CARDIOVASCULAR DISEASE DIAGNOSTICS

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Cardiovascular disease has traditionally been thought to be a rare occurrence in companion birds, but a growing body of evidence collected over the last few decades indicates otherwise. It is frequently encountered in practice and poses a serious threat to the quality of life and longevity of many avian species. Successful intervention requires accurate and timely diagnosis, but cardiovascular disease poses a particular diagnostic challenge given the potential variability of its clinical manifestations (to include asymptomatic, slowly progressive disease), and the limited sensitivity of available investigative methods. These proceedings review current diagnostic options that can facilitate detection of pathologic changes.

A baseline diagnostic work-up is appropriate in any patient presenting with clinical signs consistent with cardiovascular disease, in order to begin to assess overall systemic health status. Key elements may include comprehensive serum biochemistry panel, complete blood count (CBC), and radiographic imaging (which may include imaging enhanced with contrast), ultrasonography, electrocardiography (ECG) and blood pressure measurement to further characterize the nature and extent of cardiovascular disease. Endoscopy and advanced imaging, including computed tomography (CT) and magnetic resonance imaging (MRI), also have application in diagnosis and characterization of cardiovascular disease in some settings.

HISTORY, CLINICAL SIGNS, AND PHYSICAL EXAMINATION FINDINGS

Diagnosis of cardiovascular disease begins with careful history collection and thorough physical examination, to be performed in a manner in keeping with patient stability. Examination findings, as well as relative predisposition to cardiovascular disease given the species, age, gender, lifestyle, and diet should be taken under consideration when formulating initial differential diagnoses and prioritizing diagnostic maneuvers.

Clinical presentations of cardiovascular disease share many commonalities, particularly as more than one condition can exist concurrently, but there are distinguishing features of some disease states that warrant mention. Many cases are likely subclinical and go unrecognized for many years until well advanced. Clinical signs can have a subtle, insidious onset, with owners reporting progressively declining activity level, reduced appetite, and waning interest in household activities, toys, and vocalizations that were historically of interest to the bird. In some cases, no premonitory signs are appreciated prior to sudden death. Presenting complaints common to most forms of cardiovascular disease are lethargy, weakness, reduced appetite, respiratory distress, and exercise intolerance. Physical examination findings may include cachexia, tachypnea, dyspnea, harsh lung sounds, cyanosis, tachycardia, arrhythmia, systolic murmur, coelomic distension and ascites, peripheral edema, and altered mentation.

Atherosclerosis

Patients with clinically significant atherosclerosis most often present for falling or collapse, frequently accompanied by transient or persistent weakness and dysfunction of one or more limbs, and with or without altered mentation. Extension and rigidity of one leg (and sometimes the ipsilateral wing), clenching of the toes, ataxia or difficulty perching, and tremors or convulsions may be reported. These signs are considered most consistent with stroke, but rarely is this confirmed diagnostically. These events can be difficult to distinguish from seizure activity, and indeed seizures can occur subsequent to ischemic stroke. Signs may be acute and transient, or there may be persistent neurologic abnormities, including reduced mentation, blindness, seizures, vestibular signs, paresis of one or both pelvic limbs, and ataxia. In cases with concurrent congestive heart failure, dyspnea and exercise intolerance may be part of the history and appreciable upon physical examination along with other congestive signs.

Congestive Heart Failure

Birds with congestive heart failure present most consistently with respiratory embarrassment owing to either intracoelomic air sac compression (caused by ascites and organomegaly), pulmonary edema, or a combination of the two. Coelomic distention is among the congestive signs appreciable on physical examination in cases of right-sided or biventricular failure. Peripheral venous congestion and edema may also be noted. In the case of cardiogenic pulmonary edema, increased respiratory noise is typically heard upon auscultation of the lung fields in a calm bird, but characteristic "crackles and wheezes" are generally absent except in severe cases, and cough is exceptionally rare.

CLINICAL PATHOLOGY

Clinical pathology, overall, has a low sensitivity for specific cardiovascular disease. Abnormal findings are more often attributable to secondary effects on other organ systems, underlying primary disease processes, or to concurrent, unrelated disease. In principle, disease affecting the myocardium may cause elevations in aspartate aminotransferase (AST), creatine kinase (CK), and lactate dehydrogenase (LDH). Other biochemical abnormalities may be seen depending on the systems secondarily or concurrently involved, particularly elevations in uric acid and bile acids reflecting renal and hepatic functional impairment, respectively. These may occur as a consequence of renal hypoperfusion or hepatic congestion secondary to heart failure, or as concurrent manifestations of an underlying disease process affecting multiple systems. Alternatively, hyperuricemia can be causally associated with cardiac disease (ie, visceral gout), as can hypoproteinemia (which may result in pericardial effusion) and electrolyte

disturbances which can also produce cardiac arrhythmia. Hematologic changes, including elevated total white blood cell (WBC) count and shifts in the leukocyte differential are seen with many forms of inflammatory or infectious disease, as well as with stress, and can be seen in patients with cardiovascular disease.

ELECTROCARDIOGRAPHY (ECG) AND BLOOD PRESSURE

ECG is an appropriate diagnostic step for characterization of arrhythmias, and can provide information to suggest certain cardiac abnormalities, including chamber enlargement. However, it must be used in conjunction with other diagnostic modalities, namely imaging techniques, to diagnose specific cardiac disease. Severe pathology and mechanical dysfunction can exist in the absence of ECG changes.

Accurate measurement of arterial blood pressure requires the direct method, but given that this technique is challenging and often impractical in the clinical setting, indirect methods are most commonly used in veterinary practice. However, it has been consistently demonstrated that values obtained with this method do not agree with direct systolic blood pressure measurements and may therefore be of low clinical value as a diagnostic tool. In general, hypotension is defined as a systolic blood pressure lower than 90 mm Hg and a mean below 60 mm Hg. Values for hypertension have been poorly defined in birds, but are expected to be higher than in mammals owing to their greater blood pressure. Systolic values over 200 mm Hg have been proposed as hypertensive.

RADIOGRAPHY

Radiographic imaging is generally an insensitive method to identify cardiovascular disease, but allows assessment of the size, contour, and radiodensity of the cardiac silhouette and great vessels, including the aorta, brachiocephalic trunks, and pulmonary arteries and veins. In large psittacines, using high-resolution digital imaging, the common carotid and axillary arteries may be visible on the ventrodorsal view, while some major branches of the descending aorta, namely the coeliac and cranial mesenteric arteries, may be seen on the lateral view.

Enlargement of the cardiac silhouette can be seen with pericardial effusion, myocardial hypertrophy or inflammation, chamber dilatation, cardiac or pericardial masses, and aneurismal dilatation. A rounded, globoid cardiac silhouette is suggestive of pericardial effusion, but accurate confirmation and differentiation between possible etiologies is impossible without echocardiography. The size of the cardiac silhouette on the ventrodorsal view can be quantified by taking standard measurements and calculating ratios relative to skeletal landmarks. In addition to enlargement of the cardiac silhouette, radiographic abnormalities that may be seen in cases of congestive heart failure include an enlarged hepatic silhouette and caudodorsal displacement of the adjacent gastrointestinal tract, increased radiodensity of the pulmonary parenchyma, intracoelomic air sac compression, or loss of coelomic detail due to ascites. The hepatic silhouette may appear enlarged due to hepatomegaly, perihepatic effusion (fluid accumulation in the hepato-peritoneal cavities), or cardiomegaly or pericardial effusion, considering that the cardiac apex is positioned between the liver lobes. Increased pulmonary density, particularly of the reticular pattern, may be seen with cardiogenic pulmonary edema or with primary disease of the pulmonary parenchyma (inflammatory or neoplastic infiltration, fibrosis). Varying degrees of compression of the cranial and caudal thoracic and abdominal air sacs are typically seen with ascites and/or organomegaly. The clavicular air sac normally provides the contrast necessary to visualize the heart base and great vessels. When this space is lost or diminished, as occurs with space-occupying masses or accumulation of exudate within the air sac, visibility of the great vessels is obscured.

Increased radiodensity and tortuosity of the great vessels is suggestive, but not conclusive, of atherosclerosis. Assessment of increased opacity is highly subjective and subject to variability in radiographic technique, though focal and linear mineralization associated with one or more vessels is highly suggestive of advanced, calcific lesions. In psittacines, these appear most often along the ascending and descending aorta, brachiocephalic trunks, and occasionally along smaller arteries, including the coeliac artery.

ULTRASONOGRAPHY

Coelomic ultrasound allows identification of cardiac abnormalities, pericardial effusion, ascites, and hepatic parenchymal changes that cannot be distinguished radiographically beyond enlargements of the cardiac and hepatic silhouettes. Two-dimensional (B-mode) echocardiography is a well-established technique to assess morphologic and functional status in birds, but M-mode is not useful because only longitudinal and semi-transverse views are attainable. Ultrasonographic examination is complicated by unique anatomic features of birds. Cardiac views in particular are constrained by the situation of the heart in an indentation of the sternum and surrounded by the clavicular and cranial thoracic air sacs. Given these limitations, the ventromedial approach is the most commonly used for psittacine birds. The probe is placed just caudal to the sternum and the beam plane is directed craniodorsally. The liver serves as an acoustic window, avoiding the air sacs laterally and the sternum ventrally. This way, the heart can be visualized in two longitudinal views, horizontal (four-chamber view) and vertical (two-chamber view). The horizontal view allows visualization of the left and right ventricles, interventricular septum, left and right atria, left atrioventricular (AV) valve, muscular right AV valve, and aortic valve, though it is difficult to distinguish the borders of the atria from the surrounding tissue. The vertical view permits visualization of the left atrium, left ventricle, and left AV valve; a marginal sliver of the right ventricle may also be visible adjacent to the sternum.

Subjective assessments of chamber size, wall thickness, ventricular contractility, diastolic function, and valvular morphology and function can be made. Chamber dilatation, myocardial hypertrophy, valvular insufficiency and anomalies (to include vegetations), cardiac masses, septal defects, some aneurysms, pericardial

effusion, ascites, and hepatic venous congestion can be identified by ultrasound assisted by color Doppler. Ventricular and atrial dimensions, aortic diameter, and interventricular septum width can be measured in both systole and diastole, and ventricular widths can be used to calculate fractional shortening for evaluation of ventricular contractility.

ANGIOGRAPHY

Angiography, which can be performed using either fluoroscopy or computed tomography (CT), can provide an additional diagnostic modality to supplement echocardiographic findings, and to identify vascular abnormalities. Fluoroscopic angiography allows visualization of the heart and vascular tree in real time. The brachiocephalic trunks, aorta, pulmonary arteries, pulmonary veins, and caudal vena cava can be visualized on the ventrodorsal view. Ventricular hypertrophy, chamber dilatation, valvular or vascular stenosis, and aneurysms can be identified using fluoroscopic angiography. CT angiography (CTA) shows great promise for identification of vascular disease, including arterial calcification and luminal stenosis related to atherosclerosis, aneurysms, and congenital vascular anomalies.

ENDOSCOPY AND ADVANCED IMAGING

Endoscopy allows both direct visual inspection of cardiovascular structures and targeted collection of diagnostic samples as appropriate. Endoscopy can only detect gross abnormalities, including cardiomegaly, pericardial effusion, pericardial thickening or exudate, arterial discoloration (to suggest atherosclerotic disease) or gross structural changes, and neighboring masses or granulomas. Standard lateral approaches permit visualization of the heart, great vessels, lungs, and liver via the cranial and caudal thoracic air sacs and of the descending aorta and its major branches, caudal vena cava, and ischiatic veins via the abdominal air sacs. The interclavicular approach (via the clavicular air sac) is the best means of visualizing the heart base, ascending aorta, brachiocephalic trunks, carotid and subclavian arteries, pulmonary arteries, and jugular veins. The ventral midline approach, with entry into the ventral hepato-peritoneal cavities, permits evaluation of the liver, heart, and pericardium.

CT and magnetic resonance imaging (MRI) are seldom used to image the avian heart as scans cannot be gated to the fast cardiac cycle in birds to reduce motion artifacts and improve diagnostic value. However, CT can be used to image the vasculature and can readily diagnose arterial calcification associated with advanced atherosclerosis, as well as cardiomegaly, ventricular dilation, pericardial effusion, ascites, pulmonary edema, and venous congestion. Cerebral complications such as ischemic and hemorrhagic strokes can be diagnosed using CT or MRI, though concurrent atherosclerosis cannot be detected unless lesion calcification is adequately severe.

ANCILLARY DIAGNOSTICS

Fluid analysis, cytology, culture, histopathology, and pathogen-specific testing of antemortem diagnostic samples can assist in determining the etiopathogenesis of cardiovascular disease, particularly when it involves infectious disease or neoplasia. Certainly myocardial samples cannot realistically be obtained in the living bird, but pericardial and ascitic fluid, caseous exudates, and biopsies of the pericardium, other affected organs (such as liver, lung, and air sac), or tumors can be collected for analysis.

REFERENCES AVAILABLE FROM AUTHOR UPON REQUEST.