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SHORT COMMUNICATION

Utility of transesophageal electrocardiography to guide optimal placement of a transesophageal pacing catheter in dogs

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Abstract

Objective To determine if the transesophageal atrial (A) wave amplitude or ventricular (V) wave amplitude can be used to guide optimal positioning of a transesophageal pacing catheter in dogs.

Study design Prospective clinical study.

Animals Fourteen client owned healthy dogs with a median weight of 15.4 kg (IQR = 10.6–22.4) and a median age of 12 months (IQR = 6–12).

Materials and methods Transesophageal atrial pacing (TAP) using a 6 Fr pacing catheter was attempted in dogs under general anesthesia. The pacing catheter was inserted orally into the esophagus to a position caudal to the heart. With the pulse generator set at a rate 20 beats minute^{-1} above the intrinsic sinus rate, the catheter was slowly withdrawn until atrial pacing was noted on a surface electrocardiogram (ECG). Then the catheter was withdrawn in 1 cm increments until atrial capture was lost. Minimum pacing threshold (MPT) and transesophageal ECG were recorded at each site. Amplitudes of the A and V waves on transesophageal ECG were then measured and their relationship to MPT was evaluated.

Results TAP was achieved in all dogs. In 9/14 dogs the site of lowest overall MPT was the same as the site of maximal A wave deflection. In dogs with at least three data points, linear regression analysis of the relationship between the estimated site of the lowest overall MPT compared to estimated site of the maximal A and V waveform amplitudes demonstrated a strong correlation (R^2 = 0.99).

Conclusion and clinical relevance Transesophageal ECG A and V waveforms were correlated to MPT and could be used to direct the placement of a pacing catheter. However, the technique was technically challenging and was not considered to be clinically useful to guide the placement of a pacing catheter.

Keywords atrial, bradycardia, pacing, transesophageal.

Introduction

In humans, transesophageal atrial pacing (TAP) has been widely utilized in the evaluation and treatment of supraventricular arrhythmias as well as to treat clinically significant bradycardias (Gallagher et al. 1982; Nishimura et al. 1986; Santini et al. 1990; Pattison et al. 1991). In dogs, preliminary evaluations of transesophageal atrial pacing have shown it to be an effective method of heart rate control in dogs without significant atrioventricular (AV) nodal dysfunction (Green et al. 2009; Sanders et al. 2010). In these reports, fluoroscopic guidance was used to aid in the placement of the TAP catheter. In a case report describing the use of TAP to support heart rate in a canine patient with second degree AV block undergoing permanent pacemaker implantation and in a study of 10 research animals, placement of the transesophageal pacing catheter was achieved using slow withdrawal of the pacing catheter (Sanders et al. 2011; Chapel & Sanders 2012). In these reports, once atrial pacing was achieved small adjustments in catheter position were made to find the optimal pacing site.

Optimal site of catheter placement can be defined as the site at which pacing is achieved using the lowest pulse amplitude (Minimal Pacing Threshold or MPT). Finding the site of lowest MPT is desirable as it has been found that the lowest degree of extraneous muscular stimulation (EMS) is noted at the site of the lowest MPT (Chapel & Sanders 2012). Multiple methods to direct the placement of a TAP catheter to the optimal pacing site without the use of fluoroscopic guidance have been described in people. These include use of patient height or finger length to predict depth of insertion of the pacing catheter, slow withdrawal of the pacing catheter to establish cardiac pacing and the use of transesophageal electrocardiographic (ECG) waveforms to identify the optimal pacing site (Santini et al. 1990; Pattison et al. 1991). Currently, there are no studies evaluating the use of transesophageal waveforms to guide catheter placement to the optimal pacing site in the dog. Identification of a non-fluoroscopic method of guiding the placement of a transesophageal pacing catheter to the optimal pacing site may enhance the utility of TAP in veterinary medicine. The focus of this study was to investigate whether the transesophageal atrial (A) wave amplitude or ventricular (V) wave amplitude can be used to guide optimal positioning of a transesophageal pacing catheter.

Material and methods

This study was approved by the Institutional Animal Care and Use Committee of Michigan State University. Informed client consent was obtained for each animal prior to the start of the procedure. Fourteen dogs of various breeds undergoing ovariohysterectomy or orchiectomy were used in the study. Dogs were eligible for this study if their heart rate was <120 beats minute^{-1}, no abnormalities were noted during a routine physical examination prior to induction of anesthesia, and no detectable conduction disturbances were noted on a surface ECG while anesthetized. After the surgical procedure was completed, the dogs were placed in left lateral recumbency and general anesthesia was maintained with isoflurane in oxygen delivered through a standard circle system. A semi-rigid hollow silicone tube (6 mm diameter) was used as a guide to assist in the insertion of a 6 Fr quadripolar transesophageal pacing catheter (Josephson curved quadripolar electrophysiologic catheter; St. Jude Medical, MN, USA). The distance from the canine tooth to the level of diaphragm was estimated by measuring the distance from the nasal planum to the last rib. Then the pacing catheter was advanced through the oral cavity into the distal esophagus to the estimated distance. Stimulation of the diaphragm by the pacing stimulus without atrial capture was noted in all dogs and was considered suggestive that the distal tip of the catheter was aboral to the heart and near the diaphragm. Once the pacing catheter was in place the guide tube was removed. Using the distal pole as the cathode and proximal pole as the anode (inter-electrode spacing of 19 mm), TAP was attempted using a temporary cardiac stimulator (Model 7A; CardioCommand, FL, USA) with pulse amplitude of 20 mA and width of 10 ms at a pulse rate of 20 beats minute^{-1} greater than the intrinsic sinus rate. A surface ECG was used to determine if atrial pacing was achieved. A pacing stimulus immediately followed by a P wave for at least 15 consecutive beats was considered successful atrial pacing. If no atrial pacing was noted at the initial location, the catheter was withdrawn in 1 cm increments until atrial capture was obtained. When atrial capture was noted, the pulse amplitude was gradually decreased by 2.5 mA increments until atrial pacing was lost to determine MPT at each site. The presence of EMS was noted as present or absent at the MPT of each pacing site but the degree of EMS was not quantified. A unipolar transesophageal ECG using the distal pole of the pacing catheter was recorded at each site where atrial pacing was successful. The A and V waveform amplitude was measured at each pacing site using an analysis program (Windaq acquisition software; DATAQ instruments, OH, USA).

Statistical analysis

Normality of the data was determined by the Shapiro–Wilk test and non-normally distributed data is reported as median with inter-quartile range (IQR). To perform statistical analysis of the results,