Avian Respiratory Tract Surgery

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There are many diseases which lead the avian practitioner to consider thoracic surgery for diagnostic or therapeutic management. The unique respiratory system of birds works to the surgeon's advantage by providing a mechanism through which the patient can be ventilated and maintained under anesthesia while the upper respiratory tract is completely occluded.

Choanal Atresia

Choanal atresia has been only reported in African grey parrots and in one umbrella cockatoo. It is characterized by a failure of the choana to form during development. Patients present at an early age with a bilateral mucoid nasal discharge. In a normal bird, saline flushed in the nares should enter the mouth through the choana. In affected birds no saline enters the mouth when this is attempted. Instead, fluid enters the infraorbital sinus causing swelling around the eye. Rhinography may be performed to confirm the diagnosis. There is usually a choanal slit but it does not communicate with the sinuses.

Don Harris reported a technique for creating a choanal opening through which mucus, produced in the sinuses, can pass into the oral cavity eliminating the nasal discharge. A 1/8th or 7/64th inch Steinmann pin is passed into each nostril drilling through any bone to enter the choanal slit in the roof of the mouth. The pin is removed and a length of 8 Fr red rubber catheter is passed through the two openings created such that one end goes into each naris. Minor hemorrhage may occur. Openings are cut into the side of the tube at the nares to allow mucus to drain. The ends of the tube are tied behind the head and a chin strap is made of tape to prevent the tube from slipping off the top of the head. The tubes are left in place for 4-6 weeks to allow the tracts to epithelialize creating permanent openings. Once the tubes are removed, the nares are flushed twice daily for 2 weeks to help keep the openings free of debris.

Sinusitis

Effective treatment of infraorbital sinusitis depends on a definitive diagnosis of the etiology. Left untreated, sinusitis may progress to abscessation requiring surgical exploration and curettage. Purulent debris may be located within the nasal cavity, the recesses of the beak, or between the sinus and the nasal cavity caudal to the turbinates.

Trephination may be used to gain access to the dorsal and caudal aspects of the sinus which are not accessible to sinus flushing. The site for trephination varies with species and the anatomy should be studied prior to attempting surgery to avoid injury to the eyes. Following skin incision, holes are drilled into the frontal bone about ½ to 2/5 the distance from the rostral most plane of the eye to the naris. Cortical bone is removed until the cancellous bone above the supraorbital sinus is visualized. Drilling continues into the sinus, widening the hole to an appropriate diameter. Following the collection of samples for diagnostic study, the sinus is irrigated. Fluid should enter the oral cavity following sinus flushing to confirm proper hole placement. Postoperatively, the trephination sites

may be irrigated with an appropriate antimicrobial solution. Once therapy is no longer needed the sites heal with minimal scarring.

Sinusotomy is performed to curette caseous material, remove a mass, or debride a granuloma. If the nidus of infection is not found and surgically debrided, recurrence is common. In one study birds had sinusitis for up to 8 yrs and was not responsive to various systemic antimicrobial medications. MRI or CT is very useful in localizing the lesion as the infraorbital sinuses of birds are very extensive. Knowledge of the anatomy of the sinus is vital. The infraorbital sinus (paired sinuses)is the only paranasal sinus of birds. It has numerous diverticula (rostral, preorbital, infraorbital, postorbital, preauditory, and mandibular diverticula and maxillary and suborbital chambers) and communicates caudally with the cervicocephalic air sac. It opens dorsally into the middle and caudal nasal conchae.

To approach the rostral diverticulum (in the beak) a window is created with a bur through the lateral wall of the rhinotheca. A small curette is used to debride the lesion. The defect is closed using a plastic or wire mesh glued to the rhinotheca and covered with a dental acrylic.

With time, the defect will fill with granulation tissue, will epithelialize and keratinize, and the patch will be shed.

To approach the preorbital diverticula, an incision is made on the dorsal midline through the skin over the beak rostral to the beak-skull articulation but caudal to the keratinized beak and the cere. A bur is used to create an opening in the nasal bone which is enlarged with small rongeurs. After the lesion is debrided, flushing drains are placed into the sinus to allow the area to be treated topically postoperatively. The tubes should not exit through the primary incision. The bone is not replaced and the skin is closed routinely.

For lesions in the infraorbital diverticulum, a dorsal midline approach through the frontal bone is used. The skin is incised and the bone is removed using a bur allowing access to the diverticulum. A flushing drain is placed through the frontal bone and into the choana. Skin closure is as described above.

To access the suborbital, postorbital, preauditory or mandibular diverticula an incision is made in the skin ventral to the jugal bone on the affected side. It is best to place a speculum to keep the beak open during the procedure. This will enlarge the area accessible. The muscularis adductor mandibulae externus may need to be transected to access the lesion. It is repaired during closure. Penrose drains may be placed if needed. A subcuticular and skin closure is used as there is no soft tissue support in this location.

Samples collected are submitted for microbiologic, cytologic, and histologic evaluation. Appropriate topical and systemic therapies are instituted. Flushing drains are usually left in place days to weeks.

Tracheotomy

Dyspnea may result from tracheal occlusion secondary to aspiration of foreign objects, formation of cellular and mucous concretions, or the presence of fungal granulomas. Some birds present with an acute onset of respiratory distress, while others may have a history of a change in vocalization and behavior, and progressive dyspnea. An air sac cannula will provide the patient with an airway until the obstruction can be relieved. Contrast radiography may be necessary in some birds to obtain a

definitive diagnosis. A small amount of barium (0.5 cc/kg) is placed in the trachea using a catheter. Barium is inert. Rigid and flexible endoscopes, suction, and balloon tipped catheters have been used to clear tracheal obstructions. In cases where less invasive methods fail, a tracheotomy is perfromed for removal of the obstruction.

The patient is positioned in dorsal recumbency with the shoulders elevated 45° to provide the surgeon with visual exposure to the thoracic inlet. The skin over the specific area of the trachea is incised along ventral midline. The esophagus is to the right of midline and the crop bulges to the left. Over the caudal portion of the trachea the crop must be dissected free from it subcutaneous attachments and retracted to the right to allow visualization of the trachea. The trachea is easily identified by its complete cartilaginous rings. The tracheotomy is made through the ventral half of the annular ligament between rings rather than through them to lessen the chances of stricture formation. Once the foreign object or granuloma is removed, the tracheotomy is closed with a fine, nonreactive, monofilament, absorbable suture (such as 4-0 to 8-0 polydioxanone suture) placing as few sutures as possible with knots external to the tracheal lumen. Sutures are preplaced and should encompass two rings on each side of the tracheotomy. This is done to help minimize the potential for stricture formation.

If the object is located at the syrinx, a thoracic inlet approach is used. The skin is incised along the ventral midline of the thoracic inlet to the level of the clavicle. The crop is identified and dissected free from its attachments reflecting it to the right. Some patients have fat in the interclavicular region which can obscure visualization. This may be removed without consequence. The interclavicular air sac is broken down with a combination of sharp and blunt dissection. Further dissection will reveal the trachea which is easily identified by its complete rings. Sternotracheal muscles traverse obliquely along the trachea and attach caudolaterally. These muscles are transected bilaterally to allow the trachea to be retracted farther orad. There is a blood vessel in each of these muscles which must be coagulated. Two stay sutures may be placed around tracheal rings orad to the obstruction to allow atraumatic manipulations of the trachea following incision. A transverse tracheotomy is created 3-5 rings orad from the syrinx on the ventral surface about 50% of the tracheal circumference to allow retrieval of the foreign material. An endoscope is a valuable aid in removing the obstruction. It is passed per os and used to push any obstruction in the orad portion of the trachea into the tracheotomy incision. It may be passed through the tracheotomy to determine if any aborad obstruction remains. Alternatively, a probang may be used to insure that the orad portion of the trachea is clear. Fine jeweler's forceps and alligator forceps are useful for grasping the obstruction.

The trachea is closed using a fine, synthetic, monofilament, absorbable material in a simple interrupted pattern. The sutures should be pre-placed and positioned at 30° circumferentially so that a 50% tracheotomy is closed with 2-3 sutures. They should encompass at least two rings on each side of the tracheotomy and the knots are tied external to the tracheal lumen. Once the tracheotomy is closed, an endoscope is used to assure patency of the trachea and that the entire obstruction has been removed. No effort is made to reattach the sternotrachealis muscles and the remaining soft tissues are closed in a routine manner.

Clavicular Osteotomy Thoracic Inlet Approach

Retraction of the syrinx may cause avulsion of the bronchi from the lungs in Amazons, small macaws, and other small birds. In these cases exposure can be increased by performing an osteotomy of the clavicle. The skin incision must be extended along the keel about 1/4 its length.

Portions of the insertion of the pectoral muscles are incised. The clavicle is cut with a bone cutter on one side of its symphysis. A Heiss retractor is positioned between the cut ends of the clavicle.

Tracheal Resection and Anastomosis

Resection and anastomosis of the trachea is indicated for birds with partial obstruction due to localized tracheal collapse, traumatic avulsion, stricture formation, neoplasia, or granuloma. The tracheal is generally quite long in birds and removal of a section of tracheal is easy to accomplish without placing undue tension on the anastomosis. Anesthesia is administered through an air sac cannula. The approach to the trachea is as described above. The adventitia surrounding the trachea is carefully dissected from the surface of the trachea to preserve the nerve blood supply to the remaining trachea. A no.11 scalpel blade is used to transect the trachea both cranial and caudal to the pathologic section to be removed. The cut ends are then held in approximation while 5-6 sutures are preplaced circumferentially in a manner analogous to that described above for closure of a tracheotomy. The dorsal sutures are tied first while access is easier. Stricture can occur at the anastomosis site. This generally occurs during the contraction phase of wound healing 3-6 weeks postoperative.

Lateral Thoracotomy

Lateral thoracotomy is indicated for management of diseases of the syrinx, bronchi, lung, pericardium, or thoracic air sacs. The approach will vary with the location of the disease process being investigated. In most cases an intercostal approach with excision of a portion of the 2nd and 3rd ribs will provide exposure to the ipsilateral syrinx, bronchi, lung, and the heart.

The patient is positioned in lateral recumbency with the wings positioned dorsally over the back and the legs retracted caudally. The caudodorsal border of the superficial pectoral muscle is palpated and the skin incision is made along this muscle border. A curved hemostat is inserted under the pectoral muscles until it can be felt dropping into the thoracic inlet. It is then pulled caudally over the ribs so that each rib can be felt. This will assure that the second and third ribs are accurately identified. The intercostal vessels course along the cranial border of each rib. The second and third ribs are identified and the intercostal muscles are coagulated using bipolar electrosurgical forceps. They are then transected with scissors ventral to the uncinate process and as close to the junction of the sternal and vertebral ribs as possible. The large pectoral muscles make it difficult to achieve ventral exposure and will need to be ventrally retracted. If the ribs are cut too far dorsally, the lungs will be damaged. The section of ribs is removed allowing access to the thoracic cavity. A rigid endoscope may be inserted into the thoracotomy to allow visualization of the intrathoracic structures. A moist cotton tipped applicator is used to gently dissect air sacs and other structures to allow visualization of blood vessels, heart, syrinx, bronchi and lung. Dissection between the jugular vein, pulmonary artery and branches of the subclavian artery will allow visualization of the syrinx.
To remove an obstruction, the syrinx is incised with microsurgical scissors at its junction with the ipsilateral primary bronchus for exploration of the syrinx and bronchus. Following removal of the obstruction, the syrinx is not sutured and the ribs are not replace. The pectoral muscle is sutured to the epaxial muscles to cover the thoracic wall defect. Subcutaneous and skin closure are routine.

Lung Biopsy and Partial Pneumonectomy

The approach described above may also be used to obtain biopsies of thoracic structures. This is most easily accomplished with the aid of a small biopsy instrument such as would be used through a rigid endoscope. Surgical biopsies may also be obtained using more traditional techniques. The pericardium and air sacs are relatively avascular and may be sampled using scissors and forceps. If hemorrhage occurs, bipolar electrosurgical forceps must be available.

The lung may be biopsied to help diagnose diffuse pulmonary disease. Indications for partial pneumonectomy include treatment of abscesses or granulomas. There is no pleural space and the lungs are contoured to the dorsal aspect of the ribs. Compared with mammalian lungs, those of birds are more vascular and the intrinsic clotting mechanism seems to be less efficient. The affected portion of lung is elevated from the ribs and other structures. Hemostatic clips are placed on the lung tissue to isolate the portion to be removed. The portion of lung distal to the clips is transected and removed. A piece of oxidized regenerated cellulose (Surgicel; Johnson & Johnson Medical, Inc. Arlington, TX), an absorbable hemostatic agent, is placed over the site to control any residual hemorrhage and help seal the lung.

Partial Pericardiectomy

Idiopathic pericardial effusion may be treated by partial pericardiectomy. Diagnosis is made with cardiac ultrasound. Fluid should be collected for analysis and diagnostic testing prior to surgery. Therapy should be directed at treating any underlying cause for the effusion. This procedure is indicated only for the management of idiopathic pericardial effusion to relieve the potential for cardiac tamponade. The fluid is drained from the pericardial sac prior to making an incision into the pericardium to prevent the fluid from flowing into the lung. A large window is surgically created in the pericardium at the apex of the heart to allow the fluid to escape. The opening is made as large as possible. The base of the heart should be avoided as the phrenic nerve and the great vessels are located in this region.

Bifid Sternum

I have seen bifid sternum in 4 African grey parrots, a pigeon, a Quaker parakeet (*Myiopsitta monchus*), and an umbrella cockatoo. It is characterized by a failure of the two halves of the sternum to closure during embryonic development. The birds heart is visualized beating just under the skin. In adult birds, apposition of the two halves is not possible because the sternal bone is too hard. In young birds this may be possible.

The skin is incised along the ventral midline being careful not to damage the pericardium and heart immediately below the surface of the skin. The liver is visualized at the caudal aspect of the incision. The pectoral muscles are elevated from the sternum using a periosteal elevator. Dissection is continued laterally until the entire muscle is freed from the sternum and ribs. The exiting portions of the keel are cut off using scissors. The pectoral muscles are advanced to midline and suture in a simple interrupted pattern. Because of the unique avian respiratory anatomy, this is accomplished without respiratory compromise in the patient. The skin is close routinely. This provides a thick pectoral muscle pad to protect the heart. It is not likely that this defect will cause cardiopulmonary dysfunction as it does in humans.

In baby birds, the two halves of the sternum can be pulled together with sutures as the sternum is still cartilaginous and formable.

Approach to the Cranial Coelom/Thorax

Thoracotomy is indicated for removal of masses from the cranial coelom and is very challenging. With the bird placed in dorsal recumbency, a ventral midline incision is made midcervical, past the thoracic inlet, to the caudal most aspect of the sternum. The crop is bluntly dissected free and reflected to the right. The clavicular air sac and fat are removed from the thoracic inlet. An incision is made through the fascia overlying the keel and the pectoral muscles are then bluntly dissected from both sides of the keel and from the clavicles. A subtotal clavicular ostectomy is performed near their attachments to the coracoid bones. A stay retractor is used to retract the muscle and surrounding tissues. Small vessels from the sternum into the pectoral muscles will be transected. This bleeding can become significant with time so bone wax (Ethicon, Inc., Somerville, NJ 08876) is applied to the sternum to achieve haemostasis. The articulations between the coracoids and the sternum are located, and using a no. 11 blade the joint capsules are incised, allowing separation of the coracoids from the sternum with a Freer elevator. Two cuts are made in the sternum to create a V shaped piece and the keel is cut to meet at the point of the V. If possible reflect the wedge caudally without totally detaching it from the rest of the sternum. The cranial coelom is thus exposed and a mass may be removed taking care with the great vessels exiting the heart to prevent haemorrhage and blood pressure disturbances. Following removal of the mass the wedge is replaced and reattached to the sternum using nylon sutures. The coracoid bones are reattached to the sternum with nylon suture, passing the needle through the sternum and then through the coracoid cranial to the articular surface. The left and right pectoral muscles are reattached to each other suturing them together across the keel. The clavicles are not replaced. The skin is closed using a Ford interlocking pattern.

This approach has been used in two cases of cranial coelom masses (a cockatiel [*Nymphicus hollandicus*] with a carcinoma of air sac origin and an umbrella cockatoo *[Cacatua alba*] with an undifferentiated mesenchymal tumour). In both cases this approach provided excellent access to the cranial coelom. Unfortunately, both birds had masses that involved the great vessels of the heart and died during surgery due to excessive haemorrhage and / or blood pressure disturbances. It is unknown what effect the sugary would have on the birds' ability to respire normally after surgery. Analgesia would be necessary postoperatively. It is possible that this approach could also be used for heart surgery.