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Chapter 54

Nose

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Diseases of the feline nose are relatively common and include neoplasia, rhinitis, foreign bodies, fungal infections, and polyps. Treatment protocols often include surgical techniques such as biopsies, rhinotomy or nasal planectomy. Complications of nasal procedures can be major but these can be minimized by careful preoperative diagnosis and planning.

SURGICAL ANATOMY

The nose consists of the nasal planum, the nasal cavities or fossae divided by the nasal septum, and the choanae that mark the start of the nasopharynx (Fig. 54-1). The nasal fossae are divided by a dorsal concha (the extension of an endoturbinate), a curved shelf of bone originating from the ethmoidal crest. The dorsal concha (previously nasoturbinate) separates the dorsal cavity into the dorsal meatus and the middle meatus. Ventrally, the ventral nasal concha (previously maxilloturbinate) extends from the conchal crest and divides into several delicate bony scrolls. The concha divides the nasal cavity into the middle meatus and ventral meatus before forming the alar fold rostrally. Caudally, the ethmoturbinates extend from the midline ethmoidal plate to the cribriform plate; these ethmoid tubinates fill the presphenoid sinus and continue up into the frontal sinus. The ethmoturbinates can be divided into long, medially lying endoturbinates (usually seven in the cat) and smaller, more superficial ectoturbinates. The nasopharyngeal meatus is formed by the confluence of the caudal ends of the dorsal, middle, and ventral meatuses and runs to the choanae. The turbinates are covered by mucosa and act to direct the inspired air into the meatuses and humidify inspired air prior to passage to the lungs. They also act as a heat exchange mechanism and remove inhaled foreign material.

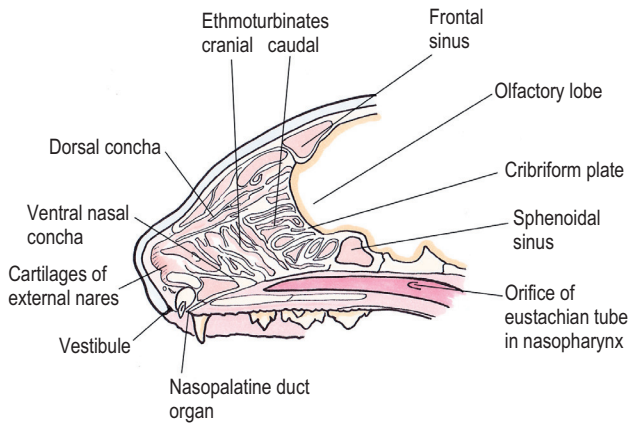

Figure 54-1 The nasal cavity of the cat, showing the position of the ethmoturbinates, nasoturbinates and maxilloturbinates.

The nasal planum is pigmented and consists of tough, thickened keratinized squamous epithelium. The philtrum marks the midline and separates the two nares. The external nares are supported by the dorsolateral cartilage, ventrolateral cartilage, accessory cartilage, and cartilaginous septum. The dorsolateral cartilage is the largest of the nasal cartilages and merges with the ventral nasal concha (maxilloturbinate).

The olfactory receptors are located mainly on the ethmoturbinates and thus are in the caudodorsal section of the nasal cavity. The nasal mucosa is well vascularized and innervated. The blood supply originates from the maxillary artery that arborizes into the sphenopalatine and major palatine branches before continuing as the infraorbital artery. The sphenopalatine artery supplies the nasal conchae, and its terminal branches are known as the caudal lateral nasal arteries. Lymphatic drainage is to the retropharyngeal, parotid, and submandibular lymph nodes.

GENERAL CONSIDERATIONS

Clinical presentation

Clinical signs of nasal disease include sneezing, stertor, nasal discharge, epiphora, epistaxis, inappetence, dyspnea, and facial swelling or distortion (Fig. 54-2). The clinical signs are often non-specific and may be associated with a variety of underlying diseases such as

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Figure 54-2 An eight-year-old female neutered domestic short-haired cat with a right-sided nasal discharge of five weeks' duration. A nasal carcinoma was diagnosed after rhinoscopy and biopsy.

infectious rhinitis, inflammatory rhinitis, tumors (such as lymphoma or adenocarcinoma), foreign bodies, hypertension, or trauma. Increased upper respiratory tract noise and dyspnea are more commonly seen with neoplasia than foreign bodies or rhinitis.[1]

Signalment may be helpful in prioritizing the differential diagnosis list; viral rhinitis is more common in older kittens while neoplasia is unusual in younger cats. A careful history is mandatory, including outdoor exposure, vaccination status, contact with other household or cattery cats, duration and progression of clinical signs, and response to previous treatments. Chronic post-viral rhinitis is seen in cats that have a history of cat flu. Cats with neoplasia tend to have a more acute history than those with rhinitis.

Clinical examination should include dental examination and careful auscultation of the larynx. Nasal airflow can be assessed by either holding cotton wool or thread in front of the nostrils or by looking for condensed water vapor on a microscope slide held in front of the nose. This should be assessed for both right and left nares. If epiphora is present, the patency of the nasolacrimal duct should be assessed with fluorescein dye. Facial deformity may be seen with neoplasia, fungal or mycobacterial disease whilst in oriental color point cats, nasal depigmentation may reflect increased temperature associated with chronic rhinitis. Depigmentation or ulceration of the nasal planum is commonly seen with nasal planum squamous cell carcinoma.

DIAGNOSTIC APPROACH

Although history and clinical signs can be helpful in prioritizing differential diagnoses, unfortunately there is considerable overlap between most of the underlying diseases. Thus a careful diagnostic approach is essential, involving blood profiles (and ideally feline leukemia virus (FeLV)/feline immunodeficiency virus (FIV) status), imaging (including rhinoscopy if available), and histology. It can be difficult to obtain a representative sample of tissue for biopsy unless a mass is directly visualized on rhinoscopy and thus a histopathology report of lymphoplasmacytic rhinitis in a cat with a rapid onset of progressive clinical signs warrants a repeat biopsy. It is also worth considering that in approximately 50% of cases of rhinitis in cats a diagnosis is not achieved after workup. In a retrospective study of 75 cats, the overall diagnostic yield was 36%. However, in 16 out of 23 cats that underwent nasal imaging, rhinoscopy and nasal biopsy, a specific etiological diagnosis was obtained, demonstrating that if nasal disease is to be investigated the investigation needs to be thorough.[2]

Diagnostic imaging

The nose can be imaged with radiography, computed tomography, or magnetic resonance imaging (MRI). For radiography, general anesthesia is essential for optimal views. A complete radiographic examination of the nose would include a lateral and dorsoventral skull and a dorsoventral intra-oral view; the latter being the most useful view. The dorsoventral intra-oral view gives good detail of the nasal chonchae and septum but requires non-screen film and thus cannot be performed with digital radiography. If digital radiography is being used, a ventro 30° rostral-dorsocaudal view can be used. In cases with suspected sinus involvement, though the lateral view is useful, a rostrocaudal sky-line or ventral 10° ventro-caudodorsal oblique sinus view is helpful, although in some cats, particularly brachycephalic breeds, this can be a very difficult view to achieve and perfect. Radiographic abnormalities include soft tissue opacity, loss of turbinate detail, lucent foci, displacement of midline structures, soft tissue opacity of the frontal sinus, and facial deformity. Unfortunately most of these changes can be seen in both rhinitis and neoplastic disease. In one study of 64 cats, rhinitis was more frequently associated with a normal radiographic appearance while neoplasia more frequently caused displacement of midline structures, unilateral soft tissue opacity, unilateral loss of turbinate detail, and evidence of bone invasion.[3] There was, however, considerable overlap between the two groups although none of the cats in the neoplastic group had normal radiographic changes. Computed tomography (CT) is better at localizing and determining the extent of nasal disease compared to radiography, but there is no difference in sensitivity of detection of the presence of nasal disease.[4]

Rhinoscopy

Rhinoscopy allows direct visualization of the nasal cavity and biopsy (at least the first sample) to be guided. Some diseases such as nasal hamartomas, fungal granulomas, and foreign bodies can be treated appropriately with this technique. Retrograde rhinoscopy is performed first using a fiberoptic bronchoscope to examine the nasopharynx and choanae so that hemorrhage does not obscure the view. Anterior rhinoscopy is then performed with a 2.7 mm or 0.9 mm diameter (for smaller cats) forward-viewing rigid endoscope (for details on equipment and technique, see Chapter 9). Isotonic fluid can be used during rhinoscopy to flush away blood contamination and aid hemostasis. In one study of 41 cats with chronic nasal disease, a mass was evident rhinoscopically in the 19 cats with neoplasia.[5]

Cytology, histology and culture

In feline nasal disease, cytologic analysis of samples from masses prepared by squash techniques can provide a relatively accurate diagnosis; agreement between cytologic and histologic diagnosis had a sensitivity of 0.94 and a specificity of 0.81 in one study of 30 cats.[6] With brush sampling, the results are far less reliable: one study of 12 cases had only a 25% agreement between cytology and histology.[7] The different results are probably due to the difficulty in locating a representative sample of tissue rather than superficial mucosa with the brush techniques as compared to the deeper sample obtained from a piece of abnormal tissue with the squash technique. Cytologic analysis will often yield a cell population suggestive of neutrophilic or suppurative rhinitis, indicating that chronic changes are not easily detected via cytology.[8] Even with biopsy and histology, incorrect

diagnosis may occur as a result of the lesion being missed. Hence in an elderly cat with rapidly progressive clinical signs, repeat biopsy is indicated if a report of rhinitis is received, as neoplasia could still be present.

Sampling of nasal discharge is only of use where there is suspicion of infection with a *Cryptococcus* spp., as cryptococci can be easily recognized in the discharge as a round organism with a lucent halo on Romanowsky stains.[9]

For nasal planum squamous cell carcinomas, biopsy samples are required to confirm the diagnosis. Cytology in the form of exfoliative samples from the surface of the lesion is less invasive but often yields predominantly inflammatory cells that may mask the presence of neoplastic cells.

Culture of nasal samples is of use in neutrophilic suppurative inflammation as antibiotic therapy can be tailored accurately to the infection present. In other conditions, a positive culture result is often obtained with the usual infective agents including *Escherichia coli*, *Pseudomonas* spp., *Streptococcus* spp., *Staphylococcus* spp., *Pasteurella* spp., *Serratia* spp., *Klebsiella* spp., and *Proteus* spp.[7] Approximately half the cases will have mixed infections. These bacteria, however, are usually secondary invaders and whilst antibiotic treatment may temporarily improve the nasal discharge, it is unlikely to resolve the clinical signs in the long term.

SURGICAL DISEASES

The diseases in the nasal cavity that may benefit from or require surgical input include neoplasia (predominately for biopsies or planectomy), polyps, fungal rhinitis, nasal planum tumors, foreign bodies, and chronic sinusitis.

Nasal and paranasal sinus tumors

Nasal and paranasal sinus tumors constitute about 5% of tumors seen in the cat and are usually malignant.[10] They generally originate from epithelium (with a split of 35% adenocarcinoma, 35% squamous cell carcinoma, 20% adenomas and 10% from submucosal or minor salivary gland origin) or are malignant lymphoma (30% of all nasal tumors). B-cell lymphoma is more common than T-cell.[11] Other rarer tumors encountered in the nasal cavity include soft tissue sarcomas, chondrosarcoma, osteosarcoma, plasmacytoma, basal cell carcinoma, melanoma, and mastocytoma.[11]

Common clinical signs include nasal discharge, dyspnea, facial swelling, and epistaxis and these signs are not specific for neoplasia (Fig. 54-3). Seizures can be seen with olfactory neuroblastomas due to extension of the tumor into the brain.[11] Cats with carcinomas tend to present at an older age than cats with non-epithelial tumors (12.8 years versus 8.8 years), and males are more frequently affected than female, with a 60:40 ratio.[11] Routine staging should be performed to check for lymph node metastasis (though this is rare) or generalized disease, particularly affecting the kidney, in cats with nasal lymphoma.

Nasal planum tumors

The majority of tumors affecting the nasal planum are squamous cell carcinoma, although other rarer tumors, including basal cell carcinoma or mast cell tumor, can occur on the planum (Fig. 54-4). Fungal granulomas do occur over the maxillary bone but tend not to originate from the actual planum. Squamous cell carcinomas are associated with exposure to ultraviolet light and thus pale sparse hair cover may predispose a cat to this disease. As multiple sites can be affected, any cats with suspicious nasal lesions should have the other predilection sites inspected, such as the pinnae and eyelids. The typical history is one of a 'scratch' or superficial crusting lesion that fails to heal in an older cat. The tumors have often been present for weeks/months before veterinary advice is sought. In cats, the lesion usually originates from the external cornified part of the nasal planum (Fig. 54-5). Initial staging for nasal planum tumors consists of radiography of the skull and inflated thorax. For more extensive lesions, MRI or computed tomography (CT) are useful for surgical planning. Aspirates are taken of the local submandibular lymph nodes although usually the metastatic rate is low.

Superficial lesions (grade Tis and small T1a, see Table 54-1) can be treated with photodynamic therapy, strontium 90 brachytherapy, radiotherapy, hyperthermia, or cryosurgery.[12–17] More than one treatment may be required with both photodynamic therapy and strontium therapy, but the cosmetic results are relatively good[12,13,15] (Fig. 54-6). Deeper lesions over 5 mm are likely to recur with the more conservative therapies and surgical treatment in the form of nasal planum resection is advised.

Figure 54-3 A nine-year-old male neutered domestic long-haired cat with a nasal lymphoma resulting in unilateral nasal discharge and distortion of the nose.

Figure 54-4 A six-year-old male neutered domestic short-haired cat with a soft tissue sarcoma originating from the right dorsal nasal planum.

Figure 54-5 An early squamous cell carcinoma of the nasal planum in a 12-year-old male neutered domestic short-haired cat.

Figure 54-6 Appearance two years after photodynamic therapy (PDT) treatment of a nasal squamous cell carcinoma in an eight-year-old male neutered domestic short-haired cat.

Table 54-1 World Health Organization staging of feline nasal squamous cell carcinoma

Grade	Description
Tis	Carcinoma in situ Superficial ulcerative/crusting lesion not extending through the basement membrane
T1a	Larger lesion <1.5 cm, exophytic
T1b	Larger lesion >1.5 cm, superficial or minimally invasive
T2	Ulcerative or infiltrative lesion of 2 cm or larger
T3	Larger lesion 2–5 cm or with invasion of subcutis
T4	Invading muscle, bone or fascia

Nasal mesenchymal hamartoma/ inflammatory polyp

Nasal mesenchymal hamartomas are also known as inflammatory polyps but are distinct from nasopharyngeal polyps that originate from the bulla or Eustachian tube. Nasal mesenchymal hamartomas are firm or cystic as opposed to the firm pink masses that form nasopharyngeal polyps. Macroscopically, nasal mesenchymal hamartomas are formed of excessive mesenchymal tissue, mainly fibrous connective tissue and woven bone that is covered by ciliated columnar epithelium.[18] Hence the terminology nasal mesenchymal hamartoma is more appropriate than inflammatory polyp as the lesion is disorganized indigenous tissue.

Nasal mesenchymal hamartomas present in young cats, usually less than one year in age. Clinical signs include epistaxis, sneezing, stertorous breathing, and mild facial deformity while nasal discharge is unusual. Occasionally, polypoid tissue is seen protruding through the nares.[19] Although these lesions are benign they can be locally aggressive with radiographic features of loss of turbinates and soft tissue opacity within the nasal cavities (Fig. 54-7). Treatment consists of surgical excision, either via a rhinotomy (see below) or per-endoscopic removal. In one case series of five cats, three were treated endoscopically, of which one had recurrence but was cured by a second treatment. One cat had spontaneous resolution of clinical signs without treatment.[18]

Fungal rhinitis

Fungal infection in the nasal cavities of cats is rare, though over the last 20 years several case reports can be found in the literature.[20–26] Pre-existing nasal damage either due to a foreign body, lymphoplasmacytic rhinitis, feline rhinotracheitis virus or calicivirus, or neoplasia may compromise nasal defense mechanisms and allow fungal infections to take hold.[20,22] Clinical signs usually consist of a mucopurulent chronic nasal discharge with epistaxis, sneezing, stertor, and mandibular lymphadenopathy. In cats with cryptococcocis nasal deformity may be seen.

The fungal species most commonly identified are *Cryptococcus* spp. and *Aspergillus* spp., though *Penicillium* infection also occurs.[27] Disseminated aspergillosis is comparatively common and usually occurs in immunosuppressed cats[28] though FeLV/FIV infection has not been documented for the nasal cases.

Cryptococcus affects males and females equally, with an overrepresentation of younger cats (two to three years) and Siamese, Himalayan and Ragdoll breeds.[29] The nasal cavity is the most commonly affected site, with other predilection areas including the skin, especially over the nasal planum where ulcerated lesions may be seen, lungs, and lymph nodes. Cryptococcocis can be diagnosed using an immunoassay for the crytococcal polysaccharide capsular antigen (CALAS), cytologic examination, histopathology, or culture. Treatment of local disease is usually successful using azole anti-fungal drugs.[27]

In cases of aspergillosis, brachycephalic Persians and Himalayans are the most common breeds reported. This is the opposite of the canine cases that tend to be dolichocephalic breeds. There is no typical age group that is affected. Orbital involvement occurs in about one-third of cases with signs including exophthalmos, epiphora, anterior uveitis, resistance to retropulsion, and prolapse of the nictitating membrane.[24] Diagnosis is by imaging, rhinoscopy, and biopsy samples that are submitted for culture and histopathology (Fig. 54-8). Failure

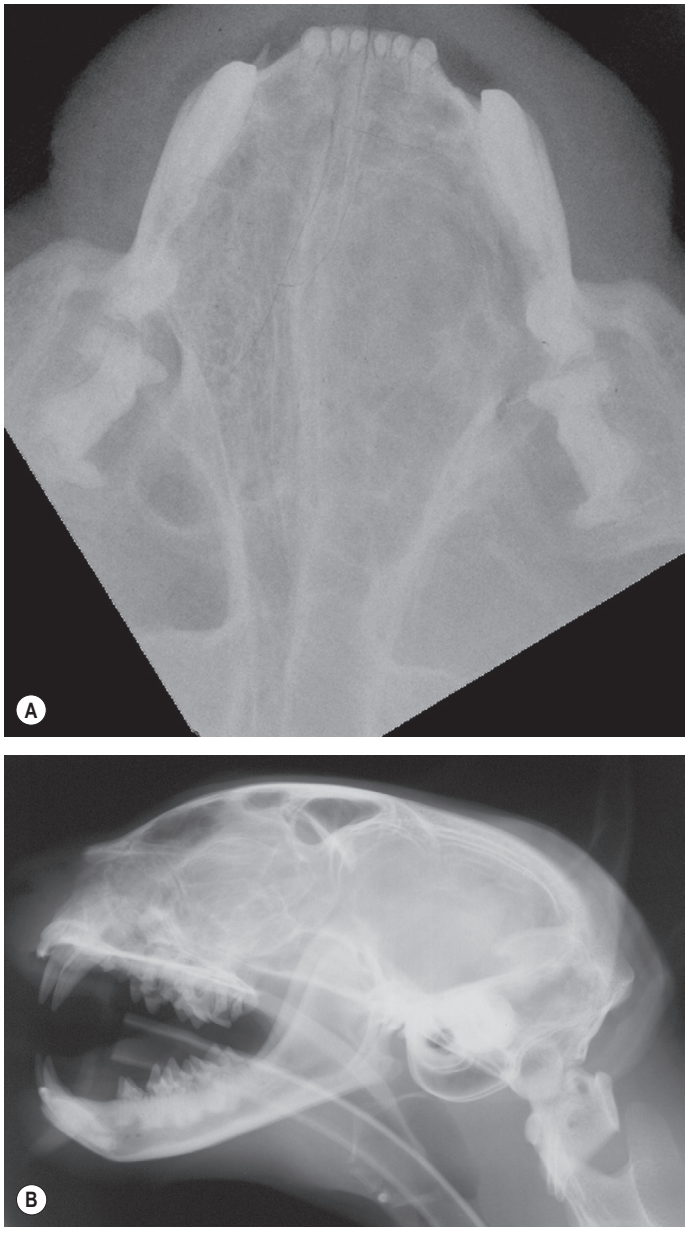

Figure 54-7 **(A)** An intra-oral dorsoventral view of the nasal cavity in a three-year-old male neutered cat demonstrating an expansile soft tissue opacity in the right nasal cavity with deviation of the vomer to the left. **(B)** A lateral skull radiograph shows increased opacity of the nasal cavity. The diagnosis in this case was nasal hamartoma (polyp).

to culture fungal infections other than *Cryptococcus* spp. is common and histology reports of fungal hyphae, rhinoscopic findings of white-gray discharge/plaques or white-yellow fungal granulomas and turbinate destruction on imaging is diagnostic. Positive aspergillosis serology on ELISA is supportive of the diagnosis though false negative results occur.[20] Treatment protocols for aspergillosis include intranasal infusion of clotrimazole[21] or systemic anti-fungal agents such as itraconazole, fluconazole, and ketaconazole. There are too few cases in the literature to give an accurate prognosis on feline nasal aspergillosis though the cases treated with intranasal clotrimazole seemed to have resolution of the infection in about 50% of cases. Orbital involvement appears to be a negative prognostic indicator.[22,30]

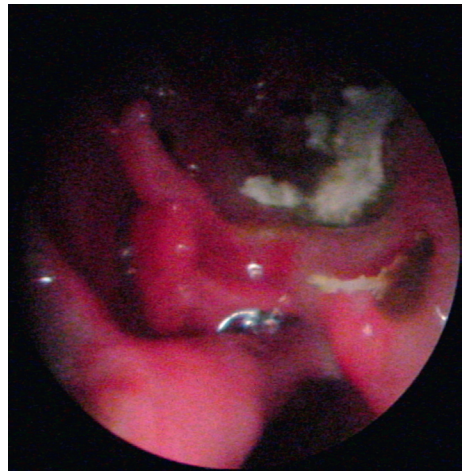

Figure 54-8 Rhinoscopic view of aspergillosis fungal plaque. *(Courtesy of Prue Neath.)*

Fungal infections of the subcutis of the nose

The skin overlying the nasal bones is a predilection site for fungal granulomas along with, to a lesser extent, other extremity sites such as digits and pinnae. These occur in cats of all ages though the incidence is more common in the middle-aged and elderly male cat.[31,32] There is usually a history of a chronic non-painful subcutaneous swelling, plaque, or non-healing wound that is non-responsive to antibiotic treatment (Fig. 54-8). The usual infective agents are *Alternaria* spp. though others are reported including *Mucor* spp., *Exophila* spp., *Ulocladium* spp.[31,33–35] Diagnosis involves cytologic analysis or biopsy of the swellings with histologic evidence of fungal hyphae along with fungal culture. In the case of alternariosis, the hyphae are hyaline and non-pigmented.

Treatment of alternariosis is most successful with surgical debridement (Fig. 54-9) followed by anti-fungal medication, but it can also be treated with protracted medication.[32] Recurrence is common. Successful treatment of the *Mucor* spp. case report involved five months of the second generation triazole, posaconazole.[33]

Foreign bodies

Nasal foreign bodies that have been reported in the cat include grass seeds, grass blades, air gun pellets, needles, stones, and canine teeth.[1,36,37] Clinical signs common to cats with nasal foreign bodies include nasal discharge and sneezing though facial distortion, cough, lethargy, and lymphadenopathy are also reported.[1] Foreign bodies may be retrieved by nasal flushing or rhinoscopy (Fig. 54-10). Occasionally, open rhinotomy approaches are required, particularly for larger foreign bodies such as teeth or air gun pellets.[36] If left in situ, foreign bodies will cause inflammation and a chronic rhinitis that may be difficult to resolve even after the foreign material has been removed.

Rhinitis

Chronic rhinitis is both a diagnostic and therapeutic challenge that is aided by classification of the inflammation by means of a biopsy. Clinical signs consist of a mucopurulent nasal discharge, often bilateral. Rhinitis can cause abnormal turbinate architecture or even destruction visible on endoscopy or advanced imaging.

In a retrospective study on rhinitis in cats, 20 cats had chronic non-specific rhinitis of over four weeks' duration. Of these 20 cats, acute

Figure 54-9 **(A)** A six-year-old female neutered cat with a fungal granuloma overlying the right nasal bone. **(B)** On surgical resection of the skin lesion, the underlying nasal bone was found to be eroded. **(C)** The skin defect was closed using a superficial temporal axial skin flap.

neutrophilic inflammation was found in four cases, mixed lymphoplasmacytic and neutrophilic inflammation in 14 cases, and two cases had chronic lymphoplasmacytic inflammation.[7] Culture of the nasal discharge will usually yield bacterial growth, with the usual contaminants including *Escherichia coli*, *Pseudomonas* spp., *Streptococcus* spp., *Staphylococcus* spp., *Pasteurella* spp., *Serratia* spp., *Klebsiella* spp., and *Proteus* spp.[7] These bacteria are likely to be secondary infections as the likely etiology of many cases of feline rhinitis is viral, particularly

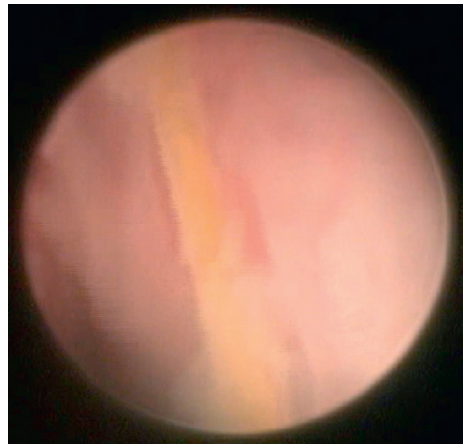

Figure 54-10 A rhinoscopic view of a grass blade nasal foreign body in a four-year-old female neutered domestic short-haired cat that presented with an abscess over the frontal sinus.

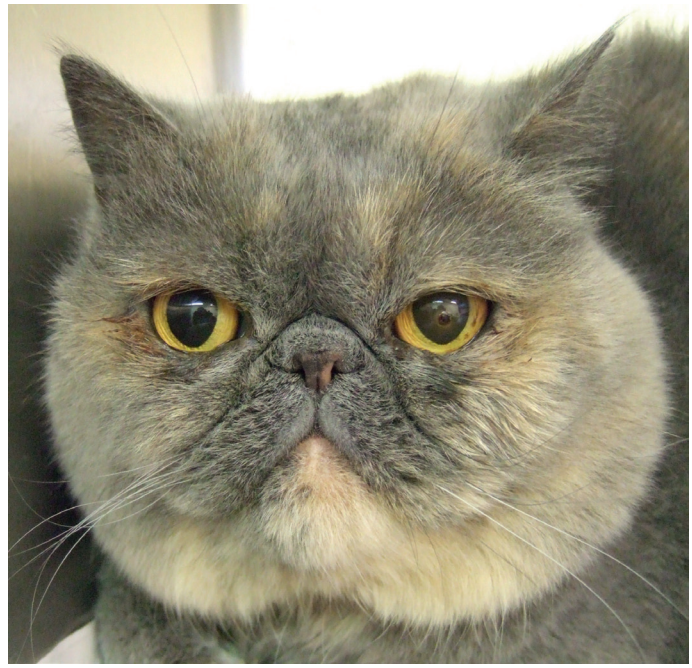

Figure 54-11 A five-year-old female neutered Persian with stenotic nares. This cat had no associated clinical signs.

feline herpes virus (FHV-1) and feline coronavirus (FCV). *Chlamydophilia felis* and *Bordetella bronchiseptica* are also capable of causing a primary rhinitis.

In cases of feline rhinitis that have frontal sinus involvement and are refractory to medical treatment, it is possible that infection of the frontal sinus is producing a nidus of infection that is difficult to resolve. Surgical obliteration of the frontal sinus has been described to try and resolve any frontal sinus contribution to the rhinitis.[38,39] Results have only been reported in a limited number of cats and this procedure is not commonly performed, but out of six cats in one series, four cats had resolution of signs following surgery and two cats showed improvement.[39]

Stenotic nares

Some breeds of brachycephalic cat, particularly the Persian (Fig. 54-11) and Himalayan, have increased nasal resistance due to a

combination of stenotic nares and incongruency between the size of the shortened nasal cavity and the nasal conchae. Clinical signs consist of upper respiratory tract noise, particularly stertor and occasional labored breathing.[40] The stenotic nares can be opened by a number of different techniques that reduce the size of the dorsolateral nasal cartilage. These include horizontal, lateral or vertical alaplasty, or punch resection alaplasty.[41]

GENERAL SURGICAL CONSIDERATIONS

Prior to performing any nasal procedures, the owners should be adequately prepared for postoperative complications and cosmetic alterations. Most nasal procedures, even biopsies, tend to result in a few days of hemorrhagic nasal discharge that can be profuse during sneezing episodes. Clipping of the face even before resection of tumors or surgical incisions can be disturbing to some owners. Preoperative photos of the likely immediate postoperative appearance can prepare owners and avoid the unfortunate scenario of tears on collection of their cat.

The nasal mucosa is friable with a tendency to marked hemorrhage when traumatized. Hematology profiles including coagulation profiles should thus be performed prior to planned procedures. In some surgeries such as rhinotomy and the combined nasal planectomy and premaxillectomy, there is the potential for rapid blood loss and blood products should be available even though transfusion is rarely required. Blood-typing is thus advisable (see Chapter 5). In middle-aged to elderly cats, biochemistry blood profiles are used primarily to screen for concurrent disease.

After induction maxillary nerve blocks, the introduction of local anesthetic such as bupivacaine or ropivacaine into the area of the infraorbital canal provides very useful intraoperative and initial postoperative analgesia (see Chapter 2). Local anesthetic spray can also be used in the nares prior to insertion of an endoscope or biopsy forceps as this is a very sensitive area and sneezing or movement during rhinoscopy can result in hemorrhage and an obscured view.

The pharynx should be packed with a mouth pack. This can be a swab or length of bandage to prevent aspiration of blood into the trachea and lungs. After completion of the surgery, the pharynx should be carefully inspected and suctioned if necessary after removal of the mouth pack. Recovery of the cat with the head down allows blood to run out of the nares and mouth rather than into the pharynx.

Useful surgical equipment includes an air powered burr that greatly aids rhinotomies, both ventral and dorsal. A Freer elevator is a good tool for elevation of periosteum and for checking the depth of osteotomies. Ice cold saline is used to flush the surgical site or pack exposed nasal cavity and aids hemostasis. An accurate set of weighing scales is required. Due to the potential for marked blood loss, swabs should be weighed during the procedure and, after the deduction of any fluids that were used, the increased weight in grams will give the blood loss in milliliters.

With rhinotomies and more aggressive nasal planectomies, the neck may be clipped for temporary carotid ligation whether this is planned as part of the procedure or as an emergency intervention after hemorrhage. After a ventral cervical midline incision, the carotid sheath is identified and the carotid artery is carefully isolated and occluded either with a bulldog clamp or a Rummel tourniquet. The advantage of using suture and Rummel tourniquet is that at the end of the procedure the tourniquet can be removed from the incision without needing to open the wound again. The carotid artery can be occluded for 40 minutes with no detrimental effects. In the cat, carotid ligation should be unilateral as the collateral vertebral blood supply is not as developed as in the dog and thus temporary bilateral carotid ligation can lead to permanent blindness and neurologic deficits. Likewise, permanent carotid artery ligation is safe in the dog but this is not the case in the cat.[42]

Nasal surgery can lead to inappeteance postoperatively due to the lack of the sense of smell, obstruction of nasal airflow, and pain. In cats undergoing major procedures (rhinotomies, anti-fungal flushes, and nasal planectomy), it is worth placing an esophagostomy tube (see Chapters 6 and 12) at the end of surgery, particularly in sensitive or fussy cats. If cats do resume eating quickly then the feeding tube can be removed easily but for the reluctant cat it is a stress free way to supplement oral intake.

SURGICAL TECHNIQUES

Biopsies

It is prudent to warn owners that more than one biopsy may be required to obtain a diagnosis in nasal disease as it easy to miss lesions, particularly if blind biopsies are being taken.

Biopsy techniques include blind biopsies, rhinoscopically guided biopsies, nasal flushes, and trephination though the maxillary bone. As hemorrhage is likely in all these techniques, the pharynx should be packed as previously described (see above).

For blind biopsies, radiographs or advanced imaging should ideally be used to locate the approximate area of disease. A pair of crocodile or cup forceps is measured from the nares to the medial canthus of the eye and a piece of tape placed at this level to avoid damage to the cribriform plate. Multiple biopsies should be taken to try and maximize the chance of a diagnostic result. Blind biopsies can also be taken by using a stylet or 16 gauge catheter with an end that is cut obliquely and attached to a 10 mL syringe to apply negative pressure to the sample. Again, the stylet should be marked at the level of the medial canthus to prevent over-penetration.

With rhinoscopically guided biopsies, a sheath with a working channel will allow the passage of biopsy forceps alongside the scope so the tips of the forceps are visible. The area of suspicion should be biopsied first. The site of hemorrhage after the first biopsy can be flushed with cold isotonic fluids, thus allowing more guided biopsies to be taken. A pair of crocodile or cup forceps can also be passed parallel to the scope rather than through the biopsy channel in the scope, which allows bigger forceps to be used.

Nasal flushes rely on high-pressure saline being flushed through the nares with a 20 mL syringe whilst the other nostril is digitally occluded. The technique is repeated in each nostril two to three times to try and maximize tissue yield. This technique can yield large lumps of tissue if masses are present that will be located on a swab which is packing the pharynx. After the procedure, the pharynx should be checked and suctioned if necessary to remove debris. There is a risk of cerebral damage if the cribriform plate is damaged, though in one case series of 41 cases, of which 12 were cats, there was a 90% success rate of obtaining diagnostic material with no major adverse effects.[43]

If repeated nasal biopsies have failed to yield a diagnostic result, any mass lesion seen on imaging can be biopsied via trephination through the maxillary bone. In this case, a small area is clipped and prepped aseptically. After making a small skin incision, the bone is perforated with a Michel's trephine or K-wire of large enough diameter to allow crocodile forceps to be passed into the nasal cavity. This technique is rarely necessary but can be useful for tumors originating from the maxillary sinus.

In nasal planum squamous cell carcinomas, a superficial slice of the nasal planum taken using a scalpel blade often yields a diagnostic result. Alternative biopsy techniques include punch biopsies or

incisional biopsies. Any postoperative hemorrhage is usually easily controlled with gentle pressure from surgical swabs.

Rhinotomy

The nasal cavity can be accessed from a dorsal or ventral approach. The ventral approach (Box 54-1) gives adequate exposure for exploration of the nasal cavity[44] and also gives a better cosmetic result with less chance of subcutaneous emphysema postoperatively.[45] The disadvantage of the ventral approach is that it involves working in the oral cavity, which can limit manipulation of instruments and require a pharyngostomy tube to be placed rather than an endotracheal tube. The dorsal approach (Box 54-2) gives good access to the nasal cavity but is more disfiguring, with a risk of postoperative subcutaneous emphysema.

Nasal planectomy

Nasal planectomy (Box 54-3) is the treatment of choice for squamous cell carcinomas of greater than 5 mm in depth that are likely to recur with the more conservative therapies. This surgery, though disfiguring, results in a good functional outcome and usually contented owners, with cats that are unconcerned (possibly unaware) of their appearance.

As the cosmetic appearance can be shocking, it is prudent to show the owners photos of cats that have undergone the procedure to prepare them fully for the postoperative appearance. Most owners, though initially distressed by the cosmetic appearance, will adjust to it easily. Occasionally owners find the postoperative appearance better than the preoperative tumor, particularly in the case of ulcerative tumors.

Box 54-1 **Ventral rhinotomy**

The cat is placed in dorsal recumbency with the head secured in a level position with tape around the maxillary canines.

If the oral cavity is compromised by the presence of an endotracheal tube, a guarded pharyngostomy tube should be placed by making a small skin incision caudal to the hyoid apparatus onto the point of some large forceps such as Rochester carmalt that are then used to bring the tube into the pharynx. It is then retroflexed into the trachea. The pharynx is then packed with a swab.

The palate is then incised over the midline from the level of the canine teeth to the fourth premolars; any bleeding is stopped by swab pressure and sparing use of electrocoagulation. The mucoperiosteum is elevated to expose the palatine bone, taking care to avoid the major palatine artery which runs alongside the dental arcade from the carnassial tooth (see Fig. 56-1), and stay sutures are placed either side, at both the cranial and caudal ends of the incision, to maintain exposure (Fig. 54-12). If a large exposure is required, a hinged mucoperiosteal flap of palate is raised and retracted.

A burr is then used to gently burr through the palatine bone and access the nasal cavity/Unilateral or bilateral access can be obtained, depending on the extent of the nasal lesion. If a burr is not available, two holes can be made with K-wires and then connected with rongeurs which can be used to enlarge the cavity. Ice cold saline is used to decrease hemorrhage and flush the nasal cavity to allow the lesion to be visualized.

After removal of the mass or foreign body, the palatine mucoperiosteum is closed with a relatively long-lasting suture material such as polydiaxonone or glycomer 631 in a single layer using a simple interrupted suture.

The excised tissue should always be submitted for histopathology examination. The pathologists are aided in their assessment of surgical margins if the cut edge of the tissue is marked with Indian ink. Alternatively, a few tiny samples from the wound bed can be submitted after excision of the tumor.

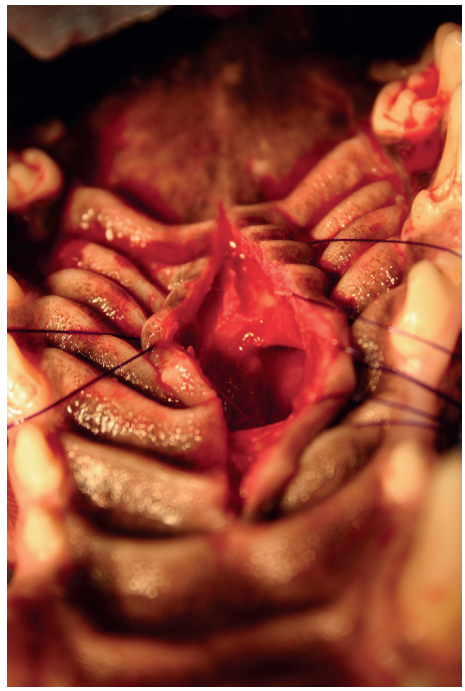

Figure 54-12 The use of stay sutures to increase exposure in a ventral rhinotomy.

Box 54-2 **Dorsal rhinotomy**

The cat is placed in sternal recumbency, with the nose positioned level on a sandbag. The pharynx is packed with a swab or bandage.

A midline incision is made from the medial canthus of the eye rostrally over the nasal bone. The skin and periosteum are elevated and retracted by stay sutures or Gelpi retractors placed in the tissues either side of the incision (Fig. 54-13A).

Hemorrhage is stopped by judicious use of bipolar electrocoagulation or swab pressure. A burr is used to gently burr through the nasal bone and access the nasal cavity (Fig. 54-13B). If a burr is not available, two holes can be made with K-wires and then connected with rongeurs, which can then be used to extend the cavity as necessary for exposure. Alternatively, an airsaw can be used to cut a rectangular flap of bone although this technique is difficult in cats due to the confined incisional area.

After removal of the abnormal tissue or foreign body the nasal cavity is flushed with ice cold saline and the periosteum closed with relatively long-lasting suture material such as polydioxanone or glycomer 631 and the mucosa and the skin is closed as a separate layer.

A small piece of sterile tube is sutured into the wound dorsally connecting the nasal cavity with the air to act as a drain for any subcutaneous air that accumulates. Alternatively, a small gap is left at the dorsal aspect of the incision though this can easily become occluded.

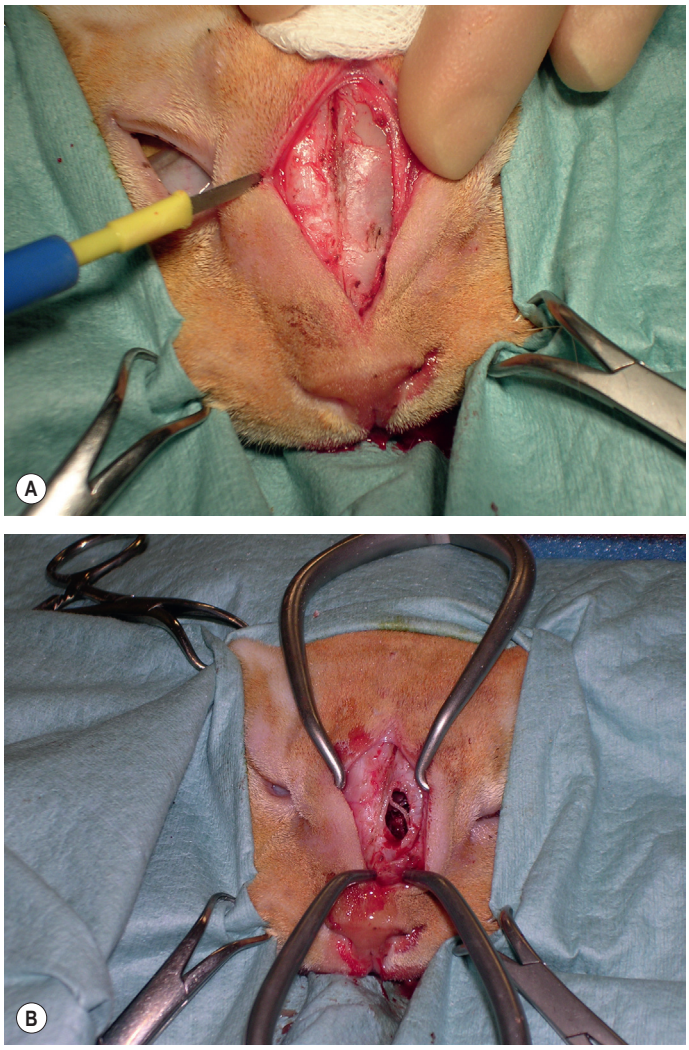

Figure 54-13 **(A)** A dorsal rhinotomy in a three-year-old male neutered cat. This is the same case as shown in Figure 54-7, and the expansile nature of the hamartoma can be seen affecting the nasal and frontal bones on the right. **(B)** Removal of the nasal bone with a burr revealed the hamartoma.

Anti-fungal flushing

A 1% solution of clotrimazole in propylene glycol has been described for intranasal flushing and is adapted from the canine technique.[12,13] The cat is placed in dorsal recumbency with the pharynx packed with swabs. A 14 French (Fr) Foley catheter is introduced into the right nares and advanced through the ventral meatus into the nasopharynx where inflation of the balloon prevents leakage of clotrimazole into the pharynx. Size 8 Fr Foley catheters with the tips cut off are then placed into each nare and inflated to prevent rostral leakage. Eight to 10 mL of clotrimazole solution is slowly and gently infused into each 8 Fr catheter until back-leakage occurs. The solution is left in situ for an hour, turning the cat into each lateral after 15 minutes and topping up with solution as the cat is turned.

If frontal sinus involvement is present, the frontal sinuses can be trephined (see below for detail) and debrided and 1% clotrimazole infused through the frontal sinuses into the nasal cavity after ensuring patency of drainage with saline. The ostium between the frontal and sphenoid cavities and the nasal cavity in cats is large, thus drainage should be rapid. Clotrimazole cream can be inserted into the frontal sinuses at the end of the procedure for a longer lasting anti-fungal effect.[46]

The cat should be recovered with the head down to allow the anti-fungal solution to drain rostrally.

Box 54-3 **Nasal planectomy**

The surgical clip is 1–2 cm from the planned surgical margins; whiskers are left in situ if possible. The skin is routinely aseptically prepared and the oral cavity prepped with a dilute povidone-iodine solution (Fig. 54-14A).

The cat is placed in ventral recumbency with the mouth slightly opened using a mouth gag. The drapes are placed in the mouth, covering the endotracheal tube and over the maxilla, but the commissures of the lips are exposed in case they are required during reconstruction.

The surgical margins are planned to extend to 1cm from the visible edge of the tumor if possible. If a 1 cm margin is not possible due to the size of lesion, a 0.5 cm margin will often result in clean surgical margins. After deciding on the surgical margins, the excision line is drawn on the skin with a sterile marker prior to the incision.

For small lesions, where removal of the nasal planum provides an adequate margin, the nasal planum and some of the underlying turbinates are sliced off using a scalpel with a number 10 or 15 blade starting dorsally with a 360° incision and angling ventrally to leave the lips in place. A small strip of skin is left in place at the rostral lip margins to aid reconstruction (Fig. 54-14B).

For larger tumors, or those situated more ventrally, the nasal planectomy should be combined with a premaxillectomy. After incising dorsally through the skin onto the maxillary bone, a full thickness labial incision is made perpendicular to the lip margin. The lips are very vascular and hemostasis is provided by the cautious use of electrosurgery, artery forceps, and ligation. Ice cold saline-soaked swabs are used to wrap the incised lip margins.

The incision is continued through the subcutis and nasolabial muscles to the maxillary bone. The rostral maxilla, nasal planum, turbinates, and palate are then removed with an oscillating saw. Swift removal followed by pressure applied with surgical swabs or ligation of the palatine arteries is the best way to control the hemorrhage.

Reconstruction

In cases where only the nasal planum has been resected, the skin can be sutured to the maxilla using simple interrupted rolling sutures or a purse-string suture. Simple interrupted rolling sutures are placed by anchoring the skin through holes made in the maxilla using K-wires and are more difficult to place than a purse string but give a good cosmetic appearance. The purse-string suture is faster and easier to perform but may result in more marked stenosis postsurgery. An absorbable suture of 2M or 1.5M monofilament suture such as polydioxanone is a good choice.

When the nasal planectomy has been combined with a premaxillectomy, unilateral or bilateral labial flaps are used to close the oral defect. The labio–gingival borders are incised as necessary to permit tension-free advancement, aiming for a palatobuccal recess of about 1 cm. Suturing the labial submucosa to the palatine bone using bone holes made with K-wires helps to prevent the formation of a rostral oronasal fistula, which can occur if the lip-palatine sutures break down (Fig. 54-15).

A three-layer closure of palatine periosteum/ bone tunnels to labial submucosa followed by oral mucosa medially and skin laterally is used.

Sinus ablation

Frontal sinus ablation (Box 54-4) is advocated for treatment of chronic rhinitis with frontal sinus involvement. Obliteration of the frontal

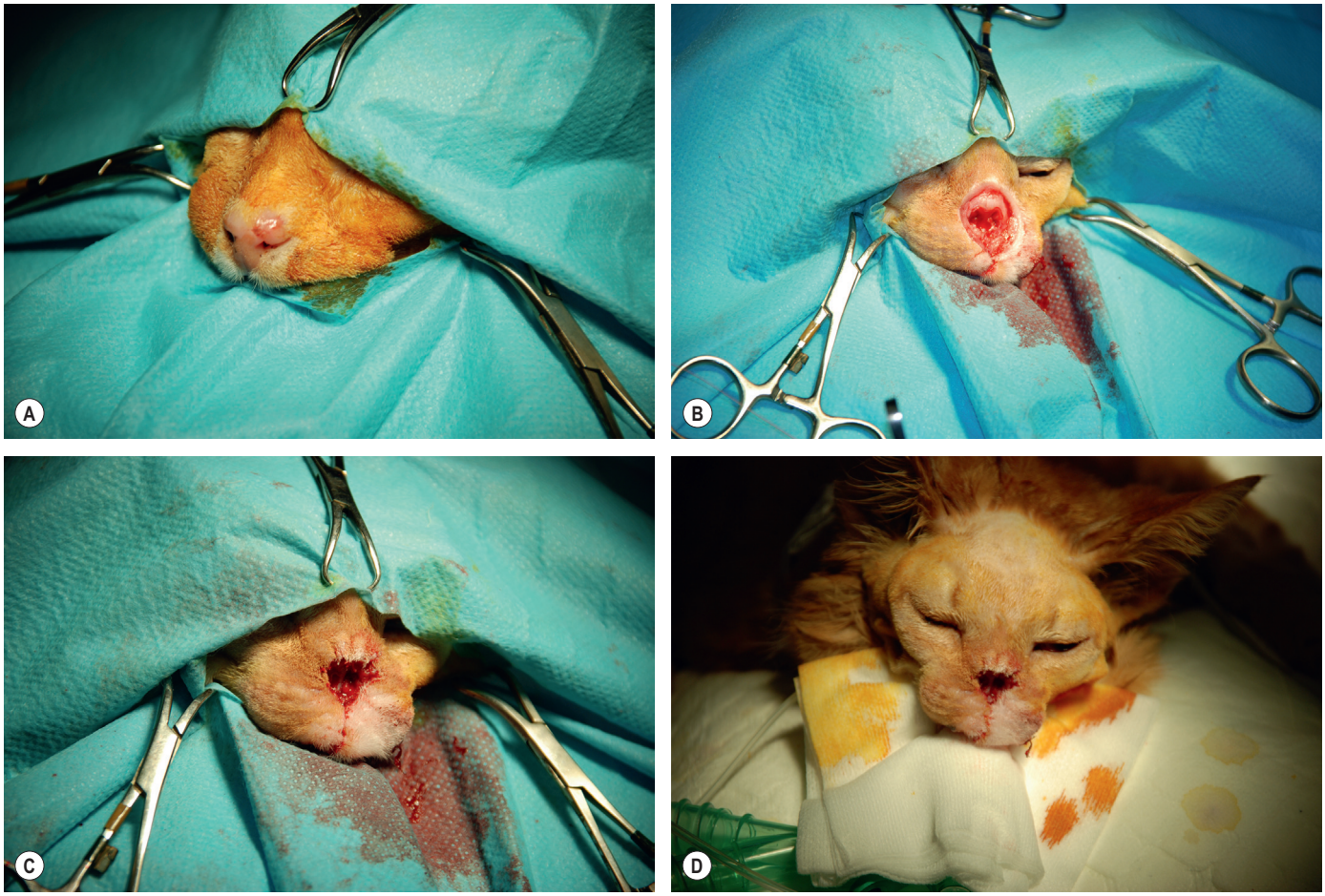

Figure 54-14 Nasal planectomy in a 12-year-old male neutered domestic short-haired cat. **(A)** The preoperative appearance. **(B)** Removal of the nasal planum using a 10 scalpel blade. **(C)** Reconstruction was performed using individual rolling sutures. **(D)** Immediate postoperative appearance.

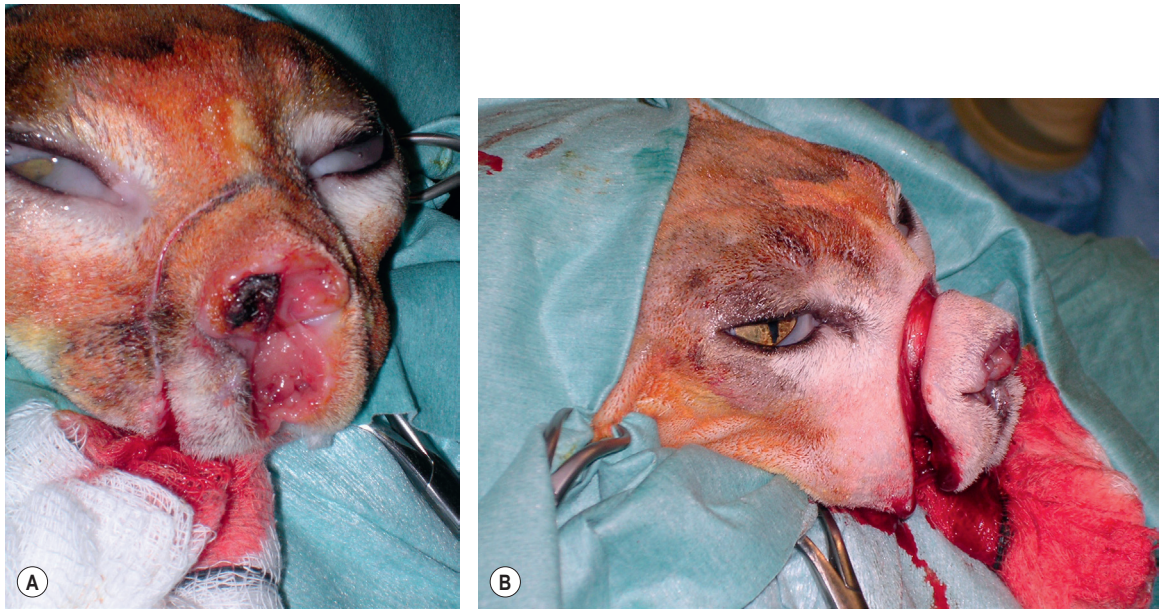

Figure 54-15 A 13-year-old male neutered domestic short-haired cat with a grade 4 squamous cell carcinoma requiring a nasal planectomy and maxillectomy. **(A)** The initial surgical incision is made after marking the margins on the skin with a sterile pen. **(B)** Appearance after incising through all the soft tissues. Hemorrhage is reduced by the use of ice cold saline.

Figure 54-15, Continued **(C)** An oscillating saw is used to section through the nasal bone after the soft tissues have been incised. **(D)** Reconstruction is performed initially by incising along the gingival margin of the upper lips to advance the lip and recreate the philtrum. **(E)** Immediate postoperative appearance of the nasal planectomy and premaxillectomy. **(F)** The six week postoperative appearance. Clean surgical margins were obtained and no recurrence was noted at two years following surgery.

sinus with curettage of the ethmoid conchae removes the infection within the bony cavity and allows drainage to be re-established. Fat grafts can be used to encourage ablation of the sinuses.[31,32] Trephination and irrigation of the frontal sinuses without curettage produced an improvement in clinical signs in 20 cats but this was short term.[47]

Alaplasty

There are a number of techniques described for alaplasty (nares resection), including wedge resection (horizontal, vertical, and lateral) or punch biopsy. A horizontal wedge resection allows a deeper slice of tissue to be taken, which decreases the width of the alar fold (Box 54-5).

POSTOPERATIVE CARE

Although many cats will resume oral intake the day following surgery, the temporary disruption of the normal sense of smell combined with surgical stress, possible discomfort, and medications will result in some cats being anorexic. Oral food that is initially offered should be soft and pungent.

Analgesia needs careful consideration. For the first 24 hours, once the local anesthetic nerve block has worn off, methadone is a good analgesic choice for planectomies and rhinotomies. An opiate with less sedative effects such as buprenorphine is then used with the addition of non-steroidal inflammatory drugs once food intake is reasonable.

A buster collar may be required and if so will need frequent cleaning. This is usually left in place for the first week though this depends on the temperament of the cat. Grooming will also need to be assisted in the first few weeks postsurgery. Immediately after nasal planectomy surgery the turbinates are exposed and bone is visible; however, a scab rapidly forms over the exposed tissue and granulation tissue usually covers the exposed bone within three weeks of surgery. In some cases, the nasal aperture will initially need gentle cleaning with damp cotton buds or swabs to remove food debris.

If a drain is placed in the wound during a rhinotomy, this can be removed after three to five days. If the drain becomes occluded and subcutaneous emphysema occurs this is usually self-resolving in seven

Box 54-4 **Sinus ablation**

The cat is initially positioned in dorsal recumbency and a piece of subcutaneous fat approximately 5 cm × 2 cm × 1 cm harvested from the ventral abdomen. The cat is then repositioned in sternal recumbency with its head elevated on a sandbag and stabilized with adhesive tape. A three-sided skin flap which hinges rostrally is made, starting at the midpoint between the base of the pinna and the lateral canthus of the eye, and then extending rostrally to the level of the lateral canthus and then connecting the two incisions dorsally across the temporal area (Fig. 54-16A).

The skin is elevated and retracted rostrally before a similarly positioned bone flap is created with an oscillating saw (Fig. 54-16B). The rostral side of the bone flap is scored with the saw to allow the bone flap to be hinged rostrally. Using surgical loupes or an operating microscope, the frontal sinuses are debrided and all the mucoperiosteal lining removed (Fig. 54-17). The ostium to the nasal cavity is checked for patency and increased in diameter, allowing the ethmoturbinates to be debrided. A piece of temporal muscle is then harvested and used to plug the ostium. The previously harvested fat graft is placed in the sinus prior to closure of the bone flap and the temporal fascia is resutured. The subcutaneous tissues and skin are closed routinely.

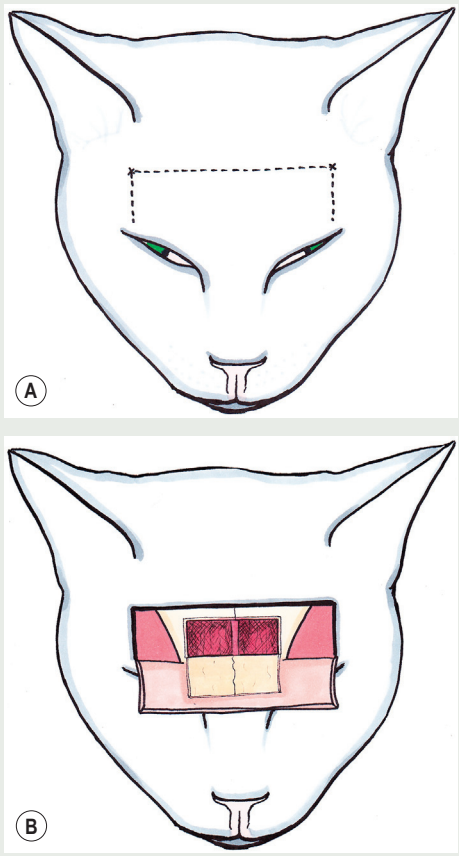

Figure 54-16 Sinus obliteration. **(A)** A three-sided rectangular flap of skin is made and hinged rostrally. **(B)** A smaller rectangular section of bone is cut and elevated to give access to the frontal sinuses.

to ten days' time and there is little point in trying to remove the accumulated air prior to this time. Skin sutures, if present, are removed ten to 14 days postsurgery under sedation or general anesthesia, and the oral wounds after ventral rhinotomy are carefully checked at this stage to ensure adequate healing.

Figure 54-17 Unilateral sinus obliteration in a 13-year-old domestic short-haired cat that presented with chronic rhinitis refractory to medical treatment. MRI revealed sinus involvement.

COMPLICATIONS

With all nasal procedures some nasal hemorrhage is expected on recovery and for the following few days. Sneezing is common and can result in epistaxis. Anorexia is possible after planectomies and rhinotomies but in the author's cases has only ever been short term in duration.

Dorsal rhinotomies can produce subcutaneous emphysema in the first couple of weeks that is self-limiting and causes little morbidity. Dehiscence of ventral rhinotomies can result in an oronasal fistula but in a case series of 58 patients, including dogs and cats, only one incidence of an oronasal fistula was seen.[44] After both dorsal and ventral rhinotomies, a persistent nasal mucopurulent or serous discharge is common due to the altered architecture of the nasal conchae and resulting inflammation. With any facial surgery dehiscence is possible which may necessitate further surgery. There are a number of axial skin flaps that can be used for reconstruction and the local subdermal flaps are well vascularized (Fig. 54-19).

With nasal planectomies, dehiscence may be seen, usually of the premaxilla reconstruction, and this is usually only a cosmetic issue but the wound can be resutured if required. Nasal stenosis is sometimes apparent; the nasal orifice should be revised if this is causing a clinical problem. Mild nasal discharge may be noted after surgery due to the increased size of the nasal orifice and inflammation associated with exposure of the nasal turbinates. This is rarely a significant problem.

Recurrence of nasal planum squamous cell carcinomas may be seen if clean margins are not obtained. Radiotherapy in this area is often difficult after surgery due to the close proximity of the eyes and brain. If further surgical resection is possible this is often the best treatment.

Sinus curettage and obliteration can result in short duration subcutaneous emphysema. This is self-limiting and resolves in three to five days.

Box 54-5 **Alaplasty**

The cat is placed in sternal recumbency and the nostrils prepped with povidone-iodine.

Lateral wedge resection

An 11 blade is used to cut a wedge of tissue from the lateral cartilage (Fig. 54-18A). Hemorrhage is rapid but stops when the cut surfaces are re-apposed with a soft suture material such as polyglactin 10. Pressure is also applied by a sterile cotton bud. The sutures are left to fall out or removed two to three weeks postsurgery.

Punch resection technique

The lateral cartilage is stabilized with forceps and a 2 mm punch biopsy instrument used to remove a circular plug of tissue to the level of the alar fold (Fig. 54-18B). A 2–3 mm rim of tissue is left medially and laterally after the plug is sectioned. The tissue edges are then apposed with simple interrupted sutures.[34]

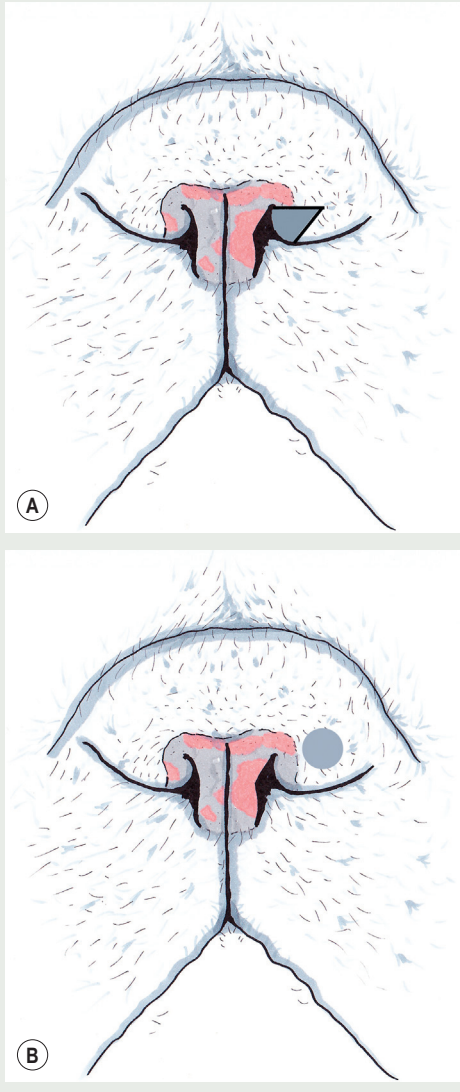

Figure 54-18 Stenotic nares correction. **(A)** Horizontal wedge technique. **(B)** Punch resection technique.

Figure 54-19 **(A)** Wound breakdown in a nine-year-old female neutered cat that had a chondrosarcoma removed from the maxillary bone. The superficial temporal axial pattern flap had distal necrosis. **(B)** The wound was reconstructed with a local subdermal rotation flap. **(C)** Six months postsurgery there is a good functional outcome with a reasonable cosmetic result.

PROGNOSIS

Nasal tumors

Both of the common nasal tumor types, lymphoma and carcinomas, can be treated effectively, albeit palliatively with radiotherapy, both orthovoltage and megavoltage; lymphomas are far more radiosensitive. There are few case series of non-lymphomatous nasal tumors in the literature but survival times are in the range of 315 days or 40% survival at one year for adenocarcinoma.[48,49] Lymphomas tend to have a better initial response to radiotherapy, with median survival times (when death from progression of the nasal tumor was analyzed) in the range of 530 days.[49,50] Similar survival times were obtained by using chemotherapy protocols but the inclusion of radiotherapy in the treatment protocol was pivotal for local disease control.[51] A variety of chemotherapeutic protocols are commonly used for nasal lymphoma (Box 54-6).

Little difference was noted in survival times of cats treated with either COP or Wisconsin–Madison (WM) in a study of 149 cats with lymphoma.[52] Surgical debulking of nasal tumors prior to radiotherapy or chemotherapy is not associated with improved survival times.[53]

Nasal planum squamous cell carcinomas

The one year survival rate after resection for nasal planum squamous cell carcinomas in cats is over 80% and disease free intervals postsurgery are reported as more than 500 days[54,55] (Fig. 54-20). There are fewer long-term reports following the more radical surgery[56] in cats but in the author's opinion and experience the results with combined nasal planectomy and premaxillectomy are very similar to those of nasal planectomy.

Fungal rhinitis

The prognosis for cats with aspergillosis rhinitis is guarded, with resolution of clinical signs in approximately half the cases treated. Orbital involvement appears to be a negative prognostic indicator.[14,22] Cryptococcocis is easier to treat. Cases that are localized to the nasal cavity were responsive to azole anti-fungal medication such as itraconazole, though therapy was often protracted (over a year) and relapse occurred in about one-third of cases.[18] In cases where the infection had invaded into the CNS additional treatment with amphotericin B with or without flucytosine was required.[20]

Box 54-6 Chemotherapeutic agents commonly used for treatment of nasal lymphoma

COP: vincristine, cyclophosphamide, prednisolone
Wisconsin–Madison (WM): vincristine, L-asparaginase, cyclophosphamide, prednisolone, doxorubicin, methotrexate
Prednisolone

Figure 54-20 The long-term cosmetic appearance following a nasal planectomy. This cat had no obvious morbidity associated with the procedure

Sinus obliteration

There are few published clinical case series of sinus obliteration. In a series of six cats, three of the cat owners reported excellent results between 18 and 22 months postsurgery. Two cats were improved with only intermittent sneezing and discharge and one cat was lost to follow up.[30]

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