Transvenous electrical cardioversion in horses: tips and tricks

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The 'darling arrhythmia', atrial fibrillation[1], can be converted by medical treatment (most commonly quinidine sulphate) or transvenous electrical cardioversion (TVEC)[2]. Because anti-arrhythmic drug-associated side effects can be avoided and especially because of the very high success rate of >95%, even in chronic and in quinidine resistant cases, TVEC is increasingly being applied to treat atrial fibrillation in horses. The treatment requires general anaesthesia, special equipment and trained personnel that is familiar with cardiac ultrasound, cardiac catheterisation, pacing and defibrillation.

This document gives information on how the TVEC procedure is carried out by the Equine Cardioteam at Ghent University. These tips and tricks are however clinician dependent and might not apply to your situation or your personal preference.

Catheter storage

During the sterilisation process and storage, we prefer the cardioversion catheters to be kept in a stretched position, not in coiled condition. Indeed, a curvature in the catheter facilitates it to be manoeuvred from right ventricle to pulmonary artery, but entering into the left pulmonary artery might be slightly more difficult.

Catheter insertion

Three introducers with haemostatic valve are placed in the lowest part of the right jugular vein. AVOID AIR AT ANY TIME! Although the cardioversion catheters (Gaeltec, UK) are more than long enough, a low position in the neck limits the movement of the catheter during induction of anaesthesia and reduces the risk for dislocation. It is strongly advised to use sterile covering over the whole length of the catheter. Catheters are now inserted for about 20 cm into the introducers: the pacing catheter in the most caudal introducer, the pulmonary artery (PA) and right atrial (RA) cardioversion catheter in the middle and cranial introducer, respectively. In case a catheter shows a slight curvature, one intuitively inserts the catheter with the tip pointing ventrally. This, however, occasionally results in the catheter entering into (the ventrally positioned) side vessels such as cephalic or axillary vein. The catheter is then likely to fold over and enter the RA with its bended part. Inserting the catheter with its tip pointing dorsally usually makes it enter straight into the cranial vena cava and RA. Ultrasound at the thoracic inlet allows to visualize correct entering of the catheter in the cranial vena cava. Placement of the catheters is started with the PA TVEC catheter, followed by the RA TVEC catheter and the RV pacing catheter. At Ghent university, the whole procedure of catheter placement is solely based on ultrasound. Many clinicians, however, prefer to use pressure monitoring and/or radiography as additional help during the procedure.

Pressure guidance and radiography

TVEC catheters with lumen (Gaeltec, UK) allow to register blood pressures from the catheter tip, using a fluid-filled line and pressure transducer. The characteristic RA, RV and PA pressure trace can be identified as the catheter is manoeuvred through the heart towards the PA and serves as an additional confirmation of the position of the catheter tip. Still ultrasound is needed to identify correct position in the left PA and absence of a recoiled tip (see below).

Thoracic radiography can be used to confirm catheter position and presence of a straight tip. It can be done in the standing horse but is most informative during anaesthesia as catheter movement might occur during the induction process.

Ultrasound guidance

Once the catheter is inserted in the introducer sheath for about 35 cm, ultrasound from the right hemithorax should be performed using special views that have been described recently[3]. The clinician performing catheterisation should be able to see and interpret the ultrasound images during the procedure. The clinician performing ultrasound should continuously search for the catheter and attempt to get long axis views of the catheter, trying to identify the catheter tip. Short axis sections through the catheter are not very informative. The catheter tip has a very typical reflection that facilitates it to be identified on ultrasound. Also the large shock electrode on the catheter has a typical hyperechoic appearance.

During insertion, the catheter can be seen leaving the cranial vena cava and entering the RA, usually in the direction of the intervenous tubercle. At that time one should attempt to slight rotate the catheter tip in ventral direction towards the tricuspid valve and make it enter into the right ventricle (RV). During this process the ultrasound probe is gradually rotated counter clockwise towards a four chamber view. One should pay special attention that the tip doesn't enter the caudal vena cava. In those cases where the catheter tip is curled backwards (because of partial entering in cephalic or axillary vein, or because it flips back at the intervenous tubercle), gently advancing the catheter usually makes it usually jump into the RV. However, avoid too large loops because of the potential risk to make a knot. As soon as the catheter enters the RV special attention should be paid to ensure that the tip of the catheter does not become lodged between papillary muscle and the rest of the myocardium, which is usually accompanied by many ventricular premature beats. If so, the catheter should be pulled back to the RA and re-inserted into the RV. The catheter is now further inserted into the RV and usually best visualized in the caudal RV area (4^{th} or 5^{th} intercostal space). One should now attempt to direct the tip slightly towards the RV outflow tract (RVOT), although this is not always possible. The catheter is gently advanced towards the PA. This part of the procedure is often difficult to follow on ultrasound because of catheter bending and the variable position. Often isolated ventricular premature beats occur. If they appear in a salvo the author prefers to pull back the catheter for 5 cm, slightly rotate and try again.

As soon as the catheter is visible in the RVOT or PA one should identify the tip of the catheter and ensure that the tip is not flipped backwards. It is not uncommon for the PA TVEC catheter to enter the PA with a loop and this should be avoided at any time as cardioversion failure is more likely. Once the tip enters the PA correctly the catheter is advanced into the left PA. Be aware that many horses present a linear artefact in the right PA. Identify this artefact before you start PA catheterisation to avoid misinterpretation during the procedure. Occasionally the catheter is difficult to identify in the PA because it is pushed against the PA wall. If so, advance the catheter 5-15 cm or pull it back slightly: it will then often move to the middle of the vessel and become easy to spot. From a right parasternal view, while the right PA is easy to spot, only the very first part of the left PA can be visualized. Therefore, a correctly positioned PA TVEC catheter is pointing straight towards the left PA but often the left PA itself is barely visible.

Next, the RA TVEC catheter is advanced and positioned in a similar manner. In the standing horse, the catheter is manoeuvred into the right ventricle, close to the apex, and will only be pulled back to the RA during general anaesthesia. The presence of two catheters in the right ventricle makes the visualization slightly more challenging so try to have an idea of how the PA TVEC catheter is sitting in the RV beforehand.

Finally, the RV pacing catheter is inserted[4]. This catheter serves for backup RV pacing in case transient bradycardia occurs. Temporary bradycardia and the associated lower blood pressure are relatively well tolerated in horses, but a long period of ventricular asystole leads to an increased risk for development of potentially dangerous ventricular tachyarrhythmia. Ultrasound guidance is performed as described

above but becomes more difficult as 3 catheters are now positioned in the heart. However, the pacing catheter is connected to an electrogram recorder during catheter placement which facilitates positioning. Indeed, when entering the RA, rapid depolarizations (about 350/min) become visible. Entering the RV will suddenly display sharp deflections simultaneous with the QRS complex (and T wave), thus at a slow rate. The tip of this catheter is manoeuvred into the RV apex.

The PA TVEC catheter position is now checked from a left parasternal view using specific views as recently described[3] to ensure that the catheter is not flipped back, and that the tip is entering into the (left branch of the) left PA. The catheter tip can be seen to follow the left PA as it bends around the fourth pulmonary vein ostium[5]. It is then advanced another 5 cm.

General anaesthesia and shock delivery

Subsequently, general anaesthesia is induced. The author prefers to use a sling for gentle induction and to avoid the horse to fall on the catheters. The horse is put (on the table) in left lateral position. Three legs are tied together to a hoist; the upper front is left loose during ultrasound examination and tied to the hoist during shock delivery.

Catheter positions are verified and adjusted if needed. The RA TVEC catheter is slowly pulled back until the tip remains about 1 cm in the RV, positioned between the tricuspid valve. At that time the coil is in the middle of the RA. The RV pacing catheter is connected to a temporary pacing unit and position adjusted to obtain consistent capture during temporary pacing[6].

A surface ECG is connected to the biphasic defibrillator which is operated in synchronous mode[7]. It is of utmost importance to confirm that consistent QRS sensing without any T wave sensing occurs. One should never proceed when occasional T wave sensing occurs. In that case surface electrodes should be changed position. Cardioversion can now be started. The author starts at 150J and increased energy in steps of 50J if needed.

References

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