Cardiac arrhythmias in horses: anything new to expect?

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Cardiac murmurs and arrhythmias are commonly found in horses. Assessment is important for pre-purchase evaluation, to assess the effect on performance and assess potentially associated risks. Nowadays, echocardiography is common practice for the evaluation of murmurs and overall cardiac function. Ambulatory, 24 hour and exercise electrocardiography (ECG) have become a routine procedure in many practices.

The exact underlying cause or mechanism of an arrhythmia is, however, not always known, partially because a 1-lead or 3-lead ECG recording does not provide sufficient detail and 12-lead ECG recordings and vector electrocardiography are not well established in horses. The difference between sinus arrhythmia and atrial premature beats or between different types of atrial tachycardia, such as focal atrial tachycardia and macroreentry atrial tachycardia, can often not be made. Similarly, the exact origin of ventricular premature beats or the mechanism behind ventricular tachycardia is often not known in horses. Accessory pathways do occur in horses [1] but the exact anatomical location to target the pathway is usually unknown.

Recent studies have shown that 3D electro-anatomical mapping is possible in adult horses[2]. The sophisticated mapping technique, using Rhythmia mapping equipment (Boston Scientific), uses a steerable catheter with 64 electrodes that record all electrical activity from within the heart during the whole mapping procedure. At the same time, a magnetic field created over the heart allows to determine very precisely the 3D position of the catheter. Combining the 3D and electrical information allows to acquire 3D electro-anatomy. By moving the catheter along the endocardial border, the system remembers the outer shell with all electrical information (amplitude and timing), which is a copy of the inside of the heart. The final result of the mapping procedure is a 3D copy of the heart with a 'map' of all electrical activity. The amplitude data of the electrical impulses allow to create a voltage map which can be useful to identify regions of decreased voltage due to fibrosis. The timing of the impulses allows to display the activation map: a movie that shows the exact onset of depolarisation and how the activation wave moves over the myocardium during the cardiac cycle. In sinus rhythm activation starts at the sinus node and gradually activates both atria. The 3D electro-anatomical activation map in horses, shows nicely that activation of the left atrium appears after that of the right atrium, and starts at the point where Bachmann bundle is supposed to end. Ventricular activation maps shows the depolarisation to start in the lower third of the septum with subsequent rapid spread to ventral and to the left ventricular free wall, followed by a depolarization in dorsal direction.

A better understanding of the normal atrial and ventricular activation pattern might help to fine-tune ECG recording techniques. Adapted electrode positions and multiple lead surface ECG recordings might be able to better identify the depolarisation pattern of the heart. That would be helpful to better diagnose specific atrial or ventricular arrhythmias or conduction abnormalities. The Rhythmia system has recently shown to be able to differentiate focal atrial tachycardia from macroreentry atrial tachycardia in adult horses[3]. The procedure of 3D electro-anatomical mapping is, however, complicated and requires highly specialized equipment. Nevertheless, less sophisticated, invasive diagnostic techniques can be applied, even in standing horses. Insertion of one or more pacing/sensing catheters in right atrium or ventricle allow atrial and ventricular sensing (own rhythm) and pacing. By placement of multiple catheters at very specific locations in the heart, the

depolarisation wave morphology combined with its timing allows to identify the dominant activation pattern across that chamber and determine the underlying mechanism. This multiple catheter technique is commonly used in human medicine and is being introduced in small animal cardiology for diagnosis and treatment of complex arrhythmias and requires less sophisticated equipment. One of the main difficulties in horses is that cardiac imaging by fluoroscopy provides very little information and that MRI and CT of the heart cannot be performed. Efforts are therefore being made to define new ultrasonographic views that allow ultrasound-guided catheter placement[4]. In horses, pacing/sensing catheters have already been used to confirm specific arrhythmias and to measure atrial fibrillation cycle length and atrial and ventricular electrophysiological properties[5, 6]. Catheters at a specific location also allow to perform cardiac stimulation by temporary pacing to study the electrophysiological properties of the myocardium[7]. Therapeutic pacing has been successfully used in horses for temporary or permanent treatment of symptomatic bradycardia[8, 9] and for termination of sustained atrial tachycardia by overdrive pacing[10]. Selective pacing might also be applied in macroreentry atrial tachycardia in order to achieve entrainment and find the isthmus of re-entry.

Building such catheter-based diagnostic procedures will refine the diagnosis of complex arrhythmias and allow development of new treatment strategies. As in human and small animal cardiology, the most promising treatment option for specific arrhythmias is targeted radiofrequency ablation. This technique is also catheter-based. During ablation, a specific, small myocardial area is destroyed by heating the tissue using radiofrequency energy. In order to do so, the tip of the catheter should be pushed against the abnormal myocardial tissue. Ablation requires excellent imaging and positioning tools as it may have dramatic consequences when applied to the wrong spot (e.g. atrioventricular node). The technique has recently be applied with success to terminate sustained atrial tachycardia in an adult horses[3]. The major advantage of ablation is that it not only terminates the arrhythmia, it also prevents recurrence by destroying the ectopic focus.

The most important catheter-based treatments in horses include temporary and permanent (pacemaker implantation) pacing for bradycardia, and transvenous electrical cardioversion of atrial fibrillation. Recent application of 3D electro-anatomical mapping and radiofrequency ablation in horses show that catheter-based diagnosis and treatment of complex arrhythmias is technically feasible and should be further developed in future.

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