Echocardiography of Macaques

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Outline
- Brief literature review of naturally occurring heart disease in macaques
- Case discussion

Congenital heart disease
- Double-outlet right ventricle and double septal defects in a Rhesus macaque diagnosed on post mortem
- Ventricular septal defect

Acquired heart disease
- Chagas disease
  - *Trypanosoma cruzi* has been reported sporadically in NHP colonies in the USA
  - Low prevalence (1.6%) even in endemic region (Louisiana)
  - Cardiac disease: myocarditis (rare); dilated cardiomyopathy
  - Pig-tailed macaques appear to be especially susceptible

Acquired heart disease
- Cardiomyopathy
  - Case report of pheochromocytoma and cardiac changes in a Rhesus macaque
  - Case report of hyperthyroidism and hypertrophic cardiomyopathy in 2 Rhesus macaques
  - Hypertrophic cardiomyopathy in Cynomolgus macaques

Cardiomyopathy in cynomolgus macaques
- Similarities to hypertrophic cardiomyopathy in humans and cats
  - Myofiber disarray
  - Interstitial fibrosis
Vertebral heart size (VHS) in Japanese Macaque (N=56)

- Normal VHS:
  - males: 10.56±0.73
  - females: 9.97±1.03

- This VHS = 5.2 x 4.4 = 9.6
  → 7.2 x 6.4 = 13.6


Case #1
16 year old male Rhesus

- One of the first primates treated with gene delivery
- EPO
- Ongoing treatment: phlebotomy as necessary
- Cardiology consultation requested because of heart enlargement on thoracic radiographs

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**DX:** Restrictive cardiomyopathy

- Treatment:
  - Cat vs human?
  - ACEI?
  - Beta adrenergic blockers?
  - Positive inotropes?

- Case treatment
  - ACEI (enalapril)
  - Pimobendan

Case #2

4 year old male cynomolgus

- Screening for a toxicology study
- Believed to be asymptomatic

Case #2

Systolic anterior motion of the mitral valve (SAM)

- Left heart
  - LV
  - AO
  - LA
Systolic anterior motion of the mitral valve (SAM)

SAM in humans and cats

- Predisposing factors
  - Mitral valve dysplasia, left ventricular hypertrophy
- Provocative testing
  - Stress echocardiography, Valsalva maneuver

Case #2
Diagnosis

- SAM +/- early hypertrophic cardiomyopathy
- Lost to follow up
- Recommendations
  - Feline: Monitor for structural cardiac changes +/- atenolol
  - Human: disopyramide, surgery, alcohol ablation

Case #3
8 year old female cynomolgus

- Breeding colony
- Cardiology consultation requested because a cardiac murmur was noted on routine physical examination
- No other clinical signs detected

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ACC/AHA Classification of Heart Failure

- At risk for heart failure
  - **STAGE A**: No structural disease, but high risk for developing heart disease
  - **STAGE B1**: Asymptomatic disease, minimal remodeling
  - **STAGE B2**: Asymptomatic disease, significant remodeling
- Heart failure
  - **STAGE C**: Past or current signs/symptoms of HF
  - **STAGE D**: End stage HF, signs refractory to Rx

Case #3 Diagnosis

- Presumptive degenerative valve disease: stage B2
- Recommendations:
  - In dogs, there is no clear evidence that beginning medications at this stage of disease will alter outcome.
  - Retire from breeding colony

Treating congestive heart failure

\[
\text{Cardiac Output} = \frac{\text{Preload} \times \text{Contractility} \times \text{Heart rate}}{\text{Afterload}}
\]

With CHF, preload, afterload and HR are chronically elevated due to adrenergic activation and activation of the renin-angiotensin-aldosterone pathway.

Canine Heart Failure

- **Stage A**: High risk, no known injury, no clinical signs
- **Stage B1+B2**: Structural injury, no clinical signs
- **Stage C**: Structural injury, current or past clinical signs
- **Stage D**: Structural injury, refractory signs

Treatment options

- Treating arrhythmias
  - Supraventricular
    - Calcium channel blockers
    - Beta adrenergic blockers
    - Cardiac glycosides
  - Ventricular
    - Drugs vs. internal defibrillators
    - When to treat???

- Treating congestive heart failure
  - Preload reducers
  - Afterload reducers
  - Inotropic agents
  - Heart rate control
Preload reducers

- Diuretics
  - Furosemide
  - Hydrochlorothiazide
  - Spironolactone
  - Nitroglycerine

Afterload reducers

- Angiotensin converting enzyme (ACE) inhibitors
  - Enalapril, benazepril, lisinopril
  - Hydralazine
  - Calcium channel blockers
    - Amlodipine, diltiazem
  - ACE receptor blockers

Inotropic agents

- Chronic support
  - Digitalis glycosides
  - Pimobendan

- Acute support
  - Dobutamine

Questions?