Canine nasal disease: investigation and management

Alison Moores, David Walker

Alison Moores graduated from the University of Bristol in 1996. Following four years in practice, she completed an internship, surgical residency and lectureship at the Royal Veterinary College. She has been a diplomate of the European College of Veterinary Surgery since 2005 and is an RCVS recognised specialist in small animal surgery. For the past five years, she has worked in referral practice at Anderson Moores Veterinary Specialists in Hampshire.

David Walker graduated from the Royal Veterinary College in 2003. Following an internship and some time in practice, he completed a three-year residency at the Royal Veterinary College. He has been a diplomate of the American College of Veterinary Internal Medicine since 2008 and is an RCVS recognised specialist in small animal internal medicine. He is head of medicine at Anderson Moores Veterinary Specialists in Hampshire.

doi:10.1136/inp.f2017

Nasal diseases represent an interesting array of disorders to both diagnose and manage. The challenge is to differentiate between the underlying causes, which have widely different prognoses for response to treatment and survival. This article describes the advantages of different diagnostic tools for investigating nasal disease, in particular the use of rhinoscopy. The diagnosis, management and prognosis of specific nasal diseases are discussed in detail.

EARLY recognition of nasal disease allows appropriate therapy and in many cases offers the possibility of greater therapeutic success. However, many dogs have had nasal discharge and other clinical signs for many months before a full nasal investigation is performed (Fig 1).

Table 1 shows the incidence of different nasal diseases in the dog as reported by two different studies. The variation in incidence can be attributed to the small number of dogs in each study (42 to 80) and the different geographical locations.

The diagnostic approach to nasal disease is complicated by the difficulty in accessing the nasal cavity. Nonetheless, it starts with a thorough history, including the time since onset and progression of clinical signs, as well as response to previous therapy. Clinical signs and physical examination findings are invaluable for assessing the severity of disease and may indicate extension into surrounding tissues (Box 1, Fig 2). During physical examination of animals with possible nasal neoplasia it is important to try to retropulse both globes (see below). Physical examination should also include examination of the oral cavity under anaesthesia, including the teeth, hard and soft palate, tonsils, pharynx and larynx. Rare clinical conditions, such as pseudo-uvula cleft palate, can be misdiagnosed if they are not considered as a differential diagnosis.

Diagnostic imaging

Imaging is important in the investigation of nasal disease (Table 2, Box 2). Computed tomography (CT) offers a number of advantages over radiography in most cases, including elimination of superimposition, better turbinate detail, superior evaluation of the frontal sinuses and better evaluation of the cribriform plate. The radiographic features of individual diseases are discussed later.

Rhinoscopy

Evaluation of the nasopharynx and choanae via caudal (posterior) or retrograde rhinoscopy, and evaluation of the nasal cavity via rostral (anterior) rhinoscopy, provide useful information in a minimally invasive fashion. Both approaches should be performed in every case to ensure a thorough evaluation and to avoid missing the lesion.

Animal preparation

The cuff of the endotracheal tube is inflated to protect the lower airways and is tied to the lower jaw to allow easier access to the nasopharynx. A mouth gag stops the animal biting down on the endoscope, which could damage or break it. The dog is positioned in sternal recumbency, to prevent the lower nasal cavity becoming contaminated with fluid, with the nose tilted ventrally. The head should not be elevated excessively to avoid fluid running into the trachea. Once caudal rhinoscopy has been performed the caudal pharynx is packed to reduce aspiration of fluid and blood during rostral rhinoscopy. This can be achieved with swabs, bandage material or absorbent feminine hygiene products, all of which must be counted on placement and removal.

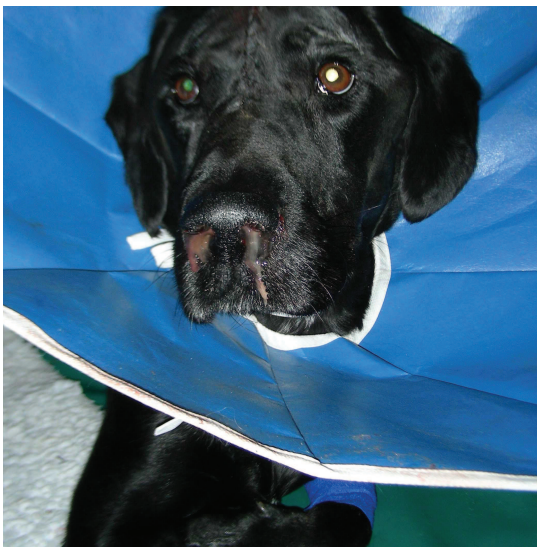


Fig 1: A dog with mucopurulent nasal discharge

Table 1: Causes of nasal discharge, and incidence as reported in two different studies

	Incidence (%)	
	Meler and others (2008)	Tasker and others (1999)
Primary nasal diseases affecting dogs		
Idiopathic lymphoplasmacytic rhinitis	24	24
Nasal neoplasia	15	33
Sinonasal aspergillosis	9	7
Foreign body	1	7
Parasites (eg, *Pneumonyssoides caninum*)	1	–
Primary bacterial rhinitis	1	–
No definitive diagnosis	36	7
Local diseases causing nasal cavity involvement		
Cleft palate	9	–
Periodontal disease	4	10
Nasal extension of local neoplasia (eg, maxilla, soft tissues)		–
Coagulopathy (epistaxis)		–
Oronasal fistula		2
Miscellaneous		10

Caudal endoscopy

Caudal endoscopy is performed before rostral endoscopy to avoid contamination of the nasopharynx with fluid and blood, which can obscure visualisation. It requires a flexible endoscope and typically the endoscope used for tracheobronchoscopy or feline gastroduodenoscopy can be used. The authors commonly use a 4.9 mm diameter endoscope but in larger animals a wider diameter endoscope can be used. As a poorer alternative, a dental mirror, light source and spay hook or Allis tissue forceps (to pull the soft palate forward) can be used to assess the caudal nasopharynx. However, this rarely allows visualisation of the choanae, especially in dolichocephalic dogs, and this technique should not be relied upon if flexible endoscopy is available.

Caudal endoscopy (nasopharyngoscopy) is performed by advancing the endoscope into the oral cavity and then retroflexing it (180°) dorsally over the caudal edge of the soft palate. Alternatively, the retroflexed endoscope can be advanced into the larger dog's mouth and hooked over the soft palate. As the endoscope is retroflexed, the image seen is upside down and reversed (ie, dorsal is ventral and left is right). Once a clear image of the nasopharynx has been obtained, the endoscope has to be pulled rostrally to get closer to the choanae. Nasopharyngoscopy elicits a strong gag reflex and a slightly deeper plane of anaesthesia is usually required during this procedure than during the rest of the endoscopic examination. In practice it is probably safer to administer a small volume of propofol intravenously, to effect, rather than maintaining a deeper plane of anaesthesia using inhalational anaesthetic drugs. Bleeding secondary to minor trauma with the endoscope is not uncommon, and often the first view obtained is the best one. Bleeding is generally reduced with experience and a more gentle technique.

Healthy nasopharyngeal tissue is smooth and pink (Fig 3). Diseased tissue is often hyperaemic, irregular and friable (Box 3). Caudal nasal discharge (eg, blood, mucus or pus) is always considered abnormal. Raised nodules indicative of benign lymphoid hyperplasia can be seen in the nasopharynx of chronic inflammatory conditions; however, if there is ever any concern about the nature of a lesion, biopsy is always indicated. Cytology can also be performed using a guarded cytology brush. If a biopsy instrument or brush for cytology

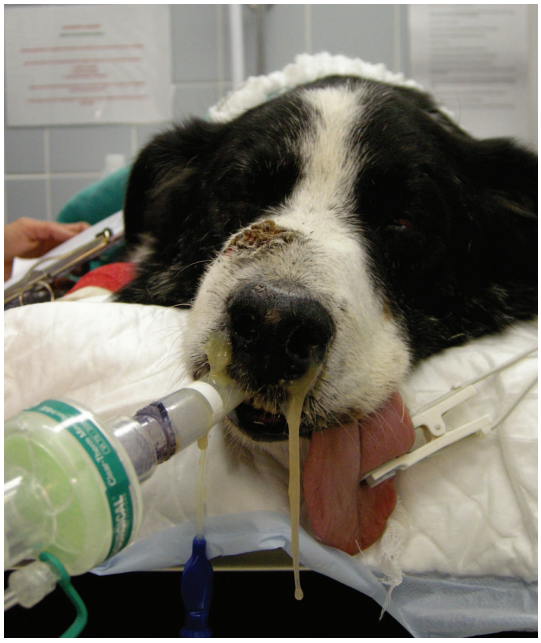


Fig 2: An anaesthetised dog undergoing evaluation of nasal discharge. Note the extension of disease through the dorsal aspect of the nose and involving the overlying skin. (Picture: Davina Anderson)

Box 1: Clinical signs and physical examination findings in dogs with nasal disease

Clinical signs

- Nasal discharge (serous, mucopurulent or serosanguinous)
- Nasal or facial pain
- Sneezing
- Reverse sneezing
- Epistaxis
- Depression
- Decreased appetite
- Seizures/altered behaviour (if extension through cribriform plate)

Physical examination

- Altered nasal air flow (decreased with neoplasia, decreased in the presence of mucus, often increased with aspergillosis)
- Nasal planum depigmentation (aspergillosis)
- Facial deformity attributable to frontal bone hyperostosis or soft tissue mass (advanced cases of neoplasia or aspergillosis)
- Epiphora secondary to extension into the orbit
- Forebrain dysfunction

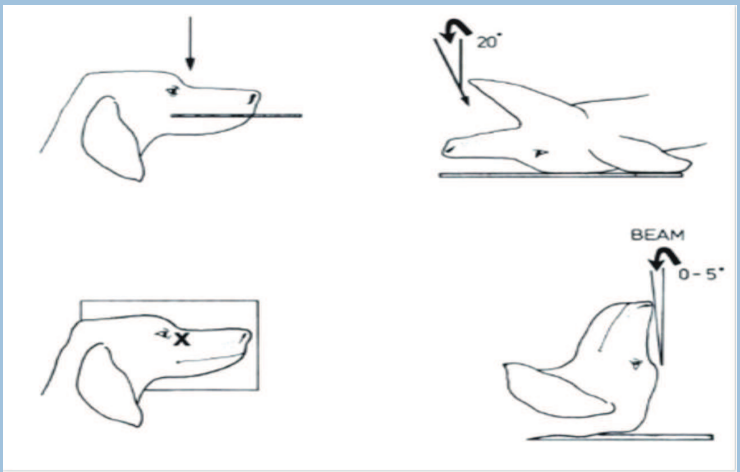
Table 2: Features of nasal disease identified on diagnostic imaging

Abnormality seen on radiography/CT/MRI	Differential diagnoses
Loss of turbinate detail	Aspergillosis
Loss of turbinate detail with soft tissue opacity	Neoplasia
Bone lysis	Neoplasia, aspergillosis

CT Computed tomography, MRI Magnetic resonance imaging

Box 2: Nasal radiography

- Three views should always be obtained (intraoral or rostroventral 20° caudodorsal oblique, lateral skull, and rostrocaudal skull)
- The intraoral view can be obtained with non-screen film to enhance contrast but this is not easily achieved with digital radiography
- The intraoral view and ventrodorsal oblique view allow the two sides of the nasal cavity to be compared. The intraoral view provides a better assessment of the caudal nasal cavity than the ventrodorsal oblique view. The dorsoventral view may be useful for neoplasia of the caudal nasal cavity
- The lateral view gives information regarding the frontal sinuses and the state of the maxilla and frontal bones
- The rostrocaudal view provides a skyline of the frontal sinuses. The caudorostral view may be easier to achieve in some situations



Reproduced from Sullivan (1987)

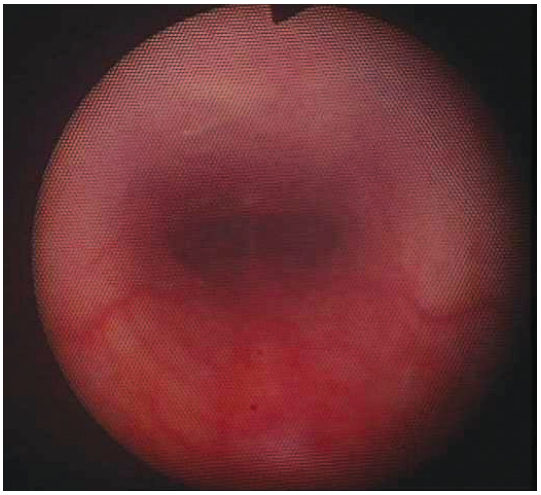


Fig 3: Normal choanae seen during posterior rhinoscopy. The cause of this dog's disease was sinonasal aspergillosis (see Fig 10)

Box 3: Abnormalities seen on caudal rhinoscopy in animals with nasal disease

- Hyperaemia, mucosal irregularity, mucosal friability
- Discharge (eg, blood, mucus or pus)
- Soft tissue mass
- Raised nodules
- Foreign material
- *Pneumonyssoides caninum*

is to be introduced down the working channel of a flexible endoscope, the endoscope must first be withdrawn and straightened. Forcing biopsy instruments down the channel while the endoscope is retroflexed will lead to severe damage.

Rostral rhinoscopy

A flexible or rigid endoscope can be used to perform rostral rhinoscopy. The image quality is dependent upon the type of endoscope used, with some rigid endoscopes providing a superior image to flexible endoscopes, and vice versa. There are a number of types of rigid endoscope available; some have an integrated instrument/working channel (for biopsy and/or fluid administration) and no sheath, while the majority have a protective sheath that also allows the ingress of fluids and, if the sheath is big enough, flexible biopsy instruments. The sheath serves to protect the telescope; the smaller telescopes are very fragile without their sheath.

The endoscope should be lubricated with sterile lubricating jelly before insertion, but care should be taken not to get any on the lens as this will impair image acuity. The administration of 0.9 per cent sodium chloride, under high pressure via a pressure bag, is useful to optimise image quality. Occasionally, very high pressure irrigation can obscure the view and the rate of flow can be controlled easily via the tap that is present on most rigid endoscopes.

Rigid endoscopes with integrated working channels, or with sheaths that allow instruments to be passed, are of larger diameter so are generally not suitable for small dogs and cats. If a guided biopsy is required and no working channel is available, long narrow biopsy forceps are used alongside the telescope. As an alternative, the endoscopist can use a flexible endoscope for guided biopsy, assuming an adequate image can be obtained without the ingress of fluid.

Rigid endoscopes are available with a variety of viewing angles, most commonly 0° and 30°. With no angulation the field of view is centred on the axis of the telescope. Acute viewing angles offer the advantage of visualisation of a greater area when the telescope is rotated on its longitudinal axis; however, they are slightly more challenging to use for the novice endoscopist in regard to spatial orientation.

If neither a rigid endoscope nor a small flexible endoscope is available an otoscope can be used to evaluate the rostral portion of the nasal cavity. This is typically only useful in the presence of a very rostral foreign body or severe aspergillosis when pronounced turbinate destruction or fungal plaques may be appreciated.

The endoscope should be measured externally to the level of the medial canthus of the eye and tape applied so that the endoscope is not passed any further than this level internally, to avoid damage to the cribriform plate. The rigid endoscope should be held like a handgun with the light cable facing towards the floor. The normal or less severely affected side is examined first. The nasal planum is deflected dorsally and the endoscope is introduced over the alar fold into the nose (Fig 4). Typically the ventral nasal meatus is examined first by pointing the endoscope ventrally and medially during insertion. It should be possible to pass the endoscope to the level of the nasopharynx via the ventral

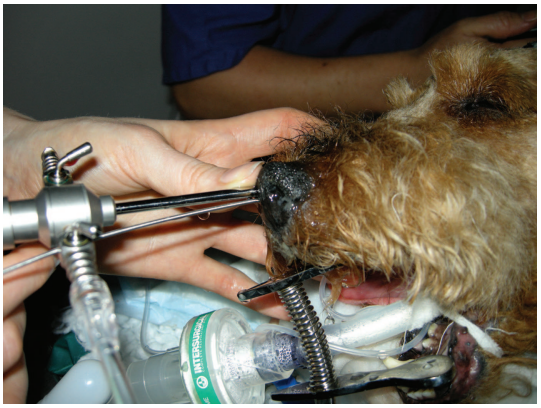


Fig 4: Anterior rhinoscopy using a rigid endoscope. Note the use of a mouth gag to protect the endoscope. The nasal planum is deflected dorsally. Biopsy forceps are passed alongside the endoscope. (Picture: Davina Anderson)

meatus; however, if the endoscopist is unsure of the endoscope's location, it is good practice not to advance further than the premeasured level of the medial canthus of the eye. Once the ventral meatus has been assessed fully, the endoscope is retracted rostrally and the dorsal meatus and ethmoid turbinates examined.

The scroll-like conchae should be pink in colour (cold saline can blanch the mucosa) and fine mucosal capillaries should be visible. They may be obscured by mucosal oedema or secretions, both of which are abnormal. Perceived excessive bleeding without much trauma may imply mucosal inflammation or neoplasia. If large amounts of mucus are present, the endoscope should be removed and a nasal flush should be performed (Box 4). A complete thorough examination of both nasal cavities should be performed before biopsy as this leads to a large amount of bleeding and will render further examination impossible.

It is important to biopsy numerous areas of the nasal cavity as there is little correlation between visual appearance and specific disease entities. Biopsies can be achieved via a flexible endoscope, a rigid endoscope with a working channel, alongside a rigid endoscope, or blindly. If a known lesion is present from imaging or rhinoscopy, the biopsy forceps can be inserted to this level. Counting the level of a lesion via the premolar teeth can often be useful. Guided biopsies should be taken of any gross lesions and repeat sampling of the same site ('woodpeckering') can often be useful; this is because neoplastic tissue is often surrounded by

Box 4: Performing a nasal flush

- Check pharyngeal packing and cuffing of the endotracheal tube
- Point the animal's nose towards the floor
- Approximately 60 ml of saline is rapidly infused into the nare via a catheter tip syringe, which is occluded around the syringe before flushing

inflammatory tissue and the small biopsy size often leads to procurement of the surrounding inflammatory tissue only. If obvious pathology has not been seen, large, blind, grab biopsies should always be taken. A sample containing turbinate bone implies a good, deep biopsy. Biopsies should be placed into formol saline (Fig 5). Bacterial culture is not performed routinely; it is questionable whether primary bacterial rhinitis exists and culture will yield a mixed population of nasal commensal bacteria.

The procurement of large biopsies will invariably lead to bleeding (Fig 6), but typically this stops within five minutes. Occasionally, animals will continue to bleed and a number of options are available for haemostasis, including cold compresses, tampons and topical adrenaline or topical phenylephrine (causing vasoconstriction). A combination of these is often the most effective strategy. If heavy bleeding is present the animal should be kept anaesthetised until it has stopped. Very rarely, bleeding is so severe that the animal becomes haemodynamically compromised and a blood transfusion is necessary. It is sensible to be proactive and always warn clients of the risk of severe bleeding. Some people advocate the measurement of clotting times before biopsy; however, the authors only do this if there is a clinical indication of a coagulopathy; for example, epistaxis.

Very occasionally, there is the need to perform endoscopy of the frontal sinuses, which can be achieved via a hole drilled in the sinus using a Steinmann pin or Jacob's chuck. The frontal sinuses can sometimes be reached via the nasal cavity. In practice, if severe frontal sinus disease is present, a sinusotomy is performed in preference to endoscopy as it allows debridement (and biopsy) to be performed.

Postendoscopy management

The animal's nose should be lowered to encourage flow of blood and fluid out of the nose and mouth, rather than into the pharynx. The pharyngeal packing is removed

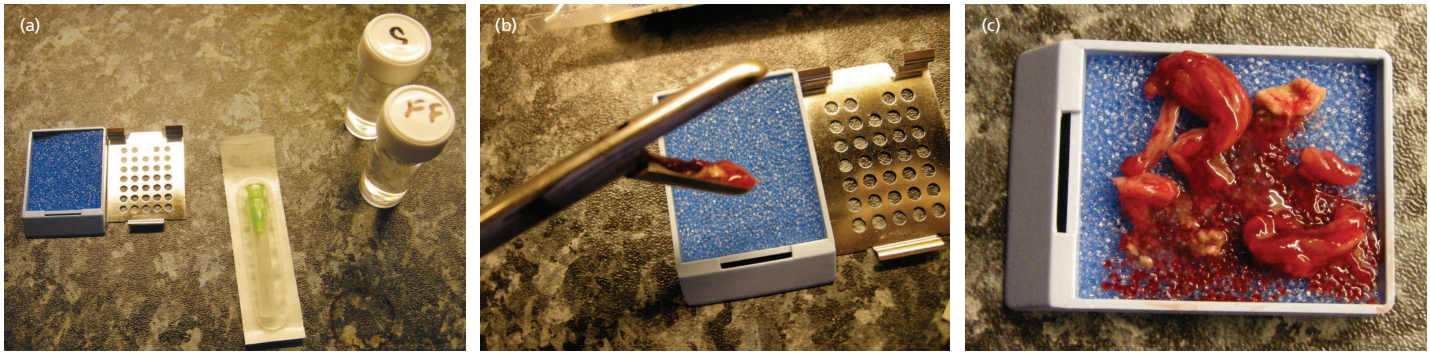


Fig 5: Equipment used for handling biopsies. A needle is used to lift the biopsy tissue from the forceps to prevent crush damage that would occur if forceps were used. Samples are placed into formol saline for histopathology, and into a small volume of saline or in a dry pot (depending on laboratory preference) for culture. Placement of histopathology specimens into a cassette protects them, helps to preserve architecture and prevents small samples from getting lost. (Picture: Davina Anderson)

Fig 6: Epistaxis after anterior endoscopy and biopsy. Cotton buds help to stem less severe haemorrhage. (Picture: Davina Anderson)

before recovery from anaesthesia, ensuring everything has been retrieved, and then the pharynx is suctioned. Extubation is left as late as possible to ensure that the gag and cough reflexes are present. The endotracheal tube is removed with the cuff partially inflated to prevent fluid passing into the trachea. In small dogs persistent saline flushing can lead to a significant decrease in the core body temperature; therefore, proactive measures should be taken during anaesthesia to lessen the risk of hypothermia (eg, Bair Hugger therapy, warm fluids for nasal instillation, blankets and bubble wrapping the feet). Microwaved fluid bags, gloves filled with hot water and hot water bottles should not be used for warming as they can lead to severe burns.

Mucosal swelling secondary to biopsy can cause short-term stertor, which should resolve over the three to five days following the procedure. If blood loss has been a concern, packed cell volume (PCV) should be monitored; bear in mind that it will take time for the PCV to fall, as fluid shifts into the intravascular space to replace the lost volume.

Parenteral opioid analgesia (morphine, methadone, pethidine or buprenorphine) is typically provided for 12 to 24 hours, depending on the perceived degree of discomfort. Animals are usually discharged with oral non-steroidal anti-inflammatory drugs, provided there is no contraindication to their use.

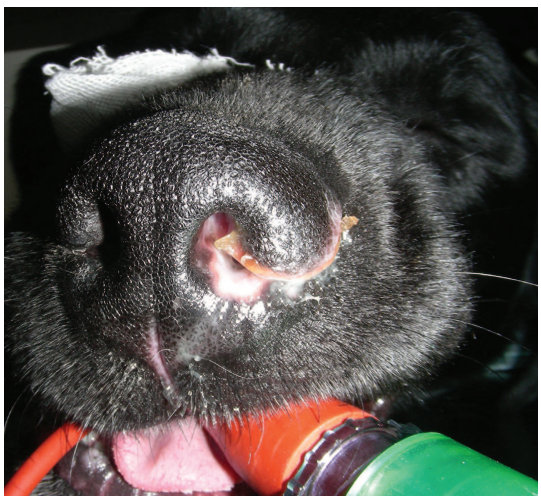


Fig 7: Depigmentation of the nasal planum in a dog with sinonasal aspergillosis

Nasal diseases

Sinonasal aspergillosis

Aspergillosis in dogs is most often caused by *Aspergillus fumigatus*, a filamentous saprophyte and ubiquitous fungus, although infections with other *Aspergillus* species, *Penicillium* species and *Cryptococcus neoformans* have been reported. The term nasal aspergillosis, which has previously been used to describe this condition, has been replaced by sinonasal aspergillosis, because the infection commonly involves both the nasal cavity and frontal sinuses.

Sinonasal aspergillosis is an uncommon cause of nasal discharge in dogs in the UK. It typically occurs in otherwise healthy, young to middle-aged dogs. Local immune dysfunction is suspected, and the role of increased interleukin-10 mRNA expression in the nasal mucosa is being investigated. The disease is typically unilateral on first presentation, but progresses to become bilateral. Typical clinical signs are profuse mucopurulent to purulent nasal discharge, nasal pain and ulceration/depigmentation of the nasal planum (Fig 7). Sneezing, reverse sneezing, epistaxis, depression and decreased appetite can also be seen. The presence of facial or nasal pain and ulceration/depigmentation of the nasal planum help to differentiate it clinically from some of the other causes of nasal discharge. Systemic aspergillosis, by comparison, is a rare disease affecting mostly German shepherd dogs; systemic immunodeficiency is suspected and affected dogs generally do not have nasal involvement.

Sinonasal aspergillosis is often suspected on the basis of signalment, history and physical examination findings, although other nasal diseases such as nasal neoplasia, idiopathic lymphoplasmacytic rhinitis, nasal foreign body and tooth root abscess can share similar clinical features. Diagnosis of aspergillosis is complicated by the fact that *Aspergillus* species may be isolated from normal dogs' noses or as a contaminant in dogs with other causes of nasal disease. The presence of antibodies on serological testing indicates exposure but does not indicate whether this is an active or historical response. While some papers suggest high sensitivity and reasonably high specificity with serological testing (97 to 100 per cent sensitivity and 76 to 88 per cent specificity), anecdotal reports and the authors' experience indicate that it is not as accurate as rhinoscopy.

Diagnostic imaging

Diagnostic imaging will often increase the index of suspicion for sinonasal aspergillosis. While a good-quality radiographic series shows typical features of aspergillosis in most cases, CT imaging is much better at defining the extent of the pathology and assessing the cribriform plate. Radiographic findings can include radiolucency in the rostral nasal cavity in conjunction with increased radiopacity in the caudal aspect (Fig 8). Increased radiopacity is also often found in the frontal sinus, due to fungal disease or fluid from reduced drainage through the nasofrontal ostium.

CT offers distinct advantages over radiography including cross-sectional imaging that eliminates superimposition of structures, adjustment of contrast scale to optimise optical density and discriminate fine turbinate detail, and multiplanar reconstructions

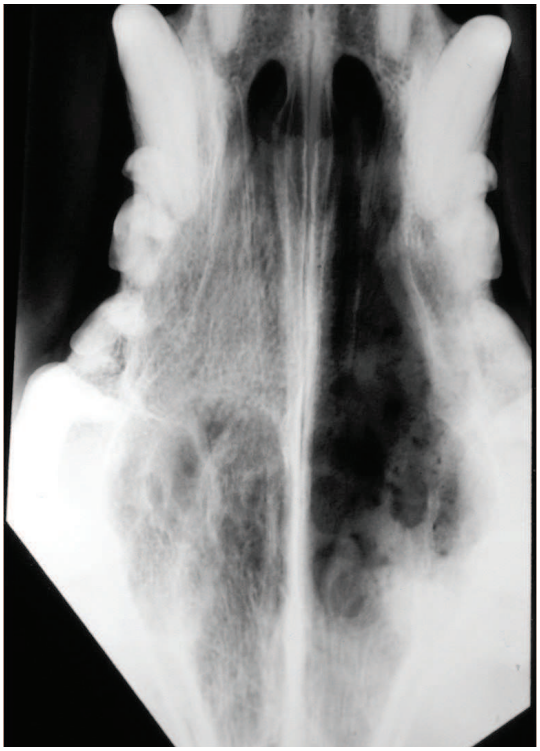


Fig 8: Dorsoventral intraoral radiograph of a canine nasal cavity showing turbinate destruction in the left nasal cavity in a dog with sinonasal aspergillosis. Compared with the normal right side, there is an overall reduction in radiopacity on the left, caused by the advanced destructive changes. (Picture: Queen's Veterinary School Hospital, University of Cambridge)

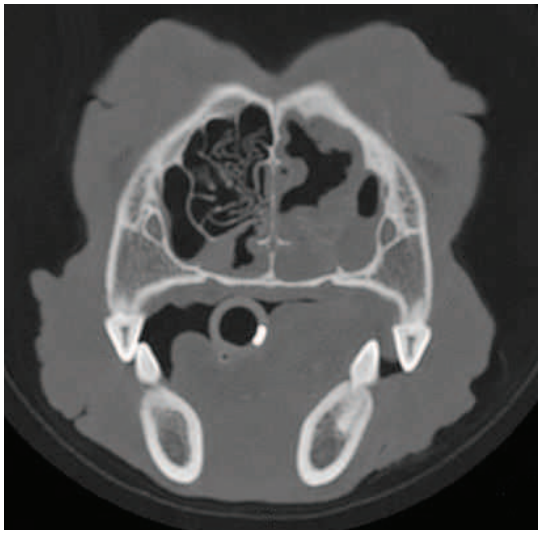


Fig 9: Computed tomography of the nasal cavity of a dog with sinonasal aspergillosis, showing loss of turbinates on the left. The increase in soft tissue may represent fungal plaques or nasal discharge

for better evaluation of the cribriform plate (Fig 9). Despite recent advances in diagnostic imaging, the 'gold standard' for diagnosis of the disease remains direct visualisation of fungal plaques during rhinoscopy or identification of fungal elements on cytology or histopathological examination.

Rhinoscopy

Rhinoscopically, destruction of the turbinates is often seen with aspergillosis, creating a 'cavernous' appearance (Fig 10a). Fungal colonies will be recognised as grey, white or yellow plaques if present (Fig 10b). Colonies should be sampled directly with biopsy forceps for cytology and histopathology. While this can be highly frustrating and time consuming, there is little doubt that sampling from a lesion identified at rhinoscopy is more likely to be diagnostic than a blind biopsy procedure. There is no merit in collecting nasal secretions or nasal swabs for fungal culture as it is extremely unlikely to yield a positive result.

Treatment

Several treatment options for sinonasal aspergillosis have been employed over the last few decades. Systemic oral therapy is no longer considered first-line treatment as it requires prolonged treatment due to moderate to poor efficacy and is associated with side effects such as anorexia and vomiting, which may be the result of hepatotoxicosis. Systemic oral therapy is typically reserved for refractory cases where topical treatment has failed. Topical instillation of antifungal drugs, especially clotrimazole or enilconazole, has been associated with greater success than oral therapy. There are a number of options for instillation of topical therapy, including nasal cavity catheters, intrasinus Jamshidi needles and indwelling frontal sinus tubes.

Cure is achieved in 85 to 90 per cent of dogs with each of the topical treatments. Initial reports on clotrimazole described soaking both nasal cavities with the liquid formulation for an hour. This technique has been modified to a bilateral infusion of a 1 per cent clotrimazole solution through surgically placed catheters or Jamshidi needles into both the frontal sinuses (Fig 11a). This is followed by the instillation of clotrimazole cream to act as a depot agent for extended drug

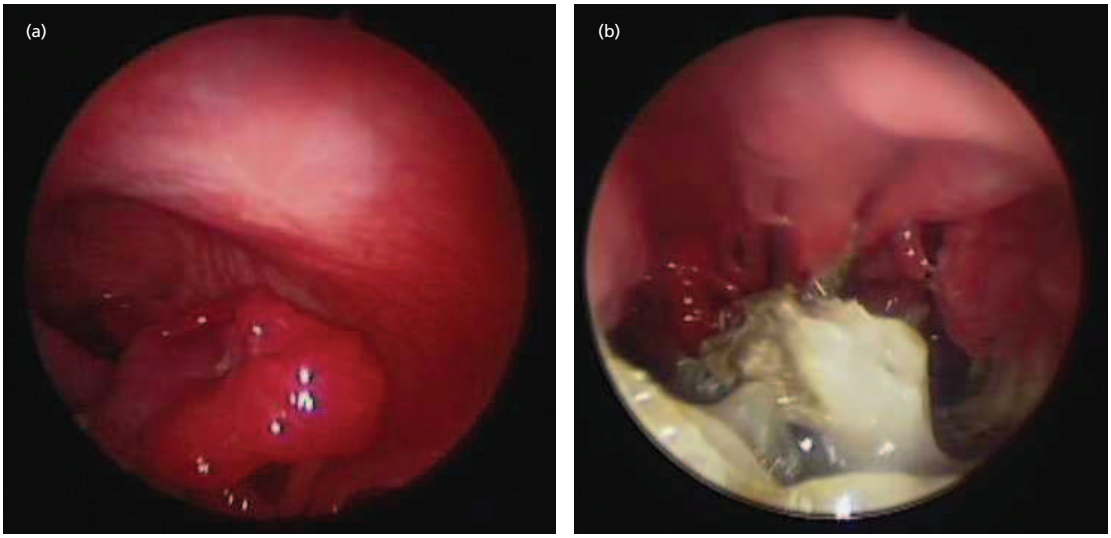


Fig 10: Anterior rhinoscopy of a dog with aspergillosis. (a) Destruction of the turbinates creates a 'cavernous' appearance. (b) Fungal plaques

contact (Fig 11b). This has a reported success rate of approximately 86 per cent and is the authors' current preferred technique for naive infections.

Surgical extirpation of the frontal sinuses is performed in dogs with large fungal plaques, followed by application of topical clotrimazole (Fig 12). Topical enilconazole is rarely used, as it must be administered via indwelling drains in the frontal sinuses twice daily for seven to 14 days, leading to prolonged hospitalisation times and costs. Most importantly it is very unpleasant; even the most placid dogs may react unfavourably to the procedure and in some cases a full course of treatment cannot be given due to these side effects. The authors resort to indwelling tubes for instillation of enilconazole (Fig 13) if an animal has failed to respond to clotrimazole on two occasions, as it has a similar success rate to clotrimazole.

Aspergillomas in the frontal sinus are debrided surgically if identified on CT. Rhinotomy offers a last resort for animals with refractory disease or where the diagnosis has not been made, but surgery by no means guarantees success. There are reports of using iodine-impregnated swabs or topical enilconazole with oral antifungal drugs after rhinotomy for refractory cases. There is often some morbidity following rhinotomy, with side effects such as subcutaneous emphysema. Further damage to the nasal turbinates can increase the risks of long-term complications.

In the long term, dogs may suffer from nasal discharge after recovery from sinonasal aspergillosis. In most cases it is a secondary bacterial rhinitis that will respond to antibiotics, although sometimes it may be the end result of severe turbinate destruction. Pomrantz and Johnson (2010) found that, after intranasally administered clotrimazole, the presence of nasal discharge and results of repeated serological testing were not consistent with disease status. The diagnosis of recurrence is therefore based on a lack of response to antibiotics and repeat rhinoscopy. There are sporadic reports of sinonasal tumours in dogs following successful clotrimazole treatment, but it has not been ascertained whether this was due to the underlying disease, associated inflammation or treatment, or, indeed, if they were present at the time of diagnosis.

Cryptococcosis

While cryptococcosis is the most common systemic mycotic disease of cats, it is rarely reported in dogs. The most common causative organism in animals is the subspecies *Cryptococcus neoformans* var *neoformans*, which is found in the environment, including in soil, fruits, pigeon droppings and other avian habitats. It may remain viable in pigeon droppings for two years.

Some dogs have been shown to be asymptomatic carriers of *Cryptococcus gattii* and *C neoformans* var *neoformans* based on nasal washings. A lack of serum cryptococcal antigen and the absence of yeast-like organisms from the nose is suggestive of contamination rather than infection. While some animals may clear the organism, some remain subclinically infected and others develop clinical disease, with no known factors determining what will happen in individual animals.

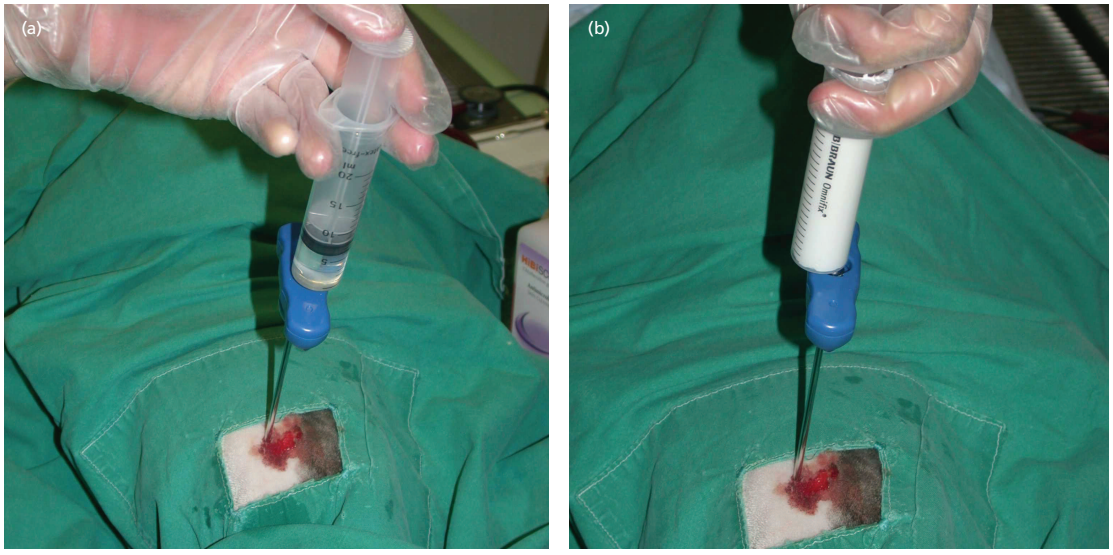


Fig 11: (a, b) Treatment of sinonasal aspergillosis by topical instillation of clotrimazole via Jamshidi needles. Saline is flushed through the sinus followed by clotrimazole solution and then clotrimazole cream. Treatment is administered into both frontal sinuses (only the first sinus is seen being treated in these images)

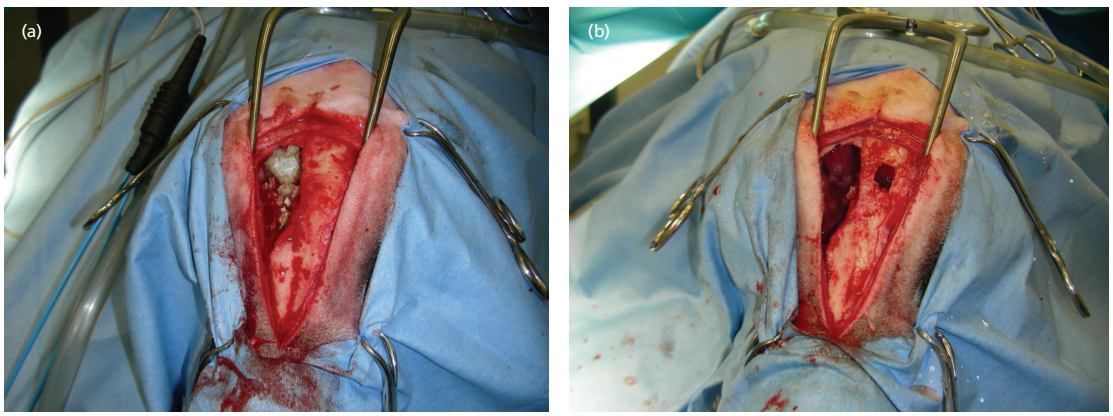


Fig 12: (a, b) Surgical extirpation of the frontal sinuses for treatment of sinonasal aspergillosis and large fungal plaques. This is followed by topical clotrimazole therapy into the frontal sinuses and nasal cavity. (Pictures: Davina Anderson)

Fig 13: Treatment of sinonasal aspergillosis using indwelling tubes for instillation of enilconazole

Affected dogs may present with a selection of clinical signs, including sneezing, nasal discharge, epistaxis and nasal deformity. Rhinoscopy may reveal roughened, erythematous nasal turbinates, and fungal granuloma may be seen as a mass lesion. The latter may also be visible on diagnostic imaging. Diagnosis is by demonstration of the fungus on histopathology as well as by tissue culture and serum antigen titres.

Other rarely reported fungal infections of dogs include *Rhinosporidium* (causing obstructive nasal polyps), *Exophiala*, *Alternaria*, *Trichosporon*, *Blastomyces* and *Histoplasma* species and the alga *Prototheca*, but these have not been reported in the UK.

Nasal neoplasia

Tumours involving the nasal cavity are rare in dogs, accounting for approximately 1 per cent of all neoplasms identified. They typically affect older, medium to large breed dogs and it has been suggested that being dolichocephalic, living in an urban environment and being exposed to tobacco smoke all lead to increased risk. Carcinomas (adenocarcinoma, squamous cell carcinoma and undifferentiated carcinoma) represent approximately two thirds of tumours, with sarcomas (fibrosarcoma, chondrosarcoma, osteosarcoma and undifferentiated sarcoma) comprising the majority of the rest. There are occasional reports of other tumours; for example, melanoma. The metastatic rate is typically low at the time of diagnosis but approaches 40 to 50 per cent at the time of death.

Nasal neoplasia is typically a unilateral disease process, at least initially, and the average duration of clinical signs before diagnosis is three months. Clinical signs include nasal discharge, epistaxis, sneezing, stertor, stridor and epiphora. Air flow will typically be reduced on the affected side. During physical examination of animals with nasal neoplasia, it is important to try to retropulse both globes as the neoplasm can invade the retrobulbar space, as well as assessing for facial pain or deformity. Most animals with nasal neoplasia are euthanased as a result of extension of local disease, leading to clinical signs such as facial deformity and pain, exophthalmus, intractable epistaxis and seizures if there is invasion into the cranium, usually via the cribriform plate.

A definitive diagnosis of nasal neoplasia can only be made by histology. Supportive data can be obtained with imaging (radiography, CT or MRI) (Figs 14 to 17) and rhinoscopy. CT is the optimal imaging modality due to the information it provides about bone and the extent of disease, especially lesions of the palate, nasopharyngeal meatus, maxillary sinus, caudal ethmoturbinates and periorbital tissues. Biopsy is often difficult due to the caudal location of masses; large blind grab biopsies are often performed and it may be necessary in

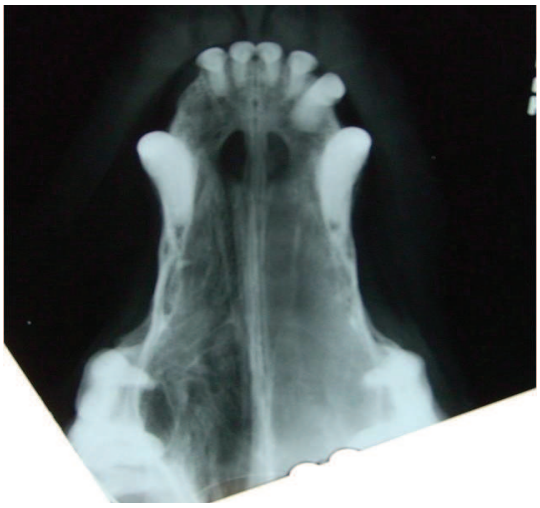


Fig 14: Dorsoventral intraoral radiograph of a canine nasal cavity showing turbinate destruction and increased soft tissue opacity in the left nasal cavity in a dog with a nasal tumour. In comparison with destructive rhinitis, there is a marked overall increase in radiopacity on the affected side. Multiple teeth are missing, representing an incidental finding in this case. (Picture: Queen's Veterinary School Hospital, University of Cambridge)

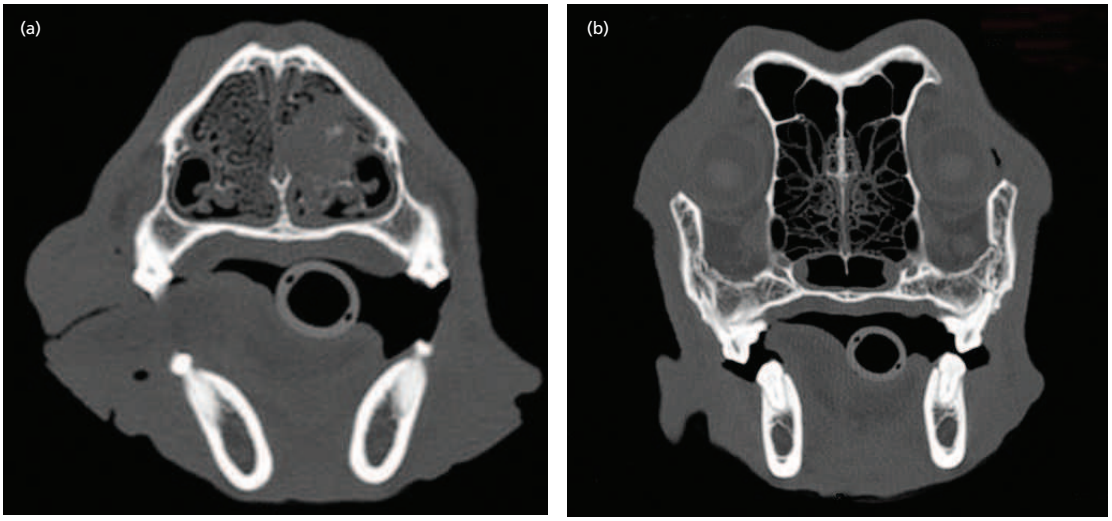


Fig 15: (a) Computed tomography (CT) of the rostral nasal cavity of a dog with a nasal carcinoma. (b) CT is useful to show the extent of disease. In image (b) of the same dog, the mass does not involve the caudal nasal cavity. CT is necessary for planning and using radiation therapy

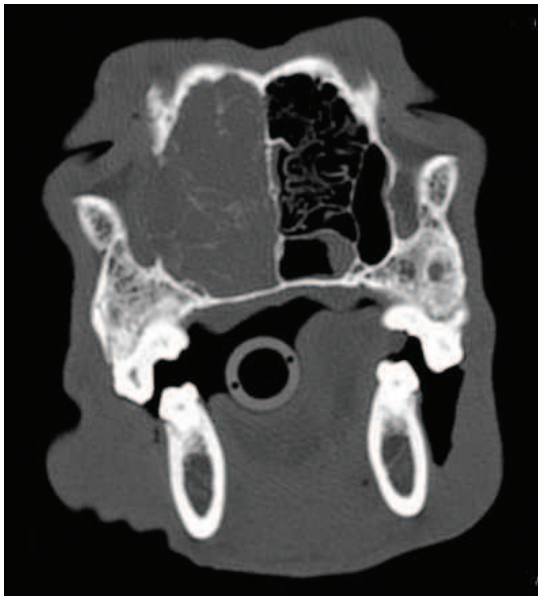


Fig 16: Computed tomography of the rostral nasal cavity of a dog with a nasal carcinoma in the right nasal cavity. Note destruction of the turbinates and replacement with a soft tissue opacity. There is destruction of surrounding bone

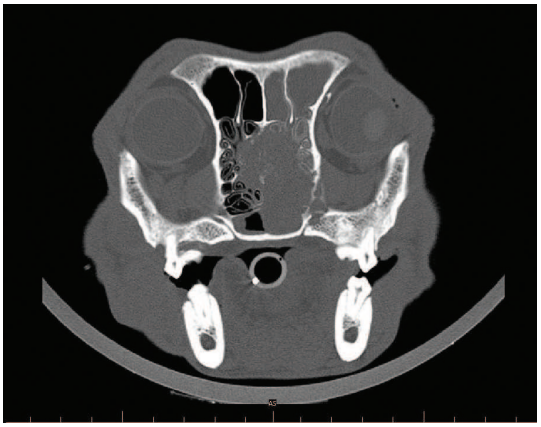


Fig 17: Computed tomography of the rostral nasal cavity of a dog with a nasal carcinoma in the left nasal cavity, with extension through the nasal septum to involve the right nasal cavity. There is a soft tissue opacity in the left frontal sinus

rare cases to perform a rhinotomy for biopsy (Fig 18). A nasal flush (Box 4) should always be performed in cases of suspected nasal neoplasia, as a piece of the tumour is occasionally dislodged and later identified when the pharyngeal packing is removed. If there is significant damage to the cribriform plate, this procedure might cause iatrogenic damage. However, all nasal biopsy procedures entail risk, especially when trying to achieve a reasonably sized diagnostic sample. Staging of the lymph nodes and thorax is necessary.

As most tumours are located in the caudal nasal cavity, disease is usually advanced at the time of diagnosis, with significant bony invasion. Median survival in untreated dogs with carcinoma was just 88 days for dogs with epistaxis and 224 days for those without. Treatment of nasal neoplasia in dogs is aimed at slowing progression and reducing tumour mass; this is best achieved with fractionated radiation therapy, which is very well tolerated by most dogs, although loss of sight in at least one eye will be seen in almost half of dogs treated this way. Median survival and one- and two-year survival times vary between reports, which is not surprising given the differences in treatment modalities and possible differences in animal selection.

A summary of survival times reported in the literature over the past 25 years is given in Table 3. A poorer prognosis is seen in older dogs, those with advanced local disease or lymph node metastasis, and one report suggests that there may be a poorer response to orthovoltage radiation. Dogs with carcinoma have a poorer prognosis than those with sarcoma (predominantly chondrosarcoma), with a relapse rate that is 3.3 times higher. Surgery is associated with significant morbidity and infers little in the way of increased survival; chemotherapy is not considered to improve survival.

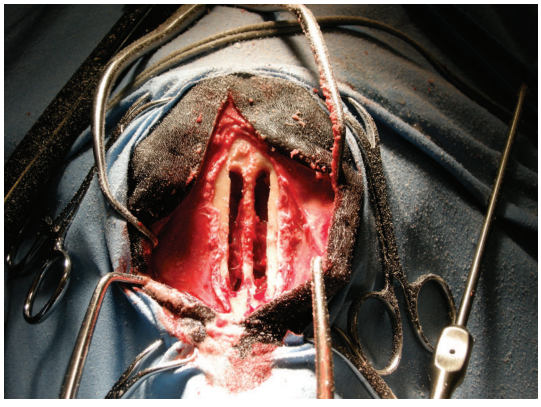


Fig 18: Bilateral rhinotomy can be used to obtain samples for histopathology as well as for removing foreign bodies. This is a last resort where endoscopy has failed. (Picture: Davina Anderson)

Idiopathic lymphoplasmacytic rhinitis

Lymphoplasmacytic rhinitis (LPR) is microscopically characterised by infiltration of the nasal mucosa with lymphocytes and plasma cells, although variable numbers of neutrophils and eosinophils may also be present. The definitive cause of LPR is unknown, although some authors believe that the condition is a chronic inflammatory response to an inhaled irritant, pollutant or allergen. An immune-mediated pathogenesis has also been suggested, but poor glucocorticoid response in most dogs with LPR does not support this hypothesis.

Young to middle-aged dolichocephalic and mesaticephalic large breed dogs are typically affected. Unfortunately, signalment helps very little in differentiating dogs with LPR from dogs with other nasal diseases. Chronic unilateral to bilateral mucoid to mucopurulent nasal discharge is often present, although some dogs may have mucohaemorrhagic discharge or epistaxis. Obstruction to airflow through the nose may result from excessive mucous within nasal passages and turbinate mucosal oedema. Lymphoplasmacytic inflammation may be present concurrently with nasal neoplasia, fungal rhinitis, dental disease, oronasal fistula or foreign body rhinitis; therefore it is imperative that these diseases be thoroughly excluded before a definitive diagnosis is made. CT images may mimic fungal rhinitis as turbinate destruction occurs in some cases, although typically the changes are not as pronounced and destruction of the nasal septum, bones of the frontal sinuses and cribriform plate are not expected. Frontal sinus opacification on CT can occur due to fluid trapping. Changes on endoscopy are non-specific (Fig 19).

Treatment of idiopathic lymphoplasmacytic rhinitis is extremely frustrating and a cure is rarely achieved. Allergen avoidance is usually unhelpful and difficult to accomplish. While systemic corticosteroids are seldom effective in controlling clinical signs, inhaled steroid therapy (eg, fluticasone propionate or beclomethasone) does seem to lead to a partial improvement in some animals. Antihistamine medications are rarely effective,

Table 3: Summary of median and one- and two-year survival times of dogs with nasal tumours treated with radiation with or without surgery/chemotherapy*

Tumour type	Treatment modality	Median survival	One-year survival (%)	Two-year survival (%)	Reference
Carcinomas and sarcomas	Radiation ± surgery	8.1 months (12 months adenocarcinoma, six months SCC/ undifferentiated carcinoma)	38	30	Adams and others (1987)
	Radiation ± surgery	12.8 months	59	22	McEntee and others (1991)
	Radiation ± surgery	12.6 months	60	25	Theon and others (1993)
	Radiation + chemotherapy	19.3 months	81	39	Lana and others (1997)
Adenocarcinoma	Radiation ± surgery/chemotherapy	14.1 months	–	–	Henry and others (1998)
	Radiation ± chemotherapy	14.3 months	60	36	Adams and others (1998)
	Orthovoltage (21 dogs), cobalt photons (109 dogs)	267 days (8.9 months)	–	–	LaDue and others (1999)
	Surgery combined with radiation	220 days (7.4 months)	37	17	Northrup and others (2001)
	Radiation	212 days	45	15	Mellanby and others (2002)
Carcinoma	Radiation	146 days			Gieger and others (2008)
	Intensity-modulated radiation therapy	446 days	50	25	Hunley and others (2010)

SCC Squamous cell carcinoma;
*Cytoreductive surgery was performed in some dogs as an adjunct to radiation

but they occasionally reduce the severity of nasal discharge. Long-term administration of antibiotics that have immunomodulatory effects, combined with non-steroidal anti-inflammatory agents, can be helpful in some animals. Doxycycline is frequently trialled for a period of four to six weeks; however, as recent studies have failed to identify any infectious agent associated with this disease, any beneficial effect may well be from immunomodulation.

Pneumonyssoides caninum

Pneumonyssoides caninum is the canine nasal mite. The life cycle and mode of transmission of the parasite are not fully known. Cases typically present with non-specific signs referable to the upper respiratory tract, including sneezing and reverse sneezing. *P caninum* has recently been identified in the UK. Treatment options include milbemycin oxime 1 mg/kg given orally three times at 10-day intervals. This dose regimen is more frequent than the monthly dose of 6 to 12 mg/kg recommended for flea infestations. According to the manufacturer, selamectin has been administered at 10 times the recommended dose without undesirable effects.

Foreign bodies

Foreign material in the nose will cause sneezing and irritation initially. Untreated foreign bodies may lead to nasal discharge and, occasionally, epistaxis. Radiography is rarely helpful, as most foreign material is organic, but CT can be helpful for identifying sticks and other large foreign bodies (Figs 20 and 21). Endoscopy allows both diagnosis and treatment in most cases, although the presence of large volumes of nasal discharge can make identification of foreign material difficult. Nasal flushing is invaluable in these cases.

Summary

Dogs presenting with sneezing and nasal discharge may have similar clinical signs and progression of disease, especially in the early stages. However, the prognoses for the different diseases vary widely, emphasising the need for a full diagnostic evaluation.

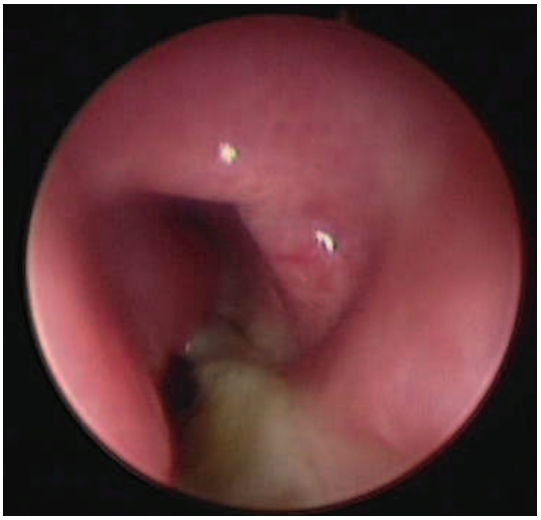


Fig 19: Anterior rhinoscopy of a dog with lymphoplasmacytic rhinitis showing nasal discharge

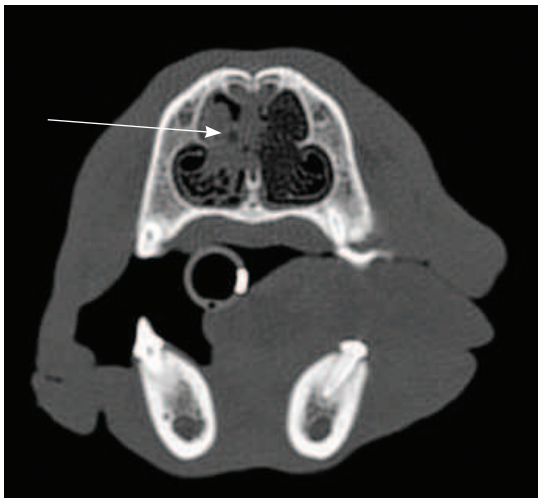


Fig 20: Computed tomography of the rostral nasal cavity of a dog with a stick foreign body (arrow) surrounded by nasal discharge

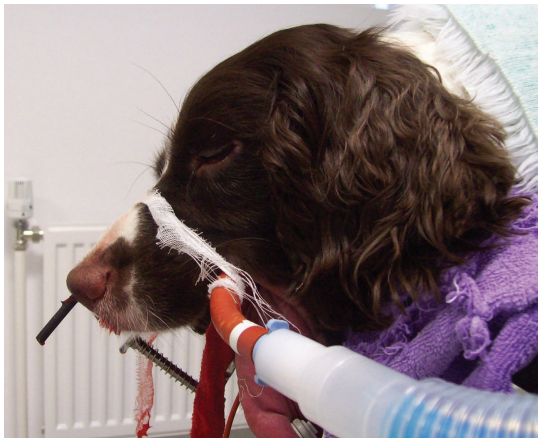


Fig 21: A stick foreign body has been pulled from the nasal cavity using anterior rhinoscopy

Acknowledgements

The authors thank Davina Anderson and Queen's Veterinary School Hospital, University of Cambridge, for providing some of the images.

References

ADAMS, W. M., MILLER, P. E., VAIL, D. M., FORREST, L. J. & MACEWEN, E. G. (1998) An accelerated technique for irradiation of malignant canine nasal and paranasal sinus tumors. *Veterinary Radiology and Ultrasound* **39,** 475-481

ADAMS, W. M., WITHROW, S. J., WALSHAW, R., TURRELL, J. M., EVANS, S. M., WALKER, M. A. & KURZMAN, I. D. (1987) Radiotherapy of malignant nasal tumors in 67 dogs. *Journal of the American Veterinary Medical Association* **191,** 311-315

GIEGER, T., RASSNICK, K., SIEGEL, S., PROULX, D., BERGMAN, P., ANDERSON, C., LADUE, T., SMITH, A., NORTHRUP, N. & ROBERTS, R. (2008) Palliation of clinical signs in 48 dogs with nasal carcinomas treated with coarse-fraction radiation therapy. *Journal of the American Animal Hospital Association* **44,** 116-123

HENRY, C. J., BREWER, W. G., JR, TYLER, J. W., BRAWNER, W. R., HENDERSON, R. A., HANKES, G. H. & ROYER, N. (1998) Survival in dogs with nasal adenocarcinoma: 64 cases (1981-1995). *Journal of Veterinary Internal Medicine* **12,** 436-439

HUNLEY, D. W., MAULDIN, G. N., SHIOMITSU, K. & MAULDIN, G. E. (2010) Clinical outcome in dogs with nasal tumors treated with intensity-modulated radiation therapy. *Canadian Veterinary Journal* **51,** 293-300

LADUE, T. A., DODGE, R., PAGE, R. L., PRICE, G. S., HAUCK, M. L. & THRALL, D. E. (1999) Factors influencing survival after radiotherapy of nasal tumors in 130 dogs. *Veterinary Radiology and Ultrasound* **40,** 312-317

LANA, S. E., DERNELL, S. W., LARUE, S. M., LAFFERTY, M. J., DOUPLE, E. B., BREKKE, J. H. & WITHROW, S. J. (1997) Slow release cisplatin combined with radiation for the treatment of canine nasal tumors. *Veterinary Radiology and Ultrasound* **38,** 474-478

MCENTEE, M. C., PAGE, R. L., HEIDNER, G. L., CLINE, J. M. & THRALL, D. E. (1991) A retrospective study of 27 dogs with intranasal neoplasms treated with cobalt radiation. *Veterinary Radiology* **32,** 135-139

MELER, E., DUNN, M. & LECUYER, M. (2008) A retrospective study of canine persistent nasal disease: 80 cases (1998-2003). *Canadian Veterinary Journal* **49,** 71-76

MELLANBY, R. J., STEVENSON, R. K., HERRTAGE, M. E., WHITE, R. A. & DOBSON, J. M. (2002) Long-term outcome of 56 dogs with nasal tumours treated with four doses of radiation at intervals of seven days. *Veterinary Record* **151,** 253-257

NORTHRUP, N. C., ETUE, S. M., RUSLANDER, D. M., RASSNICK, K. M., HUTTO, D. L., BENGTSON, A., RAND, W. & MOORE, A. S. (2001) Retrospective study of orthovoltage radiation therapy for nasal tumors in 42 dogs. *Journal of Veterinary Internal Medicine* **15,** 183-189

POMRANTZ, J. S. & JOHNSON, L. R. (2010) Repeated rhinoscopic and serologic assessment of the effectiveness of intranasally administered clotrimazole for the treatment of nasal aspergillosis in dogs. *Journal of the American Veterinary Medical Association* **236,** 757-762

TASKER, S., KNOTTENBELT, C. M., MUNRO, E. A. C., STONEHEWER, J., SIMPSON, J. W. & MACKIN, A. J. (1999) Aetiology and diagnosis of persistent nasal disease in the dog: a retrospective study of 42 cases. *Journal of Small Animal Practice* **40,** 473-478

THEON, A. P., MADEWELL, B. R., HARB, M. F. & DUNGWORTH, D. L. (1993) Megavoltage irradiation of neoplasms of the nasal and paranasal cavities in 77 dogs. *Journal of the American Veterinary Medical Association* **202,** 1469-1475

SULLIVAN, M. (1987) Differential diagnosis of chronic nasal disease in the dog. *In Practice* **9,** 217-222

Further reading

PEETERS, D. & CLERCX, C. (2007) Update on canine sinonasal aspergillosis. *Veterinary Clinics of North America: Small Animal Practice* **37,** 901-916

SISSENER, T. R., BACON, N. J., FRIEND, E., ANDERSON, D. M. & WHITE, R. A. (2006) Combined clotrimazole irrigation and depot therapy for canine nasal aspergillosis. *Journal of Small Animal Practice* **47,** 312-315

Self-assessment test: canine nasal disease

(1) Which treatment modality is the most beneficial for the palliation of nasal carcinoma?

a. Surgical resection
b. Prednisolone
c. Radiation
d. Metronomic chemotherapy

(2) What are the potential complications of rhinoscopy?

a. Haemorrhage
b. Aspiration pneumonia (± death)
c. Damage to the cribriform plate/brain
d. All of the above

(3) When is systemic oral therapy for aspergillosis indicated?

a. If epistaxis is present
b. On first presentation of disease
c. If fungal plaques are present
d. For refractory disease

Answers
(1) c, (2) d, (3) d.