AIRWAY DISEASES

Professor D. White

1. Laryngeal paralysis

2. The brachycephalic airway obstruction syndrome

3. Chylothorax

BVetMed PhD DSAS DVR

Diplomate, ACVS Diplomate, ECVS

European, ACVS & RCVS Specialist in Small Animal Surgery

RCVS Specialist in Veterinary Oncology

Dick White Referrals

The Six Mile Bottom Specialist Veterinary Centre

London Road

SIX MILE BOTTOM

Newmarket, CB8 0UH

Tel: 44 1638 572012

Email: dw@dickwhitereferrals.com

I: Laryngeal Paralysis

Anatomic structure

The larynx is a semi-rigid fibro-elastic cylinder separating the upper and lower respiratory tracts, the structural basis of which are three major and two smaller hyaline cartilages. The larger cartilages include the spoon-shaped epiglottis positioned most rostrally, behind which are found the horseshoe-shaped thyroid cartilage and the circular cricoid cartilage. The thyroid and cricoid cartilages occupy fixed positions relative to each other by virtue of their firm attachment at the cricothyroid articulation although the thyroid is capable of some limited movement in a rostrodorsal plane. This 'chassis' provides the rigid base necessary for movement of the other cartilages. The epiglottis hinges in a rostro-caudal plane about its base which is in contact with the thyroid cartilage. The smaller, paired arytenoid cartilages articulate with the cricoid cartilages on their medial aspect and are capable of a swinging latero-medial movement about the cricoarytenoid articulations. Interposed between the arytenoids and lying rostral to the lamina of the cricoid are the interarytenoid and the sesamoidean cartilages which bind the arytenoids to the dorsal aspect of the cricoid. The larynx is supported rostrally by its attachment to the hyoid apparatus - the thyro-hyoid membrane and caudally by its attachment to the trachea.

Two paired of ligaments are found within the lumen of the laryngeal cylinder - the vocal ligaments which extend from the vocal processes of the arytenoids to the ventral midline and the vestibular ligaments which extend from the cuneiform process to the ventral midline. The larynx is lined with a stratified mucosa, folds of which protrude into the lumen of the cylinder over these ligaments - these are, respectively, the vocal and vestibular folds. The resultant crypts formed between the two folds are the laryngeal ventricles. The ventricles are absent in feline species. The diamond-shaped opening within the laryngeal lumen delineated by the arytenoids dorsally and ventrally by the vocal folds is termed the rima glottidis and is the narrowest point separating the upper and lower airways. The diameter of the rima is determined by the position and length of the vocal folds which in turn are dependant on the position of the arytenoid cartilages and to a lesser extent on that of the thyroid cartilage. Dorsolateral movement of the arytenoids about their cricoid articulation pulls the vocal folds apart thereby widening the rima. Medial movement reduces the diamond-shape of the rima to a slit-like opening or completely closes it. Cranial to the rima is the wider opening of the larynx the aditus laryngis which is delineated by the corniculate processes of the arytenoids, the epiglottis and the aryepiglottic folds.

The larynx has both extrinsic and intrinsic muscles. The extrinsic muscles function in concert with the hyoid apparatus to vary the position and angle of the larynx. The intrinsic muscles of the larynx are responsible for controlling glottic diameter and can be broadly divided into the constrictors and dilators, depending on their primary function. They contain Type I and II fibres providing both rapid and sustained contractile function. The majority of the intrinsic muscles are associated with glottic constriction (adduction) of the rima and include the cricothyroid, lateral crico-arytenoid, transverse arytenoid ventricular and thyro-arytenoid muscles. The latter of these being the most important in terms of constricting function. Only the dorsal cricoarytenoid muscle is concerned purely with dilation (abduction) of the rima. This muscle originates on the dorsal aspect of the cricoid cartilage and inserts on the muscular process of the arytenoid. Its contraction rotates the arytenoid laterally over the articulation with the cricoid.

The larynx is innervated by the vagus via the cranial and caudal laryngeal nerves. The cranial laryngeal nerves are concerned primarily with sensory function and provide innervation to the mucosal lining of the larynx via their internal branches. The sole exception to the sensory function of the external branches is the motor innervation to the cricothyroid muscles. The caudal (recurrent) laryngeal nerves arise from the vagal branches at the thoracic inlet, the right looping behind the subclavian artery and the left behind the aorta before heading rostrally to lateral surface of the larynx. They provide motor innervation to all the intrinsic muscles of the larynx with the exception of the cricothryoid muscle.

The vascular supply of the larynx originates from the external carotid artery via the cranial laryngeal artery. The cranial laryngeal vein drains to the external maxillary vein.

Laryngeal function

The larynx performs a valve-like role at the junction of the upper and lower respiratory tracts and its major functions can be summarised as:

- Protection of the lower respiratory tract from inhalation of debris,
- Control of airway diameter during the respiratory cycle,
- Phonation.

Airway protection

Prevention of aspiration is the result of a twofold reflex mechanism. Firstly, during the swallowing phase the epiglottis hinges about its base and is 'flipped' backwards over the aditus to direct the food upwards and over the larynx into the lateral food channels,

thereby preventing aspiration. The epiglottis provides a tight seal at the level of the aryepiglottic fold and the whole process occurs in conjunction with rostral movement of the larynx and caudal movement of the tongue. Secondly, glottic protection is also provided by the intrinsic muscles of the larynx which adduct the vocal folds and arytenoid cartilages sealing off the rima tightly during swallowing. This may also occur in response to stimulation of the cranial laryngeal nerves by any food or liquid debris passing beyond the aditus.

Control of airway diameter

During the resting phase of the respiratory cycle the arytenoids and vocal folds lie in a passive or 'neutral' midline position such that the rima is a narrow slit. Contraction of the dorsal cricoarytenoid muscles during inspiration causes the arytenoids to rotate quickly in a dorsolateral direction dilating the rima to accommodate the inward flow of air. On expiration, the vocal folds move passively towards the midline slowing the outward air flow. During prolonged or heavy exercise the rima may remain dilated during both the inspiratory and expiratory phases to minimise resistance to continued air flow.

Phonation

Barking or meowing is a glottic function and is the result of vibration of the vocal folds as air flows over them. The tone and pitch of the bark or meow are determined by the speed and amplititude of the vibrations which in turn are governed by air flow rate and the length of the vocal cords. Vocal fold characteristics are governed primarily by tone in the vocalis and cricothyroid muscles.

LARYNGEAL PARALYSIS

Pathophysiology

Laryngeal paralysis is the failure of arytenoid movement during the respiratory cycle. The absence of abducting function affecting one or both arytenoids during the inspiratory phase with consequent narrowing of the rima results in an increased resistance to air flow through the larynx. Air flow becomes turbulent both due to the increased resistance which necessitates a higher flow rate through the rima and to the movement of air over the fixed vocal fold(s). The concomitant reduction in intralaryngeal pressure may narrow the rima still further contributing to additional air flow resistance. This airway obstructive condition is encountered with some frequency in dogs and is occasionally seen in cats.

Aetiology

Paralysis of the vocal folds through failure of arytenoid function most often results from disease or damage to the innervation of the intrinsic muscles of the larynx. Much less frequently it may occur through disease involving the dorsal cricoarytenoid muscles themselves.

Idiopathic laryngeal paralysis (ILP): by far the majority of dogs with laryngeal paralysis fall into this category. ILP has a marked predisposition for medium to large breeds which in the UK includes such breeds as Labrador retrievers, Afghan hounds, Irish setters, Pointers and some giant dogs. The male is affected two or three times more frequently than the female and the average age of the affected dog is usually greater than 10 years. The underlying cause of ILP still remains unclear. The suggestion that the condition may arise more frequently in hypothyroid dogs remains largely unsubstantiated. The condition has also been reported as part of a laryngeal paralysis-polyneuropathy (LPP) complex in which affected dogs manifest signs of a generalised neuropathy including motor deficits involving the rear limbs. Demyelination and remyelination and also axonal degeneration involving the intrinsic laryngeal and appendicular peripheral nerves have been recorded in these dogs.

Congenital: laryngeal paralysis has been reported as an inherited congenital disease in the Bouvier des Flandres and the Siberian Husky. The disease is transmitted as autosomally dominant trait in the Bouvier affecting the male more frequently and may be unilateral or bilateral. Degenerative changes are found both peripherally in the laryngeal nerves and centrally in the nucleus ambiguus. Selective breeding has now significantly reduced the incidence of this condition in Europe. More recently, a LPP complex has been recorded in the Dalmatian affecting dogs under the age of 6 months and presenting as a diffuse, generalised polyneuropathy distinct from that found in the Bouvier and Husky. Electromyographic abnormalities are present in laryngeal, facial, oesophageal and distal appendicular muscles and axonal degeneration is found affecting the laryngeal and appendicular nerves. A significant number of these dogs also have megaoesophagus. Most dogs with inherited laryngeal paralysis are presented as young pups and are rarely suitable for treatment.

Traumatic: injuries to the neck or cranial thorax may bruise, or even sever the laryngeal innervation. Pharyngo-oesophageal trauma and 'Big dog / little dog'

confrontations resulting in crush injuries to the cervical region are probably the most important causes in this respect.

Neoplastic: tumour infiltration of the caudal laryngeal nerve may disrupt normal conduction function. Amongst the more common tumours causing this presentation are malignancies of the thyroid gland and cranial mediastinal masses such as lymphomas and thymomas. Lymphomatous infiltration of the laryngeal nerve has also been recorded in the cat.

Iatrogenic: any surgical intervention in the cervical region or rostral thorax which involves dissection of the caudal laryngeal nerves may result in their temporary dysfunction through neuropraxia or more seriously, in permanent paralysis. Although many surgeries may potentially result in this complication the most notable procedure in this category is reconstruction of the trachea which necessitates separation of the nerves from their tracheal course and may give rise to this complication.

Cats: the aetiology of laryngeal paralysis in the cat is unknown although it has been recorded as part of a generalised neuropathy.

Clinical presentation

ILP typically has a prolonged and insidious onset and the clinical signs associated with it may predate presentation by months or even years. Inspiratory stridor is the major and consistent finding in all patients and results from the accelerated, turbulent air flow over the fixed vocal fold(s).

Exercise intolerance occurs frequently although this sign is less obvious in some dogs which appear to tailor their exercise function to the reduction in their respiratory capacity. Severe cases will exhibit degrees of **cyanosis** and **syncope**, possibly progressing to asphyxiation. These signs are frequently exacerbated by a warm environment and although dogs may present at any time of the year many are presented during the summer months. Excitement, car travel, anxiety and stress also tend to promote the signs.

Dysphonia, or change in the character of the bark, is a very useful diagnostic pointer but is only found in approximately half of dogs with ILP. Dysphagia or cough whilst eating or drinking is occasionally encountered although aspiration leading to lower respiratory infection and coughing is probably less common than has previously been suggested. The symptoms of some patients may be exacerbated or precipitated by the presence of other coexisting respiratory disease, for instance, primary lung tumours.

Many of the above features are also common to cases of laryngeal paralysis caused by non-idiopathic conditions. The consistent presenting sign in cats with laryngeal paralysis is a whistling inspiratory stridor.

Diagnosis

In many cases the presenting signalment may help the clinician to reach a presumptive diagnosis. A ten year old, male Labrador retriever with a prolonged history of exercise intolerance and stridorous breathing should raise a significant index of suspicion.

Auscultation over the larynx even in the resting dog should allow detection of the earliest inspiratory stridor. This high-pitched, whistling respiratory noise should become more audible during exercise but care should be taken not to over-stress the patient and precipitate an obstructive crisis merely for the purposes of diagnosis.

A complete physical examination should be performed in all cases and in cases of non-idiopathic paralysis a search should be made for possible causes (e.g.: thoracic mass). Thoracic radiographs should be taken at this stage to assess if any aspiration pneumonia is present which until satisfactorily resolved may temporarily preclude progression to the next diagnostic step.

Laryngeal paralysis is a failure of dynamic function and hence a definitive diagnosis can only be made by observing this function or lack of it. In most instances this is done by means of laryngoscopy. In some dogs it may be possible to inspect laryngeal function under sedation but in most a light plane of anaesthesia is more satisfactory. A deep plane of anaesthesia will paralyse the intrinsic laryngeal muscles and remove all laryngeal movement preventing a meaningful assessment of function. Laryngoscopy is best performed therefore either during induction of light anaesthesia or in the recovering patient as the laryngeal reflexes return. Arytenoid abduction is reduced or absent during the inspiratory phase in dogs with laryngeal paralysis. Most cases of ILP are affected bilaterally although it is common for one side to be more severely affected than the other and asymmetric abduction may occur. Care should exercised when evaluating arytenoid movement since paralysed vocal folds often show paradoxical movement (i.e.: move apart *passively* due to the expiratory air flow). It is essential, therefore, that each phase of the respiratory cycle is identified preferably by an assistant, whilst the larynx is observed. In some dogs the mucosa overlying the corniculate process of the paralysed arytenoid cartilage(s) is often hyperaemic due to the turbulent air flow over the mucosal surface.

The use of ultrasonographic examination of the canine larynx has recently been described. Movement of the arytenoid and vocal folds during the respiratory cycle could be identified and this gives rise to the possibility of recognising laryngeal dysfunction using this technique. The non-invasive nature of ultrasonographic examination of the larynx coupled with the ability to perform it in unanaesthetised patients are attractive advantages of this approach.

Respiratory function measurement techniques have been described in the investigation of laryngeal paralysis. The patient's hypoxic (i.e.: low P_aO_2) status can be quantified by blood gas analysis. The abnormal air flow versus volume pattern can be identified by tidal breathing flow volume loop (TBFVL) studies. It is doubtful if these measurements add materially to the assessment of an individual clinical case which can be gained by careful auscultation and laryngoscopy but they do permit a more objective analysis of the problem for research purposes.

Electromyography, **nerve conduction velocity** and **histological** studies have been used to demonstrate abnormalities in the laryngeal nerves and intrinsic muscles.

SURGERY

Undoubtedly the most common indication for surgical intervention involving the larynx of small animals is the relief of laryngeal paralysis. Techniques for the management of laryngeal paralysis are intended to enlarge the rima permanently and ameliorate the restricted air flow. It should be emphasised that a variety of surgical procedures have been described for the treatment of this condition since it was first recognised and there is ongoing controversy as to what are the most appropriate procedures. It is convenient to categorise these procedures according to whether or not the surgery disrupts the structures within the lumen of the larynx.

Preoperative workup should include:

- Routine haematological and biochemical investigations since almost all patients will be geriatric.

- Thoracic radiographs to rule out co-existing pulmonary disease: primary neoplastic masses, aspiration pneumonia).

- Investigation of any dysphagic signs.

Extralaryngeal Procedures

Procedures which dilate the rima without disrupting the laryngeal mucosa have significant advantages and in the author's view are to be preferred. In particular, the following advantages are recognised:

- Gaseous anaesthesia can be maintained by routine endotracheal intubation throughout the surgery.

- The risk of aspiration during surgery and the postoperative period is minimal.

- The requirement for postoperative care, notably temporary tracheostomy management, is substantially reduced.

- The incidence of intralaryngeal scarring is extremely low.

Arytenoid Lateralisation

Dilation of the rima by fixing the arytenoid(s) in abduction and attempting to mimic the function of the dorsal cricoarytenoid muscle has been described by various authors and is now a well established technique. The procedure may be performed with a variety of modifications and the following is a description of the basic technique:

- The unilateral procedure is performed with the patient in right lateral recumbency for a right-handed surgeon and vice-versa for the left. The neck is partially extended and supported on a pack. An incision is made at a point below the junction of the maxillary and linguofacial veins and the fibres of the panniculus muscle split.

- The dorsal wing of the thyroid cartilage is palpated through the overlying soft tissue which is dissected bluntly to expose the thyropharyngeus muscle. This muscle is transected horizontally or its fibres split longitudinally to expose the dorsal wing of the thyroid cartilage.

- The thyroid cartilage can then be retracted laterally allowing the fascial tissue lying between the thyroid and the cricoid to be broken down. At this point the firm cricothyroid articulation may be disrupted if required.

Self-retaining retractors are used to retract the dorsal aspect of the thyroid laterally and the sharp prominence of the muscular process of the arytenoid cartilage overlying the rostrodorsal aspect of the cricoid cartilage is located by digital palpation. The fibres of the dorsal cricoarytenoid muscle fan out from this

- to the dorsal midline of the cricoid and are carefully transected to allow access to the cricoarytenoid articulation below. In cases of idiopathic paralysis this muscle will be atrophied but in cases of acute onset paralysis (e.g.: trauma) the muscle remains substantial. It is very useful to leave part of the muscle attached to the muscular process to permit manipulation of the arytenoid during the procedure without tractioning the cartilage itself since it may prove to be friable in some cases. The arytenoid cartilage is now carefully separated with fine scissors from its underlying cricoarytenoid articulation without disrupting the laryngeal mucosa medially.

Technique I: Arytenoid Lateralisation

- The sesamoidean interarytenoid articulation is then cut which permits free movement of the cartilage.

- The arytenoid is now anchored in lateral abduction by means of a suture prosthesis attached to the thyroid cartilage. A swaged-on needle is used to introduce the suture through the thyroid cartilage immediately rostral to the caudal cornu. The needle is passed through the lateral aspect of the arytenoid emerging in the centre of its articular face and is then passed back through this surface from a more medial point. The mattress pattern is completed by passing the suture through the medial face of the thyroid cartilage in the region of, but not immediately adjacent to the original bite. The suture is now tied firmly but without over-tensioning since this may cause it to 'cheese wire' through the cartilages. The degree of arytenoid abduction can be inspected at this stage by temporarily removing the endotracheal tube.

Technique II: Arytenoid Rotation

- The sesamoidean interarytenoid articulation is left intact permits rotational movement of the cartilage in the direction of cricothyroid m. contraction.

- The arytenoid is now anchored in rotation by means of a suture prosthesis attached to the caudal aspect of the dorsal cricoid cartilage in a mattress pattern.
    For both techniques a non-absorbable suture materials are essential since this will be required to retain the abducted arytenoid permanently. Materials such as polypropylene or monofilament nylon are most suitable since stainless steel even when coated may tear through a more delicate cartilage.

- The thyropharyngeus muscle is closed routinely with absorbable sutures over the thyroid cartilage and the potential dead space overlying the larynx is obliterated by meticulous closure of the various layers of overlying soft tissues.
- If not previously inspected the larynx should be evaluated at this stage before the patient recovers consciousness to confirm that there is satisfactory dilation of the rima. Any blood which may have accumulated in the laryngeal lumen should the mucosa have been perforated during the procedure should also be removed by suction.

Modifications of the above technique include the following:

- Bilateral arytenoid lateralisation can be performed by repeating the above technique contralaterally with the patient in left-sided recumbency has been reported. This has been recommended for younger, working dogs in which there may be a need for more glottic dilation to accommodate their greater exercise requirements. Bilateral surgery is reported to be associated with a higher incidence of postoperative dysphagia and aspiration.
- A ventral approach has been described with the patient positioned in dorsal recumbency to permit bilateral surgery. Access to each arytenoid is achieved by rotating the larynx laterally about its longitudinal axis and is restricted as compared with that achieved by the lateral approach.
- Disarticulation of the cricothyroid junction is an optional step to allow further retraction of the thyroid cartilage and exposure of the cricoid and arytenoid cartilages. Some bleeding may occur from small vessels in the region of the articulation and it is important that this should be dealt with by careful diathermic cautery. Although omitting this step restricts access to the arytenoid cartilage it shortens the operative time somewhat and may result in a more stable base to which the lateralising prosthesis can be anchored. Bilateral disarticulation of the cricothyroid joint is reported to result in dorsoventral collapse of the rima.

Postoperative care should include:

A brief period of hospitalisation to permit observation of the patient for any signs of respiratory distress. In most cases this should be no more than 24 hours and patients should be discharged with instructions for limited exercise and permanent avoidance of collar use.

- Perioperative antibiotic therapy since there is potential for minor disruption of the laryngeal mucosa and perforation of the airway mucosa. Antibiotic therapy may be extended postoperatively if any risk of aspiration is perceived.

Complications of arytenoid lateralisation include:

- Fragmentation of the arytenoid or thyroid may occur during the procedure if either cartilage is handled too vigorously or the prosthetic suture is repeatedly placed through the cartilage. In the event of this complication the procedure should be repeated contralaterally.

- Oedema may develop within the first 24-48 hours post-operatively in the perilaryngeal tissues causing obstruction of the rima and severe respiratory distress. Corticosteroids may be employed following a prolonged dissection to pre-empt this complication which may otherwise necessitate temporary tracheostomy intubation. The development of a seroma or haematoma is a similar possibility which may also necessitate airway by-pass in severe cases.

- Prosthetic avulsion is occasionally encountered in the immediate postoperative period and is normally due to the inclusion of an inadequate cartilage 'anchor' within the suture. Much less commonly, it may be seen as a chronic development several weeks or even months after surgery. A repeat, contralateral procedure is a feasible solution in cases in which a unilateral procedure has been performed.

- Aspiration is in theory at least, a complication of all procedures which leave the rima permanently dilated. Although this may appear as a potential problem after arytenoid lateralisation workers have reported no increase in the incidence of this problem after the unilateral procedure. There appears, however, to be more risk of dysphagia and aspiration following the bilateral surgery. Providing that the other glottic protection mechanisms (i.e.: epiglottic movement, lateral food channels) remain functional after surgery the risk of aspiration after unilateral procedures should be acceptably low.

Prognosis

The long term results of unilateral lateralisation for older dogs with ILP are very favourable indeed with rapid return to previous exercise function. In one long term study of the results of unilateral lateralization more than 90% of dogs were alive one year postoperatively and had little discernible stridor or exercise intolerance due to

respiratory dysfunction. The technique can be applied to all sizes of dog and is also feasible in the cat.

Intralaryngeal Procedures

Procedures which necessitate surgery within the lumen of the larynx are characterised by a number of significant intra- and postoperative considerations. These include:

- Endotracheal intubation is precluded during the procedure and hence maintenance of general anaesthesia dictates either placement of a temporary tracheostomy tube or the continuous infusion of an intravenous agent.

- Blood or tissue debris from the surgical site may aspirate into the lower respiratory tract. The risk of aspiration during the procedure is further increased in the absence of endotracheal intubation.

- The tracheostomy tube should be maintained in situ beyond the postoperative period to by-pass any upper airway obstruction resulting from intralaryngeal oedema.

- The surgical disruption or removal of the laryngeal mucosa is intermittently associated intermittently with the incidence of intralaryngeal scarring or so-called 'webbing' which may severely stenose the airway at the level of the rima.

Prognosis

The long term results of unilateral lateralisation for older dogs with ILP are very favourable indeed with rapid return to previous exercise function. The technique can be applied to all sizes of dog and is also feasible in the cat.

Intralaryngeal procedures

Procedures which necessitate surgery within the lumen of the larynx are characterised by a number of significant intra- and postoperative considerations. These include:

- Endotracheal intubation is precluded during the procedure and hence maintenance of general anaesthesia dictates either placement of a temporary tracheostomy tube or the continuous infusion of an intravenous agent.

Blood or tissue debris from the surgical site may aspirated into the lower respiratory tract. The risk of aspiration during the procedure is further increased in the absence of endotracheal intubation.

- The tracheostomy tube should be maintained in situ beyond the postoperative period to by-pass any upper airway obstruction resulting from intralaryngeal oedema.

- The surgical disruption or removal of the laryngeal mucosa is intermittently associated intermittently with the incidence of intralaryngeal scarring or so-called 'webbing' which may severely stenose the airway at the level of the rima.

All of the above considerations should be examined carefully before selecting any intralaryngeal procedure.

Partial Laryngectomy

Resection of the vocal folds or ventriculocordectomy is perhaps the oldest approach to creating a permanently-enlarged rima. Several options exist including resection of one or both folds, and combination of this with partial arytenoidectomy (ie: removal of part of one or both arytenoid cartilages). Following the induction of anaesthesia a midcervical, transverse tracheotomy is performed to permit gaseous anaesthesia via an endotracheal tube or cuffed tracheostomy tube. Conventional laryngeal intubation with intermittent withdrawal of the endotracheal tube from the anaesthetised patient to allow access to the surgical site is an alternate, but less desirable option for maintenance of anaesthesia. The dog is positioned in sternal recumbency with the mouth held open by means of a gag. The rima is visualised by simultaneous rostral retraction of the soft palate and ventral depression of the tongue and epiglottis.

Ventriculocordectomy

This is performed by grasping the vocal fold with long dissecting forceps and tensing it rostrally. Beginning at its attachment to the vocal process of the arytenoid the vocal fold and adjacent vocalis muscle are then resected using either fine Metzenbaum scissors or crocodile-action cup biting forceps the latter allowing for piecemeal removal of the fold. The procedure is repeated bilaterally. A small section of mucosa is left at the ventral commissure of the rima between the resected folds and is said to reduce the risk of postoperative intralaryngeal scarring.

Partial Arytenoidectomy

Arytenoid resection is performed in conjunction with ventriculocordectomy as described above. Cup forceps are then used to resect additional arytenoid cartilage. Opinion is divided as to how much of the cartilage should be removed in order to

achieve the desired improvement in airway function. Previously, it has been customary to remove corniculate, cuneiform and vocal processes but more recent reports indicate that the incidence of postoperative complications, notably aspiration pneumonia, may be reduced by removal of only the corniculate process. The procedure is performed unilaterally and the decision as to which side should be operated is based on preoperative laryngoscopic examination in the case of unilateral paralysis.

Haemorrhage after partial laryngectomy procedures are controlled by direct pressure using a small dental sponge on the excision sites. Any blood clots or mucus which accumulates in the airway should be meticulously suctioned following the completion of surgery. The tracheostomy tube is maintained postoperatively and periodically occluded over the next 48 hours to ascertain at what point it may be safely removed. Antibiotic therapy should be maintained for several days after surgery to reduce the risk of pneumonia resulting from the aspiration of any debris.

Complications of partial laryngectomy include:

- Aspiration pneumonia has been reported as a frequent and potentially fatal postoperative complication after vocal fold resection and partial arytenoidectomy. Recent reports suggest that bilateral vocal fold resection alone or alternatively, the use of an inflatable tracheostomy tube during surgery may result in a significant reduction in the incidence of this problem.

- Glottic stenosis may be encountered as a longer term problem due to scarring ventrally of the site of the excised vocal folds. The so-called 'webbing' granulation tissue may prove difficult to manage and may recur after resection. Other techniques include lining the site with mucosal flaps or the use of a ventral silicone stent to dilate the rima. Tapering doses of prednisolone following surgical resection has been reported as providing good results.

- Oedema may develop within the larynx at the resection sites necessitating temporary tracheostomy. The perioperative use of dexamethasone sodium phosphate (0.25 - 1.0 mg/kg IV) or methylprednisolone sodium succinate (0.5 - 2.0 mg/Kg IV) may reduce the incidence of this problem which otherwise prolongs the postoperative tracheostomy period.

Castellated Laryngofissure

Ventral bisection and separation of the thyroid cartilage has been described as an alternative concept for glottic dilation. The technique as originally described for the

dog was a modification of a procedure for the management of cricoid collapse in humans and involved the creation of a series of step-like incisions through the base of the thyroid cartilage following tracheotomy intubation. The castellated thyroid projections allow the two halves of the cartilage to be abducted ventrally thereby dilating the rima. The basihyoid bone is then used to anchor the unstable thyroid fragments. This technique is combined with bilateral ventriculocordectomy and consequently has many of the problems associated with intralaryngeal manipulation. There is an only one long term study of the results of castellated laryngofissure.

Modified castellated laryngofissure

The subsequent modification of the castellated laryngofissure procedure to include bilateral arytenoid lateralization, underlined the unsatisfactory results achieved by the original procedure. There must be doubts too as to the rationale for the modified procedure since it is clear that arytenoid lateralisation alone is extremely successful in alleviating the signs of laryngeal paralysis and there are few reports of the clinical use of modified castellated laryngofissure.

In cases where the laryngeal changes are limited to chronic eversion of the saccules which does not respond to conservative management resection of the everted tissue may be performed. The patient is prepared for surgery as for partial laryngectomy and positioned in sternal recumbency. The everted saccules are identified as small, red pea-like protrusions immediately behind the vocal folds and grasped with dissecting forceps. The saccules are resected through their base with fine scissors and haemorrhage is controlled by direct pressure over the site. As is the case for laryngectomy procedures the risk of postoperative aspiration may be reduced by temporary tracheostomy intubation.