Case report: Pacemaker implantation in a Boxer

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CPD

PRESENTING HISTORY

Murdo is a six-year-old male neutered Boxer presented for investigation of a bradycardia noticed at a pre-anaesthetic check when the intention was to remove an epulis. The dog was completely asymptomatic and there was no previous history of illness.

CLINICAL EXAMINATION

On presentation Murdo was overweight (36 kg; ideal weight 32 kg) but bright, alert and responsive. On clinical examination his mucous membranes were pink and his capillary refill time was less than 2 seconds. He seemed fully hydrated. Multiple epuli were visible in his mouth. No jugular distension was noticed. A strong and regular apex beat was palpable and no precordial thrill was felt. Abdominal palpation, although difficult because of the dog's obesity, was unremarkable. All lymph nodes were within normal limits. All his extremities were nicely warm. His pulses were strong and without any deficits.

On auscultation a very regular heart rate was audible. The heart rate was 60 BPM. No murmur was audible. The lungs sounded unremarkable. Rectal temperature was 38.5°C.

PROBLEM LIST AND DIFFERENTIAL DIAGNOSIS

Regular bradycardia

Sinus bradycardia

Physiological

- in very fit animals
- in animals with increased vagal tone (brachycephalic breeds)
- sleep

Pathological

- hypothermia
- hypothyroidism
- hyperkalaemia
- CNS disease, increased intracranial pressure
- upper airway obstruction
- gastro-intestinal (obstruction)
- urinary (obstruction)

Pharmacological

- tranquilliser, anaesthesia, digoxin, ß-blockers, morphine

Third degree AV-block

- Infiltrative disease (neoplasia, inflammation)
- Idiopathic fibrosis
- Myocardial infarction
- Hyperkalaemia
- Lyme disease
- Bacterial endocarditis
- Associated with congenital defects (aortic stenosis, ventricular septal defect)

DIAGNOSTIC WORK-UP

The dog was admitted to the hospital for electrocardiography, blood work, thoracic radiography and colour flow Doppler echocardiography.

ECG

A 12-lead ECG confirmed the presence of third degree AV-block with a ventricular escape rhythm of 60 BPM. The P-wave rate was 120 per minute (Fig. 1).

Atropine response test

An atropine response test (atropine 0.02 mg/kg IV; in normal animals one can expect a 50-100% increase in heart rate depending on the initial heart rate) increased the P-wave rate but not the ventricular escape rate.

Lab-work

a. Haematology (Table 1)

Haematology was unremarkable.

TABLE 1.

	Patient data	Normal
Haemoglobin	12.5 g/dl	12.0-18
Red Cell Count	6.3 x 10^{12}/l	5.5-8.5
Packed Cell Volume	43 %	39-55
MCV	72.7 fl	60-77
MCHC	33.4 g/dl	32-36
White Cell Count	10.6 x 10^{9}/l	6-15
Neutrophils (mature)	7.6 x 10^{9}/l	3.6-12
Eosinophils	0.3 x 10^{9}/l	0-1
Monocytes	0.53 x 10^{9}/l	0.0-1.5
Lymphocytes	2.1 x 10^{9}/l	0.7-4.8
Platelets	256x 10^{9}/l	200-500

b. Biochemistry (Table 2)

The biochemistry showed the presence of a marginally elevated cholesterol level. T4 levels were within normal limits. Mildly increased urea and creatinine were consistent with a mild prerenal azotaemia.

TABLE 2.

	Patient data	Normal
Total Protein	63.4 g/l	58.0-73.0
Albumin	34.5 g/l	26.0-35.0
Globulin	28.9 g/l	18.0-37.0
Bile Acids	4.9 µmol/l	0.0-7.0
Cholesterol	7.16 mmol/l↑	3.8-7.0
Creatinine	135 µmol/l↑	0.0-106.0
Glucose	5.2 mmol/l↑	3.0-5.0
Urea	9.5 mmol/l↑	1.7-7.4
AP	60.0 IU/L	20.0-60.0
ALT	45.0 IU/l	15.0-60.0
Calcium	2.55 mmol/l	2.3-3.0
Magnesium	0.82 mmol/l	0.69-1.18
Inorganic phosphate	1.19 mmol/l	0.9-1.2
T4	43.0 nmol/l	15.0-48.0

c. Electrolytes (Table 3)

All electrolytes were within normal limits.

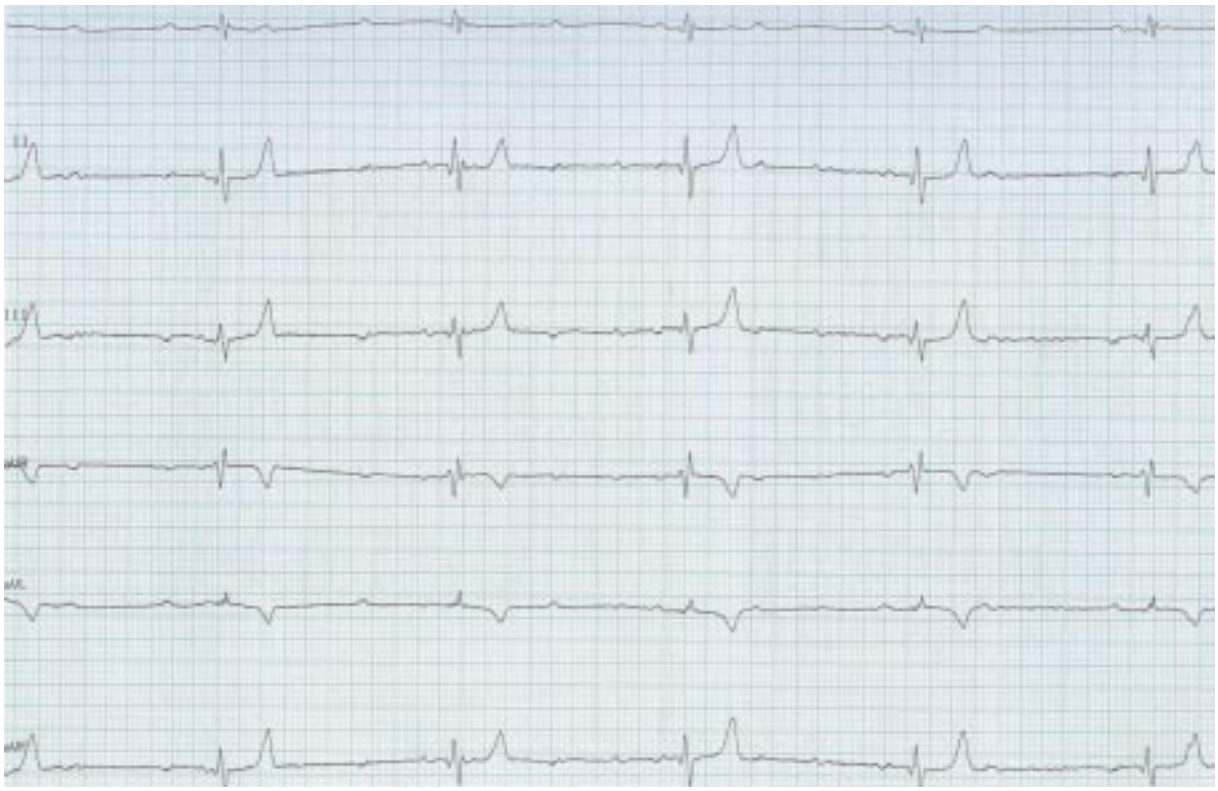

Fig. 1: *Six-lead ECG showing third degree AV-block with an escape rhythm at 60 BPM (50 mm/s; 1 cm=1 mV).*

TABLE 3.

	Patient data	Normal
Sodium	149.0 mmol/l	139.0-154.0
Potassium	5.3 mmol/l	3.6-5.6
Chloride	115 mmol/l	99.0-115

Radiography (Fig. 2)

The Vertebral Heart Score was 12.5. There was sign of mild R-sided cardiomegaly. The great vessels (aorta, pulmonary artery and caudal vena cava) and the pulmonary vasculature were within normal limits. The pleural space and the lung fields were unremarkable.

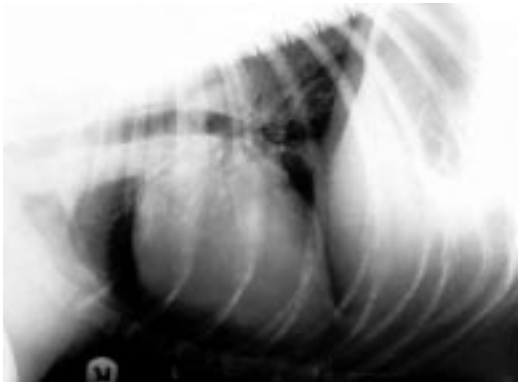

Fig. 2: *Right lateral thoracic radiograph (expiratory film): rounding of the cranial border of the cardiac silhouette. The lung fields are clear.*

Colour flow Doppler echocardiography

All chambers measured within normal limits. Posterior wall and interventricular septal wall thickness were within normal limits in diastole. The fractional shortening (FS) as indicator of myocardial contractility was mildly increased (FS53%).

A hyperechoic area was visualised in the lower part of the interatrial septum (Fig. 3). There was no sign of valvular insufficiency. The velocity across the aorta and pulmonary artery were within normal limits.

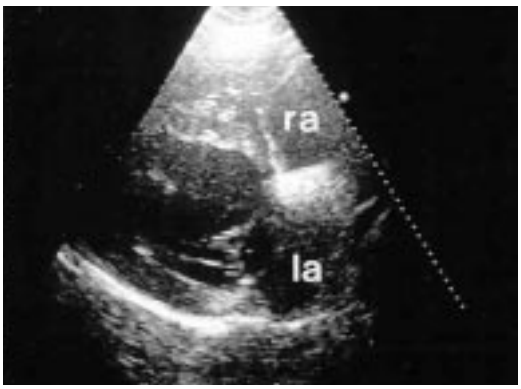

Fig. 3: *Right parasternal long-axis view showing the hyperechoic area in the interatrial septum (la: left atrium; ra: right atrium).*

FINAL DIAGNOSIS

Idiopathic third degree AV-block.

TREATMENT

The dog was pre-medicated with acepromazine (ACP®, C-Vet; 0.0125 mg/kg) and pethidine (0.5 mg/kg; Martindale) intramuscular. Prophylactic antibiotics (cephalexin, Kefzol®, Lilly; 20 mg/kg IV q 8 hrs) and analgesia (carprofen, Rimadyl®, Pfizer; 4 mg/kg IV) were administered. General anaesthesia was induced with thiopentone IV (Thiovet®, C-Vet; 412 mg) and maintained with isoflurane/O_2 (Isoflo®, Mallinckrodt). Under fluoroscopic guidance a bipolar lead (Bipolar Endocardial Lead, Porous tip, Tined; Guidant®, Basingstoke UK; Fig. 4) was implanted in the right ventricle via the left

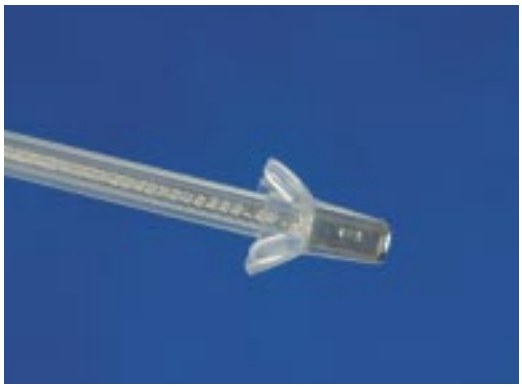

Fig. 4: *Detailed view of the end of a tined pacemaker lead.*

jugular vein. The whole procedure was monitored electrocardiographically. The bipolar lead was first connected to an external temporary pacemaker. Once the position of the lead established (pacing threshold less than 1 mA) it was tunnelled subcutaneously and attached to the pacemaker device. The permanent pacing generator (Pacesetter® VVI system) was implanted subcutaneously cranial to the left shoulder. The rate was pre-programmed at 70 BPM. A thoracic radiograph (Fig. 5) was taken for a permanent record of lead placement. The wounds were closed routinely and a protective bandage was applied.

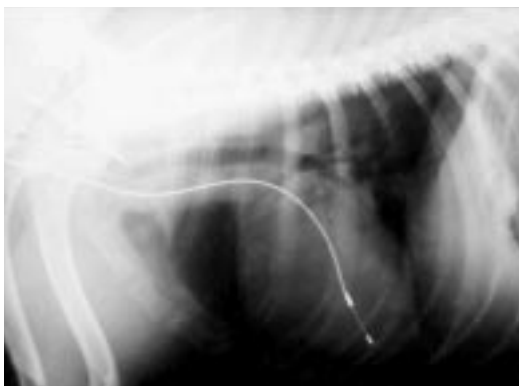

Fig. 5: *Right lateral thoracic radiograph showing correct placement of the pacemaker lead in the right ventricle. The lead has an S-bend to allow movement of the neck without putting strain on the lead.*

The dog recovered well from anaesthesia, stayed in the Intensive Care Unit for 48 hours and was hospitalised for another three days. After a last technical check at the human hospital, he was discharged with a one-week course of antibiotics (20 mg/kg cephalexin BID PO, Ceporex®;Virbac).

OUTCOME

Three years post-intervention Murdo is still doing very well and the pacemaker seems to be pacing at all times (Fig. 6).

DISCUSSION

Third degree AV-block is an uncommon arrhythmia in the dog. It has been associated with several other conditions (Table 4). In this case no underlying cause could be determined. Dogs with third degree AV-block are usually middle-aged suggesting a degenerative change in the conduction system. Degeneration of the conduction system is common in many breeds. It has been stated that German Shepherd Dogs and Cockers Spaniels are over-represented and there is one report where Dobermanns are the most common breed.

TABLE 4: Conditions associated with 3rd degree AV-block in the dog

Isolated congenital AV-block
Congenital defects like aortic stenosis and ventricular septal defect
Infiltrative disease
Idiopathic fibrosis
Trauma
Myocardial infarction
Hypertrophic cardiomyopathy
Severe digoxin toxicity
Hyperkalaemia
Lyme disease
Myasthenia gravis
Bacterial endocarditis

The importance of the hyperechoic area in the inter-atrial septum remains unclear. Hyperechogenicity is seen with fatty infiltration and collagen changes. Fibrosis and infiltrative disease are known aetiologies for third degree AV-block. Only a histopathological section might give an explanation.

Although no acetylcholine-esterase receptor antibodies were determined, myasthenia gravis was excluded as a possible aetiology on the basis of the complete absence of clinical signs. *Borrelia burgdorfi* antibody titres were ignored because Lyme disease is not endemic in the area where the animal lives.

Full bloodwork excluded electrolyte imbalances as a possible reason for the third degree AV-block. The azotaemia was, despite the lack of urinalysis (urine specific gravity), thought to be prerenal secondary to a decreased cardiac output due to the bradycardia. The renal perfusion and renal function parameters (urea, creatinine) should return to normal after pacing but no follow-up data are available in this case regarding this aspect. The mildly increased cholesterol levels could have been suggestive of hypothyroidism but T4 levels in the higher range of normal made this very unlikely.

Most animals with third degree AV-block have exercise intolerance as the main presenting sign. Dogs may also be presented because of syncope or congestive heart failure. In this case the dog was completely asymptomatic. It should be appreciated that third degree AV-block may not cause clinical signs unless there are periods with inadequate escape activity. Most healthy dogs can maintain a normal arterial blood pressure at rest with a heart rate as low as 40-60 BPM. The ECG confirmed the presence of a relatively stable escape rhythm at 60 BPM. Considering the rate, the

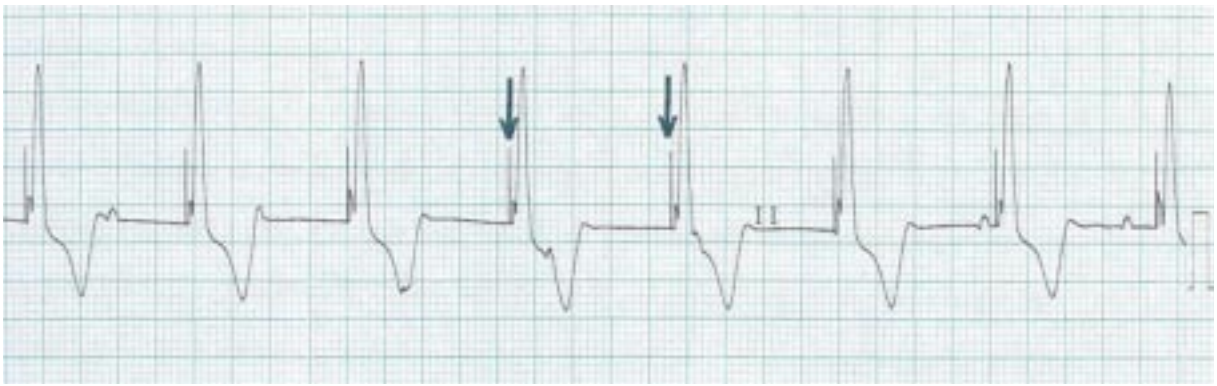

Fig. 6: *ECG showing that the pacemaker is pacing at all times, pacing spikes 1 mV heart rate 70 BPM). 25 mm/sec 1 cm=1 mV.*

escape rhythm was thought to be originating from the subsidiary pacemakers in the bundle of His and the AV-node was the most likely site of the block.

On clinical examination no heart sounds (4th heart sounds) consistent with atrial contraction were noticed, partly due to the broad-chested nature of the dog and his obesity. The bouncy nature of the dog also made prolonged auscultation very difficult. The slow regular rhythm and the absence of a sinus arrhythmia were suggestive of an abnormal rhythm in this dog. The typical cannon A-waves, generated when atrial contraction occurs when the mitral valve is closed, were not observed in this animal's jugular veins.

The radiographic changes were consistent with breed variation. Boxers have an increased VHS compared to other dogs (normal for Boxers 10.3-12.6v). As well as that bradycardia causes prolonged filling and can cause apparent cardiomegaly (diastolic frame). The echocardiographic changes (increased FS) in this case were typical of a hyperdynamic ventricle (Frank Starling mechanism).

Since the atropine response test was negative (atropine will usually increase the atrial rate without changing the ventricular rate because the ventricles are supplied mainly by sympathetic fibres and have few parasympathetic fibres) and since there was no increase of the heart rate after theophylline treatment a pacemaker implantation was the only alternative.

Despite the animal being asymptomatic, but knowing that the escape mechanism might fail, and that chronic bradycardia might lead to heart failure, pacemaker implantation was recommended. A VVI (Fig. 7) pacemaker was chosen. A rate responsive pacemaker was avoided considering the bouncy nature of the dog.

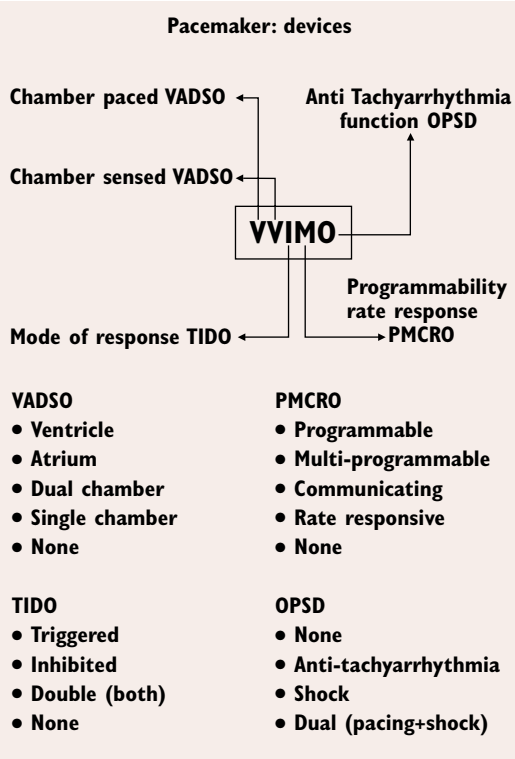

Fig. 7: *Different types of pacemakers available with nomenclature.*

Fig. 7 explains the three or five letter abbreviations used for describing the capabilities of the pulse generator. The first letter stands for which chamber is paced (V for ventricle, A for atrium,...), the second letter for which chamber is sensed (ditto), the third letter indicates the mode of response (I for inhibitory, T for triggered,...), the fourth letter shows that the device has multiple parameters that can be programmed and the final letter denotes if an anti-tachydysrhythmia function is present.

The procedure and the post-operative period passed uneventfully in this case. However, one has to be aware that major (Table 5) and minor complications (Table 6) can occur. Survival analysis in the largest retrospective canine pacemaker study published revealed 1-, 2-, 3- year survival rates of 70, 57 and 45 % respectively.

TABLE 5: Major complications seen with pacemaker implantation (Canpacers study)

Lead dislodgement (10%)
Generator failure (6%)
Cardiac arrest during implantation (6%)
Infection (5%)

TABLE 6: Minor complications seen with pacemaker implantation (Canpacers study)

Seroma formation (12%)
Muscle twitch (11%)
Inconsequential arrhythmias (11%)

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These multiple choice questions are based on the above text. Readers are invited to answer the questions as part of the RCVS CPD remote learning program. Answers appear on the inside back cover. In the editorial panel's view, the percentage scored, should reflect the appropriate proportion of the total time spent reading the article, which can then be recorded on the RCVS CPD recording form.

1. **Which of the following is not on the differential list of third degree AV block in the dog:**
   a. Myasthenia gravis
   b. Lyme disease
   c. Thoracic trauma
   d. Mitral endocardiosis
   e. Endocarditis

2. **Which of the following is not on the differential list of bradycardia in the dog:**
   a. Hypothyroidism
   b. Hyperthermia
   c. Hyperkalaemia
   d. Fit animal
   e. Increased intracranial pressure

3. **Which of the following statements regarding pacemaker implantation is incorrect:**
   a. Pacemaker implantation is not needed in animals with 3rd degree AV block but no clinical signs.
   b. Chronic bradycardia might lead to heart failure
   c. Cardiac arrest is a not uncommon and often fatal major complication of pacemaker implantation.
   d. The survival analysis in the largest retrospective canine pacemaker study published revealed 1-, 2-, 3- year survival rates of 70, 57, and 45 % respectively.
   e. Lead dislodgement is a common complication in the immediate post-operative period and therefore dogs remains hospitalised and cage confined for around 3-5 days post implantation.