

Successful Use of an Acceleration Rate Response Pacemaker with a Transvenous Steroid-Eluting Screw-in Lead for Third-Degree Atrioventricular Block in a Labrador Retriever

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ABSTRACT. Permanent pacemakers are commonly used in veterinary practice and can have a dramatic effect on the treatment of heart block. A Labrador Retriever dog suffering from exercise intolerance secondary to third degree atrioventricular block was treated with a new pacemaker system. A steroid-eluting screw-in type lead that has the advantage of being more fixed to the myocardial wall without increasing the pacing threshold was used. The heart rate was regulated with an acceleration sensing pacemaker generator that included several automatic modulation systems. Nineteen months after implantation, the dog has a normal level of activity. The present case suggests that this pacemaker design may offer important advantages for canine patients.

KEY WORDS: canine, cardiac arrhythmia, heart block.

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Permanent pacemakers with transvenous electrical lead have been used frequently in clinical veterinary practice with dramatic effects on the treatment of heart block. However, there are still many complications encountered with pacemaker use [4, 6, 10, 13, 15, 16]. Lead dislodgement is one of the major problems [14, 18]. In human medicine, a steroid-eluting screw-in type lead has been developed that is less invasive, yet can be anchored more effectively to the myocardial wall [9]. This new design may minimize the lead troubles that have been reported in dogs.

Most implanted pacemakers for dogs have a fixed rate that do not allow pacing to vary according to the dog's physical demands. An activity-controlled rate response system with a single chamber lead has been introduced into canine practice, and a few cases with positive outcomes have been reported [4, 15, 16]. The activity-controlled rate response sensor includes several different types: vibration, acceleration, gravitation, and movement [5]. In contrast, pacemaker generator with an acceleration system functions in a position-independent manner, because the sensor floats within the generator. This design may be more suitable for quadrupedal patients, but has not been evaluated on dogs in clinical practice.

In the case of this report, one of these new pacemaker systems, both lead (the steroid-eluting screw-in type) and generator (acceleration type sensor), was used to treat a dog with third degree atrioventricular block.

A 6-year-old intact male Labrador Retriever, weighing 32 kg, was referred to the Veterinary Teaching Hospital of Kagoshima University for permanent pacemaker implanta-

tion. The owner reported that the dog had a history of exercise intolerance and syncope. The referring veterinarian had detected bradyarrhythmia on physical examination. Medical management of the bradycardia had not been attempted.

At the veterinary teaching hospital, the dog's heart rate was approximately 40 beats per minute (bpm). No cardiac murmur was auscultated. Other physical examination, routine complete blood count and biochemical analysis findings were within normal limits. A lateral thoracic radiograph revealed mild generalized cardiomegaly. An echocardiogram detected no abnormal findings. An electrocardiogram demonstrated third-degree atrioventricular block with an atrial rate of 120 bpm, and a regular, complex ventricular rhythm at 40 bpm (Fig. 1).

After premedication with atropine (0.05 mg/kg, subcutaneously), anaesthesia was induced with thiopental sodium (15 mg/kg, intravenously) and maintained with oxygen and inhaled isoflurane. The dog was placed in right lateral recumbency, and a steroid-eluting screw-in endocardial bipolar ventricular electrical lead (CapSureFix Silicone Models 5068-58; Medtronic, Inc.; Fig. 2) was advanced through the jugular vein into the right ventricle under fluoroscopic guidance. The lead tip was gently pressed against the endocardium until a stable position was obtained. The fixation tool was then rotated clockwise in order to extend the inner coil from lead tip and anchor the coil into the endocardium. Initially, the pacing threshold was 0.4 Volts (V) per 1.0 m second (msec) and an impedance of 619 ohms. The R wave measured 18.2-19.6 mV. The ventricular lead was then fixed securely to the jugular vein using an anchoring sleeve with the excess length positional into a subcutaneous loop, and then connected to the extension lead (IS-1 bipolar extension adapter 6984 M; Medtronic, Inc.). The

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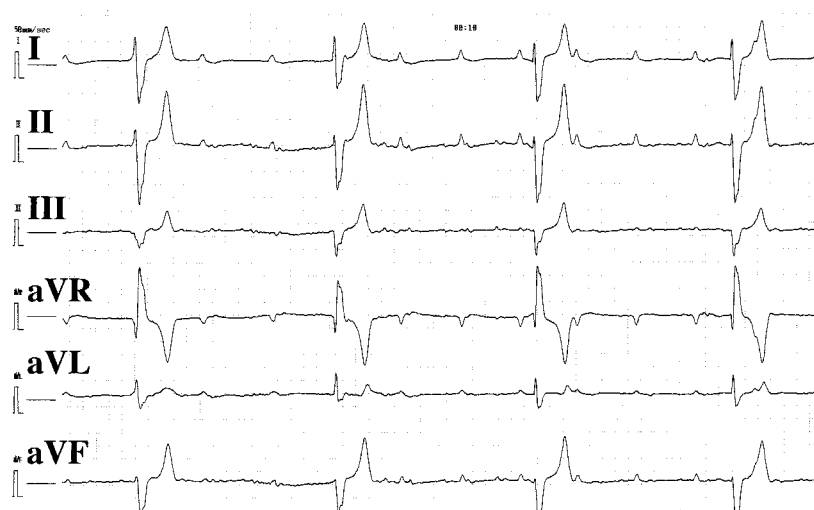


Fig. 1. Six-lead electrocardiogram recorded at 50 msec showing third-degree atrioventricular block. The atrial rate (P wave) is 120 beats/min, and the ventricular escape rhythm (QRS complex) is 40 beats/min. There is no relationship between the P waves and QRS complexes.

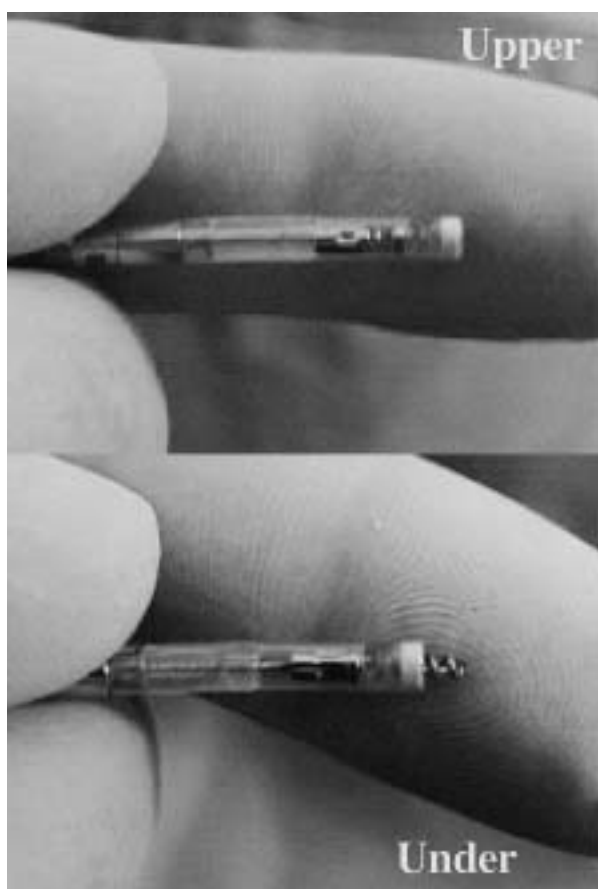


Fig. 2. Tip of steroid-eluting screw-in lead (CapSureFix Silicone Models 5068–58; Medtronic, Inc.). There is a steroid-eluting collar surrounding the screw. Upper: The inner screw is within the collar before use. Lower: The inner screw is extended from lead tip and the coil is anchored into the endocardium wall by rotating.

proximal end of the extension lead was attached to the pacemaker generator (KAPPA SR701; Medtronic, Inc.) via a subcutaneous tunnel. The pacemaker generator was positioned into a pocket formed within the subcutaneous tissues at the dorsal surface of the neck. The pacemaker generator was initially programmed to ventricle pacing, ventricle sensing, and inhibited response (VVI) mode with a fixed rate lower limit of 80 pacings per minute (ppm) [11]. The area where the pacemaker generator was positioned and where the ventricular lead entered the jugular vein were heavily bandaged and a dressing applied to protect the suture lines. Postoperative recovery was uneventful.

The patient was restricted to cage rest for two days after surgery, and antibiotics (ampicillin Na, enrofloxacin) were given for two weeks. Sutures were removed on day seven. Lateral radiographs of the thorax taken one day postoperatively showed maintenance of a satisfactory lead position. Re-evaluation of pacemaker function allowed reduction of the pacing threshold to 0.25 V per 1.0 msec. One week later, radiograph of the thorax also showed maintenance of a satisfactory lead position (Fig. 3). Pacemaker interrogation during electrocardiogram monitoring indicated that all ventricular activity was pacemaker-induced. The pacing threshold was increased to 1.25 V per 1.0 msec because of normal tissue reaction blunting the impulse. The pacemaker was then re-programmed to start the activity-controlled rate response result in VVIR mode [11]. Rate response program was set with the lower and upper rate limits of 80 and 150 ppm, and the activities of daily living (ADL) rate at 100 ppm [20]. In this pacemaker generator, the submaximal and maximal rate response can be divided into five grades based on the patient's level of activity. Grade four was selected for this dog. Three weeks after surgery, the actual rate profile histogram data showed appropriate rate response during the two week period that followed re-programming of the

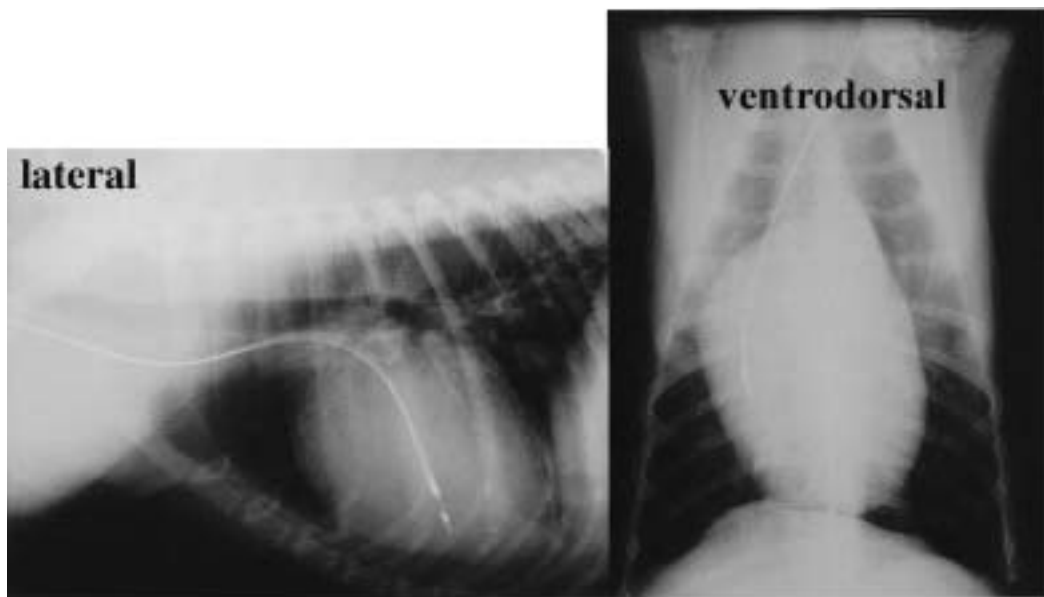


Fig. 3. Plain lateral and ventrodorsal thoracic radiographs taken one week postoperatively show the maintenance of satisfactory lead position.

pacemaker (Fig. 4). A long-term follow-up examination 19 months after the surgery confirmed that all ventricular activity was still pacemaker-induced and the pacing threshold was 1.125 V per 1.0 msec (Fig. 5). The owner reported that the dog was doing well and had recovered sufficiently to be able to run around and enjoy a normal life.

Lead trouble is one of the major complications experienced with permanent cardiac pacemakers and can cause life-threatening problems [8, 11, 14, 17]. Of 154 dogs studied by Oyama, lead dislodgement occurred in 17 (11%) [14]. Lead dislodgement is more serious in veterinary practice than in human patients because dogs do not restrict activity in the post-operative period [6, 7, 13]. Infection can also be a major complication in both the acute and chronic phase of pacemaker implantation [14, 17]. Oyama reported that infection of the generator or the lead occurred in 7 (5%) of 154 dogs [14]. If infection develops at the site of pacemaker implantation, it is extremely difficult to cure unless both the generator and electrical lead are removed [17, 19]. Furthermore, it is not easy to remove the endocardial lead when time has elapsed after implantation of a permanent pacemaker [19].

Endocardial leads used currently in veterinary practice are divided into two main types: tined and screw-in. Compared with the tined lead, the screw-in lead is anchored more strongly to the endocardium, but often causes a profound increase in the pacing threshold [3] due primarily to the induction of an inflammatory response at the tip [12]. Increasing the pacing threshold is a problem due to its impact on the level of energy required from the pulse generator, and thus on battery life. Steroid elution from the new screw-in type lead used in the current report reduces the

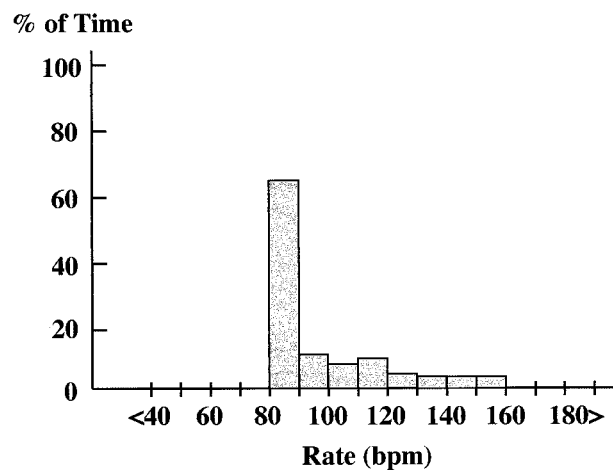


Fig. 4. Histogram of actual rate profile during the second week after the activity-controlled rate response was set. The vertical axis indicates the % of total beats and the horizontal axis is a range of actual rate profiles. The lower and upper rate limits are set at 80 and 150 pacings/min, respectively, and the activities of daily living (ADL) rate is 100 pacings/min. Both the ADL and exertion responses were grade four. The percentages of rate events per total events are as follows: 80–89 beats/min=65.6%, 150–159 beats/min=0.66%, other ranges=from 1.66 to 9.54%. Over pacing, 150–159 beats/min may be recorded because of the pacemaker induction above setting of upper rate limits.

inflammatory response and results in substantially lower thresholds [21].

A previous study compared the tined and screw-in type lead by investigating the tensile force required for lead

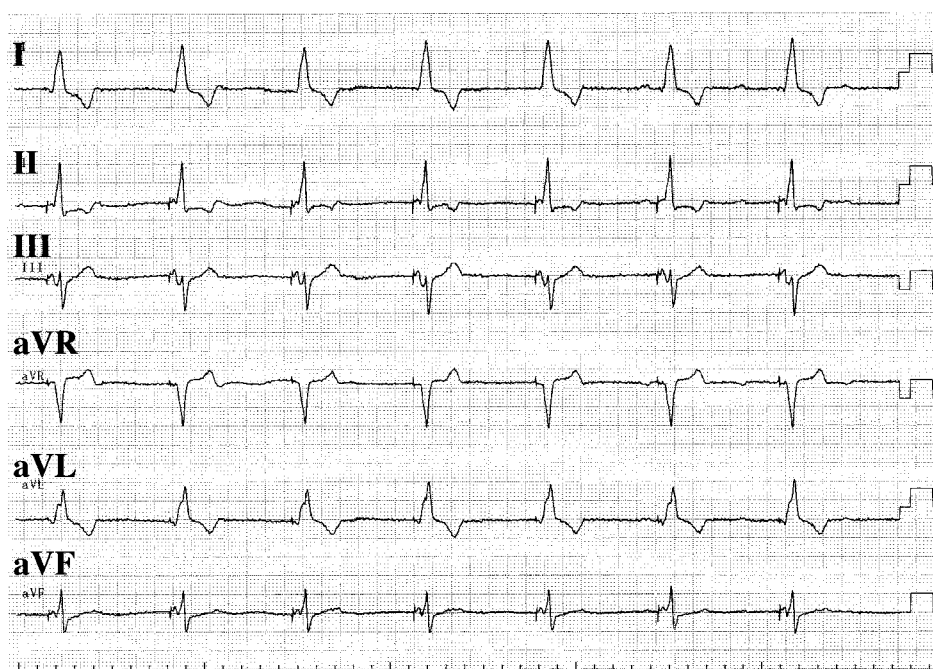


Fig. 5. Six-lead electrocardiogram (ECG) recorded at 50 msec after pacemaker implantation. All ventricular activity events are induced by the pacemaker.

extraction and the histological findings at the site where the lead connects to the endocardial wall [2]. The tensile force needed to remove the screw-in type lead is less than that needed to remove the tined type. Only minimum cylindrical fibrous tissue corresponding to the tip of the lead was observed macroscopically with the screw-in type [2]. In another study, the steroid-eluting screw-in lead created only a small area of fibrous tissue and a slight inflammatory cell infiltration, with no distinct pathological damage [1]. In addition, the screw-in lead enables postoperative procedures and medical management of the veterinary patient to be accomplished without sedation and without causing lead dislodgement.

The present pacemaker can be noninvasively reprogrammed after implantation by telemetry and has a rate profile optimization system that is expressed as a histogram. We were able to determine lower and upper limits and the ADL rate by the estimated histogram during the first implantation week at the start of the rate response system [20]. The submaximal rate response (called ADL rate response) refers to how many times during any giving day the pacemaker can increase the heart rate above the defined ADL set point (100 ppm in this patient). The ADL rate response is graded from 1 through 5 as follows: 1-inactive; 2-less active; 3-moderately active; 4-more active; 5-active. The maximal rate response (called exertion rate response) refers to how many times during any giving week the pacemaker can increase the heart rate to the defined maximal set point (150 ppm in this patient). The exertion rate response is similarly graded from 1 through 5: 1 is infrequent and 5 is

most frequent. We selected the fourth grade for both rate responses at the first setting in this case because this dog was generally more active than a human. It should be added that this pacemaker has several other automatic coordination systems involving AV/Upper rate management, patient-specific rate response management, threshold management, and so on. These systems can respond rapidly when a dog suddenly runs off from a resting state, but will increase slowly when the dog moves off at a normal rate. Once the program is set, adjustments should not be made unless remarkable differences arise between the setting program and the patient's demand. We think that this pacemaker works well for dogs because when the first program must be changed, reprogramming can be done based on the target and actual rate profile histogram that is stored automatically in the pacemaker. When a minimal difference between the target rate and the actual rate occurs, this pacemaker can adjust to the patient's needs with several automatic systems. Every week for one month after the first setting, we rechecked the data and histogram and did not change the first setting. Previous reports using a rate response system in dogs indicated beneficial effects [4, 15, 16]. Similarly, this patient dramatically recovered his exercise capacity according to this rate response system, and now seems able to enjoy a normal level of activity.

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