Treating the Irregularities of Atrial Fibrillation

Presentation Notes

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Pathophysiology of atrial fibrillation (AF)

- 400-600 re-entry circuits (wavelets) within the atria
    - Wavelength = conduction velocity x refractory period
    - Shorter refractory periods lead to shorter wavelengths
    - Slow conduction leads to shorter wavelengths
    - Shorter wavelengths = more wavelets
- Wavelets consistently bombarding the AV node – leads to an irregularly irregular ventricular rate
- Often tachycardic if the AV node allows the majority of the signals through to the ventricles
- Two main components of AF
    - Initiation
    - Maintenance
- Initiation of AF
    - Ectopic foci that spark multiple re-entry circuits (often from the pulmonary veins in people)
    - Heterogeneity in refractory periods and wavelengths of adjacent atrial myocytes
        - Different refractory periods allow the wavelets to maintain themselves or spark other wavelets
        - Heterogeneity occurs with:
            - Different tissues (i.e. pulmonary vein openings have different refractory periods than atrial tissue)
            - Fibrosis atrial tissue
            - Vagal tone – changes in vagal tone change the refractory period
            - Atrial enlargement
- Maintenance of AF – “A fib begets A fib”
    - Electrical remodeling
        - Atrial fibrillation changes potassium and calcium channels → changes in refractory periods and cycle lengths → heterogeneity
    - Fibrosis
        - Electrical remodeling creates fibrosis
        - Fibrosis exacerbates electrical remodeling
    - Critical mass
        - Atrial enlargement sufficient enough to accommodate 400-600 wavelets

Causes of AF

- Cardiac pathology
    - Critical mass – atrial enlargement
    - Fibrosis
    - Altered electrical propagation
    - Dispersion of refractoriness (heterogeneity)
- Vagal tone – changes refractory periods and cycle lengths

- Hypothyroidism
- Hypoadrenocorticism
- Atrial stretch – IV fluid boluses, etc.
- Cardiothoracic surgery +/- direct cardiac irritation/trauma
- Alcohol consumption

Lone AF

- No underlying cardiac pathology
- Occurs in giant breed dogs
- Take with a grain of salt – some studies show microscopic fibrosis on histology even in dogs diagnosed normal cardiac structure and function on echo
- Common in horses due to the inherent large size of their hearts

Clinical signs

- Weakness
- Lethargy
- Inappetance
- Anxiety
- Syncope – especially right when AF kicks in

Diagnosis

- ECG
    - Irregularly irregular rhythm
    - No discernable P waves
    - Often tachycardic, but not always

Sequelae of AF

- Loss of atrial contraction → loss of ~25% cardiac output
- Irregular ventricular response rate → decreases cardiac output
- Tachycardiomyopathy → decreases cardiac output and can lead to CHF
- Increased morbidity and mortality
    - Increased cardiac-related death and reduces survival time in dogs with DCM and in dogs with MMVD
- Thromboembolic events – rare, but reported in animals
- Poor performance in sport animals

Treatment

- Three categories
    - Rate control
    - Rhythm control
    - Ablation
- Rate control
    - Patient remains in AF, but heart rate is controlled
    - Ideal HR $\leq$ 160 bpm in the hospital setting
    - Medications
        - Diltiazem – Ca channel blocker
        - Sotalol – K channel blocker + beta-blocker
        - Diltiazem + sotalol

        - Digoxin – Na/K ATPase pump inhibitor
        - Diltiazem + digoxin
    - Usually required life-long
- Rhythm control
    - Pharmacologic conversion
        - Mechanism – gets the majority of the atrial myocytes on the same page (same refractory period and wave lengths)
        - Most success when AF is present for a short period of time
        - Amiodarone is the most commonly used drug to convert AF
            - Class III antiarrhythmic, but as properties of all four classes
            - Given IV or PO
            - 35% conversion rate with PO administration
            - Higher success rates with IV amiodarone and short duration of AF
            - **Can cause hepatotoxicity – especially in Dobermans**
                - Recommend monitoring chemistry panel every few months
                - Hepatotoxicity occurs 4-6 months after starting amiodarone, and usually resolves within 2-3 months after discontinuing it
            - Used prior to electrical cardioversion
        - Sotalol
            - Class III antiarrhythmic
            - Better for rate control, not as efficacious for rhythm conversion
        - Class I antiarrhythmics
            - Lidocaine (IB) and procainamide (IA)
                - Used when AF duration is acute (initiation of AF detected while the patient is hospitalized) – often associated with vagal tone
                    - GDV, opioid administration
            - Quinidine (IA)
                - Used in horses
                - 85% success rate (lower if AF present longer than 2 months)
        - Flecainide (IC)
            - Used in humans, not routinely used in veterinary species

    - Electrical cardioversion
        - Two methods
            - Transthoracic
            - Transvenous
        - Transthoracic electrical cardioversion
            - Requires general anesthesia
            - Biphasic defibrillator paddles applied to both sides of the chest
            - Success rates in the 90%
        - Transvenous electrical cardioversion (TVEC)
            - Requires general anesthesia
            - Electrode catheters placed in the left pulmonary artery and right atrium via minimally invasive, interventional approach
            - Success rates in the 90%
            - Usually requires lower amount of energy vs. transthoracic cardioversion
            - Commonly performed in horses

        - AUVTH Cardiology service is the first to do it in client-owned dogs
    - **ALWAYS remember to sync the defibrillator machine to detect R waves**
        - **Without syncing the machine to the R waves, R-on-T phenomenon may occur**

- Ablation
    - Radiofrequency ablation used to carve separation lines in atrial tissue – prevents ectopic foci and wavelets from crossing over to other areas
    - Case reports of this being performed in dogs with atrial flutter

Atrial fibrillation in cats

- ALL reported cases had cardiac disease
- Often a grave prognosis since AF is most likely only present in cats if significant cardiomegaly is present

Atrial flutter

- Similar to atrial fibrillation, except there is usually only a few (usually one) re-entry circuit instead of 400-600 re-entry circuits
- Typically slower atrial rate than atrial fibrillation
- Atrial flutter is often referred to as an unstable arrhythmia – it can go back to normal sins rhythm or degenerate into atrial fibrillation
    - Strike while the iron is hot – this is the time to try and convert
- Treatment is the same
    - May be more responsive to pharmacological and electrical conversion
    - Ablation with radiofrequency catheters has been performed in dogs