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The Brachycephalic Problem

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#1 VETERINARIAN RECOMMENDED

Editor's Note

This issue gives a lot of space to upper airway abnormalities as well as the problems encountered with brachycephalic breeds.

World wide the veterinary profession is starting to stand up against breeding for looks and not function and in South Africa we need to start doing our part to prevent the breeding of animals which will require much medical or surgical intervention throughout their lives and even then have poor quality of life and even pain. Dr Kurt de Cramer is placing an article in the next edition and is well placed to take on this task - if anyone is interested to contact him.

Thanks once again to Prof. Leisewitz for the dermatology article - pruritic disease in cats. Some important basics are once again re-iterated.

Hope you enjoy the edition

Liesel

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PREVIOUS EDITION: May 2019

- Certification for Pet Export
- Approach to Diet Trials in Pruritic Dogs
- Management of Noise Phobias

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VET360 aims to be a leader in the field of continuing veterinary development in Southern Africa by providing veterinary professionals from diverse disciplines with tools to help them meet the challenges of private practice. The magazine aims to make information accessible, both paper and electronic, and provide clinical, business and other veterinary information in a concise form to enable the practitioner to rapidly acquire nuggets of essential knowledge.

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Prof. Andrew Leisewitz BVSc, MMedVet(Med), PhD - Dermatology

Shaping the future of animal health

Feline Allergic Dermatitis

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Faculty of Veterinary Science

The following review is based largely on a very well written publication entitled 'Cutaneous hypersensitivity dermatoses in the feline patient: A review of allergic skin disease in cats.' It was published in Veterinary Sciences, 2017, 4, 25; 1-10 and written by Alison Diesel of the Department of Medical Sciences, School of Veterinary Medicine, University of Wisconsin, Madison in the USA.

Introduction

Although it is often commented throughout the veterinary profession that cats are not small dogs, this fact becomes particularly apparent with regards to the manifestation of feline dermatological abnormalities. Cats present a unique clinical entity in terms of their manifestation of inflammatory skin disease, particularly the cutaneous hypersensitivity dermatoses.

Frequently, the allergic feline patient will present with at least one of the four common cutaneous reaction patterns indicative of pruritus and inflammation:

1. Head/neck/pinnal pruritus with excoriations,
2. Self-induced alopecia,
3. Miliary dermatitis,
4. Eosinophilic lesions (including eosinophilic plaques, eosinophilic granulomas, and indolent ulcers).

The reaction patterns themselves are just that: patterns. They do not represent a definitive diagnosis. Although feline cutaneous reaction patterns are often indicative of underlying allergic skin disease, other differentials need to be considered prior to arriving at a diagnosis of allergy. This should include parasitic and infectious etiologies.

As with dogs, hypersensitivity skin diseases in cats fall into three main categories; however, the nomenclature is a bit different. Flea (and other insect bite) hypersensitivity and food induced hypersensitivity dermatitis (cutaneous adverse food reaction) are similar between dogs and cats, but atopic dermatitis is where the two species differ. Due to the lack of conclusively demonstrated influence of IgE (immunoglobulin E) on disease pathogenesis, the term "non-flea, non-food hypersensitivity dermatitis" (NFNFHD) is preferred when discussing "feline atopic syndrome". In general, when allergic skin disease is compared across the two species, much less is known in cats as opposed to dogs.

Flea and other insect bite hypersensitivities

Flea bite hypersensitivity

Flea allergy dermatitis (FAD) has historically been considered the most frequently diagnosed hypersensitivity condition in the cat. Classically, the disease presents more commonly in flea endemic areas and may be seen as a sole entity or in conjunction with other allergic skin disease.

Evidence of flea exposure including "flea dirt" or the presence of live fleas may or may not be apparent. Although dorsal lumbosacral pruritus with miliary dermatitis is noted most commonly with flea bite hypersensitivity other reaction patterns may also be observed, leading to difficulty distinguishing between strictly FAD and other hypersensitivity diseases in the feline patient. This may be further complicated by the fastidious grooming behaviour in cats which can make identification of fleas nearly impossible, particularly when only a small population is present.

Other dermatologic lesions which may be noted with FAD include eosinophilic plaques or ulcers, bilaterally symmetrical self-induced alopecia, ventral abdominal alopecia, or generalized pruritus. One study identified a frequent occurrence of indolent lip ulceration in cats with experimentally induced FAD; the same has also been noted for the naturally occurring disease.

The fact that several of these cutaneous reaction patterns may be observed highlights the importance of ruling out other potential causes of pruritus such as FAD prior to arriving at a clinical diagnosis of NFNFHD in the cat.

The mainstay of management for cats with flea bite hypersensitivity, however, relies on consistent and aggressive adulticidal flea prevention, along with additional anti-pruritic medications for times of disease flare. Various products are available for the feline patient including continuous release collars, long-lasting topical isoxazoline medications, and other topical and oral anti-parasitics. To help further minimize exposure for the cat with FAD, all in-contact animals (e.g., other household pets) should also receive consistent adulticidal flea prevention.

Definition: Miliary Dermatitis - a crusted papule, like a small seed (millet) stuck on the skin. Felt as small tightly adherent crusts on the skin.

Mosquito bite hypersensitivity

A closely related hypersensitivity condition in the feline patient is mosquito bite hypersensitivity. Also a type I (immediate-type) hypersensitivity reaction, mosquito bite hypersensitivity shares several features with FAD. The most common lesion reported is miliary dermatitis; eosinophils are easily demonstrated on lesions of affected cats. Head, neck and pinnal pruritus are commonly reported as lesions often concentrate along the convex surface of the pinnae as well as along the bridge of the nose. (Fig. 1) Paw pads may occasionally be affected in disease presentation as well. While less commonly seen, other eosinophilic lesions such as granulomas and plaques have been demonstrated in affected cats.

The disease is more commonly reported in cats that venture outside in geographic regions where mosquitos are endemic.

The mainstay of therapy involves avoidance. Ideally, affected cats should be kept indoor where mosquito exposure is decreased. It is important to note that many insect repellents designed for humans are not

Figure 1. Cat showing lesions on the bridge of the nose due to mosquito bites

safe to use on cats (e.g., those products containing DEET). Permethrin-based products should also be avoided due to toxicity seen in the feline species. The newer synthetic pyrethroid, flumethrin, has proven safety in cats and may be beneficial for managing mosquito bite hypersensitive patients. While not yet evaluated, isoxazolines may additionally provide repellency due to their wide spectrum of insecticidal activity. As with FAD, administration of anti-pruritic therapy may be indicated periodically for disease flare.

Food hypersensitivity dermatitis (Cutaneous adverse food reaction; food allergy)

In a cat with non-seasonal pruritus, and where parasitic and infectious causes of pruritus have been ruled out, food induced hypersensitivity dermatitis should be a considered differential diagnosis. Although information sources disagree on the prevalence of cutaneous reactions to food in the feline patient, with incidence ranging from 1% to 6% of all feline dermatological abnormalities, most sources agree that the condition is uncommon. This may represent a true finding or it may be that it is under-investigated and hence underdiagnosed.

Anecdotally, however, cutaneous adverse food reactions (CAFR) may be more common in the cat as compared to the dog. As with dogs, the pathogenesis of feline cutaneous adverse food reactions is not fully understood. The involvement of food intolerance (abnormal physiologic response to food not due to an immunologic reaction) may also contribute to the development of cutaneous adverse reactions to food in the feline patient.

Non-seasonal pruritus is the hallmark of feline food hypersensitivity. The condition presents similarly to NFNFHD in the cat in that one or more cutaneous reaction patterns may be noted. Although other body regions may be affected and the pruritus may be considered generalized in some cats, several reports identify pruritus as often disproportionally severe and more commonly involving the head, neck, and pinnae in cats with CAFR. Concurrent gastrointestinal abnormalities are variably noted which may include vomiting, diarrhoea, or soft stool. One study has reported concurrent gastrointestinal abnormalities in one-third of cats presenting for cutaneous adverse reactions to food. Another found the combination of both gastrointestinal abnormalities and dermatological disease to be highly suggestive of food sensitivity in the feline patient.

Prior to investigating CAFR in the feline patient, parasitic and infectious causes of pruritus should be ruled out. Additionally, adulticidal flea prevention should be instituted to address sole or concurrent FAD. With regards to testing for food sensitivity, the only accurate way to diagnose the condition is with a strict elimination diet trial followed by a provocative food trial to confirm the food sensitivity. Without dietary challenge following improvement with a novel protein or hydrolyzed diet, food sensitivity can only be presumed.

As with dogs, the duration recommended for the hypoallergenic diet trial and dietary choice varies among veterinary dermatologists. Evidence based review of several sources found that more than 80% of cats with CAFR showed improvement with dietary manipulation within 6 weeks, however extending the diet trial to 8 weeks lead to complete remission in approximately 90% of cats and dogs with food sensitivity. Hydrolyzed protein diets are the preferred diets for conducting the diet trial. Common food allergens including beef, chicken, dairy and fish. If the diet trial improves the skin disease, it should be followed with a challenge of the original diet. Food sensitivity is confirmed if pruritus returns after feeding the original diet.

Non-flea, non-food hypersensitivity dermatitis (Feline Atopic Syndrome)

The designation of "feline atopic dermatitis" was used to describe a clinical syndrome in a group of feline patients with recurrent pruritus, positive reactions to several common environmental allergens on intradermal testing, and where other causes of pruritus (external parasites, infections) had been ruled out. Over the years, however, primarily due to the lack of conclusive IgE involvement in the disease process, the veterinary community has rather adopted the terminology of "non-flea, non-food hypersensitivity dermatitis" when referring to what was historically called feline atopic dermatitis (AD) or feline atopic syndrome. As with canine AD, pruritus is a hallmark

Figure 2. Obvious erythema and self-trauma with a heavy crusting dermatitis around the head typical of a reaction pattern seen with feline food hypersensitivity or non-flea non-food hypersensitivity dermatitis.

of feline NFNFHD; however, the pattern of lesion distribution is more variable in the cat.

In a detailed retropsepctive study of 45 cases of feline atopy the disease prevalence was 12.5%, with domestic mixed (n = 24), Abyssinian (n = 6) and Devon rex (n = 3) cat breeds predisposed. The median age of onset was 2 years (62% <3 years; 22% >7 years; range 3 months to 12 years). Common presentations were severe (82%), nonseasonal (82%), waxing/waning (36%) pruritus, with alopecia/crusting/excoriations and/or erosions/ulceration (73%). Miliary dermatitis (20%)

Figure 3. The symmetrical alopecia often seen with cats that self-groom as a result of pruritus.

and eosinophilic granuloma complex lesions (27%) occurred. The face/head (71%), ventral abdomen (51%), neck (51%), limbs (38%), pinnae (31%), dorsum/rump (31%) and feet (16%) were frequently affected sites; lesions were restricted to the head/neck in only five cats (11%). Concurrent otitis externa (16%), superficial bacterial pyoderma (49%), Malassezia dermatitis (7%), flea-bite hypersensitivity (24%) and adverse food reaction (13%) occurred. Severe nonseasonal pruritus was most common, with a varied spectrum of lesions affecting a range of body areas. (Fig. 2)

Good response to cyclosporine (100%; 10 of 10), systemic glucocorticoids (55%; 22 of 40) and allergen-specific immunotherapy (57%; 13 of 23) and good/partial response to antihistamines (67%; 22 of 33) were reported. It was concluded that the prevalence of feline AD was higher than previously suggested, and breed predispositions were confirmed.

With regards to the pathogenesis surrounding NFNFHD in cats, the disease does share some similarities to both human and canine AD. Although less well described in cats, genetic influence of disease development does seem possible as is true for dogs and people. Exposure to environmental allergens appears to exacerbate the disease in cats , but the role of allergen-specific IgE involvement in NFNFHD is still uncertain. Although the exact immunologic mechanism of disease development remains a bit unclear in the cat, histopathological studies have found a very similar pattern of inflammatory cells in the skin of cats with NFNFHD as compared to chronic AD lesions in dogs and people. Whether or not interleukin-31 is involved in feline NFNFHD remains yet to be determined. The role of skin barrier function has become an increasingly important area of investigation with regards to human and canine AD. This has not been well evaluated in the cat.

Clinical signs of NFNFHD in cats revolve around the presence of pruritus (Fig 2 and 3). Feline patients often do not present with a history of pruritus. As they may exhibit such signs only privately ('silent groomers'). Diagnosis is far from straightforward (and may well be more difficult than in the dog). Pruritus distribution may include any one or more of the four cutaneous reaction patterns. NFNFHD is a diagnosis of exclusion, as is true for AD in dogs and other species, and ruling out parasites, infections, and other allergic diseases (FAD, CAFR) is imperative.

Historically, concurrent bacterial pyoderma has been considered to be an uncommon to rare finding in cats with NFNFHD. This may be due to decreased bacterial adherence to corneocytes compared to dogs and people, which could suggest relative resistance to the development of pyoderma in feline patients. A study evaluating the frequency of isolation of Staphylococcus species bacteria in cats with and without inflammatory skin disease did not find a significant difference in bacterial isolation between the two populations . However, other sources suggest that feline bacterial pyoderma may be more prevalent than previously reported.

As with NFNFHD, bacterial pyoderma in cats has less well-defined lesions than canine bacterial pyoderma. Variable lesions of feline bacterial pyoderma may include crusted papules with or without erosion and exudation, pustules, furuncles, eroded to ulcerated plaques which may also be crusted and exudative, and linear to nodular granuloma lesions that may be ulcerated. As several of these lesions are similar to common cutaneous reaction patterns in feline NFNFHD, the involvement of bacterial infection may frequently be overlooked.

As with bacterial pyoderma, Malassezia species overgrowth is considered to be a common concurrent finding in dogs and people with AD. Historically, secondary Malassezia overgrowth in feline patients with allergic skin disease has only been reported anecdotally. More frequently, Malassezia overgrowth was noted in cats with systemic illnesses including thymoma-associated dermatitis, paraneoplastic alopecia, and cats infected with feline leukemia virus or feline immunodeficiency virus. These reports led to the general belief that Malassezia overgrowth in

the cat was an indicator of serious systemic disease including neoplasia or retroviral infections. As with bacterial pyoderma, however, secondary Malassezia overgrowth in cats with allergic skin disease may be a more prevalent finding than what was previously reported.

One study found that Malassezia organisms were isolated much more frequently in cats with NFNFHD than in cats without allergic skin disease. Lesions were in parallel with the distribution of feline allergic pruritus and were frequently accompanied by alopecia, erythema, greasy brown scales that adhered to the skin, increased cerumen, and hyperpigmentation. The improvement noted with administration of systemic antifungal medication (i.e., itraconazole) supported the contribution of Malassezia overgrowth to the degree of noted pruritus in allergic cats. These studies support the association between secondary infections in cats with allergic skin disease and highlight the need for utilising diagnostics and therapy to identify and resolve secondary bacterial pyoderma and yeast overgrowth in allergic feline patients.

Along with the cutaneous reactions patterns noted in cats with NFNFHD, other non-cutaneous clinical signs may be concurrently present. This may include allergic otitis, sinusitis, and conjunctivitis as well as potentially feline small airway disease or "asthma".

Although pinnal pruritus is a fairly common manifestation of feline NFNFHD, the ear canals themselves are frequently normal in appearance. This is in contrast to atopic dogs who frequently present with erythematous otitis externa secondary to allergic disease. Some cats with NFNFHD will present with recurrent, ceruminous otitis externa, often in the absence of infectious organisms (i.e., bacteria and yeast). This may be misdiagnosed as ear mite infestation even if mites are not found.

As with AD in other species, there is no cure for NFNFHD in cats. Rather, the goal of managing the disease relies on decreasing the severity and frequency of pruritic flares along with other cutaneous and non-cutaneous complications. Care should be taken to identify and manage any secondary disease entities such as parasites and infections as this will compound the degree of pruritus appreciated. Additionally, any other flare factors should be recognized and addressed.

Various therapeutic entities are available for managing feline NFNFHD. As no one specific treatment may be ideal, each option should be carefully evaluated for each feline patient. Therapy typically includes administration of glucocorticoids or cyclosporine. Cats tend to be a bit less sensitive to steroids compared to dogs and often require a higher starting treatment dose (e.g., 1–2 mg/kg prednisolone every 24 h and then tapered). The microemulsion form of cyclosporine (cyclosporine (modified); e.g., Atopica®, Elanco) is recommended in veterinary species due to more predictable absorption and bioavailability. Oclacitinib (Apoquel®, Zoetis), a Janus kinase inhibitor labeled for the treatment of allergic pruritus and AD in dogs, has shown efficacy in reducing clinical signs in a small population of cats with NFNFHD. This medication, however, has not been well studied yet in cats; ideal dose range and administration recommendations have yet to be established in this species.

The caninized monoclonal antibody directed against interleukin-31 (lokivetmab; Cytopoint®, Zoetis) for the management of canine AD is not recommended for cats due to the likelihood of severe adverse reactions to the foreign protein. Allergen-specific immunotherapy may also be an effective treatment options for cats with NFNFHD. Various options for formulation exist; however, subcutaneous injection has been used most frequently in this species as compared to oral/sublingual allergy drops. Reported success rates vary between 60 and 78%. In some cases a reduced dependence on antipruritic drugs may be chieved which may be regarded as partial success. Response is usually seen in 3 – 8 months but may take as long as a year.

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29 August 2019

by Prof. Andrew Leisewitz

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Topic TBC (more information to follow)

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Shaping the future of animal health

Business Column Brought to you by Nedbank

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7 Steps to a High Performance Practice

Alan Robinson BVSC MRCVS DMS
Director, Vet Dynamics UK Ltd

Veterinary practice is a reactive business. Practices tend to wait and see what happens to them (e.g. economy, legislation, internet, competition, etc.) then knee-jerk react positively or negatively to the consequences.

As a result life in practice can be chaotic, reactive and stressful – many vets working far too hard for too many hours for too little return in regards to profit or time – essentially a 'sick' practice in need of some Emergency Room care.

There are 7 Key Symptoms that most practices that are struggling have in common are

1. **Profit is too low,** (<5%), for a good life and a sustainable future
2. **Consumable costs are too high**, (>30% of turnover), tying up useful cash
3. **Drug Sales providing** >75% of profit – drug dependency!
4. **Staff costs high, >50%** , because of underperforming staff
5. **No marketing budget** for attracting & retaining better clients
6. **No CPD budget** for training and improving skills.
7. **No Time** to manage because of **Stress**, frustration and inefficiency of the business

All too obvious and all too common...

Triage is required at 4 levels (if that makes sense?)

1. Financial trends
2. Marketing and Client Quality
3. Professional Pricing
4. Vet Performance

These diagnostics reveal much, but not the whole picture. They clearly indicate where change is necessary - no doubt about that. However that does not make change any easier to implement for the same reasons. Usually the current situation is indicative of the cultural climate and the prevailing (limiting) set of beliefs in the practice.

Cultural problems in business are caused by the absence of one or more of four essential things:

1. **Vision** - a clear and explicit picture of what your practice is about and what it is trying to achieve
2. **Information** - what needs to be done and how to do it
3. **Systems** - the processes and procedures through which that information is implemented in the business to produce practical and quantifiable results
4. **Communication** - the link from the vision to the processes through the people that will achieve your outcomes

This cultural map is the combination of the leadership capability and team engagement:

Are we doing the right things. Leadership is not inherent – it needs to be learnt and developed. So what do we recommend?

Leadership tools and systems need to be integrated and used regularly and consistently. These include:

1. Developing a shared vision with the team
2. Managing yearly & quarterly planning process
3. Implementing protocols and continuous improvement processes
4. Accurate and timely data to make wise decisions
5. Creating clear management structures
6. Creating and using clear and frequent communication structures
7. Using robust decision and delegation structures

If this sounds like spinal surgery to you you're right – this is advanced therapy – but the only way to get lasting and sustainable change.

And like a great surgical or medical team all this depends on....

Team Engagement - as distinct from staff employment. An engaged team work with you not just for you. When you employ people you are concerned with their skills, knowledge and attitudes to work – but this will not be enough.

Intrinsic motivation for the team consists of Autonomy, Mastery and Purpose

Lastly, the Heath Checklist to take home and put on the fridge. So what are the seven vital signs of a successful practice you need to be focused on?

Practices succeed due to:

1. **Leadership & vision**
2. **Team engagement**
3. **Focused marketing & client care**
4. **Internal communication** systems
5. **Accounting & financial** knowledge & systems
6. Focus on **Professional fees** vs. **drug sales**
7. Ability to **charge appropriately** for services

Simple, but no-one said it was easy.....

Brachycephalimania

Dr Daniela Steckler
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Based on their skull morphotypes, dog breeds are currently classified as dolichocephalic (long skulls such as the greyhound, Afghan Hound, Dachshund, German Shepherd), mesocephalic (normal length skull) or brachycephalic (short skull such as the pug, English bulldog, French bulldog, Boston terrier). Dolichocephalic breeds excel in hunting due to their great peripheral vision while brachycephalic breeds are bred to focus and connect due to their forward facing eyes and visual clarity.

Brachycephalic breeds have gained tremendous popularity over the last 20 years, the most popular being the English bulldog, French bulldog, and pug. While the pug is an ancient breed originating from China , which only came to England in the 1600s, the English bulldog is a more recent breed originating in the 1600s. The French bulldog, a cross between the English bulldog and a French Rat dog (similar to a Fox terrier) originated in the 1800s. Selective breeding for more childlike facial features such as dark round eyes, short skulls and flat faces, which are seen as endearing by human owners, has unintentionally led to associated health issues. This includes but is not limited to anatomical defects of the upper airway causing breathing difficulty, also known as Brachycephalic Obstructive Airway Syndrome (BOAS); recurring skin infections related to skin folds; eye disease; inability to breed or give birth naturally (requiring Caesarean sections), spinal disease which may, or may not, be related to having a screw-tail or short-tail.

The images in Figure 1 show the CT scans of a non-brachycephalic dog versus a brachycephalic dog, visualizing the short skull base (purple) of a brachycephalic dog which stopped growing prematurely. As a result the cranium is shorter but grows taller and consequently the top of the head becomes rounder and domed (panel d: bright red

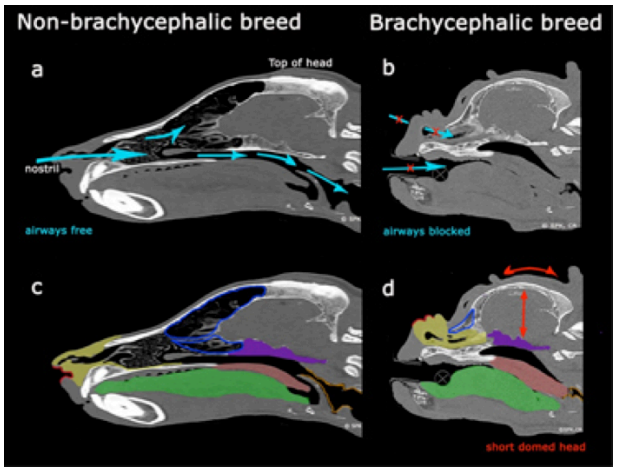

Figure 1: CT scan of the head of a non-brachycephalic and a brachycephalic dog (credit to Dr Clare Rusbridge and Dr Penny Knowler https://www.bva.co.uk/news-campaigns-and-policy/bva-community/bva-blog/brachycephalic-ct-scans-%E2%80%93-the-science-behind-the-shock-factor/)

arrows). The muzzle is shorter and the nose is more "button like" (dark red line) lying between and just below the eyes. A reduction in the frontal sinus (dark blue outline) results in a broad and flat forehead. As a consequence the same amount of oral and / nasopharyngeal soft tissues (grey areas) found in non-brachycephalic dogs fills and obstructs the airway in brachycephalic dogs. The tissue around the nasal passage (yellow) in panels c and d shows how severely restricted the breathing through its nose is in a brachycephalic dog. Consequently, the dog must open its mouth to breathe but even that airway may be obstructed by a tongue (green) and soft palate (pink) that is compressed to fill the reduced space. The soft palate pushes back on the larynx (orange) further obstructing the airway. The small nostrils, larynx and trachea allow less air to get into the lungs – like breathing through a narrow and obstructed straw. As a consequence the increased effort in breathing causes inflammation of the soft palate and larynx and this swelling further obstructs the airway.

Less severely affected dogs may have noisy open-mouthed breathing and snore at night. Severely affected dogs have sleep disturbance, cannot exercise and are distressed and can even turn cyanotic. In severe cases the too small cranium results in pressure on the brain and spinal cord causing signs suggesting head and neck pain (Chiari malformation) or even more severe neurological problems such as the severe spinal cord disease syringomyelia (https://www.bva.co.uk/news-campaigns-and-policy/bva-community/bva-blog/brachycephalic-ct-scans-%E2%80%93-the-science-behind-the-shock-factor)

Perceived as cute and desirable by the general public, brachycephalic breeds are predisposed to a life time of poor health and possible suffering. The use of brachycephalic breeds in advertisements, international or local TV shows, has added to the unhealthy demand of these breeds. The British Veterinary Association (BVA) has recently stated that the huge current demand for brachycephalic puppies is causing a veterinary health crisis. As a result the Brachycephalic Working Group has been formed, consisting of members of the veterinary community, researchers, welfare organisations and breed experts, in order to reduce and eliminate health problems associated with the selection for a flattened face shape when breeding brachycephalic dogs. In addition the BVA has actively been discouraging companies to use images of brachycephalic dogs in advertising. As a result the journal Veterinary Record and its sister titles (In Practice, Veterinary Case Reports, and Veterinary Open Records) no longer accept adverts with images of brachycephalic breeds.

The Federation of European Companion Animal Veterinary Association (FECAVA) has released a Position Paper on Breeding healthy dogs, and recently the Netherlands have taken steps towards healthier breeding of brachycephalic dogs such as the enforcement of laws prohibiting the breeding of dogs with muzzles considered too short (less than a third of the skull) and introducing fitness tests for brachycephalic dogs. Just as the BVA has been leading the drive to see more responsible breeding of brachycephalic dogs in the UK, the same should be happening in South Africa.

In South Africa the English bulldog is, and has been, the most registered breed with the Kennel Union of South Africa (KUSA) for at least the last three years, followed by the Rottweiler and the Labrador retriever. While the demand for bulldogs and pugs in South Africa has shown a slight decrease, the French bulldog in particular is in demand. The number of French bulldogs imported from overseas greatly exceeds that of any other breed (KUSA registry statistics; www.kusa.co.za). While these numbers show the overall demand for brachycephalic breeds, there is no means of knowing their actual population size within South Africa, or the number of animals that are being bred but not registered with the Kennel Union.

The Kennel Union/Club and the show sector should take an integral part in promoting healthier dog conformations amongst the pet-buying public and encourage breeders to follow standards through the selection of healthier breeding lines. The veterinary profession has a social and moral responsibility, and should act collaboratively to (https://www.bva.co.uk/news-campaigns-and-policy/bva-community):

- Promote and undertake annual brachycephalic health assessments.
- Increase awareness of the health and wellness issues associated with brachycephalic dogs amongst current and prospective owners.
- Educate owners about the effect of obesity in exacerbating health problems linked to

brachycephaly, and that frequent respiratory sounds such as snoring and snorting are not normal but a clinical signsof compromised breathing.
- Report conformation-altering surgery and caesarean section to the Kennel union or to other clinical surveillance programmes
- Encourage research and develop an objective measurement to assess the problematic conformation of each individual dog.

The BVA published a 10 Point plan for veterinary practices to improve the welfare of brachycephalic dogs and to promote responsible ownership. Implementing only a few of the following points will help a tremendous amount (https://www.bva.co.uk/news-campaigns-and-policy/bva-community/bva-blog/-breedtobreathe---how-vets-can-improve-health-and-welfare-of-brachy-breeds/):

1. Offer a pre-purchase consultation to prospective dog owners which clearly outlines the potential health problems of brachycephalic dogs.
2. Strongly advise against breeding if a dogs suffers from BOAS or requires conformation altering surgery.
3. Promote a puppy contract.
4. Promote and actively participate in available health schemes.
5. Carry out exercise tolerance tests and functional grading for brachycephalic breeds as part of their annual health assessment.
6. Enrol the practice in clinical surveillance programs.

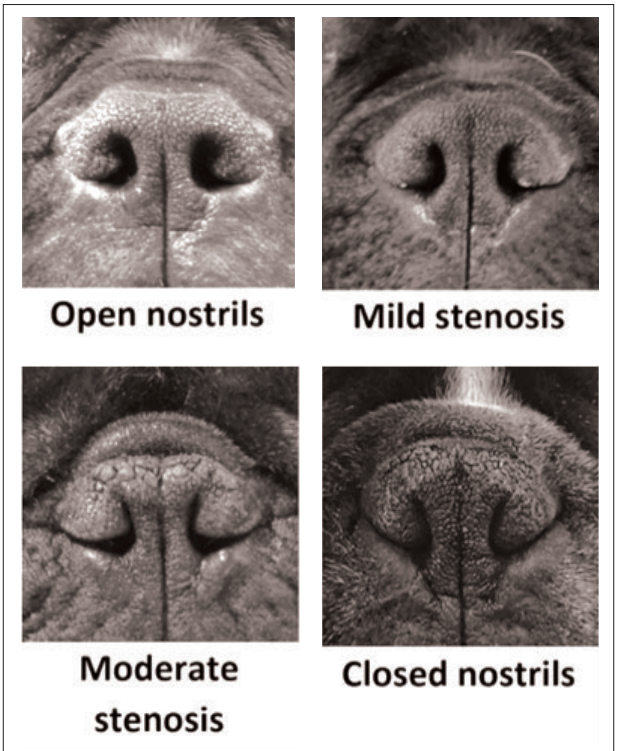

Figure 2: Degrees of stenosis of the nares in brachycephalic breeds (Image credit: Cambridge BOAS Research Group)

7. Repeatedly, clearly and consistently communicate the health problems experienced by brachycephalic dogs.
8. Do not portray dogs with brachycephalic conformation as cute, humorous or appealing in your practice.
9. Educate your staff so they can convey evidence based information and advice to owners.
10. Support local breed clubs to implement plans to improve the health of dogs with brachycephalic conformation.

It goes without saying that already owned and loved brachycephalic dogs or puppies will be afforded all the veterinary care they need and certainly not be discriminated against.

Long term aims of the veterinary profession and associated associations should be to:

- Review breed standards and implement breed health and conservation plans.
- Better understand and address the prevalence of and trends in conformation-related ill-health in brachycephalic dogs and the welfare impacts resulting from brachycephaly through research and extended data gathering.
- Discourage VIPs, advertisers, designers and veterinary practices to use the images of brachycephalic dogs in order to reduce their desirability and demand.

Brachycephalic health assessments

Brachycephalic health assessments should be used in both breed shows and veterinary consultations to improve the health of the current population and to encourage the selection of healthier breeding lines. All brachycephalic dogs should receive an annual brachycephalic health assessment by their vet to assess potential conformational-related health issues. BOAS is a conformation-related respiratory disorder resulting from deformation of the upper airway tract leading to obstruction, as the soft tissues have not reduced proportionately with the length of the skull (Hendricks, 1992). This results in noisy and laboured breathing with exercise and heat intolerance, accompanied by sleep disturbed breathing, gastrointestinal disorders such as regurgitation and vomiting, and in extreme cases cyanosis, collapse and death (Amis and Kurpershoek, 1986; Hendricks et al., 1987; Hendricks, 1992; Meola, 2013). Affected dogs have a reduced lifespan of approximately 3 years (O'Neill et al., 2013; Michell, 1999; Cassidy, 2007; O'Neill et al., 2015).

The Cambridge University's veterinary medicine department found that BOAS affected 40% of all studied English bulldogs, 46% of French bulldogs and 60% of pugs. Meanwhile no prevalence of the disease was found in the control group (crossbreeds only).

It is estimated that 60% of owners do not recognise clinical signs of BOAS such as snoring (Packer et al., 2012; Liu et al., 2015) as they think it is normal for the breed.

In order to reduce the prevalence of BOAS in brachycephalic breeds a reformation of the breed standards has been suggested. In order to do so the causal anatomical lesions causing BOAS need to be identified and quantified. Quantitative measurements described included the length and thickness of the soft palate (Grand and Bureau, 2011), the tracheal diameters (Kaye et al., 2015), nasopharyngeal dimensions (Heidenreich et al., 2016), glottis dimensions (Caccamo et al., 2014), and mucosal contact points of the nasal turbinates (Schuenemann and Oechtering, 2014).

However these measurements require sedation and general anaesthetic, which is impractical for screening a pet population. Instead an assessment of the body condition score (BCS), the degree of nostril stenosis, exercise intolerance test, and soft tape measurements of the skull and body may be performed to estimate the occurrence of BOAS (+) in a dog or not (BOAS-):

1. Body condition score assessment on a 1-9 point scale (see http://www.wsava.org/WSAVA/media/PDF_old/Body-condition-score-chart-dogs.pdf)
2. Assessment of the degree of nostril stenosis: open or mild nostril stenosis are considered acceptable, while moderate or severe stenotic nostrils are unacceptable (Figure 2).

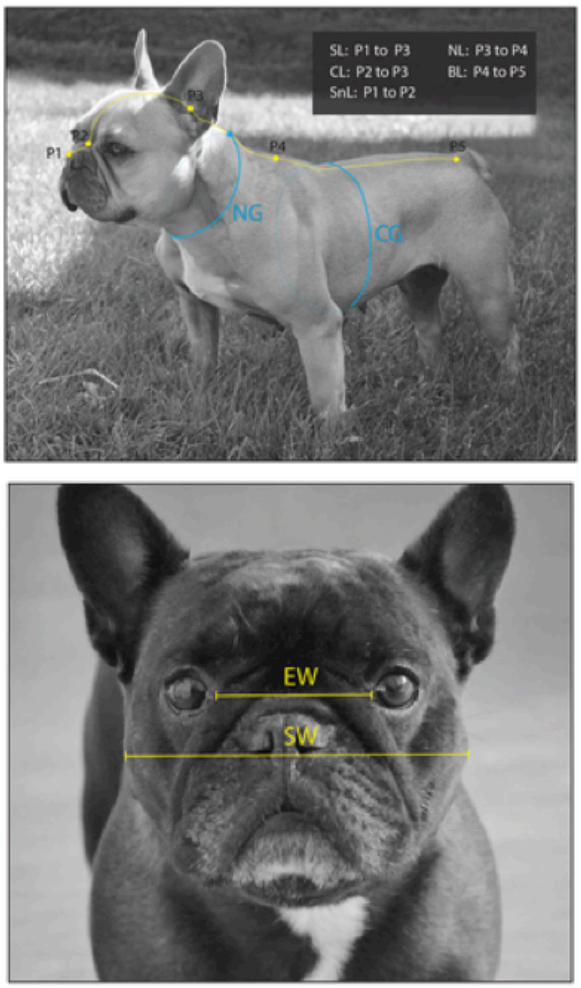

Figure 3: Demonstration of the soft tape measurements of skull and body of brachycephalic breeds. Skull length (SL), cranial length (CL), snout length (SnL), neck length (NL), body length (BL), eye width (EW), and skull width (SW). Also see Table 1 for description of measurements1. (https://doi.org/10.1371/journal.pone.0181928.g002)

Table 1: Description of the soft tape measurements of skull and body of brachycephalic breeds.

	Descriptions
Cranial length (CL)	The distance along the surface of the head at the skull midline from the external occipital protuberance to the point between the medical canthus of the left eye and the medial canthus of the right eye
Snout length (SnL)	The distance along the surface of the head at the skull midline from the stop to the rostral end of the nasal planum
Skull length (SL)*	The distance along the surface of the head at the skull midline from the external occipital protuberance to the rostal end of the nasal planum
Skull width (SW)	The linear distance (widest distance) between the left external zygomatic arch and the right external zygomatic arch.
Eye width (EW)	The linear distance between the medial canthus of the left eye and the medial canthus of the right eye
Neck length (NL)	The distance along the dorsal body midline from the external occipital protuberance to the point between the cranial angle of the left scapula and the cranial angle of the right scapula
Neck girth (NG)	The circumference of the neck at the median distance between the external occipital protuberance and the point between the cranial angle of the left scapula and the cranial angle of the right scapula
Chest girth	The circumference of the deepest part of the thoracic cavity
Body length	The distance along the dorsal body midline from the point between the cranial angle of the left scapula and the cranial angle of the right scapula to the root of the tail

**Skull length measurement in this study was the sum of CL measurement and SnL measurement*

3. An exercise tolerance test (ETT) should be used in order to standardise a functional grading by vets according to the functional grading system developed by the Cambridge Veterinary School BOAS research group. The EET of the BOAS group used a three minute trot test (at approximately 6km/h). Dogs are auscultated (larynx, pharynx and chest) before and after the test and the respiratory effort, chest and thoracic movement, ability to breathe through the nose, and recovery time are being assessed and recorded (see attached BOAS assessment template).
4. Soft tape measurements of skull and body: nine measurements of the skull and body of each dog can be taken using a standard one-meter soft tape measure (millimetre scales)
   a. skull length (SL),
   b. cranial length (CL),
   c. snout length (SnL),
   d. skull width (SW),
   e. eye width (EW),
   f. neck length (NL),
   g. neck girth (NG),
   h. chest girth (CG), and
   i. body length (BL).

The definitions of each measurement are listed in Table 1, while Figure 3 illustrates the method of measurement (Liu et al., 2017). From above measurements the following ratios can be calculated: eye width ratio (EWR) eye with/ skull width; skull index SI: skull width/ skull length; neck length ratio NLR: neck length/body length; neck girth ratio NGR: neck girth/ chest girth.

A study by the Cambridge BOAS Research Group, (Liu et al., 2017) using the above assessments have reported that pugs have a significantly higher BCS (median BCS=7) than French bulldogs (median BCS=5) and English bulldogs (median BSC=6) predisposing them to developing BOAS. 74.5% of French bulldogs had moderately to severely stenotic nostrils compared to pugs (65.3%) and bulldogs (44.2%). And the proportion of pugs with BOAS was 64.6%, higher than in French bulldogs (58.9%) and the English bulldog (51.2%) (Table 2).

Table 2: Comparison of age, gender, body weight, BCS, nostril stenosis and BOAS grade between pugs, French bulldogs and English bulldogs (*Liu et al*. 2017)

	Pug	French bulldog	English bulldog
Number	189	214	201
Study population	Clinical: 14.8%	Clinical: 17.3%	Clinical: 4.5%
	Volunteered: 85.2%	Volunteered: 82.7%	Volunteered: 95.5%
Age (months, median with range)	36 (12-147)	28 (12-126)	26 (12-178)
Gender	Male: 40.7%	Male: 44.4%	Male: 43.8%
	Female: 59.3%	Female: 55.6%	Female: 56.2%
Neuter status	Intact: 64.6%	Intact: 68.7%	Intact: 91.5%
	Neutered: 35.4%	Neutered: 31.3%	Neutered: 8.5%
Body weight (kg, mean ± SD)	8.53 ± 1.47	12.12 ± 2.05	25.47 ± 3.11
BCS (median with range; obesity*)	7 (4-9); 60.8%	5 (3-9); 8.4%	6 (4-8); 35.3%
Degree of nostril stenosis	Open: 9.5%	Open: 10.8%	Open: 26.9%
	Mild: 21.2%	Mild: 13.6%	Mild: 28.4%
	Moderate: 38.1%	Moderate: 29.0%	Moderate: 34.3%
	Severe: 19.6%	Severe: 45.33%	Severe: 9.5%
	NA: 11.6%	NA: 1.4%	NA: 1.0%
BOAS Functional Grade	Grade 0: 4.8%	Grade 0: 10.7%	Grade 0: 10.9%
	Grade I: 30.7%	Grade I: 30.4%	Grade I: 37.8%
	Grade II: 44.9%	Grade II: 43.5%	Grade II: 38.8%
	Grade III: 16.9%	Grade III: 15.4%	Grade III: 12.4%

*SD, standard deviation; BCS, body condition score, BOAS, brachycephalic obstructive airway syndrome; NA, data not available. * Obesity was defined as BCS ≥ 7 on a 9-point scale.*

The above study also showed that nostril stenosis is a strong predictor of BOAS for all three breeds. Dogs with moderate to severe stenosis of the nostrils were at higher risk of developing BOAS. Body condition score is significantly associated with BOAS in pugs and bulldogs with obese dogs having a higher risk of being BOAS positive. Among the conformation measurements, the neck girth ratio (NGR) is a valid predictor of BOAS in male bulldogs and highly reliable between different observers, thus it could potentially be used for breeding selection. Eye width ratio (EWR) and Skull Index (SI) in pugs, and NGR and neck length ratio (NLR) in French bulldogs, SI in bulldogs, were associated with BOAS but had poor-moderate inter-observer reproducibility. Nevertheless, they may be of use for directing the reformation of breed standards.

The Bracheal Assessment Sheet on the facing page may be useful for private practices that would like to implement yearly brachycephalic assessments

Reporting of conformation altering surgery

Up to date reporting and recording of conformational problems requiring surgical correction has been encouraged in vets and breeders/pet owners in South Africa. The purpose of the recording is not to put undue pressure on owners but to reduce the risk of welfare problems and is important for the health and welfare of the individual animal and the particular breed.

Data collection will help to identify potential genetic/breed specific problems and assist in gathering statistically significant canine health data. This way anecdotal evidence of certain issues in some breeds can be backed up by data and be evidence for the inheritability of and the level at which various conditions occur. To the authors knowledge no such data collections systems exist to date in South Africa but can be send to kznreproductionservices@gmail.com.

Data should include owner details, dog details, KUSA registration if registered and data is available, which surgery has been performed.

The following surgeries should be reported:

Respiratory:
- Brachycephalic airway syndrome
  - Stenotic nares
  - Elongated soft palates
  - Everted laryngeal saccules
- Laryngeal collapse
- Tracheal collapse
- Tracheal hypoplasia
- Cleft palate
- Hair lip

Musculoskeletal:
- Any joint replacements (other than for proven trauma)
- Cruciate repair
- Joint dysplasia
- Patellar luxation

Ophthalmic:
- Adnexal problems:
  - Entropion
  - Ectropion
  - Other eyelid plastic surgery
  - Distichiasis
  - Trichiasis
  - Incomplete eyelid closure
  - Diamond eye
  - Nictitating gland prolapse
- Lens luxation
- Cataract
- Glaucoma
- Retinal detachment
- Keratoconjunctivitis sicca
- Corneal ulceration that is breed associated

Cardiac:
Any cardiac or major vessel surgery (e.g. PDA)

Neurological:
- Syringomyelia
- Intervertebral disc protrusion
- Cervical spinal instability (Wobbler syndrome)
- Atlantoaxial subluxation
- Lumbosacral stenosis
- Dermoid sinus
- Persistent hepatic portal vein
- Hydrocephalus

Dermatological:
- Skin fold surgery
- Ear canal surgery

Alimentary:
- Dental malocclusion
- Cheiloplasty
- Vascular ring abnormalities
- Cricopharyngeal achalasia
- Hiatus hernia
- Gastric torsion
- Pyloric stenosis

Urogenital:
- Caesarean section
- Retained testicle
- Vaginal prolapse
- Urolithiasis
- Ectopic ureter

Miscellaneous:
- Umbilical hernia
- Inguinal hernia

References available online: www.vetlink.co.za

Bracheal Assessment Sheet

Date:
Dog details: **Owner details:**
History (e.g. snoring, dyspnoe, syncope and/or cyanosis)

BCS: 1/9 2/9 3/9 4/9 5/9 6/9 7/9 8/9 9/9
Nostril stenosis: mild/moderate moderate/severe

Exercise intolerance test (ETT):

		Respiratory Noise	Inspiritory effort	Dyspnoea/Cyanosis/Syncope(s)
Grade 0	Pre-ETT Post-ETT	Not audible Not audible	Not present Not present	Not present Not present
Grade 1	Pre-ETT Post-ETT	Not audible to mild Mild	Not present Not present to mild	Not present Not present
Grade 2	Pre-ETT Post-ETT	Mild to moderate Mild to severe	Mild to moderate Mild to severe	Not present Mild dyspnoea no cyanosis or syncope
Grade 3	Pre-ETT Post-ETT	Moderate to severe Severe	Moderate to severe Severe	Moderate to severe dyspnoe, may or may not show Cyanosis Severe dyspnoe, may or may not show Cyanosis/Syncope

Respiratory noise diagnosed by pharyngolaryngeal auscultation:
Mild: only audible under auscultation
Moderate: intermittent audible noise that can be heard without stethoscope
Severe: constant audible loud noise that can be heard without stethoscope

Inspiratory effort: also use of nasal flaring
Mild: regular breathing patterns with minimal use of diaphragm
Moderate: evidence of diaphragm and accessory muscle of respiration
Severe: marked movement of diaphragm and accessory muscles of diaphragm

Dyspnoe, syncope, cyanoses
Mild dyspnoea: presents signs of discomfort
Moderate dyspnoea: irregular breathing, signs of discomfort
Severe dyspnoea: irregular breathing with signs of breathing discomfort and difficulty breathing

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Upper Airway Causes of Dyspnoea in Dogs

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1. Brachycephalic Obstructive Airway Syndrome (BOAS)

Brachycephalic obstructive airway syndrome (BOAS) is a complex syndrome affecting brachycephalic dogs. The syndrome is made up of primary and secondary anatomical malformations that lead to increased resistance of airflow through the upper airway.

The primary anatomical defects consist of stenotic nares, elongated soft palate, macroglossia and trachea hypoplasia. Recent studies have shown these patients also have abnormal caudal nasal turbinates, which lead to increased resistance in the nasal cavity and partial obstruction of the nasopharynx (Figure 1.).

The secondary anatomical defects consist of everted laryngeal saccules, laryngeal collapse and oropharyngeal inflammation. These are thought to be consequence of the chronically high air pressures and increased turbulence moving through the upper airway which leads to secondary changes, which ultimately worsens the obstruction of the upper airway.

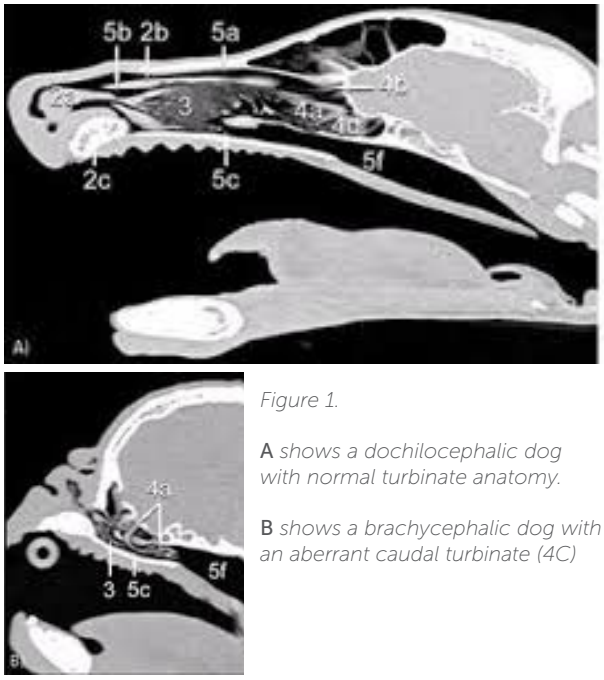

Figure 1.

A *shows a dochilocephalic dog with normal turbinate anatomy.*

B *shows a brachycephalic dog with an aberrant caudal turbinate (4C)*

Clinical signs

There are generally two scenarios for BOAS in practice.

The first is the patient presented for signs of stertorus breathing often more pronounced at night. These patients may have a history of exercise intolerance when trying to exert themselves. These are often younger dogs which have not had an episode of severe respiratory distress. Some of these patients may in rare cases present with signs of vomiting and gastro-oesophageal reflux from the sustained high negative pressure in the thoracic cavity during breathing.

The second scenario is a dog presenting in severe respiratory distress due to exertion, hyperthermia or recovery from general anaesthesia. These patients often present with marked cyanosis and upper respiratory obstruction that can progress rapidly to death if action is not taken.

Diagnosis

In the stable patient the initial clinical exam should focus on the respiration of the dog in the consulting room and at home. Owners should be asked if the dog struggles with normal activity or exercise, does this worsen the respiration. Does the patient snore at night?

Examination of the nostrils will often show marked stenosis. Auscultation of the airway and the heart are essential, a high number of brachycephalic dogs with BOAS have cardiac disease with pulmonic stenosis being the most common. Generally full serum biochemistry and a haematology are recommended if BOAS is suspected. Thoracic radiographs need to be taken prior to sedation to check for any underlying pulmonary oedema, aspiration pneumonia and tracheal diameter to rule out concurrent tracheal hypoplasia. A normal tracheal diameter to thoracic inlet diameter for a brachycephalic dog is 12% of

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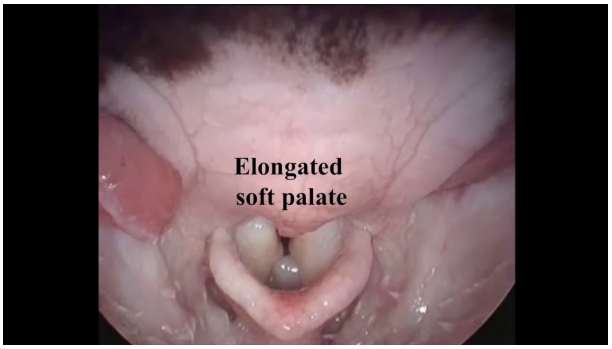

Figure 2. Shows a grade I laryngeal collapse as well as an elongated soft palate

thoracic inlet diameter. A normal dog has a tracheal diameter to thoracic inlet of 20%.

In the normal dog and cat the tracheal diameter does not change between inspiration and expiration. The thoracic inlet measurement is taken from the ventral aspect of the vertebral column at the midpoint of the most cranial rib to the dorsal aspect of the sternum, taking the narrowest measurement. The tracheal diameter is measured between the internal surfaces of the wall, oriented perpendicularly to the tracheal long axis taken at the point where the thoracic inlet line crosses the midpoint of the tracheal lumen.

To make a definitive diagnosis of BOAS sedation is needed to examine the oropharynx to assess the length of the soft palate, any eversion of the laryngeal saccules and the degree of laryngeal collapse. This examination needs to be rapid to allow rapid intubation. The soft palate should end at the level of the caudal pole of the tonsils. (Figure 2) No part of the soft palate should be in the laryngeal opening. The arytenoids should show symmetrical opening on inspiration with no deviation towards the midline.

In patients with signs of aspiration pneumonia or other airway disease an endotracheal wash should be performed for cytology, culture and antimicrobial sensitivity. In patients with gastrointestinal signs a gastroscopy should be performed. The oesophagus should be assessed for hyperaemia from reflux, assessment for a hiatal hernia performed and mucosal biopsies of the stomach taken to rule out a concurrent gastritis.

Anaesthesia and preparation for surgery

Anaesthesia and surgical preparation play a massive role in surgery of the upper respiratory tract. Generally corticosteroids are administered prior to the surgery as a part of the premedication for anaesthesia. The preferred corticosteroids are dexamethasone (0.05 to 0.1 mg/kg) and prednisolone sodium succinate (0.5

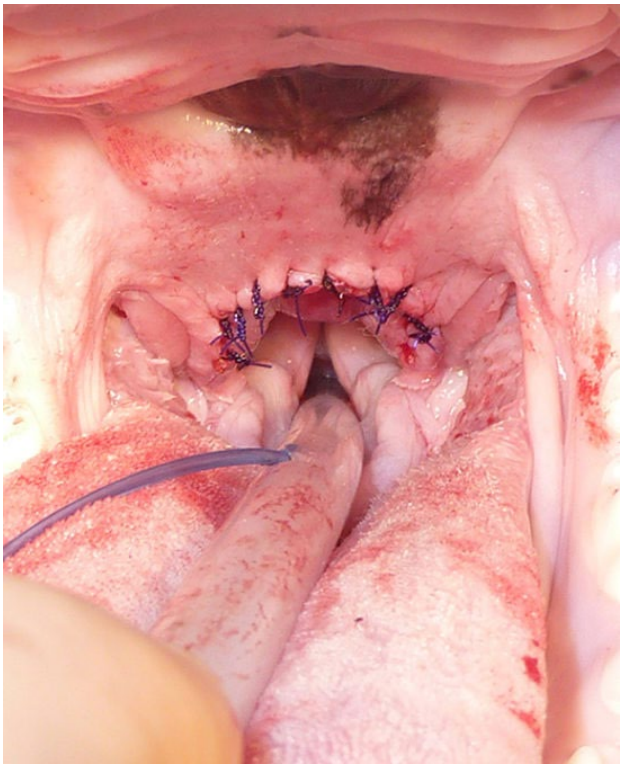

Figure 3. Shows a soft palate post surgery trimmed to the correct level.

to 1mg/kg). This limits postoperative swelling related to the surgery. All patients need to be intubated after rapid IV induction. All patients should have an IV catheter placed prior to anaesthesia.

Surgical treatment

The elongated soft palate should be trimmed. The landmarks for this are the caudal poles of the tonsils (Figure 3.). This should be sutured with a continuous absorbable monofilament suture material. There should be no soft palate in the opening of the larynx once trimmed. The everted saccules are grasped with an Allis tissue forceps and cut. A nareoplasty can be performed to open up the nostrils. In recent times carbon dioxide laser has been used to trim the soft palate. The exciting advances with BOAS surgery are the use of the carbon dioxide laser to remove the aberrant nasal turbinate opening up the airflow through the nasopharynx. Once the surgery is complete the oropharynx and larynx should be suctioned with a suction catheter under low vacuum to clear the blood and saliva that may have accumulated.

Postoperative care

BOAS surgery itself is relatively simple, however the aftercare is where most of the patients run into complications. These patients should be placed in a

24 hour monitored ICU facility. They should be kept cool at all times. Generally placing these patients in an oxygen cage will lead to overheating. If supplemental oxygen is required then this can be achieved by a nasal cannula. Patients need to be kept calm and limit their stimulation during the recovery period.

These patients should be extubated in sternal recumbency when they stop tolerating the endotracheal tube. Early extubation is not recommended. Generally feeding is not performed for the first 24 hours post surgery. Water can be offered after 12 hours if they are doing well.

Any vomiting must be treated aggressively as this can lead to increase airway swelling and aspiration pneumonia.

Patients that develop a severe upper respiratory stridor post surgery should be sedated the airway examined and evaluated for a temporary tracheostomy tube if need be. The prognosis once a tracheostomy tube is placed is 60% in brachycephalic dogs. However if there is continuous stridor and dyspnoea death is inevitable without a tracheostomy tube.

Prognosis

The prognosis is good with around 90% of dogs doing well after surgery. Dogs older than 2 years with everted saccules have a poorer prognosis in some studies. The eversion of the saccules has recently been graded as a grade I collapse of the larynx (Figure 2.). Patients with a grade III collapse of the larynx have a poor prognosis and may need a tie back or arytenoidectomy. This carries a survival rate of about 50%.

2. Laryngeal paralysis

Laryngeal paralysis can be seen as two distinct presentations. The congenital form seen in certain breeds of dogs usually develops / become clinical under one year of age. The acquired form develops in dogs usually around nine years of age. The cause of the acquired form is considered to be idiopathic. This form can be associated with other neuronal degenerative signs like paresis and ataxia. This has been reported in a wide range of breeds, Bouvier des Flanders appear to be over-represented.

Theories put forward for idiopathic laryngeal paralysis include chronic degeneration of the recurrent laryngeal nerve from the pulsatile action of the vasculature associated with it or an under lying neuro-hormonal degeneration. There are reported cases of paralysis secondary to cervical trauma, iatrogenic damage during surgery, organophosphate toxicity, hypothyroidisim and mass lesions compressing the nerves. Labradors and golden retrievers appear over represented in the acquired form

Clinical signs

The presenting signs for both the congenital and acquired forms are similar and are usually due to the underlying upper airway obstruction caused by the paralysis of the dorsal cricoarytenoid muscle. This is the only adductor of the arytenoid process during inspiration. Paralysis of this muscle leads to a change in bark or loss of bark, gradual decrease in exercise tolerance and in the final stages a "roaring "upper respiratory stridor.

Diagnosis

Dogs presenting with clinical signs of laryngeal paralysis should have a total T4 and a TSH screen run as a part of the diagnostic work up.

Thoracic radiographs should be taken to rule out aspiration pneumonia prior to any surgery. Aspiration pneumonia has been reported in 8% of dogs presenting with laryngeal paralysis. Surgery should be delayed until the aspiration pneumonia is under control.

Megaoesophagus can be present in up to 11% of dogs with laryngeal paralysis secondary to a generalised neuropathy. Dogs with concurrent megaoesophagus and laryngeal paralysis have a poorer postoperative survival rate.

Definitive diagnosis is made by direct examination of the amount of adduction of the arytenoid cartilages under light sedation. The use of alpha 2 agonists or other premedication's are avoided to limit the effect on laryngeal motion. The depth of sedation should allow opening of the mouth but maintain a laryngeal reflex in the oropharynx and a laryngeal reflex. If there is concern about the depth of anaesthesia Doxapram can be given to lighten the plane of anaesthesia increase tidal volume and respiratory rate.

Paradoxical movement of the arytenoid cartilage can occur. This should not be confused with normal movement. In paradoxical movement the arytenoids will seeming adduct on inspiration, moving towards the midline due to the high negative pressure created in the airway sucking them inwards. These cartilages will abduct on expiration, moving way from the midline as the air is forced out the airway. This gives the impression

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that there is movement of the cartilages. The easiest way to prevent this is to have an assistant watching the breathing and telling the observer when inspiration and expiration occurs.

Emergency management

High ambient temperatures and excitement will increase the respiratory rate and effort in patients with laryngeal paralysis. This can lead to oedema of the upper airway and worsening of the upper airway obstruction. These patients can present in severe obstructive dyspnoea and cyanosis. These animals should be cooled by being placed in a cool environment. In severe cases a wet towel can be placed on the animal with a fan blowing on the patient. Supplemental oxygen should be administered in a stress free manner. Flow by oxygen is often the least stressful. IV accesses should be attained as soon as possible in these patients. Intravenous corticosteroids should be given to try decrease the oedema. Fluid therapy is indicated but should be closely monitored as they may develop pulmonary oedema once the upper airway obstruction resolves.

Patients not responding to this should be anaesthetised and intubated. This will allow cooling of the patient and resolution of the swelling. Ideally once this stage is reached the patient should be taken in for a corrective procedure of the larynx or a temporary tracheostomy to bypass the obstruction.

Surgical treatment

Surgery is the treatment of choice for dogs showing a decrease in exercise tolerance and the only option for dogs showing acute severe upper respiratory obstruction. Mildly affected animals can be managed with changes in lifestyle, exercise restriction and weight loss. The concern is that mildly affected animals can progress to an emergency at any stage and owners should be informed of this.

Unilateral arytenoid cartilage lateralisation or tie back (Figure 4.) is the most commonly used technique to manage laryngeal paralysis. Bilateral tie back has been associated with a doubling of the expected complication rate post surgery. As a standard the left arytenoid is done in most presenting dogs on the first surgery. Improvement is seen in 90% of dogs that have a tie back performed. The complication rate however can be high, as up to 50% of dogs can have postoperative complications. These can be serious and fatal such as aspiration pneumonia to surgical failure by tearing out of the suture with return of respiratory signs. The minor complications that can occur are persistent cough, seroma and infection of the surgical site.

Figure 4. Shows a schematic of a laryngeal tie back

Trans-oral partial laryngectomy involves resection of the arytenoid cartilage through a trans oral approach. It is a simple procedure but often associated with a large degree of swelling of the larynx. Some authors recommended placing a temporary tracheostomy tube to manage the obstruction post surgery. I would recommend this procedure as a salvage once a bilateral tie back has failed.

The complication rate is high with aspiration approaching 33% in this surgery. A variation of this technique can be performed via a ventral approach, which allows more precise dissection of the tissue. This approach can be used to remove laryngeal webbing that may develop as a complication of a partial laryngectomy.

Some authors recommend a permanent tracheostomy as a treatment for laryngeal paralysis. This should be considered an end stage salvage procedure. The management of this requires a dedicated owner and a very compliant patient.

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Tracheal collapse is a progressive, diffuse disease that can affect the trachea, mainstem bronchi and bronchioles. It occurs mainly in middle-aged toy- and small-breed dogs, with Yorkshire terriers representing up to two-thirds of cases. The cause of tracheal collapse is multifactorial, but of primary importance is weakening of the tracheal rings secondary to a reduction in glycosaminoglycans as well as laxity of the dorsal tracheal membrane resulting in dorsoventral flattening of the trachea.

Secondary factors associated with the onset of clinical signs are: obesity, chronic bronchitis, laryngeal paralysis, respiratory tract infections and airway irritants. Once dogs become symptomatic for tracheal collapse, the cycle of airway inflammation is constantly perpetuated by coughing

Treatment of tracheal collapse, whether it be medical or surgical, is palliative, but can result in dramatic improvement in the patient's quality of life and be lifesaving in cases where there is severe respiratory distress. Treatment options can be tailored for the four different presentations of tracheal collapse as follows:

1. Patients which mainly present with coughing and very little or no signs of airway obstruction are poor candidates for tracheal stenting and are primarily medically managed.
2. Patients which present with signs of airway obstruction are candidates for tracheal stenting, assuming medical therapy has failed by this point.
3. Patients which present with both airway obstruction and a severe cough are candidates for surgical intervention if medical management has failed.
4. Patients which present with a fixed airway obstruction due to tracheal ring malformation/ inversion ("w" shaped trachea), causing inspiratory and expiratory dyspnoea, are poor candidates for intraluminal stenting, due to insufficient contact with the tracheal mucosa. In these cases, prosthetic ring placement should be considered.

Surgical intervention becomes necessary when medical therapy, including weight loss, anxiolytics, antitussives, steroid therapy, bronchodilators and in specific cases, antimicrobials, have failed to control clinical signs, or when the tracheal collapse is severe enough to affect the patient's quality of life. The current surgical intervention of choice is fluoroscopic placement of an intraluminal, self-expanding metallic stent, made from nitinol (Vet Stent Trachea, Infiniti Medical LLC, Menlo Park, CA).

Every effort should be made to size the stent as precisely as possible to the specific patient (Fig. 1 and 2), as most tracheal stent complications are due to incorrect sizing. Stent lengths have traditionally been chosen to span only the area of collapse, but given the progressive nature of the disease, it is now preferred to stent as much of the trachea as possible, between the cricoid and carina (Figure 3 and 4).

Correctly sized stents should be able to expand fully, decreasing the risk of stent fracture and migration. It is also important that the stent diameter is such that it has complete contact with the tracheal mucosa as this reduces the risk of inflammatory tissue formation and recurrent infections.

Complications of the procedure include stent fracture, shortening or migration of the stent, formation of

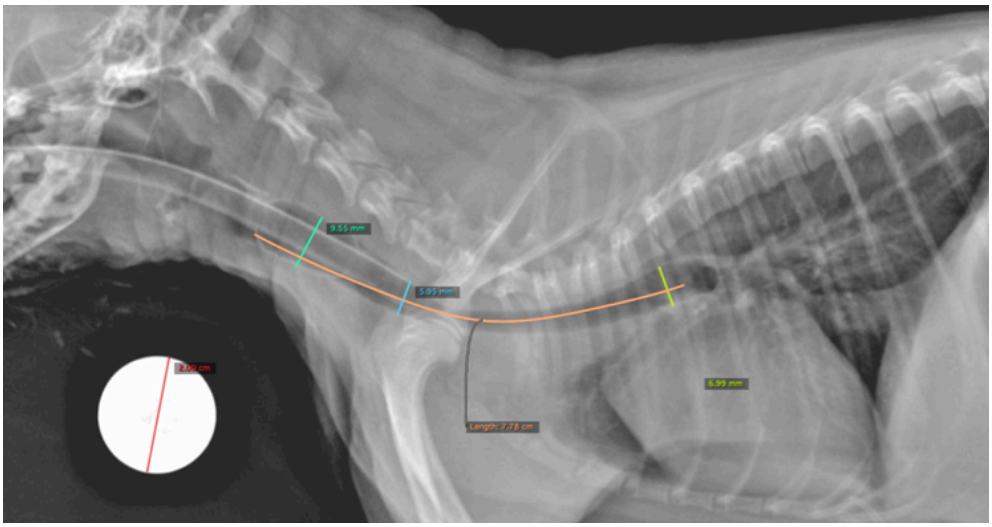

Figure 1. Accurate measurements of the tracheal diameter and length are essential to successful placement. Ideally an oesophageal radiolucent marker with 1cm centimeter graduations (not in image) should be used. Alternative, a coin of known diameter can be used (radio dense structure in bottom left of image) to assist in accurate measurements. The most important measurements are the tracheal length, maximum intra- and extra-thoracic tracheal diameter at 20cm H_20 of positive pressure ventilation and the position of collapse.

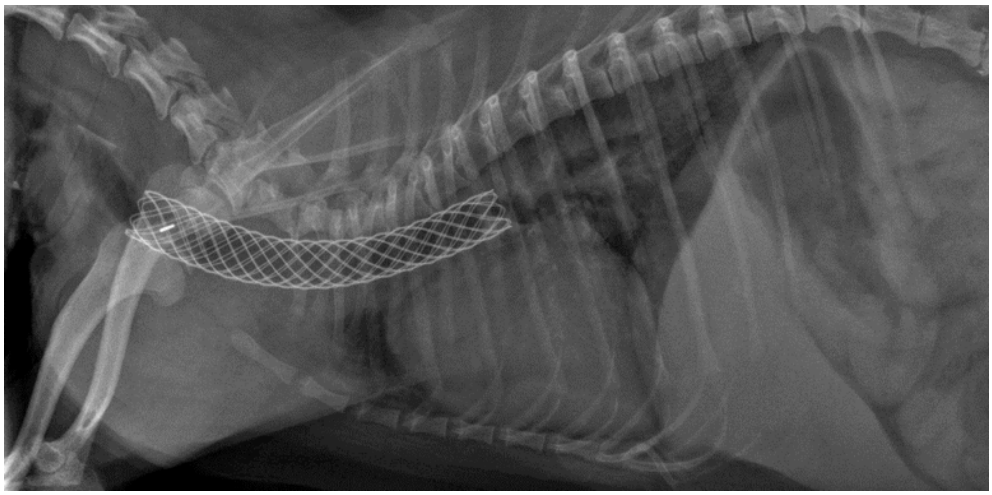

Figure 2. Same patient as Figure 1 after placement of a tapering stent.

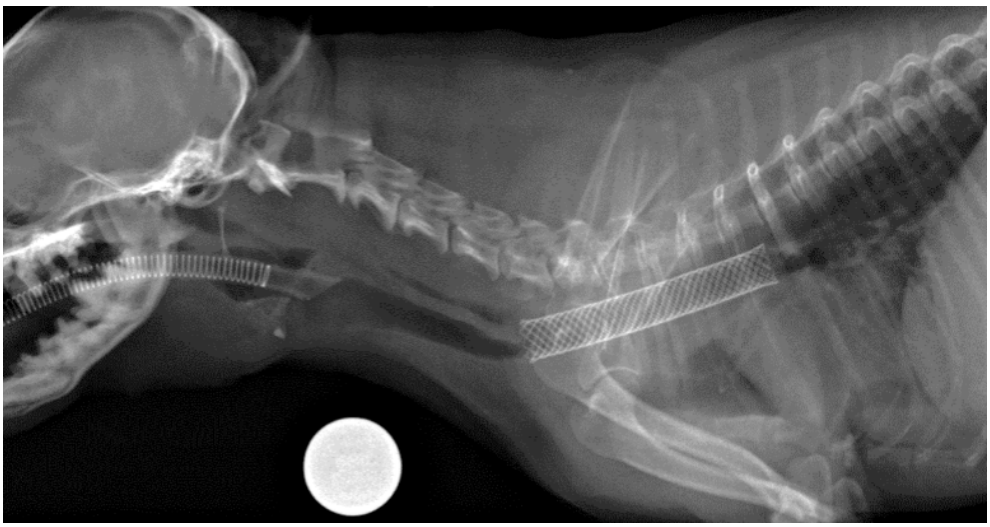

Figure 3. A previously placed tracheal stent with collapse (arrow) of the trachea cranial to the stent two years after placement.

excessive inflammatory tissue in the trachea, chronic infections and progressive collapse of unstented regions of the trachea.

Patients are usually discharged the day after stent placement unless there is concurrent pneumonia. Thoracic radiographs are taken before discharge to confirm positioning of the stent and to monitor for pneumonia, an occasional complication of the procedure. Patients are discharged with a two to three week tapering course of corticosteroids (starting dose 0.5mg/kg every 12 hours) and cough suppressants.

A dry, self-limiting cough can be present for four to six weeks after placement. Thoracic radiographs are taken every three to four months for the first year and thereafter six-monthly to detect stent migration, fracture or the development of inflammatory tissue.

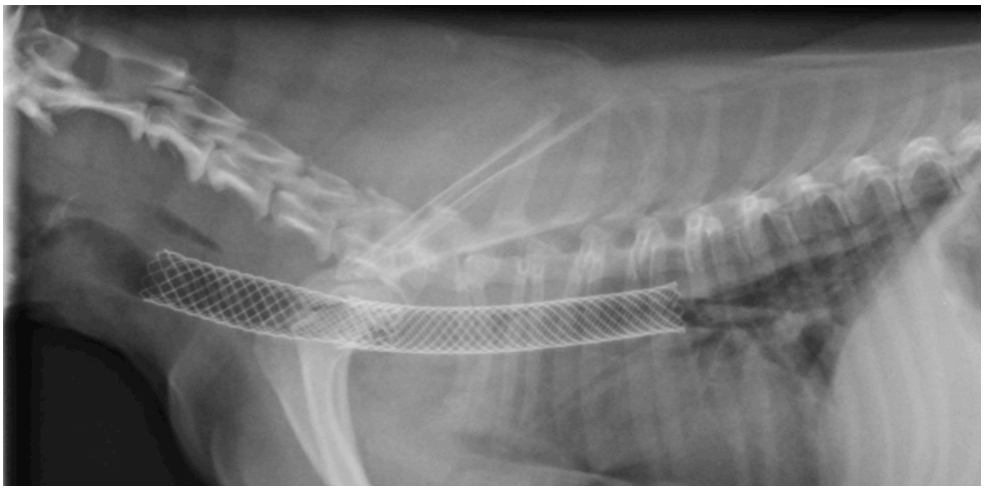

Figure 4. Same dog as Figure 3 after a second tracheal stent was placed to correct the collapse cranial to the originally placed stent.

Thoracic radiographs are immediately indicated if the patient's cough suddenly worsens or respiratory distress develops.

It is important that the expectations of the owner are discussed before stent placement, since most dogs will continue to require lifelong medical management and monitoring to achieve a good long-term outcome.

Suggested reading:

1. Clarke DL. Interventional radiology, management of tracheal and bronchial collapse. Veterinary Clinics of North America 2018; 48: 765 – 779.
2. Ettinger SJ, Feldman EC, Côté E. Textbook of Veterinary Internal Medicine 2017; 8th ed: 466 – 472.
3. Tappin SW. Canine tracheal collapse. Journal of Small Animal Practice 2016; 57: 9 – 17.
4. Weisse C, Berent A, Violette N, McDougall R, Lamb K. Short-, intermediate-, and long-term results for endoluminal stent placement in dogs with tracheal collapse. Journal of the Americal Animal Hospital Association 2019; 254: 380 – 392.

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1. Which one of the following statements regarding head and skull shapes is incorrect?

a. Dolichocephalic dogs have long skulls
b. Mesocephalic dogs have a normal length skull
c. Brachycephalic dogs have short skulls
d. Dolichocephalic breeds have great peripheral vision
e. Brachycephalic breeds have poor visual acuity

2. Which one of the characteristics listed below is NOT typical of a brachycephalic skull?

a. Short skull base which stops growing prematurely
b. The cranium is shorter but rounder, growing taller
c. Muzzle is shorter
d. Increased frontal sinus space
e. Broad flat forehead

3. Which one of the measurements listed below has NOT been suggested as a screen for brachycephalic breeds?

a. The length and thickness of the soft palate
b. The tracheal length
c. Nasopharyngeal dimensions
d. Glottis dimensions
e. Mucosal contact points of the nasal turbinates

4. Which one of the criteria listed below IS considered acceptable in a BAOS assessment test in a bulldog?

a. BCS 7
b. Mild nostril stenosis
c. Grade 3 ETT
d. Moderate nostril stenosis
e. Skull width to length ratio of > 1.75

5. Which one of the conditions listed below is NOT part of the BOAS?

a. Elongated soft palate
b. Macroglossia
c. Trachea hypoplasia
d. Laryngeal paralysis
e. Abnormal caudal nasal turbinates

6. Which one of the conditions listed below is a secondary sequela to BOAS?

a. Everted laryngeal saccules
b. Tracheal collapse
c. Laryngeal inflammation
d. Chronic bronchitis
e. Nasopharyngeal polyps

7. Which one of the following seen on a thoracic radiograph is not a likely complication of BOAS?

a. Pulmonary oedema
b. Cor pulmonale - pulmonic stenosis
c. Aspiration pneumonia
d. Tracheal hypoplasia
e. Tracheal collapse

8. Which one of the following statements regarding acquired laryngeal collapse in dogs is INCORRECT?

a. Develops in dogs usually around nine years of age
b. The cause is generally considered to be idiopathic
c. Can be associated with hypothyroidisim and resolves with T4 replacement
d. Can be associated with other neuronal degenerative signs like paresis and ataxia
e. Labradors and golden retrievers appear over represented in the acquired form

9. Which one of the conditions listed below is NOT a secondary factor associated symptomatic tracheal collapse?

a. Obesity
b. Tricuspid mitral valve disease
c. Chronic bronchitis
d. Laryngeal paralysis
e. Respiratory tract infections and airway irritants

10. Every effort should be made to size the stent as precisely as possible to the specific patient. Which one of the following statements is incorrect?

a. Most tracheal stent complications are due to incorrect sizing
b. Tracheal ring malformation/ inversion ("w" shaped trachea), are not stenting candidates
c. The stent should extend just further than the affected tracheal rings
d. Stent diameter is such that it has complete contact with the tracheal mucosa
e. Complications of the procedure include stent fracture, shortening or migration of the stent

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Geriatric Veterinary Dentistry
How old is too old to make it right?

It's never too late to correct oral problems, as long as the patient's age remains top of mind

Jan Bellows, DVM, DAVDC, DABVP, FAVD

Pediatric and adolescent companion animal dentistry focuses largely on the diagnosis and treatment of congenital and developmental oral issues, including persistent and retained deciduous teeth, supernumerary teeth, orthodontic malpositions, and malocclusions. Mature canine and feline dentistry deals primarily with fractured teeth, tooth resorption, and periodontal disease (PD) prevention.

Senior dental problems center around moderate to advanced PD and both benign and malignant oral masses. In addition, the veterinarian and staff must be comfortable tailoring anaesthesia to the individual patient, with attention to concurrent conditions, as well as diligent monitoring during and after procedures.

Figure 1A. Marked periodontal disease and subsequent caudal ulceration in a 12-year-old Yorkshire terrier.

Figure 1B. Resolution after full-mouth extraction.

Periodontal disease in senior patients

The degree of PD severity relates to a single tooth. It is important to keep in mind that a patient may have teeth with different stages of PD. Typically, geriatric dental patients have multiple stages of PD occurring simultaneously. Therefore, intraoral imaging is essential, along with probing to determine the tooth's support. Treatment options for PD include:

- Dental scaling and polishing for patients with stage-1 PD
- Root planing and locally applied antimicrobials for pockets less than 5 mm in patients with stage-2 PD.
- Extraction for teeth affected by advanced PD and those with moderate PD for which the owner cannot perform adequate home care (Figures 1 and 2).

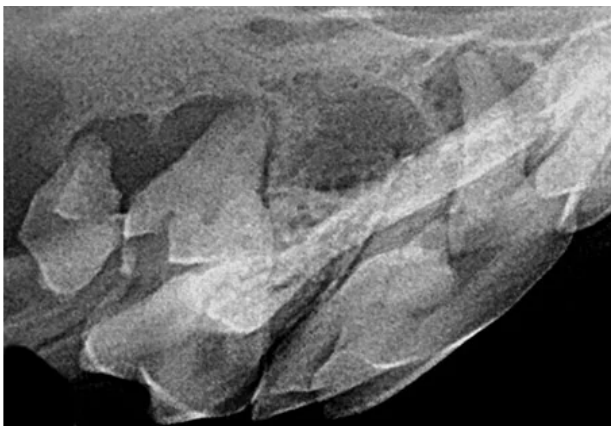

Figure 2A. Periapical lucencies surrounding the roots of the left maxillary first and second molars consistent with advanced periodontal disease, plus periapical lucency surrounding the roots of the fourth premolar consistent with advanced endodontic disease.

Figure 2B. Postoperative radiograph confirming complete extraction.

Senior dogs and cats with advanced PD affecting the entire mouth often require full-mouth extractions. Fortunately, these patients usually thrive once their mouth is pain-free.

Stages of periodontal disease

Normal (PD 0): clinically normal; no clinically evident gingival inflammation or periodontitis

Stage 1 (PD 1): gingivitis only without attachment loss; normal height and architecture of the alveolar margin

Stage 2 (PD 2): early periodontitis; less than 25% attachment loss as measured by probing the clinical attachment level, by radiographic determination of the distance of the alveolar margin from the cementoenamel junction relative to the length of the root, or by the presence of stage 1 furcation involvement in multirooted teeth

Figure3A: Stage 3 periodontal disease in a cat.

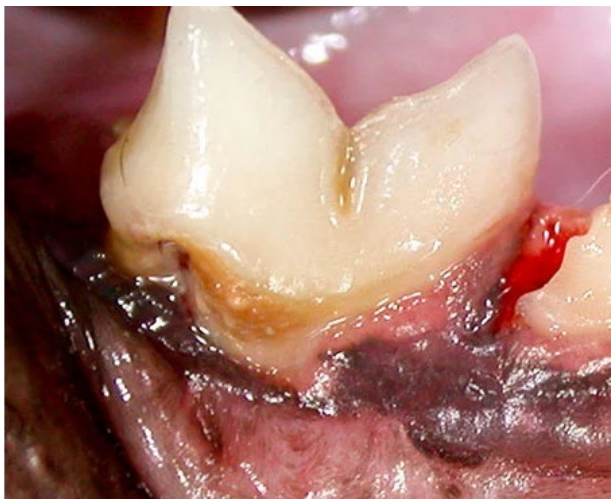

Figure 3B: Stage 3 periodontal disease a dog.

Stage 3 (PD 3) (Figure 3): moderate periodontitis; 25% to 50% attachment loss as measured by probing the clinical attachment level, by radiographic determination of the distance of the alveolar margin from the cementoenamel junction relative to the length of the root, or by the presence of stage 2 furcation involvement in multirooted teeth

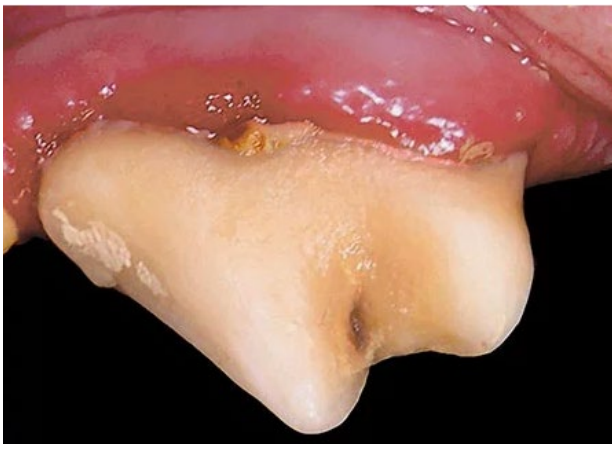

Figure 4A: Stage 4 periodontal disease in a cat.

Figure 4B: Stage 4 periodontal disease in a dog.

Stage 4 (PD 4) (Figure 4): advanced periodontitis; more than 50% attachment loss as measured by probing the clinical attachment level, by radiographic determination of the distance of the alveolar margin from the cementoenamel junction relative to the length of the root, or by the presence of stage 3 furcation involvement in multirooted teeth.

Oral masses in senior patients

Types of tumors

Oral masses are frequently noted in geriatric dogs; they are less common in cats. Commonly diagnosed oral masses include the following:

- **Adenocarcinoma:** an invasive, malignant epithelial neoplasm derived from glandular tissue of the oral cavity, nasal cavity, or salivary tissue (major or accessory) with moderate metastatic potential.
- **Fibrosarcoma:** an invasive, malignant mesenchymal neoplasm of fibroblasts with a low metastatic rate; a distinct histologically low-grade, biologically high-grade variant is often found in the oral cavity.
- **Hemangiosarcoma:** a malignant neoplasm of vascular endothelial origin characterised by extensive metastasis; it has been reported in the gingiva, tongue, and hard palate.
- **Malignant melanoma:** an invasive, malignant neoplasm of melanocytes or melanocyte precursors that may or may not (amelanotic) be pigmented, with a marked tendency to metastasise.
- **Multilobular bone tumor:** a potentially malignant and locally invasive neoplasm of bone that more commonly affects the mandible, hard palate, and flat bones of the cranium with a multilobular histologic pattern of bony or cartilaginous matrix surrounded by a thin layer of spindle cells that gives it a near-pathognomonic radiographic "popcorn ball" appearance; also called multilobular osteochondrosarcoma, multilobular osteoma, multilobular chondroma, chondroma rodens and multilobular osteosarcoma.
- **Osteosarcoma:** a locally aggressive, malignant mesenchymal neoplasm of primitive bone cells that have the ability to produce osteoid or immature bone with a high metastatic rate.
- **Peripheral nerve sheath tumor:** a group of neural tumors arising from Schwann cells or perineural fibroblasts (or both) of the cranial nerves, spinal nerve roots, or peripheral nerves; may be classified as histologically benign or malignant.
- **Peripheral odontogenic fibroma:** a benign mesenchymal odontogenic tumor associated with the gingiva and believed to originate from the periodontal ligament; characterised by varying amounts of inactive-looking odontogenic epithelium embedded in a mature, fibrous stroma, which may undergo osseous metaplasia; historically has been referred to as fibromatous epulis or, when bone or toothlike hard tissue is present within the lesion, ossifying epulis.
- **Plasma cell tumor:** a proliferation of plasma cells, commonly occurring on the gingiva or dorsum of the tongue; also called plasmacytoma.
- **Squamous cell carcinoma:** an invasive, malignant epithelial neoplasm of the oral epithelium with varying degrees of squamous differentiation; the distinction between tonsillar and nontonsillar has been made, with the former having a higher metastatic rate and being associated with a poorer prognosis.

Treatment options

Once a mass is noted, treatment planning involves making a definitive diagnosis through cytology or histopathology and removal, if possible and practical. Close excision is usually curative for benign masses. For malignant masses without apparent metastasis, after staging, wide excision with at least 2-cm clean margins is the goal (Figure 5). If the client is willing, the excision can be accomplished in a single procedure. Alternatively, two procedures can be performed: a biopsy to confirm malignant diagnosis followed by complete excision with margins, if possible.

Multiple surgical and radiation options are available to treat neoplasia. Surgical options include intracapsular, marginal, or *en bloc* excision as well as radical resection. Intracapsular excision removes the tumor from inside the capsule to treat well-differentiated odontomas, which can be curetted from the maxilla or mandible.

Marginal excision removes the lesion visually but may be poorly suited for lesions that are not well demarcated from surrounding healthy tissues. This treatment option may leave remnants of the tumor in place, resulting in regrowth.

En bloc excision removes the tumor, pseudocapsule, reactive zone, and a narrow margin of normal

Figure 5A. Oral mass in a 10-year-old golden retriever. Cytology at the time of initial anaesthesia indicated malignancy, which was later confirmed by histopathology as fibrosarcoma. (Figure 5B.)

Figure 5B. Wide excision with at least 2-cm margins confirmed on histology.

Figure 5C. The patient 1 year later.

tissue. It is indicated for the treatment of malignant and infiltrating tumors that are not known to extend deep into surrounding tissues.

Radical resection, in which large portions of the maxilla and/or mandible are removed, is indicated for the treatment of aggressive benign and malignant tumors that invade the mandible or maxilla or involve the tongue, resulting in removal in most of the tongue.

Radiation therapy is employed with curative intent for localised tumors with incomplete margins after surgery. Alternatively, radiation can be used to downstage oral tumors before surgery. Response rates are best for squamous cell carcinoma, with more moderate responses expected for fibrosarcomas and malignant melanomas.

Anaesthesia in the geriatric dental patient

Anaesthesia safety is a primary concern in every patient, but seniors have special needs when it comes to anaesthesia. Old age is not a contraindication to general anaesthesia, but it can increase the relative risk of the procedure compared with anaesthesia in younger patients.

Anatomic and physiologic concerns

Age-related cardiac anatomic changes include myocardial fibrosis; myxomatous valvular degeneration, potentially leading to valvular incompetence; and ventricular wall hypertrophy. Older patients have reduced cardiac reserve and a decreased ability to compensate for anaesthesia and hypoxia. Medications that increase the risk for arrhythmias (e.g. α2-adrenergic agonists such as xylazine and medetomidine) and high doses of ketamine should be used with caution. The maximal heart rate response during physiologic stress is reduced in an aging heart due to β-receptor attrition and reduced receptor affinity. An increase in vagal tone and a reduction in blood volume are also seen.

Older patients also have reduced respiratory reserve, which becomes particularly important when combined with the depressant effects of opioids and anaesthetic agents. It is, therefore, important to preoxygenate a geriatric patient for at least 5 minutes.

Anaesthetic medications that are dependent on renal excretion (e.g. ketamine) may have a longer half-life in geriatric patients, so they should be used cautiously and conservatively, with medication dose and frequency altered accordingly.

As a result of its α1-adrenergic receptor blockade, acepromazine can produce vasodilation and exacerbate hypotension, particularly when used in combination with other anaesthetic medications that also cause vasodilation. Although generally it is best to avoid acepromazine use in geriatric patients, microdoses can be useful in very anxious dogs when an opioid alone has not provided the required sedation. Acepromazine is a poor and unreliable sedative in cats.

Propofol and alfaxalone are potent vasodilators, and profound hypotension may result from their use, especially if the infusion rate is too rapid. A 20% to 40% reduction in blood pressure can be expected with induction doses.

The combination of ketamine/benzodiazepine anaesthesia induction can provide good cardiovascular stability, with patients generally maintaining good blood pressure due to stimulation of the sympathetic nervous system and catecholamine release. Ketamine's effects on the cardiovascular system include increases in cardiac output, heart rate, systemic blood pressure, pulmonary arterial pressure and central venous pressure. With its significantly shorter half-life, midazolam is a much better choice than diazepam. (See Table 1 on the next page)

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Potential problems during anaesthesia

Aggressive fluid therapy and fluid overload should be avoided in geriatric patients. In addition, older patients are highly susceptible to hypothermia. Placing the animal in a warm environment (e.g. with radiant energy and forced warm air blankets) from the time of premedication can help minimize heat loss.

Shivering, which can increase oxygen requirements two- or threefold, increases the patient's vulnerability to hypoxia, particularly during recovery if oxygen demands are not met.

Table 1: Anaesthetic Medications

Drug	Dose
Acepromazine	Dogs: 0.01-0.02 mg/kg SC; 0.005-0.01 mg/kg IV Cats: Not an effective sedative
Midazolam	Dogs: 0.1-0.5 mg/kg SC, IV for induction Cats: 0.1-0.2 mg/kg SC, IV
Diazepam	Dogs: 0.1-0.5 mg/kg SC, IV for induction Cats: 0.1-0.2 mg/kg SC, IV
Ketamine	Dogs: — Cats: 2-5 mg/kg SC for sedation; 1-2 mg/kg IV for sedation
Butorphanol	Dogs: 0.1-0.2 mg/kg SC Cats: 0.1-0.2 mg/kg SC
Hydromorphone	Dogs: 0.1-0.2 mg/kg SC Cats: 0.1-0.2 mg/kg SC
Buprenorphine	Dogs: 0.01-0.03 mg/kg SC Cats: 0.01-0.02 mg/kg SC
Fentanyl	4-10 µg/kg/hr constant-rate infusion. Capnography is essential, as respiratory depression is likely with the higher doses. Dogs: 2-5 µg/kg IV Cats: 2-5 µg/kg IV
Propofol	0.5 mg/kg IV incremental doses to effect for induction; up to 4-8 mg/kg total dose. Use caution; best to combine with fentanyl and midazolam as this will substantially reduce the required dose of propofol and thus the potential for hypotension.
Alfaxalone	Dogs: 0.25 mg/kg IV given in incremental doses to effect for induction; up to 1-5 mg/kg total dose Cats: 0.5 mg/kg IV given in incremental doses to effect for induction; up to 3-5 mg/kg total dose
Ketamine/ benzodiazepine	Mix 0.5 mg/kg of midazolam or diazepam in a syringe with ketamine at 1-5 mg/kg, then administer IV to effect for induction.

IV = intravenously; SC = subcutaneously.

Patient monitoring

The American College of Veterinary Anaesthesia and Analgesia recommends that the minimum monitoring for all anesthetized small animal patients include blood pressure, blood oxygen saturation (Spo2), end-tidal carbon dioxide and electrocardiography. Capnography is a noninvasive method to assess the adequacy of ventilation.

Hypotension is common in patients under general anaesthesia. If decreased mean arterial pressure persists, turn down the vaporizer to decrease the inhalational agent to a minimum; the addition of an opioid may help. If the patient is hypotensive and bradycardic, treat the bradycardia with an anticholinergic agent first (e.g. atropine or glycopyrrolate).

Immediately after anaesthesia, ensure that the animal can maintain adequate SpO_2 (≥95%) on room air before discontinuing oxygen therapy. Pulse oximetry should also be utilized in a heavily sedated patient to evaluate the need for oxygen therapy (Figure 6)

Conclusion

Although they can be extensive, dental problems in geriatric dogs and cats can be corrected safely, with very positive outcomes. General anaesthesia in senior dogs and cats is considered safe as long as the patient is examined beforehand, anaesthesia and temperature control are tailored to the clinical exam findings and the patient is monitored carefully.

Figure 6. Electrocardiographic monitor clipped on a patient monitors heart rhythm postoperatively. Note the atrial premature beat, which is common in recovering patients.

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Introduction

People benefit from living with pets. As companions, they provide stress relief, stability of routine, and improved health[1]. Yet how to best care for our cats remains controversial, and there are cultural and regional differences in what people believe is the best way to house cats. As long ago as 1997, between 50-60% of cats were housed strictly indoors in the United States[2], whereas in the United Kingdom the majority of cats were allowed outside[3] whilst a study from Melbourne, Australia reported that 23% of cats were "mainly indoors"[4]. Why are there such "cultural" differences? The decision to keep a cat indoors may be practical: living on the 21st floor of an apartment building in a busy city prevents ready access to the outside. In other situations, it is true that keeping a cat indoors reduces the risks from wandering, poisoning, automobile accidents, contagious disease or fights with other animals[5,6], and owners may also believe that it removes the risk of internal and external parasites (e.g., heartworm, fleas). Other reasons to keep cats indoors include avoidance of unwanted pregnancy (assuming the pet is not spayed) and to protect wildlife.

KEY POINTS

- Cats restricted to indoor living have a reduced risk for vehicular trauma, predation, aggressive interactions with cats and other animals, and exposure to infectious diseases.
- Indoor living is not without risks.
- Not all cats can adapt readily to an indoor lifestyle, and may be at increased risk for certain behavioural and medical problems.
- All environmental and social needs must be met for successful indoor living, and the wellbeing of each cat needs to be evaluated repeatedly over time.
- Predictability, familiarity, routine and having a sense of control are key factors in reducing stress.
- Offering outdoor access does not compensate if the cat has poor conditions indoors.

What are the effects of indoor living on cats?

Are there any downsides to keeping cats strictly indoors? There is a reality-perception mismatch if owners think that their indoor cat's life is free from perils, as the indoor cat experiences different hazards. These include falls from balconies and windows, kitchen scalds or burns, and access to toxic cleaning products, unsuitable food (e.g., onion, garlic) and plants[3] (Table 1). Studies comparing mortality of cats housed indoors with those allowed outside are not available in the North American veterinary literature[7].

However, cats have not been selectively bred to be indoors 24 hours a day, and many do not adjust to living in close contact with people[4]. For this adaptation to be successful, a cat must have had complete and successful socialisation to people prior to eight weeks of age[4]. Additionally, because fearful traits can be inherited, some cats will be unsuited to close human contact[4]. Similar concerns exist when trying to integrate cats from different sources: this requires early

Table 1. Comparing lifestyle risks (adapted from (3)).

Increased risks associated with living strictly indoors	Increased risks associated with outdoor access
• Lower urinary tract diseases (idiopathic and calcium oxalate urolithiasis) • Hyperthyroidism • Obesity • Diabetes • Odontoclastic, resorpti ve lesions • Boredom • Household hazards (burns, poisons, falls) • Inactivity, decreased fitness • Problem behaviours (spraying, scratching) • Behaviour problems (obsessive behaviours) • Dermatologic problems (atopy/acral lickdermatitis)	• Infectious diseases (FeLV, FIV, rabies, parasites) • Vehicular accidents • Trauma (falls) • Altercative trauma (other cats, other animals) • Getting lost • Theft • Poisoning

socialisation and cats have different personalities (e.g., sociable, timid and unfriendly, active and aggressive) that may be incompatible[8].

A monotonous and overly predictable environment is stressful[9]. Cats may not be able to perform behaviours that express their natural telos – their cat-like nature. The resulting psychological and physiological stress may develop into either problem behaviours (natural behaviours that are unwelcome, e.g., spraying or scratching), behaviour problems (e.g., obsessive grooming), or physical illness. Signs of stress and anxiety may be overt (e.g., changes in appetite, grooming, increased vocalisation, hiding, vigilance, aggression, spraying or compulsive behaviours (Figure 1), or subtle (e.g., decreased activity, play, exploratory behaviour/inquisitiveness, facial marking, affiliative interactions with people and other animals)[10].

Certain physical illnesses are more prevalent in indoor cats (Table 1) although it can be argued that indoor cats may be more closely observed, so that behaviour changes are more readily noticed, or they receive more frequent veterinary care, so that diseases are identified more readily than in free-roaming cats, but this is only conjecture. One source states that "the disparity between physical and psychological stressors is an illusion. Host defence mechanisms respond in adaptive and meaningful ways to both"[11].

What cats need to be cats

Reducing stress for cats requires an understanding of who and what a cat is and what they need. Cats are territorial, with their territories based around essential resources, most prominently food. Both males and females mark their territories with olfactory clues: spraying urine, rubbing against objects and scratching vertical surfaces (which provides both olfactory and visual signals). Resource areas may be time-shared, so cats circumvent confrontation by avoiding contact. Fighting is a last resort and occurs when escape is impossible.

Cats require privacy for hiding, safety, observation, undisturbed rest, and sleep, whilst vantage positions allow cats to avoid or evade intruders, predators and other threats. Socially, cats may live on their own or in groups. Colonies consist of related females and their offspring, with males visiting for reproductive purposes, although they may help to provide care for related young until they are mature, either sexually or socially[12].

The "Five Freedoms", first described in 1965 to define farm animal welfare*, have more recently been adapted for cats, as follow[3]:

1. Provision of food and water: a balanced diet that meets the animal's nutritional needs at every life stage, and fresh water.
2. Provision of a suitable environment: adequate space and shelter, with sufficient light, low noise levels and no extremes of temperature. The area can be indoor-only or with outdoors access.
3. Provision of healthcare: vaccination, neutering (sterilization), parasite control, individual identification (microchip,collar), and prompt access to veterinary care.
4. Provision of opportunities to express most normal behaviours, including those directed towards conspecifics and humans.
5. Provision of protection from conditions likely to lead to fear and distress.

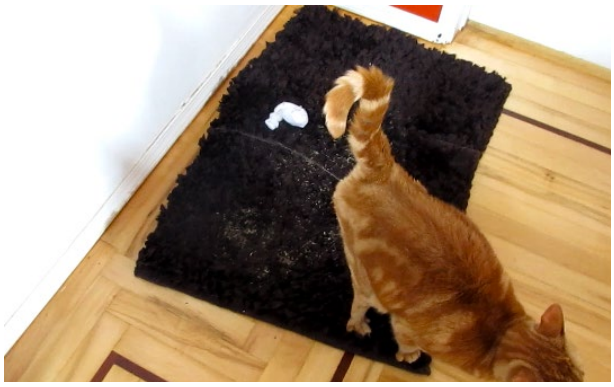

Figure 1. Psychological and physiological stress may result in unwelcome problem behaviours such as spraying. ©Terry Curtis/Margie Scherk

While the vast majority of cats kept indoors will have adequate food and water, and illnesses addressed when noticed, many do not have the ability to express normal cat behaviours. This may result in distress, fear, undesirable behaviours and potentially illness. Typical cat behaviours include play, investigation, observation, hunting, feeding, drinking, grooming, scratching, traveling, scent marking, eliminating, resting and sleeping[13-15]. Additionally, cats are crepuscular i.e., their peak activity times are around dusk and dawn.

Indoor confinement predisposes to obesity. There are numerous reasons for this, including the most obvious one i.e., ingesting more calories than they are utilising. However, it is more complicated than this. In nature, cats do not have ad libitum food intake. To avoid starvation, the drive to eye, stalk, pounce and kill is permanently active, and a cat makes numerous hunting attempts for every successful kill[16]. Mostly prey are small mammals or birds, and a cat may hunt 100 times each day to meet its caloric requirements (10-20 small prey), an intellectually stimulating and physically active endeavour.

Our cats receive food with minimal effort, becoming overweight because they eat too much and their food is often calorie-dense. One mouse (=30 kcal) meal is approximately 10 pieces of an average maintenance dry food; even eating 10 extra pieces per day can result in a 10% (1lb) weight gain over a year. Owners like to see their cats eat and may interpret inquisitive, verbal or rubbing cues from a cat as a request to be fed; rewarding such actions with food reinforces the cat's behaviour, and the owner feels needed and cared for. We inadvertently train cats to ask for food and they train us to respond to their boredom or other unmet needs by feeding them.

Neutering (males and females) reduces energy requirements by between 7-33% (most studies indicate 20-25%). Additionally, feeding induces release of neurochemicals that make the cat feel good, and eating becomes a solace for negative experiences (distress, fear) or boredom. In a multi-cat household, if the cats are stressed due to incomplete socialisation, they can express this by overeating, especially if they cannot achieve and maintain a comfortable spacing.

Obesity is a huge problem in cats. One study[17] determined that the risk factors associated with overweight or obesity were frequency of feeding and neutered status, regardless of whether cats were indoors or outdoors. Cats fed 2-3 times daily were more likely to be overfed than those offered ad libitum feeding. While contradicting the findings of other studies, this reinforces the importance of owner education regarding the amount and type of food to feed. Many diets developed for indoor cats have a higher proportion of calories derived from protein to help offset decreased exercise, and are fiber enhanced to improve stool character, reduce fecal odour and to help promote intestinal motility to reduce hairballs.

Optimizing the indoor environment

There are two aspects that need to be considered: the first is to decrease stressful stimuli and the second is to improve and enrich the environment. They may overlap in some instances, e.g., boredom is not a direct threat in the way that confrontation with another pet might be, but it is still a source of stress.

Stress results from unpleasant, noxious stimuli that cannot be predicted or controlled[18]. These may be physical or social in nature. Early life experiences, as well as genetics, play a role in an individual's ability to adapt to situations. A barren environment or a chaotic one with excessive novelty are both undesirable; e.g., a new member in the household, changes in routine or in the physical environment. Poor relationships with other animals and humans are stressful. Competition for resources may be real (with another animal or a teasing human) or perceived (inability to reach resources, fear of ambush). Most anxiety disorders (e.g., urine spraying) are a result of social or environmental stress[12].

The source of stress should be identified and removed whenever possible. Reducing disruption and creating a more predictable, harmonious schedule and environment is helpful. When the stimulus lives with the cat, (e.g., another cat, a person), a gradual and prolonged reintroduction protocol, paired with positive, pleasant reinforcement, will be needed in order to reshape the cat's experience.

If a change in routine is unavoidable, proactive positive conditioning will be helpful – so, for example, to prepare for a veterinary visit, encourage the pet to regard the cat carrier in a positive manner e.g., by putting food in the carrier and emphasising its desirability and safety. Environmental enrichment refers to both the physical and social environment and should include temporal complexity (i.e., variability)[15]. The goal is to offer more

Figure 2. If they have been well socialized as kittens, and there is sufficient space with appropriate number of separated resources, cats may live together happily. ©Terry Curtis/Margie Scherk

behavioural diversity, increase the use of space, enhance the human-cat relationship and – ultimately – improve an individual's ability to cope with adversity, thus decreasing the expression of abnormal and undesirable behaviour[3].

Depending on resource availability, free-ranging cats occupy huge ranges, from 1.2-2450 acres (0.48-990 hectares). Clearly indoor apartments are too small for the average cat, and this situation is made worse by adding unrelated and/or unfamiliar cat[12]. An indoor environment should consist of at least two rooms, but cats also need complex, stimulating, three-dimensional space; allowing a cat to climb provides distance from other cats as well as the ability to survey their environment and to predict (and evade) suspicious or threatening stimuli[3]. Most cats do not get along well in a multiple cat environment if they have not been socialized together. Adult cats accustomed to outdoor access may have difficulty adjusting to indoor-only housing. However, if they have been well socialized as kittens, introduced properly (over several months) to the new cats, and there is sufficient space

Figure 3. Hiding is an essential coping behaviour for cats, but in a multi-cat household it is essential that the cat does not feel trapped. ©Terry Curtis/Margie Scherk

with appropriate number of separated resources, cats may live well together (Figure 2). Cats may also live comfortably with a dog or other companion animal assuming that they have been habituated to each other

What can we do to optimize a cat's living area?

Recent guidelines (19) define "five pillars of a healthy feline environment", as follows:

1. A safe space: namely, somewhere that a cat can rest, relax and sleep without fear. Cats also need to be able to observe from this, or other, vantage points; hence the space is often raised. A dip in a perch or shelf allows the cat to remain concealed and have a sense of control. Hiding is an essential coping behaviour for cats: not having the ability to hide can contribute to

Figure 4. Litter boxes must be distributed throughout the home and should be large and clean. Individual cats have different preferences for type and depth of litter, but sand-like or fine clay substrates are readily accepted by most cats. ©Terry Curtis/ Margie Scherk

stress and illness (12) (Figure 3). In a household with more than one cat or with a dog or a person that might invade the cat's safe space, it is essential that the cat cannot feel trapped, so a safe space must have more than one entry. There should be at least one safe space per cat in the household, separated from each other, and placement may depend on an individual's physical restrictions, e.g., a cat with limited mobility needs a ramp access or a space that is low and easy to get into.

2. Multiple and separated key environmental resources: Given that territory is based on resource availability, cats must have access to all key resources without running a real or imagined risk of harm. Basic resources are food, water, toileting areas (litter trays), areas for scratching and playing, and places where they can observe, rest and sleep. While socially gregarious, cats hunt and eat alon[20]. Although cats are predators,they are also at risk of being prey if they are caught unawares, so covered litter trays in a multiple cat household may contribute to stress from a real or perceived fear of attack.

Separation of resources reduces competition and the chance of ambush, with each resource located in a separate area from the others rather than in the cat's "own room"[20]. Additionally, cats should have a choice for each resource: two or more feeding areas, water bowls, elimination stations, etc. Litter trays must be large – at least 1.5 times the length of the cat (Figure 4), numerous (one or more per cat) and clean. Individual cats have different preferences for type and depth of litter; in general, since soil and sand are the natural substrates for toileting, sand-like or fine clay litters are readily accepted by most cats. Litter boxes must be distributed throughout the home, just as other resources are, and away from sources of unexpected loud noises (e.g., washing machine, boiler). Trays must be scooped at least daily (preferably more often) and should be emptied completely and washed weekly.

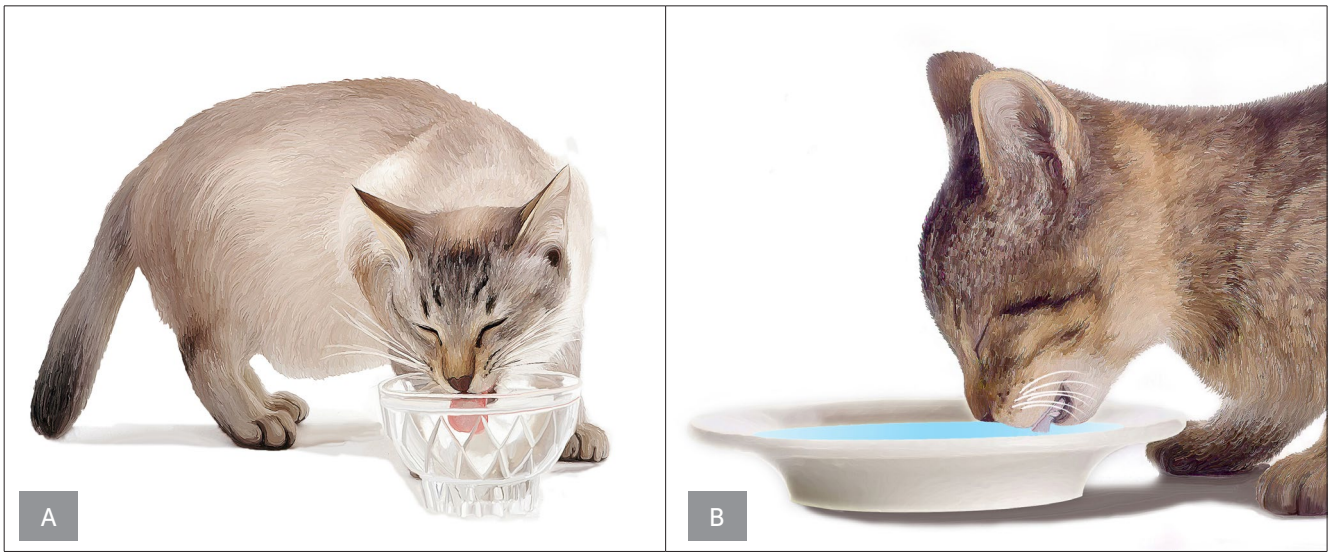

Figure 5. In a safe, home situation, whiskers can touch the edge of the food or water bowl ***(a)****, but in a clinic or unsafe environment, bowls should be wide and flat* ***(b)****. ©Royal Canin/Youri Xerr*

Scratching surfaces must be stable. Heavy immobile posts covered in carpet or sisal, rush or rattan matting, or corrugated cardboard surfaces (on the floor or affixed to the wall) are suitable options. Drinking stations may consist of a variety of bowls, vases, and fountains or a dripping tap. Water should be fresh. In a safe, home situation, whiskers can touch the edge of the food or water bowl, but in a clinic or unsafe environment, bowls should be wide and flat (Figure 5). This is because cats' whiskers sense air movement; if a cat feels a need to be vigilant (e.g., in clinic), then using a bowl that restricts the ability to sense something may cause a cat to avoid the bowl. In situations where cats have bonded as affiliates and belong to the same social group, they may share resources, but physical separation between different resources is still needed, (e.g., water should not be beside food), and every cat needs at least one feeding station.

Figure 6. Visual stimulation is important for cats; at least one resting area (e.g., a climbing platform) should allow safe, visual access of the outdoors. ©Terry Curtis/Margie Scherk

3. Occupational needs: Cats need to play and hunt, and as noted above, predation makes up a significant part of their day. Cats should be able to engage in all aspects of the predatory sequence: locating, stalking, chasing, pouncing, killing, preparing and eating their prey. In a household situation, this translates into pseudo-predatory play and feeding behaviours. If these needs aren't met, cats can become bored or frustrated and obese.

Cats may play on their own or with their owner, but rarely in a group unless raised together. Ensure that there is sufficient personal space between cats when they play (> 3 meters (10 feet)), or provide different play times. Exploration of novel objects, such as boxes or baskets, also provides stimulation, and different cats may prefer certain toys[21]. Allowing them to hunt for their food bowl or using a feeding toy are mentally stimulating activities.

Scratching is an essential need, not just for sharpening claws and to shed the nail sheaths, but also for stretching and for depositing scent on vertical objects. In addition to providing scratching surfaces, owners can undertake nail trimming with positive, treat-based reinforcement. If an owner is concerned about a cat damaging furniture, nail caps may be beneficial (although the owner should still trim the cat's nails regularly) and sticky tape may act as a deterrent if a particular surface or object is valued. Motion detectors may be used to deliver an aversive sound and blast of air as a deterrent if required, but they must be used carefully and the desired behaviour must be rewarded.

Visual stimulation is important for cats; at least one safe resting area (window ledge, climbing platform) should have visual access of the outdoors (Figure 6). Videos of birds, mice and squirrels provide visual as well as auditory stimulation and may be useful, especially when there is no opportunity to see or hear the outdoors. Placing a ping-pong ball in a bathtub for 30 minutes each day provides exercise as well as visual and auditory stimulation. Cat grass provides a textured gustatory stimulus that many cats enjoy, whilst rolling on a soft, textured mat (sprinkled with catnip) provides tactile stimulation.

4. Respect a cat's olfactory sense: Cats use their sense of smell to perceive the world to a far greater degree than humans do. They also detect and communicate through pheromones. The aromatic environment – both deliberate and unrecognized– created by humans can greatly impact cats. Air fresheners, cleaning products, perfumes, and scented cat litter may be pleasant for us but overwhelming or confusing for a cat. Smells brought in from the outside on shoes or with a visitor may be threatening for a cat. Restrict the use of fragrant products and leave footwear and shopping bags near the entrance to help reduce perceived threats.

Catnip (Nepeta cataria), honeysuckle wood (Lonicera tatarica), valerian root (Valeriana officinalis) and silvervine (Actinidia polygama) are pleasurable olfactory stimulants (Figure 7). Use of familiarly scented clothing and bedding at home or in the clinic may be reassuring; avoid washing all of the cat's bedding at once to provide olfactory continuity.

New items (e.g., furniture) brought into the home should be exposed to the cat after rubbing the furniture with a cloth that has been in contact with the cat's scent glands. These glands, which produce a variety of pheromones, are located on the cheeks, in the temporal region, around the muzzle, on the tail and dorsal tailbase, and interdigitally.

When a cat marks a surface or a corner with their cheek or by scratching, they are depositing their scent and making it familiar; such marks should not be washed off. Providing sturdy scratching options (vertical or horizontal) throughout the home (but especially at the entrance) helps to provide "safety" without the need to spray urine as a means of marking/defining territory. Synthetic pheromones that replicates parts of the cheek pheromone are available in many countries and may be beneficial for a sense of security.

5. The social world: Consistency and predictability are key to positive human-cat interactions. As already mentioned, socialisation between 2-8 weeks of age is critical for cats to live successfully with humans. During this period, cats should be exposed to at least four handlers and gently introduced to many, brief, positively reinforced experiences. Human attention is very important, but cats often prefer more frequent, less intense interactions than we might think. In addition, cats like to choose the time and place for the social contact. The more the owner responds to the cat's attentions, the stronger the bond will be. After initially sniffing at the person, most cats prefer to be stroked around their head and neck rather than over their whole body. When a cat chooses to move away, one should not pursue contact. Of course, cats are individuals and some prefer assertive, more forceful play; however, when becoming acquainted with any cat, feline manners prescribe head and cheek petting only. Fixed eye contact (staring) is both rude and threatening to cats. Some cats prefer being stroked or groomed, while others prefer their interactions to be oriented around play.

Cats spend over 3.5 hours of the day grooming[14] and this is clearly an important behaviour. When a cat does not live with another cat to groom or be groomed by,

Figure 7. Toys filled with catnip can be pleasurable olfactory stimulants. ©Terry Curtis/Margie Scherk

Figure 8. Various cat-friendly outdoor enclosures are available. ©Sally Lester

the owner may need to step in, but as with stroking, unless a cat specifically solicits it, combing and brushing should be restricted to the head and neck areas [15,20].

The best of both worlds

Wherever possible, safe alternatives to a strictly indoor lifestyle should be sought. This can be achieved through secure yet stimulating, complex enclosures that prevent cats from escaping and other animals entering; various cat-friendly fencing options and outdoor enclosures designed for cats are available (Figure 8). Finally, learning to walk on a harness and leash suits some cats, but (not unexpectedly) they should be allowed to explore rather than be led.

Conclusion: in search of behavioural wellness

When the environmental and social needs of cats are met and adequate space and resources are provided, many cats will adapt to indoor housing, especially if they have been exposed to this lifestyle from an early age. However, cats accustomed to having outdoor access may find it difficult to make the adjustment as adults (3,4). Our current state of knowledge does not answer the question as to whether strict indoor living is preferable to outdoor access, and there are risks and benefits associated with both options. Each case should be assessed individually and the wellbeing of the cat, the owner and the environment should be reassessed as necessary.

References available online: www.vetlink.co.za

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Dr. Scherk is a private practitioner who founded Cats Only Veterinary Clinic, in Vancouver, BC in 1986 working there fulltime until June 2008 when she "retired" from active practice. She graduated from the University of Guelph in 1982 with a DVM from the Ontario Veterinary College. In 1995 she became board certified in the specialty of Feline Practice by the American Board of Veterinary Practitioners (ABVP). After many years of serving on the Board of the American Association of Feline Practitioners she was honoured to be its President in 2007. Since its inception in 1995, she has been a member of the AAFP Feline Vaccine Guidelines Panel, most recently having the responsibilities of being its Chair for the 2013 version.

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