Basic Avian Radiology

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Radiology is a useful diagnostic procedure in birds. It is not invasive and, with small patients, lateral and dorsoventral views can often be taken on the same plate so that various body systems can be easily evaluated. Most common indications for radiographic studies at our practice are to investigate suspected heavy metal toxicity, abdominal distension, reproductive problems, skeletal damage, paralysis and respiratory or gastrointestinal disease. In this session clinical cases involving radiology will be used as points of departure for discussing issues raised in these notes and in current avian radiology texts. (1-4)

Technique

For small patients mammography systems result in better detail compared with standard small animal techniques but their use requires increased exposure. Minimal exposure time is desirable when radiographing non-anaesthetised birds because movement can be a problem but better soft tissue definition is generally obtained by increasing MAS and reducing KVP. As x-ray machines can tend to be unreliable at very low exposures increasing MAS can also improve reliability. Several experimental exposures should be taken and a technique chart developed based on results.

Coning is important, not only to minimise operator exposure but also to reduce scatter and so improve radiographic quality.

Restraint

Assess whether the bird will handle the stress of restraint prior to radiography. There is no point in making a diagnosis if the bird dies because of the procedure!

It can be difficult to hold a bird using lead gloves. Tape can be used for restraint or the bird can be held with bare hands to position it and then lead laid over any exposed holder body parts prior to exposing the film. Take care if you use this technique that human fingers don't extend beyond the lead shielding or come within the primary beam.

To anaesthetise or not?

Birds with possible bone pathology, respiratory compromise, ones that struggle excessively or have other conditions that might predispose to injury if restrained should be anaesthetised using isoflurane prior to radiography. Anaesthesia also enables radiation exposure to holder to be reduced or eliminated. Manual restraint can be simple, rapid and cost effective. In our practice it has been used without incident in many hundreds of patients.

There is legal precedent where a macaw sustained a fracture when being restrained for radiology during a barium series. The judge ruled that, under the circumstances of the case, the veterinarian was at fault for not anaesthetising the bird. It may be wise to offer routine isoflurane anaesthesia as an option, particularly for expensive birds. If isoflurane is not available, the greater anaesthetic risk of other agents needs to be considered in deciding whether to use anaesthesia rather than manual restraint.

Positioning

Symmetry is particularly important. Wings may be taped down but if the bird is quiet it is often possible on the ventrodorsal view to restrain the head & feet, then have an assistant position the wings symmetrically and quickly take the radiograph before the bird moves. On the lateral view, with quiet birds, it is possible to extend and hold the wings with the same hand that holds the head. Expect to get bitten if you're inexperienced and try this technique with an aggressive lorikeet... and be aware of the other reasons why isoflurane anaesthesia may be preferred! Restraint boards are available commercially.

A caudocranial view of the wing can be useful projection.

Processing

Because bird radiographs are often taken on low exposure factors, developing faults are more likely to result in poor quality radiographs. Solutions should be changed frequently. Automatic processing gives better and more consistent results but cost is a drawback.

Interpretation

As for other species, develop your own standard procedure for evaluating films so that you don't just focus on the most obvious lesion and perhaps overlook more subtle changes. A useful technique is to first assess the film for overall radiographic quality from a technical viewpoint, then work sequentially through each body system and lastly look in decreasing circles from the outside to the centre of the film checking the bird as a whole.

Musculoskeletal system

Note these special features of avian radiographic anatomy:

- Osseous scleral rings
- Shoulder girdle - identify scapula, furcula, coracoid
- Ulna is larger than radius and remiges are closely associated
- Only radial & ulnar carpal bones present in psittacines, an accessory carpal bone is present in raptors
- Digits in the wings are numbered I (alular), II (major) and III (minor)
- Spine is separated into cervical, thoracic, synsacral (fused thoracic, lumbar, sacral and caudal), free caudal and pygostyle sections.
- Ribs are present on the cervical and thoracic vertebrae.
- Cervical ribs have short ventrally orientated spines
- Thoracic ribs have a dorsal portion that fuses with the vertebrae and a ventral portion that articulates with the sternum.
- Uncinate processes that anchor the caudal edge of some ribs to the cranial edge of the subsequent rib are present
- in some ribs.
- No separate tarsal bones

- Proximal tarsal bones fuse with the tibia to form the tibiotarsal bone (often just referred to as the tibia)
- Digital tarsal bones fuse with the metatarsal to form the tarsometatarsal bone (often referred to as the metatarsus)
- Avian long bones are characterised by large medullary cavities and thin cortices. Egg laying hens may show medullary or polyostotic hyperostosis (generalised medullary bone lay down).

Skeletal abnormalities

Decreased bone density occurs with nutritional secondary hyperparathyroidism. It is commonly seen due to calcium or vitamin D3 deficiency, can result in decreased bone density with pathological folding or fractures.

Metastatic calcification occurs in otherwise healthy tissue in the presence of hyper calcaemia. It can be caused by hypervitaminosis D or excessive dietary calcium and causes increased bone density and ectopic calcium deposition in kidneys, blood vessels, lungs, gastric mucosa and other soft tissues. Dystrophic calcification is deposition in non-viable or dying tissue (eg scarring, haemorrhage, old infections). (5)

Trauma

Spinal injuries most likely to occur at the junction of the fused thoracic vertebrae and the synsacum as this is the only mobile joint in the lower spine. Spinal fractures are often non-displaced and may be difficult to assess. Avian long bone fractures heal as for mammals but the endosteal bone reaction is greater. Healing is complete in 3-8 weeks.

Infection and neoplasia

Osteolysis occurs with both neoplasia and infection, these can be difficult to distinguish with certainty radiographically. Acute infection shows bone destruction with minimal periosteal reaction.

Periosteal reaction is usually present with chronic infection. Bilaterally symmetrical proliferative bony lesions have been observed in the femurs of lovebirds which improved following treatment with amoxycillin and clavulanic acid. An osteomyelitis caused by a bacterial infection spread to pneumatic bones via the abdominal air sacs, or haematogenously is postulated.

Medullary granuloma formation may be associated with fungal infections or Mycobacterium infections. These changes are uncommon in Australia.

Cardiovascular System

In the VD view, the normal cardiac silhouette measured across the heart base at the level of the atria is about 50% the width of the coelomic cavity

Pericardial effusion - globoid enlargement of the cardiac silhouette. May occur with chlamydia, polyomavirus, tuberculosis and neoplasia

Cardiomegaly - usually asymmetrical, see elongation of heart shadow, loss of indentation at the junction between the heart and liver lobes and increase transdimensional diameter. Seen associated with valvular disease, endocarditis, chronic anaemia & masses

Microcardia - usually associated with hypovolaemia or nutritional inadequacy, institute fluid therapy and review diet. May see radiolucent gap between heart and liver (cf microhepatia)

Atherosclerosis - mineralisation of the great vessels and lung fields

Respiratory System

Birds in respiratory distress should be stabilised before being subjected to radiography. An abdominal breathing tube may be needed for birds with upper airway obstructions. Isoflurane anaesthesia should be used rather than manual restraint. Good quality radiographs are needed to assess the respiratory system.

Tracheal masses - can be caused by hypovitaminosis A, bacterial or fungal infections (eg syringeal Aspergillus plugs), foreign bodies (eg millet seeds in cockatiels), pox virus (exotic disease in psittacines) or injuries. These should be investigated endoscopically. Syrinx lies between the 2nd & 3rd vertebrae. Beware the syringeal bulla in male ducks!

Thyroid masses -The thyroids lie within the thoracic inlet and can be difficult to assess. Contrast study of the upper GIT may be useful but birds are usually too compromised for this to be practical. A therapeutic trial with iodine should be tried initially if goitre is suspected. Trichomonas abscesses may cause mass lesions in the thoracic oesophagus, especially in pigeons.

Pulmonary disease - Normal lungs are honeycombed due to end on view of parabronchi. Air bronchograms or atelectasis do not occur because there are no alveoli. With pulmonary disease there will be loss of the normal honeycomb appearance a blotchy pattern suggests pneumonia, diffuse loss suggests haemorrhage or pulmonary oedema. It is necessary to take consistently good radiographs to assess this. Lung architecture will be more apparent on inspiration.

Air sac disease - may cause barrel-shaped appearance to the thorax as consolidated air sacs are not as compliant as normal air sacs and inspired air may be deposited in a relatively fixed fashion.

Hyperinflation of an air sac - is usually caused by partial obstruction of the inlet allowing air to flow in but not out. Air is contained within the air sac membrane. This may occur within the body cavity with thoracic or abdominal air sacs or under the skin with the cervico-cephalic air sacs. It may be caused by air sac trauma, eg with fractures of the coracoid or ribs. Subcutaneous emphysema is more diffuse

Radiographic changes of inflamed air sacs include Diffuse thickening, nodular infiltration, consolidation Fine lines across the air sacs, best seen on the lateral view, indicate mild thickening Loss of visualisation of the abdominal viscera, blending of interfaces and a hazy heterogeneous appearance to the air sac are suggestive of consolidation Aspergillosis, avian tuberculosis, abscesses and neoplasia are differentials for nodular air sac densities

Coelomic Cavity and Gastrointestinal System

The crop lies in the right lateral thoracic inlet. The cervical portion cannot be distinguished without contrast media unless it contains food.

Relative positioning of abdominal organs and impingement of organs into the caudal thoracic and abdominal air sac space are important in assessing possible organomegaly.

The proventriculus lies dorsal and to the left of the liver. If enlarged it will appear to flatten the cardiac/hepatic silhouette on the VD view and it will impinge into the abdominal air sac space on the lateral view. Enlargement may be associated with heavy metal toxicity, megabacterial or other infections, foreign bodies or proventricular dilatation syndrome.

The ventriculus is useful in assessing organomegaly of other soft tissue structures in the abdomen because it is usually easy to locate because it contains grit. Its normal position is to the left of the midline about the level of the acetabulum on VD view or caudal and ventral to the proventriculus on the lateral view. It may be pushed dorsally and caudally by liver enlargement or ventrally and caudally by enlargement of the gonads, kidneys or proventriculus.

Heavy metal particles can often be identified in the ventriculus or elsewhere along the GIT. They appear as radiodense particles which vary in shape depending on their source. Take two views to differentiate several particles of superimposed grit from a single heavy metal particle. Some types of grit may appear radiodense but not be associated with heavy metal, conversely not all birds showing elevated blood levels of zinc or lead will have evidence of heavy metal in the GIT. This is particularly true for lorikeets where the ventriculus is underdeveloped and grit does not remain for long in the GIT.

Gizzard impaction may occur if birds gorge on grit. The ventriculus will appear large and tightly filled with grit. This can be difficult to distinguish from some normal birds, radiographic appearance should be considered in conjunction with other clinical signs.

The spleen is usually difficult to identify if normal but if enlarged it may appear as an oval structure impinging into the abdominal air sac on the lateral view. Splenic enlargement may be associated with psittacosis, neoplasia, yersiniosis or other bacterial infections.

The liver, if normal size, should not extend beyond the sternum nor beyond a line drawn from the coracoid to the acetabulum on the ventrodorsal view. Hepatomegaly is a common finding and may be caused by a variety of infectious, neoplastic, parasitic and metabolic diseases. Most common causes include chlamydia, lipidosis and neoplasia. A liver biopsy may be needed to differentiate these further.

Microhepatia is occasionally seen and may be associated with pesticide toxicity, generalised emaciation or poor nutrition. An area of radiolucency may appear between the liver and heart.

The intestinal tract

Gas-filled intestines. Birds do not normally have air in their intestinal tract, any gas should be considered abnormal. Possible causes include aerophagia secondary to severe respiratory disease, heavy metal toxicity or gas anaesthesia

Gas forming bacterial infections

Intraluminar obstruction due to inflammation, infection, foreign bodies, parasites, intersusception, stricture, granuloma or neoplasia

Extraluminar obstruction due to neoplasia, abscesses, eggs or cysts

Functional ileus due to infections, toxicities, hypoxaemia, peritonitis or anaesthesia

Atonic distension of the cloaca may occur with spinal trauma or infiltrative neoplasms involving the sacral nerves.

Distended fluid-filled intestines should be considered abnormal except in fruit eating birds such as mynahs. Distension may be caused by infection or inflammation, intra or extraluminar obstruction or functional ileus (causes outlined above). Distension of the cloaca may be associated with retained soft shelled egg, papilloma (exotic disease) cloacolith, neoplasia or idiopathic dilatation. A barium series is indicated for complete evaluation of the intestinal tract.

Urogenital system

Kidneys are best visualised on a lateral view. They are normally surrounded by an air shadow, loss of which indicates renal enlargement, displacement of abdominal organs or presence of abdominal fat or fluid. Nephromegaly can be associated with neoplasia, cysts, infection, metabolic disease and post renal obstruction. A biopsy is necessary to differentiate neoplasia from cysts or abscesses Increased renal density is often associated with dehydration Masses involving the liver, spleen, gonads, oviduct or intestines may occupy the perirenal air shadow and need to be differentiated from renal enlargement.

Testicles

Physiologic enlargement can mimic neoplasia, take care not to misinterpret this. Tumours may secrete oestrogenic compounds and cause polyostotic hyperostosis (medullary bone lay down).

Orchitis, neoplasia and physiological enlargement are more easily differentiated by laparoscopy rather than radiology.

Female reproductive tract

An enlarged ovary will cause loss of perirenal air shadow but endoscopy or ultrasound may be needed to distinguish a reproductively active ovary from an ovarian tumour.

Hyperoestrogenism has been correlated with enlarged oviduct, medullary hyperostosis, diminished abdominal detail, visceral displacement, abnormal attempted at egg formation and abdominal hernias Not all birds showing these changes have high levels of oestrogen, related hormones or varying receptor sensitivity may be involved in the development of these changes.

Mineralised eggs are generally easily seen radiographically. Eggs can be quite large and still be difficult to palpate abdominally if they are being carried high in the abdominal cavity. Retained egg should be on the differential diagnosis for hens with laboured respiration or recurrent ill health even if the abdomen does not appear to be enlarged. Radiology can be very useful in establishing a diagnosis in these cases.

Abdominal effusion

Fluid results in a homogeneous appearance of the peritoneal cavity and obscures visualisation of of specific organs. If fluid is present in the intestinal peritoneal space there will be a homogeneous appearance to the region of the viscera and the air sacs will be compressed. With air saculitis, specific organs within the intestinal peritoneal cavity will still be definable. Abdominal effusion can be associated with ovarian neoplasia or egg yolk related peritonitis.

Diagnosing abdominal effusion is best approached by a combination of abdominocentesis with removal and microscopic examination of the effusion followed by abdominal or whole body radiography.

References

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