Avian Diagnostic Procedures: Radiology and Endoscopy

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Abstract

An overview of avian radiographic technique and interpretation is discussed. Restraint, positioning, equipment, exposure and the use of special studies is covered. A brief discussion on interpretation of radiographic changes is included. A review of avian endoscopy including equipment, restraint and positioning and laparoscopy is provided.

Introduction

The signs of disease in birds are often subtle and non-specific, so we must rely on diagnostic aids, as well as our powers of observation and clinical skills to make a diagnosis. All diagnostic procedures commonly used in small animal practice can be adapted for the avian patient and will frequently provide a diagnosis and allow one to make a reasonable prognostic judgement. These include haematology, biochemistry, microbiology, urine and faecal analysis, radiology, endoscopy and necropsy.

As the field of avian medicine advances reference values are becoming more and more available particularly for the commonly kept companion and aviary bird species. A reasonable knowledge of avian anatomy and physiology is required in order to interpret the results of some diagnostic procedures.

Radiology

Radiology is an extremely useful diagnostic aid in avian medicine. Most veterinary practices have radiographic equipment that can be used for birds, and interpretation, particularly of skeletal injuries and diseases, is usually straightforward. Radiology is also very useful for evaluating diseases of the gastrointestinal tract and other abdominal organs and the respiratory tract.

Radiology is contraindicated in severely debilitated patients where the physical and psychological stresses produced by positioning and restraining the patient may exacerbate its condition. In these cases it is best to delay the radiographic examination until the bird's condition has been stabilised with supportive therapy.

1. **Radiographic Techniques**

    a. **Restraint**

    Adequate restraint for radiography is critical if high quality diagnostic radiographs are to be obtained. Physical restraint, even if a commercially available restraining board is used, is stressful. There is a high probability of worsening the bird's condition and causing fractures. A further problem with physical restraint is the increased radiation exposure of staff.

    Anaesthesia makes the radiographic procedure less stressful (to patient and veterinarian), and clearer, more diagnostic radiographs are possible because movement is limited. The cost of the anaesthetic is usually insignificant compared to the time wasted in trying to restrain a reluctant, conscious patient, particularly if repeat radiographs are needed. Once anaesthetised it is possible to position the patient properly. The bird can easily be taped to the cassette, held by someone wearing lead gloves, or positioned using sandbags.

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b. **Positioning**

Correct positioning is important to obtain diagnostic radiographs. The aim is to prevent superimposition of limb bones over one another and over the body and to get the image as symmetrical as possible. The limbs must be extended to allow proper evaluation of the chest and abdomen. Keel and vertebrae should be superimposed in a satisfactorily positioned ventrodorsal radiograph, and the right and left acetabulae should be superimposed in a symmetrical lateral radiograph.

Lateral and ventrodorsal projections are routinely taken. For the lateral projection the bird is placed in lateral recumbency with the wings extended dorsally and slightly cranially (see Figure 1). The dependent wing is positioned cranial to the contralateral wing. The legs are extended caudoventrally. The dependant leg is positioned cranial to the contralateral leg which may be pulled caudally to get better evaluation of the abdomen, but not so far as to cause rotation of the body. By positioning the dependant limbs cranial to the contralateral limbs, the laterality of appendicular skeletal lesions can be identified on lateral body surveys. The beam should be centred equidistant between the spine and sternum, just cranial to the caudal tip of the sternum.

For the ventrodorsal projection the bird is placed in dorsal recumbency so that the sternum and spine are in line with the X-ray beam (see Figure 2). The neck is gently extended and may be taped down. The legs are extended fully in a caudal direction and are positioned symmetrically. The wings are extended laterally to full extension. Failure to extend the wings fully results in superimposition of the wing muscles on the thorax. The beam is centred on the midline cranial to the caudal tip of the sternum.

A posterioanterior projection of the wing may also be useful in some cases.

c. **Equipment, Exposure and Techniques**

Most X-ray machines normally used in small animal practice are capable of producing avian radiographs. Most standard film and screens are suitable. All films are taken at table top and a grid or Buckey are not used. The bird should be measured at its widest part within the area of interest.

In most situations factors used for small mammals are suitable for radiographing birds. Low kilovoltages, to achieve better contrast and detail, high milliamperes, and very brief exposure times should be used.

d. **Special Studies**

Contrast studies of the avian gastrointestinal tract and respiratory tract can be performed. Other contrast studies such as intravenous pyelograms, and angiography are rarely used.

For gastrointestinal contrast studies warmed barium sulphate suspension is used. This can be given directly into the crop, oesophagus or proventriculus using a crop needle or feeding tube. The volume will depend on the species. This is usually given with the bird conscious. Fifteen to twenty minutes should be allowed for the bulk of the barium to pass into the proventriculus and ventriculus before the bird is anaesthetised and radiographed.

Despite this the bird should be closely monitored for regurgitation and aspiration of the barium. Ventrodorsal and lateral radiographs should be taken at about ½, 1, 2, 4, and 24 hours after administering the barium. The bird can be safely anaesthetised with isoflurane and oxygen for each radiograph.

The interpretation of gastrointestinal contrast studies can be difficult due to the variable anatomy and gastrointestinal transit times of different species. Transit times are faster than mammals. Thickening and/or irregularities of mucosal lining, distension, displacement and filling defects are signs of gastrointestinal disease.

2. Interpretation

In order to interpret avian radiographs adequately it is important to have a knowledge of avian anatomy, normal radiographic findings and the radiographic changes which occur in pathological conditions. The air sacs and pneumatic bones of birds afford a built in contrast system enabling us to differentiate tissues in a small creature with tissue densities that are very similar.

a. **Gastrointestinal Tract** - The organs of the gastrointestinal tract are best visualised by a barium series, but a number of structures are discernible on plain radiographs. The most common finding on survey radiographs indicating a gastrointestinal abnormality is distension of the gastrointestinal tract with fluid and/or gas.

i. **Crop and Oesophagus** - The crop is a diverticulum of the oesophagus and appears as a thin-walled air density just cranial to the sternum. On the ventrodorsal projection it may be on either side or bilateral depending on the degree of distension. The crop may be empty and radiographically invisible, or it may contain seeds (multiple semiradiolucent circular structures). It is important that these are not confused with pathological lesions. The crop is absent in some species. The rest of the oesophagus is not normally visualised on plain radiographs but may be evaluated in contrast studies.

Distension and impaction of the crop may occur with overeating of grit, improper hand rearing technique and ingesting foreign materials. Distension may also occur secondary to enlarged thyroids, lead toxicity and obstruction in the proventriculus, gizzard or upper intestines. An empty crop with food available implies a poor prognosis. Other conditions of the crop and oesophagus distinguishable on radiographs include rupture or perforation, displacement (due to soft tissue masses in the neck) and the presence of calculi and tumours.

ii. **Proventriculus and Gizzard (Ventriculus)** - The proventriculus is usually only distinguishable in larger species. It appears as an inverted funnel-shaped soft tissue organ located just dorsal to the liver and cranial to the gizzard in the lateral projection. In the ventrodorsal projection it may be seen to the left of the midline and cranial to the gizzard.

The gizzard is usually the most obvious radiographic landmark when it contains grit (multiple radiopaque calculi). The gizzard of carnivorous or piscivorous birds may contain skeletons of prey. Otoliths of fish are frequently seen in the gizzard of piscivorous birds. In birds that do not have radiopaque material in their gizzards, it is identified as a rounded soft tissue density. It lies between the acetabulae and to the left of the midline in the ventrodorsal projection. On the lateral projection it may be circular or elongate and is in the ventral two-thirds of the abdomen caudal to the liver.

Diseases of these two organs are not often obvious radiographically. Lack of grit in the gizzard of birds which usually have grit and have access to grit, may be associated with hypermotility or enteritis. Radiopaque foreign bodies, eg. wire may be seen in the gizzard. The gizzard however, because it is readily identifiable and relatively mobile, is a useful indicator of the presence of other abdominal diseases. Displacement may be associated with abdominal masses, herniation or enlargement of other organs. The gizzard is displaced characteristically in a number of diseases. With hepatomegaly it is displaced dorsally and caudally and kidney masses cause ventral displacement. Splenic masses cause ventral and cranial displacement and oviduct enlargement causes ventral and caudal displacement. Caudal abdominal masses involving the intestines or uterus cause cranial displacement.

iii. **Intestines and Cloaca** - The intestines usually occupy most of the caudal abdomen. The duodenal loop and cloaca are usually readily identified. In some birds the duodenal loop is quite prominent to the right of the midline adjacent to the gizzard. The pancreas is located in the loop but is not seen radiographically. The cloaca may be identified as an air filled rounded structure in the caudal abdomen.

Birds normally do not have gas in their intestines, therefore the presence of gas with or without distension is abnormal. Distended fluid-filled intestinal loops indicate gastrointestinal problems. Gaseous and fluid distension of the intestines is usually associated with inflammation. The intestines may be displaced due to extrinsic masses, organ enlargement or due to the presence of an egg. A soft tissue mass in the caudal abdomen in a female bird may represent a non-calcified retained egg.

iv. **Liver** - In the lateral projection the liver lies in the cranial abdomen, bordered by the heart cranially, gizzard and duodenum caudally, proventriculus dorsally and sternum ventrally. In the ventrodorsal projection the caudal thoracic air sacs surround the liver laterally. The exact caudal margin of the liver cannot be sharply demarcated. The liver and heart shadows merge and the cardio-hepatic shadow has an "hourglass" shape in the ventrodorsal projection. If the hindlegs are not fully extended and parallel this normal "hourglass" shape may be altered.

b. **Respiratory System** - The air-filled trachea is seen to originate in the pharynx, pass to the right of the cervical vertebrae and end at the syrinx and tracheal bifurcation just dorsal to the cardiac silhouette. The syrinx in most birds is a slightly dilated portion of the caudal trachea, however in some species it is a bizarre osseous bulla (eg. ducks).

The lungs in the lateral projection are in the craniodorsal thorax. They have a fine "honey-combed" or reticular pattern, which represents end-on views of terminal bronchioles. They closely adhere to the ribs and vertebrae. In the ventrodorsal projection the lungs are seen in the craniolateral thorax.

Seven air sacs can be visualised radiographically. In the ventrodorsal projection the right and left lateral diverticula of the clavicular air sacs are roughly triangular air densities in the axillary regions. These communicate with the pneumatic humeri. The cranial and caudal thoracic and abdominal air sacs are bilaterally symmetrical air densities surrounding the heart and abdominal viscera respectively. In the lateral projection an air density due to the presence of a portion of the caudal thoracic air sac is seen between the lungs and abdominal viscera.

Pathology of the respiratory system can be evaluated radiographically with more accuracy than by any other means. The lungs are best evaluated in lateral projection. Obliteration of the reticular pattern results from fluid or pus and is recognised as a consolidating pulmonary change which may be localised (eg. aspergillosis) or generalised. Most pulmonary consolidation is due to infectious processes, hypovitaminosis A, or pulmonary haemorrhage.

Air sacs should have an air density. In air sacculitis the normally radiolucent air sacs may have anything from a thickened line at their edges to a soft tissue density because of diffuse thickening. In severe air sacculitis the abdominal structures and heart may be obscured. Loss of air sac space and symmetry can be due to the presence of masses, fluid, or other organ enlargement.

Subcutaneous emphysema may be seen with air sac leak or rupture, and is also possible when air escapes from pneumatic bones when fractured. Subcutaneous air is a normal feature in many seabirds, particularly pelicans and gannets.

c. **Cardiovascular System** - The heart in the lateral projection is an elliptical soft tissue density in the ventral thorax. The heart base and some major vessels can be delineated, but the apex of the heart is continuous with the liver. On the ventrodorsal projection it forms a midline triangular silhouette blending with the liver shadow caudally. On both projections the major cardiac vessels are prominent cranial to the heart and should not be confused with lung or air sac masses.

d. **Urogenital System** - The kidneys, adrenals and gonads are located along each side of the vertebral column within the pelvic girdle. The cranial poles of the kidneys protrude ventrally from the pelvic bones and can therefore be identified. The ureters empty directly into the cloaca and there is no urinary bladder.

In mature birds the testicles or ovary can occasionally be visualised anterior to the cranial pole of the kidneys and dorsal to the liver. They undergo hypertrophy during the breeding season and should not be mistaken for abdominal masses. The oviduct which enlarges during egg laying is difficult to distinguish from other soft tissue structures in the abdomen and can give the impression of an abdominal mass. Uncalcified eggs appear as approximately spherical areas of increased density.

Renal enlargement or masses (primarily tumours) may cause displacement of the gizzard. Generalised enlargement with or without increased density may be suggestive of nephritis. Increased density without enlargement has been observed in dehydrated birds and gout.

e. **Skeletal System** - Most avian long bones are pneumatic. This makes the proximal and distal portions of these bones appear expanded, lytic and osteoporotic. The avian ulna is larger than the radius and the carpal and metacarpal bones are fused to form the carpometacarpus. The tibia and proximal row of tarsal bones are fused to form the tibiotarsus and distal tarsal bones and second through to the fourth metatarsal bones are fused to form the tarsometatarsus. Vertebrae of the spinal column are variably fused and the pelvic symphysis is absent.

It is important to familiarise oneself with normal radiographic bone density and cortical thickness. This is important in evaluating birds with suspected metabolic bone disease. Generalised decrease in bone density and thinning of cortices with or without pathological fractures is usually seen with vitamin D_3 deficiency and calcium/phosphorus imbalances.

Localised change in bone density can be due to osteomyelitis or neoplasia. Medullary osteomyelosclerosis occurs in female birds associated with increased oestrogen secretion. A normal increase in medullary bone density occurs in egg laying females, but not to the same extent as in pathological hyperoestrogenism. The latter may be associated with ovarian tumours and produces multiple increases in bone density.

Most fractures are easily visualised radiographically and are usually traumatic in origin. Pathological fractures are associated with metabolic bone disease, soft tissue tumours extending to bone, primary bone tumours and osteomyelitis. Radiographic evaluation of fractures is essential for proper fracture fixation.

f. **Spleen** - The spleen is a small, rounded soft tissue density identified in the midabdominal region dorsal to the gizzard and usually overlying the dorsal portion of the proventriculus on the lateral projection. It is an important organ to identify in suspected cases of chlamydiosis in which splenomegaly is a feature.

g. **Feathers** - Incompletely developed flight feathers which are seen during a moult appear more dense than their counterparts because young growing feathers have a good blood and nerve supply and are therefore of a soft tissue density. Mature feathers are avascular and aneural.

3. Endoscopy

Endoscopy is a widely used diagnostic tool in avian medicine. It is primarily used as a means to surgically sex monomorphic species of birds (laparoscopy), but can also be used for diagnostic purposes. Body orifices including the choana, nares, cloaca and oviduct can be examined. The trachea, oesophagus, crop and proventriculus are also readily examined. Insufflation of the crop, oesophagus and proventriculus is necessary for adequate visualisation of the mucosal surfaces. Diagnostic laparoscopy can be used if the results of other procedures are inconclusive. Avian anatomy lends itself to laparoscopy as the air filled air sacs preclude the need for insufflation of the body cavity (which is necessary in mammals and reptiles). Many organs including heart, lungs, air sacs, gonads, kidney, adrenal glands, oviduct, liver and much of the gastrointestinal tract can be examined. Typical lesions of diseases such as aspergillosis, chlamydiosis and avian tuberculosis may be visualised and subsequently sampled.

Retrieval of foreign bodies, biopsies and minor surgery may be accomplished with the use of a biopsy instrument or fine forceps in conjunction with the endoscope. Swabs and aspirates of tissues or fluid can also readily be taken.

a. Equipment

The basic equipment needed are a light source, fibreoptic cable and an endoscope. A trocar or cannula set is occasionally used, but is usually unnecessary. A number of different brands and models are available. Small rigid endoscopes are most commonly used in avian medicine and are sized according to the diameter of the operating barrel. They are usually sold as human arthroscopes. Sizes useful for avian patients range from 1.7 mm - 2.7 mm. The 2.7 mm is possibly more versatile and can be used for small mammals (dogs and cats) as well. The end of the scope may be flat or bevelled to 25° and may have a wide or narrow angle of vision. A bevelled point is useful for perforating air sacs.

b. **Restraint and Positioning**

Chemical restraint should always be used for endoscopic examination. This is necessary both to protect the bird, as well as expensive equipment.

For laparoscopy, pre-operative fasting is recommended. Two to three hours is recommended for granivorous, insectivorous and frugivorous birds, while longer (6-8 hours) is recommended for carnivorous and piscivorous birds. This not only avoids the risk of regurgitation, but also ensures that the proventriculus and gizzard are empty. When full these organs may impede vision of many other organs, particularly the gonads.

The positioning of the bird will depend on what is being examined. For procedures other than laparoscopy the position will be that which is most comfortable for the veterinarian and allows adequate visualisation of what is being examined.

For laparoscopy the most common position is right lateral recumbency (this is the standard position for surgical sexing). Left lateral recumbency is useful if an area on the right side of the body is to be examined. In both cases the upper wing should be extended dorsally and the upper leg extended caudally, leaving the flank area exposed. In some cases the upper leg can be extended cranially and the abdomen entered from behind the leg. The degree of rotation of the body can be changed to suit the surgeon.

c. **Laparoscopy**

The entry site for most laparoscopies (including surgical sexing) is a point on the flank halfway between the acetabulum and stifle, either between the last two ribs or behind the last rib, depending on the species. The feathers are plucked from the area and the site prepared with povidone iodine or alcohol.

A small 3 mm incision is made in the skin using sterile, fine iris scissors and fine forceps. Blunt dissection in a ventrodorsal direction, parallel to the ribs, through muscle and peritoneum is then used to enter the body cavity. The hole is held open with the forceps while the endoscope is inserted. The endoscope is best "sterilised" by soaking it or wiping with chlorhexidine, glutaraldehyde or alcohol.

With this approach one usually enters the caudal thoracic air sac, but occasionally the abdominal air sac. If clear, organs can usually be visualised through the air sac membranes, but if clearer visualisation is required, the membrane can be punctured with the end of the scope without adverse effects. From this point a range of organs can be visualised. The gonad is located just caudal to the adrenal gland, and ventral to the cranial pole of the kidney. Just cranial to these structures is the left lung. A small amount of antiseptic/antibiotic spray or powder is put on the wound which is usually not sutured. (See MJ Cannon, *Surgical Sexing*, Proceedings 178, *Avian Medicine*, University of Sydney Post-Graduate Committee in Veterinary Science, 1991, pp 35-38).

Lack of endoscopy experience and lack of knowledge of anatomic differences among species can make organ identification and detection of pathologic changes difficult. Practice is essential and if you have endoscopic equipment every opportunity should be taken to use it in order to familiarise oneself with endoscopic techniques and normal endoscopic anatomy.

d. **Complications**

Blurring of the visual field may occur if the end of the scope is not clean, or if blood, cells or pieces of tissue obscure the lens. This can be cleared by touching the end of the scope on an organ or removing and cleaning the scope. Laparoscopy in obese birds can be difficult as excessive fat interferes with visualisation of the viscera and the lens of the endoscope easily becomes contaminated with lipid material.

Trauma to the patient such as bruising or haemorrhage may occur. This is usually not serious and can be avoided by gentle technique. Subcutaneous emphysema and infections are rare if adequate care is taken.

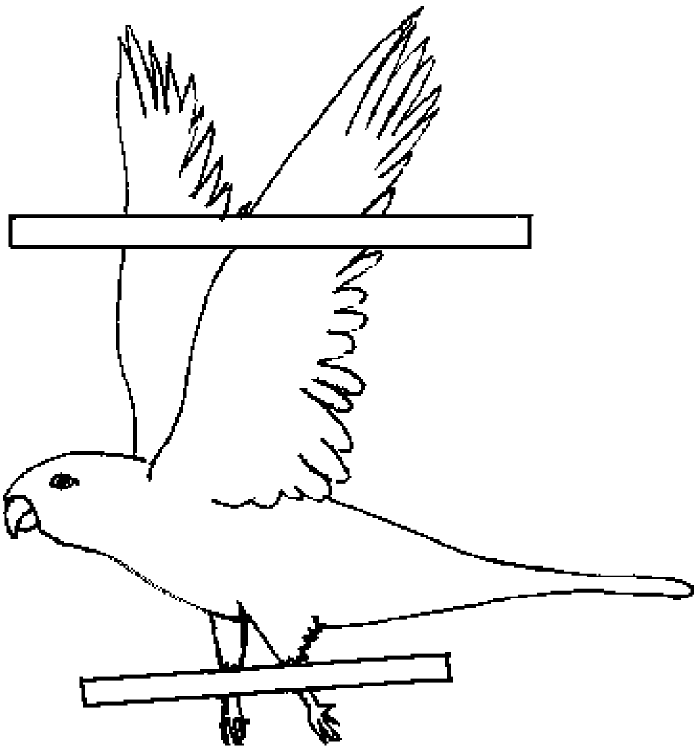

Figure 1: Positioning for a lateral projection

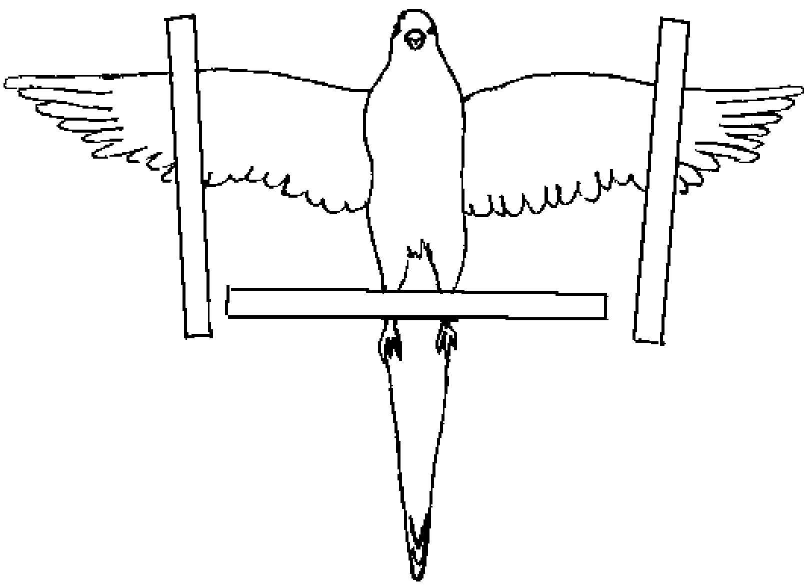

Figure 2: Positioning for a ventro-dorsal projection