intravenous catheters. Plasma samples were frozen until analyzed using a fluorescence polarization immunoassay run on an Abbott TDx analyzer. Validation of the assay was confirmed using pooled feline plasma fortified with a pure reference standard of theophylline at three separate concentration ranges (low, medium, high) and run in triplicate. Pharmacokinetic analysis was performed using non-compartment methods for both oral and IV drugs.

Results: All cats tolerated the drug administration and plasma collection with no side effects. Peak concentrations were reached for both oral products between 8-12 hours post dosing. Bioavailability was excellent. Concentrations reached were within the human therapeutic level of 10-20 mcg/mL.

Conclusions: This study has shown that the Inwood Laboratories brand of extended release theophylline is suitable for once daily administration using either the capsule or tablet formulation.



**EFFECT OF OBESITY ON DOXAPRAM HYDROCHLORID-INDUCED
EFFECTS ON WHOLE BODY BAROMETRIC PLETHYSMOGRAPHY
MEASUREMENTS IN HEALTHY BEAGLE DOGS**

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Doxapram hydrochlorid (Dxp) is a respiratory stimulant. The present study investigates the effects of body weight (BW) gain on basal respiratory parameters, as well as in response to Dxp administration, measured by barometric whole body plethysmography (BWBP), a non invasive respiratory function test. Six 6-year-old beagle dogs (4 M, 3 F) were investigated before (N = normal body score, mean weight \pm SD = 14,0 \pm 0.9 kg) and after 30 weeks being fed with a dry high-fat diet (O = obese dogs, weight \pm SD = 19.7 \pm 1.6 kg). Dogs were sedated (acepromazine 0.03 mg/kg and buprenorphine 15 μ g/kg). BWBP parameters (respiratory rate = RR, tidal volume = TV, tidal volume per kg = TV/BW, minute volume = MV, minute volume per kg = MV/BW, peak inspiratory and expiratory were evaluated before and during at least 5 minutes after Dxp IV injection (1.1 mg/kg). Mean values after Dxp injection were calculated min per min and compared with mean values before Dxp injection using an anova test for repeated measures. Values obtained after Dxp were also expressed in percentage of the basal value (%-Dxp). Results obtained in N and O dogs were compared with a t-test for paired data (P < 0.05).

Obesity induced essentially a significant increase in RR, MV and MV/BW and a significant decrease in TV, TV/BW, Ti and Te. In both N and O dogs, Dxp mainly induced an immediate significant increase in TV, in TV/BW, in PIF/BW, in PEF/BW, in MV, in MV/BW as well as an immediate significant decrease in Te. Moreover, an increase in Ti and RR and a decrease in Te/Ti were observed, but this was significant in N dogs only. %-Dxp in TV, TV/BW 1 min after Dx was significantly lower in O than in N.

Results of basal BWBP parameters (mean \pm SEM)

	RR	TV	TV/BW	MV	MV/BW	PIF/BW	PEF/BW	Ti	Te
M	11.4 \pm 0.9	137.8 \pm 8.0	9.8 \pm 0.5	1595.5 \pm 178.3	112.5 \pm 11.3	13.4 \pm 0.7	10.4 \pm 1.2	1.3 \pm 0.1	4.3 \pm 0.6
O	33.8* \pm 7.9	112.7* \pm 12.8	5.7* \pm 0.6	3249.13* \pm 437.8	166.6 \pm 25.2	12.7 \pm 1.0	8.3 \pm 0.9	0.83* \pm 0.2	1.7* \pm 0.4

* : significantly different from parameters in N dogs.

%-Dxp in BWBP parameters 1 minute after Dxp (mean \pm SEM)

	RR	TV	TV/BW	MV	MV/BW	PIF/BW	PEF/BW	Ti	Te
M	151.4 \pm 3.5	363.5 \pm 26.0	363.5 \pm 26.0	572.5 \pm 127.2	572.5 \pm 127.2	239.7 \pm 15.5	250.5 \pm 12.1	133.9 \pm 6.2	66.0 \pm 12.3
O	127.9 \pm 14.4	292.5* \pm 22.6	292.5* \pm 22.6	364.1 \pm 34.5	364.1 \pm 34.5	224.6 \pm 16.7	270.3 \pm 23.3	120.2 \pm 13.8	73.4 \pm 14

* : significantly different from parameters in N dogs.

In conclusion, obesity induces modifications of basal respiration parameters as well as an impaired response to stimulation by Dxp. Dxp and WBBP is an interesting combined procedure that could be helpful in characterizing the ventilatory deficit in dogs with restrictive pulmonary diseases, and presumably in assessing the progression of the disease and response to therapy.

EFFECT OF SAMPLING METHOD AND CULTURE CONDITIONS ON THE RESULT OF FUNGAL CULTURE IN THE DIAGNOSIS OF CANINE SINO-NASAL ASPERGILLOSIS

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Sino-nasal aspergillosis (SNA) is a common cause of nasal discharge in the dog and is most commonly caused by *Aspergillus fumigatus*. Definitive diagnosis requires the visualisation of fungal plaques during rhinoscopy or sinusoscopy or the observation of fungal hyphae on cytological or histological examination. Diagnostic tools less invasive than endoscopy, such as nasal swab culture or serology, have been shown to be poorly sensitive. In human with chronic rhinosinusitis, recent studies have demonstrated that the sensitivity of fungal cultures can be improved by modifying the culture medium or the incubation temperature.

The goal of the present prospective study was to evaluate the effect of sampling method, culture medium and incubation temperature on the result of fungal culture in dogs with SNA.

Eighteen dogs in which a diagnosis of SNA had been confirmed by rhinoscopy were included in the present study. In each dog, a nasal or sinus fungal plaque (FP) was endoscopically sampled and a nasal swab was blindly collected. A nasal swab was also obtained from eight control dogs with nasal disease not caused by SNA. All samples were inoculated on 2 media (Sabouraud-dextrose-agar with chloramphenicol (SC) and SC with cycloheximide (SCC)) and were divided into 2 groups for room air incubation at 27°C or 37°C. Cultures were examined every 2 days, for number and size of colony-forming-unit (CFU); Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were assessed.

The only fungal species cultivated was *A. fumigatus*. The results of the cultures were not influenced by the medium. Cultures from nasal swabs were negative in all control dogs and positive in 4/18 SNA cases (specificity = 100%, sensitivity = 22%, PPV = 100%, NPV = 36%) regardless the culture conditions. 16/18 FP cultures were positive in at least 2 culture conditions (sensitivity = 89%) and 15 were positive in 3 culture conditions. Cultures incubated at 37°C have grown faster and better than those incubated at 27°C but the final result of the culture was not influenced by the temperature.

This preliminary study confirms that fungal culture from blindly collected nasal swabs is not a sensitive method for the diagnosis of SNA. Not surprisingly, fungal culture from FP was much more sensitive. The presence of cycloheximide in the culture medium did not significantly influence the result of the culture. Incubation temperature influences the culture growth (eg, faster growth at 37°C than at 27°C). Further studies are needed to investigate the usefulness of other sampling techniques in the diagnosis of SNA and to more accurately evaluate the effect of temperature on culture results.

NASOPHARYNGEAL TURBINATES IN BRACHYCEPHALIC DOGS AND CATS

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Purpose: This study was undertaken to report an unusual anatomic finding, the presence of nasopharyngeal turbinates in a population of brachycephalic dogs and cats.

Methods: Medical records were reviewed for all brachycephalic dogs and cats who had undergone posterior rhinoscopy during the period between January 1999 and May 2006. Only those cases with photographic or written documentation of the presence of nasopharyngeal turbinates were included.

Results: A total of 53 dogs and 10 cats were identified and included in the study. Twenty-one percent of dogs and 20% of cats in the study were noted to have nasopharyngeal turbinates. The presence of these turbinates was more commonly reported in these animals than stenotic nares or hypoplastic trachea. While approximately one third of the dogs in the study population were Pugs, they accounted for the majority of dogs with nasopharyngeal turbinates. Biopsy results from the first patient (a Pug) in which nasopharyngeal turbinates were identified showed mild lymphocytic rhinitis with excessive dense bone. Nasopharyngeal turbinates have not been observed by the authors in non-brachycephalic breeds.

Conclusion: Nasal turbinates are formed by endochondral ossification and will grow beyond their surroundings. Therefore, it is possible that in brachycephalic breeds, the ethmoid turbinate complex may tend to protrude into the nasopharynx because of the limited space in the nasal cavity. Based on our observations and findings it is reasonable to assume that the presence of nasopharyngeal turbinates may contribute to the upper airway obstruction associated with the Brachycephalic Airway Syndrome. The identification of all components of this syndrome is important prior to undertaking surgical repair of any portion. Therefore, we recommend a complete nasopharyngeal evaluation in any brachycephalic dog or cat undergoing upper airway endoscopy to determine whether nasopharyngeal turbinates are present.

ANATOMICAL ASPECTS OF THE BRACHYCEPHALIC AIRWAY SYNDROME IN CATS AND DOGS

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Introduction: The phenotypic appearance of the brachycephalic head depends on the shape of the skull and is strongly related to breed specific skeletal features. Such short headed or round shaped breeds in cats and dogs are characterised by a short face, open orbitae and display childlike traits. The purpose of this study was to determine the functional aspects of anatomical structures within the brachycephalic nose and its potential clinical applications.

Methods: Because the animals displayed different stages of brachycephaly, and to adequately describe the functional-anatomical alterations, the head specimens were divided into four distinct categories by subjective criteria. The examination was carried out with regard to clinical and morphological aspects. The following imaging techniques were used: computed tomography (CT) compared to corresponding sheet plastinations, as well as three-dimensional (3D) reconstructions based on the CT data sets. Additionally anatomical drawings, maceration and anatomic preparation were utilized to complement the above imaging techniques.

Results: The main problems when looking at the feline and canine nose regarding the complex alterations in brachycephaly arise from the highly shortened facial bones and the resulting dislocation of nasal structures caused by the dorso-rotation of the teeth. Concomitant with increased stages of brachycephaly, the nares and the nasal entry get narrower; the rostral ending of the respiratory duct (Meatus nasi ventralis), the nasal conchae and the whole ethmoidal bone are pushed into an increased upright position; and the nasolacrimal drainage system is characterized by an increased angle and a steeper course. Nasal conchae material is pushed into the respiratory duct in some animals with higher degrees of brachycephaly and thus hinders respiratory air flow. Additional paranasal cavities are developed, while the upper ethmoidal conchae are pushed up towards the frontal sinuses by the compression processes within the lower aspects of the nasal cavity. The results presented on the complex of 'brachycephaly' suggest that brachycephalic animals should be classified into four categories (I – IV) regarding objectionable structural criteria and use this classification interpreting the law of animal welfare ('pain breed' in terms of paragraph 11b). The category IV seem to fulfil the corpus delicti of 'pain breed'. According to the present study, even animals of category I and II display alterations due to dorso-rotation (slight narrowing of the nasal entry, low grade angling of the respiratory duct and the nasolacrimal drainage system, development of additional paranasal sinuses).

Conclusions: Our study identified a significant clinical problem of those dogs and cats nasal region. Breeders of brachycephalic breeds should refrain from breeding animals with category IV and perhaps category III.

A NEW APPROACH TO BRACHYCEPHALIC AIRWAY SYNDROME: VIDEOSCOPIC ENDONASAL LASER THERAPY

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Subject: A new therapeutic approach to brachycephalic airway syndrome with video-scopically applied endonasal surgery is described. We base on the assumption that the most important reason for the development of the brachycephalic syndrome is an abnormal high intranasal airway resistance.

Methods: In 40 brachycephalic dogs (mainly Pugh, French and English bulldog) the nasal cavity was examined with rigid anterograde and retrograde endoscopy. CT-Scans were performed preoperatively to analyse endonasal obstruction and as basis for planning the surgical pathway.

Videoscopically a Diode Laser fibre was used to remove obstructing parts of the conchae thus creating a new ventral nasal meatus. Postoperative controls followed with fiberoptic endoscopy and CT-Scans including virtual CT-Endoscopy.

In the course of the study we started to measure intranasal resistance, separate for each nasal cavity, excluding the influence of both nares and palatum molle.

Results: We succeeded in reconstructing a patient ventral meatus nasi in all dogs. This was proved with analogue and virtual endoscopy. Control examinations showed, that in some cases recurrent obstructions resulted from re-expanding parts of the preoperatively compressed choncha nasalis ventralis.

Owners assessed a striking improvement in all those cases with no or little evidence of laryngeal collapse. Animals that had developed pronounced laryngeal deformations improved also, but in a lesser degree.

In many dogs abnormal conchal growth of the endoturbinat II into a caudal direction, obstructing one or both choanae, was observed.

Conclusions: If narrow and obstructed endonasal airways are the major underlying causes of brachycephalic dyspnoea, endonasal laser surgery seems to be the key for a new successful therapeutic approach to this disease.