Pacemaker is the treatment of choice for patients with symptomatic bradyarrhythmias both in human and veterinary medicine. According to the ACC/AHA/HRS Guidelines, indication for pacing are primarily represented by bradycardia due to sinus and atrioventricular node dysfunction, chronic bifascicular block, atrioventricular block associated with acute myocardial infarction, hypersensitive carotid sinus syndrome and cardiogenic syndrome, prevention and termination of atrial or ventricular arrhythmias, or hemodynamic indications. During sinus node dysfunction permanent pacemaker implantation is indicated in case of frequent sinus pauses or symptomatic chronotropic incompetence. In case of acquired atrioventricular block permanent pacemaker implantation is indicated for third-degree and advanced second-degree AV block associated with symptomatic bradycardia or ventricular arrests or for patients with third-degree and advanced second-degree AV block with concomitant AF with low ventricular response or ventricular arrests. The pacemaker consists in a generator capable to produce an electric stimulus and an electrode which delivers the impulse to the myocardium. According to the detected and the stimulated chamber, generators can be defined as single-chamber, dual-chamber or biventricular. An international code defines the pacemaker modalities: The first letter describes the chamber(s) paced and the second one describes the chamber(s) sensed with the same significance: O=none, A=Atrium, V=Ventricle, D=Dual (A+V). The third letter indicates the response to sensing: O=none, T=Triggered, I=Inhibited, D=Dual (T+I). The last one indicates the programmable functions: R=Rate modulated, C=Communicating, M=Multiprogrammable, P=simple, Programmable, O=none. The modality most commonly used in dogs are VVI or VVIR. They consist in a single chamber pacing with the electrode placed at the right ventricular apex. With VVI modality the heart is paced at constant rate, while with VVIR modality the heart is paced at constant rate at rest and at a higher ventricular rate during exercise. Different sensors have been used to improve exercise tolerance of the animals: detection sensor, QT-segment sensor, etc. Dual chamber pacing (VDD or DDD) is usually preferred because of the synchronous activation of atria and ventricles in a more physiologic manner. VDD pacing is performed with a single lead fixed at the right ventricular apex with an atrial sensor more proximal placed into the right atrium cavity. DDD pacing consists in lead placed at the right ventricular apex and a second lead placed into the right auricle. Finally biventricular pacing consists in a concomitant pacing of both ventricles, the right one through a single lead placed at the right ventricular apex and the left one through an epicardial lead placed into a lateral branch.
of the coronary sinus tributaries. The latter modalities can be used in veterinary medicine in case of refractory atrial fibrillation inducing systolic dysfunction after the ablation of the His bundle.

The electrode can be unipolar or bipolar depending on the presence of both cathode and anode on the electrode tip (bipolar), or positioned one on the electrode and one on the generator (unipolar). Furthermore regarding the modality of fixation this can occur in an active or passive fashion. In veterinary medicine the most common arrhythmias that require pacemaker implantation are 3rd degree AV block, 2nd degree advanced AV block, sinus node dysfunction, atrial standstill, and cardio-inhibitory vasovagal syncope. Clinical signs correlated with symptomatic bradycardia in dog are represented by syncope, weakness, exercise intolerance. Complications are classified into major and minor: the former include perioperative death or every conditions requiring removal of the device frequently represented by rupture or dislodgement of the electrode, migration of the generator, infections or ventricular perforation induced by the endocardial electrode. Minor complications do not required removal of the pacemaker and are represented by seroma, diaphragmatic stimulation or lack of intrinsic cardiac activity recognition (i.e. T wave oversensing). In the largest multicentre study conducted in veterinary medicine in a population of 154 dogs major complications occurred in 33% of the dogs, and minor complications in 31%. In contrast a work performed in a single centre on 105 dogs obtained the following percentage respectively 13 and 11%. Dislocation of the electrode represents a major complication, occurring in a variable percentage ranging from 7 to 33 %, followed by malfunctioning of generator (6%), cardiac arrest during implantation (6%) and infection (6%), whereas seroma results the most common minor complication in 12% of the cases. Electrode’s dislodgement can be classified as macrodislocation or microdislocation depending on the radiograph evidence. For some authors the electrode dislodgement in dogs is caused by a reduced presence of muscular trabeculae in right ventricle, associated with enhanced movements of the dog compared with humans. For this reason the use of electrodes with active fixation modality can result useful, although they can develop high impedance thresholds.

Other common complications concerning the electrode are represented by fracture or perforation of the ventricle, where a well described complication concerning the generator is the rotation on its axis (known as twiddler’s syndrome), pocket infection, cranial vena cava syndrome, jugular vein thrombosis, tricuspid stenosis and runaway pacemaker. In our laboratory major complications concur with data present in literature, whereas minor complications showed a lower incidence. We recorded an electrode’s migration occurred 24 hours after implantation as a consequence of a lesion provoked by the tiny hooks placed on the
tip of the passive electrode utilized, and a migration of the generator subsequently complicated with infection of the cutaneous pocket in which the battery was housed 11,13.

Persistent left cranial vena cava is a rare congenital abnormality representing less than 5% of the congenital defects described in dogs. This type of abnormality involves the inability to use the left jugular vein, and in our laboratory we met two dogs with this type of congenital defect. One episode of diaphragmatic stimulation, which can occur either by direct stimulation of the diaphragm or the phrenic nerve, was also found in our experience. This complication was resolved reprogramming the impulse from 0.4 to 1 msec.

The average survival time reported in dogs after pacemaker implantation varies between 70 and 85 % at one year follow-up, between 57 and 70 % at two year follow-up and from 39 and 45 % at three year follow-up 2-10.

According to the data present in the literature and to our experience, pacemaker implantation can be considered a safe and successful procedure that should be performed in all dogs with symptomatic bradyarrhythmias.

References


Conflict of interest: Nothing to disclaim