Tips and Tricks for Obtaining Good Quality Exercising ECGs in Horses

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INTRODUCTION

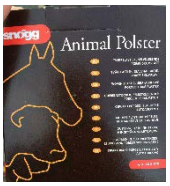
Exercise testing is an important component of cardiovascular assessment and includes continuous recording of an ECG using a device that has permanent storage and playback capabilities. Recording quality is crucial for subsequent analyses of the ECG tracing, since excessive motion artefacts or lead failure can severely impair the diagnostic quality of a recording.

While analyzing a stress ECG, the clinician has to keep in mind the main questions that need to be answered. These are usually focused on defining the safety risks to the horse and to the rider or driver, which is paramount in horses with cardiovascular disease. Safety risks may be linked to inappropriate exercising heart rates, aberrant conduction, or ectopy associated with physical activity and adrenergic stimulation. Of principal concern are the hemodynamic consequences of rate and rhythm disturbances (hypotension, low cardiac output, poor peripheral perfusion) and the potential for further electrical destabilization (malignant, potentially fatal arrhythmias). Generally, ventricular arrhythmias have a greater potential impact on safety compared to supraventricular arrhythmias.

EQUIPMENT

The choice of equipment will vary between countries and clinician preference. To obtain good quality recordings during exercise the device needs to be simple, well attached and not interfere with any other equipment the horse may require (e.g. saddle or harness). New products with ECG electrodes integrated into the girth or saddle blanket or harness are being regularly developed.

One of the most common ECG monitors used in equine practice is the Televet (Engel Engineering Service GmbH, Offenbach, Germany, www.televet.de) while others have modified Holter recording devices from humans or small animal practice. This presentation will focus on the use of the Televet recording system.



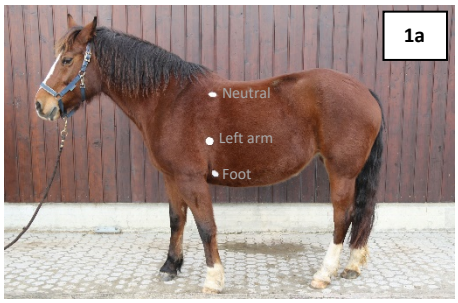
Adhesive electrodes are used and frequently additional adhesive material is used to fasten the lead to the electrode and the horse to avoid additional motion (www.kruuse.com or similar) especially as horses start to sweat during strenuous exercise.

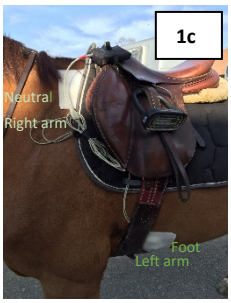
Recordings with the televet can be telemetrically displayed on a laptop, tablet or smart phone in real time, using a Bluetooth connection. It is important to also place the SD card in the transmitter, so a direct recording of the ECG can also be made. This direct recording should be used for future analysis, while the telemetric ECG is used for quality assessment and to screen for any particularly pathological rhythm events that should result in termination of the exercise test from a safety standpoint.

TYPE OF EXERCISE and PLACEMENT OF ECG

The type of horse and the type of exercise will influence how the ECG is placed. During exercising ECG examinations, horses are typically exercised at an intensity similar to that they are expected to produce during their regular exercise. For a pleasure horse that is infrequently and lightly exercised, an exercise test on the lunge for 15-20 mins may be appropriate, but for a 4* event horse, this is not likely to push them enough and a ridden exercise or treadmill exercise test might be more appropriate.

When the horse is ridden during an exercising ECG, special attention should be placed on getting the ECG leads and transmitter placed away from the rider so they do not interfere. This is especially important if the horse is galloping and/or jumping over fences.





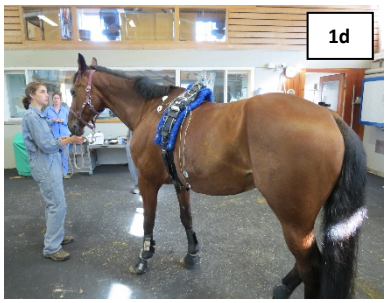


Figure 1a – ECG adhesive electrode placement in the circumferential base-apex configuration (typically used for 24hr Holter recordings).
Figure 1b – shows the Kruuse Televet Electrode Support (www.kruuse.com) holding the ECG leads and transmitter in place. This system works well for lunging exercise. The neutral/earth electrode (televet - black) is placed 10cm below the withers on the left, the left arm electrode (televet - yellow) is placed level with the point of the shoulder on the left thorax. The foot electrode (televet – green) is placed at the level of the elbow on the left thorax. The right arm electrode (televet – red) is placed 10cm below the withers on the right thorax, in a similar position to the neutral electrode on the left. This lead configuration results in Lead I, Lead II and Lead III providing additional information as to the morphology of the P-QRS-T complexes.
Figure 1c – a modified base-apex lead configuration suitable for ridden exercise testing (note the leads are under the saddle blanket and the transmitter is fixed to the D-ring on the front of the saddle. The right arm and neutral electrodes are adjacent to each other in front of the withers. The left arm and foot electrodes are adjacent to each other just caudal to the girth. The adhesive electrode-lead unit has been covered with animal polster to help it remain in place.
Figure 1d – a similar modified base-apex lead configuration is used during treadmill exercise. The electrodes are placed away from the surcingle to reduce motion artefacts. This lead configuration results in Lead I and Lead II being similar (providing a backup lead in case of electrode failure).

MONITORING AND PROBLEM SOLVING DURING EXERCISE

The most important thing to pay attention to during the exercise period is ECG quality. It is difficult to assess the ECG in real time for arrhythmias or heart rate changes, although the ECG should be monitored for serious frequent ventricular arrhythmias and the exercise test terminated if these are observed.
A good quality recording is essential for ECG analysis and subsequent detection of abnormal premature complexes. If the ECG recording is not of good quality, the electrodes should be checked for adequate contact to the skin. In some cases, clipping the coat or applying one drop of saline to the adhesive electrode sponge may be required to improve contact. Horses that are overweight have frequent motion artefacts associated with 'fat wobbles' and typically record poorer than normal quality ECGs.
If ECG quality does not improve, consider changing the ECG electrode configuration (from that seen in Figure 1a to that seen in Figure 1c, or visa versa).
ECG electrodes can become displaced if too much tension is placed on the leads during particular types of exercise (i.e. jumping fences) or if the horse becomes sweated up during the exercise. Using the additional adhesive tape (e.g. animal polster, seen in Figure 1c) over the electrode-lead combination can help prevent electrodes coming off during intense or prolonged exercise (as seen in treadmill or endurance horse exercise testing).

ECG ANALYSIS AFTER EXERCISE

The ECG file should be transferred from the SD card into the Televet software, after the end of the ECG recording period. From here, the ECG can be assessed for quality, screened for obvious rhythm events and then a detailed beat-by-beat analysis can be performed to detect the frequency and timing of any abnormal complexes. The heart rates at different exercise levels and the heart rate recovery after exercise can also be calculated.

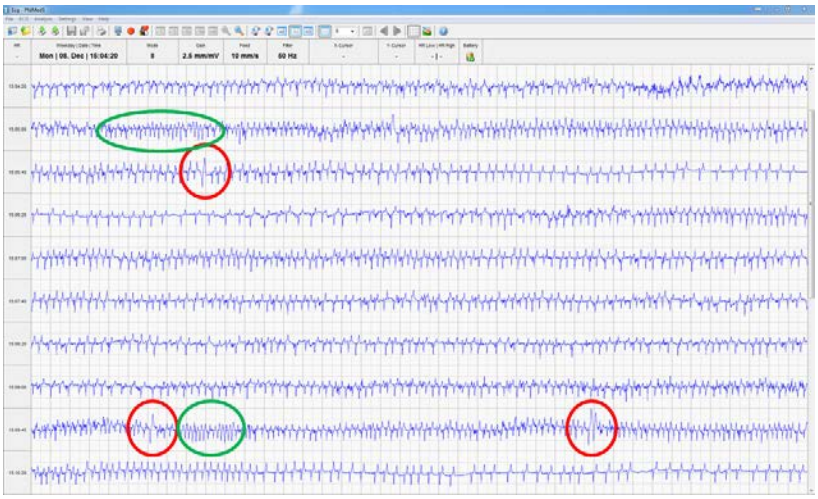


Figure 2: Overview screen of an exercising ECG recorded in a horse with atrial fibrillation. The baseline rhythm is irregularly irregular, most obvious during periods with lower heart rates. Abnormal QRS-T complexes, presumably premature ventricular complexes (PVCs) occurring as two single events and as a couplet with short coupling interval, are evident (red circles). Also, two episodes of a subjectively more regular and more rapid rhythm can be seen (green circles), suggesting either accelerated atrio-ventricular (AV) conduction or a short run of ventricular tachycardia.

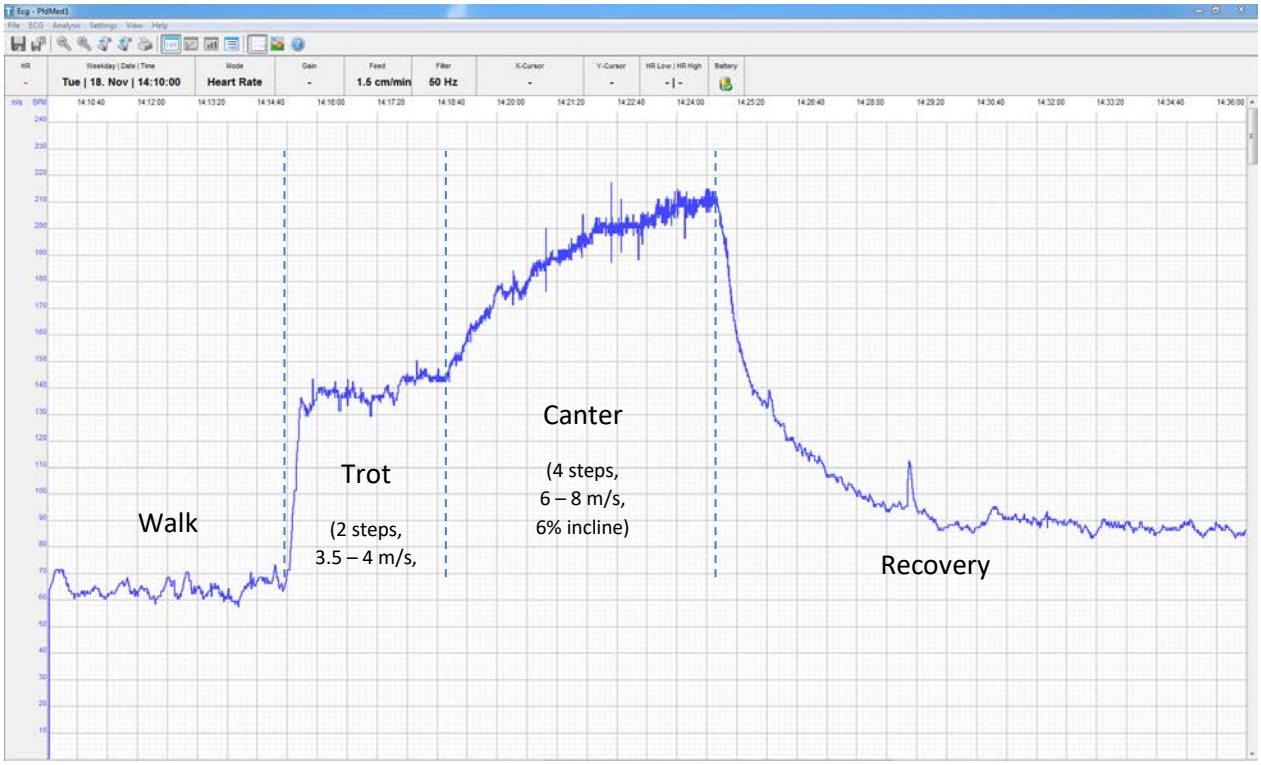


Figure 3: Example of an ECG recorded during a high-speed treadmill exercise examination. The heart rate (HR) view in the Televet software provides an overview on the course of the HR over time. The different phases of exercise (i.e. walk, trot, canter, recovery) can be identified.

REFERENCE

-Marr CM, Bowen M (eds): Cardiology of the Horse. 2nd ed. Saunders Elsevier, 2010.