CVJ CLUJ VETERINARY JOURNAL

Case Report

Endovascular single-chamber pacemaker implantation using active fixation in a 8 years old Dogue de Bordeaux with presumed Persistent Atrial Standstill: the first case documented in Romania

Florin Leca[1]*, Ştefan A. Geantă[1], Mihaela C. Bolintineanu[1], Eusebiu I. Condurachi[1], Alina Nechifor[2], Daniel Bârsan[3], Florica Bărbuceanu,[4] Nicu Caplea[5], Diana Caraza[6]

[1] AvantGard CardioTeam Interventional Veterinary Radiology Laboratory "Doctor's Vet Univers", Bucharest, Romania, leca_florin2000@yahoo.com (F.L), stefan.g.adrian@gmail.com (S.G), sebi.condurachi@gmail.com (E.C.)
[2] Veterinary Clinic "Dr. Bercaru", Bucharest, Romania alinanki4@yahoo.com (A.N)
[3] Veterinary Clinic "KronVet", Braşov, Romania, dani_bb4l@yahoo.de (D.B.)
[4] Institutul de Diagnostic şi Sănătate Animală florica.barbuceanu@idah.ro (F..)
[5] Biotronik Romania capleanicu@gmail.com (N.C.)
[6] Eximrom Biocard carazadiana@yahoo.com (D.C.)
Correspondence: leca_florin2000@yahoo.com

Abstract: Background: Symptomatic bradyarrhythmias in dogs can lead to sever hemodynamical compromise due to impaired oxygen and nutrients delivery and even sudden cardiac death. In cases refractory to medical therapy the heart rate and therefore the cardiac output are maintained in physiological ranges using artificial external, internal and temporary (emergency situations) or internal and permanent cardiac pacing.

Methods: This case report documents the implantation of a permanent transvenous Pacemaker using active fixation, for the first time in Romania in a 8 years old canine Dogue de Bordeaux with a suspicion (on surface electrocardiography) of Persistent Atrial Standstill. The diagnostic in this atrial muscular dystrophy requires differentiation from Atrial Fibrillation with Third Degree Atrioventricular Block using Cardiac Mapping, but in emergency situations or progressive Congestive Heart Failure the decision to implant the pacemaker should be based on the hemodynamical effects of the dysrhythmia and the definitive diagnostic should be made during the implantation of the device.

Results: We succesfully implanted in this case a transvenous ventricular Solia S60 lead at the level of the 1/2 distance between the mid-septal and right ventricular apex that was connected to the subcutaneously placed Pulse Generator (Enitra 6 SR).

The survival after the procedure was 202 days (6 months and 18 days) and the patient's death was not related to a cardiac cause. The necropsy showed that the active fixation in this case was preserved and there were not identified any local rejections of the lead or at the site of the pulse generator.

Conclusions: The outcome of the patient was positive regarding the described cardiac function in this case and the clinical signs went into remission shortly after the pacing.

Received: 23.12.2024
Accepted: 24.12.2024
Published: 31.12.2024

DOI: 10.52331/v29i4x55

Keywords: Cardiac Pacing, Dog, Interventional Cardiology, Symptomatic Bradyarrhythmia

1. Introduction

Symptomatic bradyarrhythmias in dogs are a class of primary or secondary cardiac conditions that can lead to temporary loss of consciousness - TLOC, Transient Loss of Consciousness 23%-77% (in dogs) (3), Cardiogenic Shock, Multiple Organ Dysfunction System (MODS) (6), or sudden death. The main bradyarrhythmias that usually require therapeutic intervention are advanced Second Degree Atrioventricular Block (3.8%-9%), Third Degree Atrioventricular Block (53%-64%), Sinus Node Disease (14.8%-29 %) (5), 4permanent pacemakers is the most effective method of treatment in symptomatic cases,

but the medical decision must take into account the severity of the hemodynamic disturbances, the coexistence of other heart diseases (valvular disease, neoplasia, etc.) or extracardiac (systemic diseases). The type of pacing, pacemaker programming, the

method of pacemaker implantation and the paced anatomical region require electrophysiologic evaluations and studies prior to the procedure (Atropine response test, Holter Electrocardiography, Cardiac Mapping) or during the procedure (by examining myocardial response to Temporary Pacing). Transvenous implantation is the most common technique in dogs but is dependent on the size of the patient (2). In cats (and dogs under 2 kg), epicardial implantation by thoracotomy or laparotomy (5) is preferred for permanent pacing or transesophageal implantation for temporary pacing (4). The pacing mode frequently preferred is VVI (Ventricular Sensing and Pacing, Sensing and Inhibited) (1) and can be used as a first intention method followed by adjustment of the pacing type according to myocardial response, condition or hemodynamic evolution. In those situations in which the type of electrical disturbance responsible for the induction of bradyarrhythmia cannot be accurately determined, the decision whether to place a pacemaker is based on the hemodynamic effect of the dysrhythmia.

This case report documents the implantation of a VVI Transvenous Pacemaker, active fixation, for the first time in Romania in a case of suspected Persistent Atrial Standstill in a dog (absence of P waves, presence of idioventricular escape rhythm in the absence of hyperkalemia) diagnosed by surface electrocardiography (diagnosis requiring differentiation from Atrial Fibrillation with Third Degree AV Block by cardiac mapping).

2. Case presentation

The patient (8 years old Dogue de Bordeaux, intact male) was referred to our clinic for cardiac exam due to bradyarrhythmia and ascites. Owner's complaints were fatigability, weight loss, "swollen belly", "dizziness". On presentation the dog was responsive, with severe abdominal distension, marked cachexia with a heart rate of approximately 40 bpm (beats per minute), synchronous pulses and a respiratory rate of 43 rpm (respirations per minute). The mucous membranes were moist and pink, with a CRT (capillary refill time) of approximately 2 seconds and a rectal temperature of 38,7 C.

Cardiac Examination

The cardiac examination consisted of electrocardiography, 24 hours Holter examination, echocardiography, blood pressure measurement, blood tests including cardiac biomarkers.

Electrocardiography

The severe bradycardia was documented with a 5 minutes (short-term) 6-lead ECG with the patient positioned in right lateral recumbency using Poly-Spectrum 8-v ECG Machine. The ECG measurements obtained were: a heart rate of 40 bpm with regular R-R Intervals, absent P-waves, Atrioventricular conduction and an Idioventricular Escape Rhythm with wide QRS complexes (137 ms) (Fig. 1).

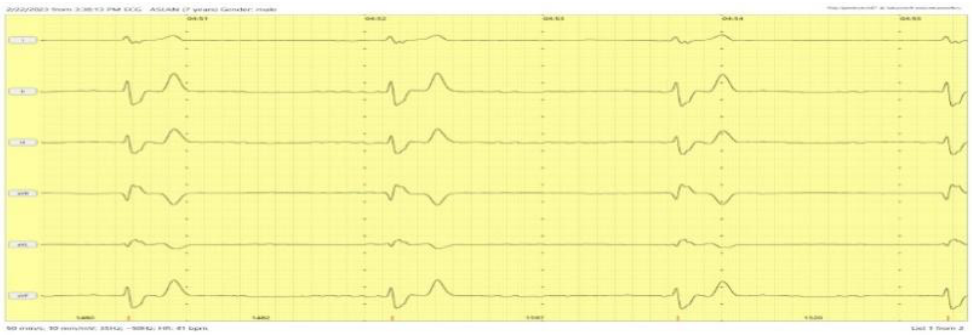

Fig. 1. ECG trace at the first visit documenting the dysrrhytmia (original photo)

Blood tests

Complementary blood tests, electrolytes and cardiac biomarkers (Cardiac Troponin I, Pro-BNP) were performed with no remarkable findings at biochemistry panel and increased cardiac biomarkers (Cardiac Troponin I 0,46 ng/ml and NT-proBNP 2845,3 pmol/l).

Echocardiography

The echocardiography was performed in a standing position using the right parasternal short axis, long axis and left apical views before the patient was positioned in a right and left lateral recumbency (in order to avoid any procedural complications related to sympathetic stress response to mechanical contention, since the patient was not compliant). The measurements were made using a Siemens Acuson Juniper Ultrasound Machine equipped with a 5P1 Phased Array and a 8V4 Phased Array probe.

Echocardiographic morphological examination

Right atrium and right ventricle enlargement, enlarged Cranial and Caudal Vena Cava, flattening of the interventricular septum, systolic pulmonary hypertension with TR Vmax (tricuspid regurgitation maximum velocity) 3,20 m/s, TR PG max (tricuspid regurgitation pressure gradient) 40,96 mmHg.

Echocardiographic functional examination

Absent A-waves on tricuspid inflow tract, mild aortic and mitral valve regurgitation, severe tricuspid valve regurgitation (Fig. 2).

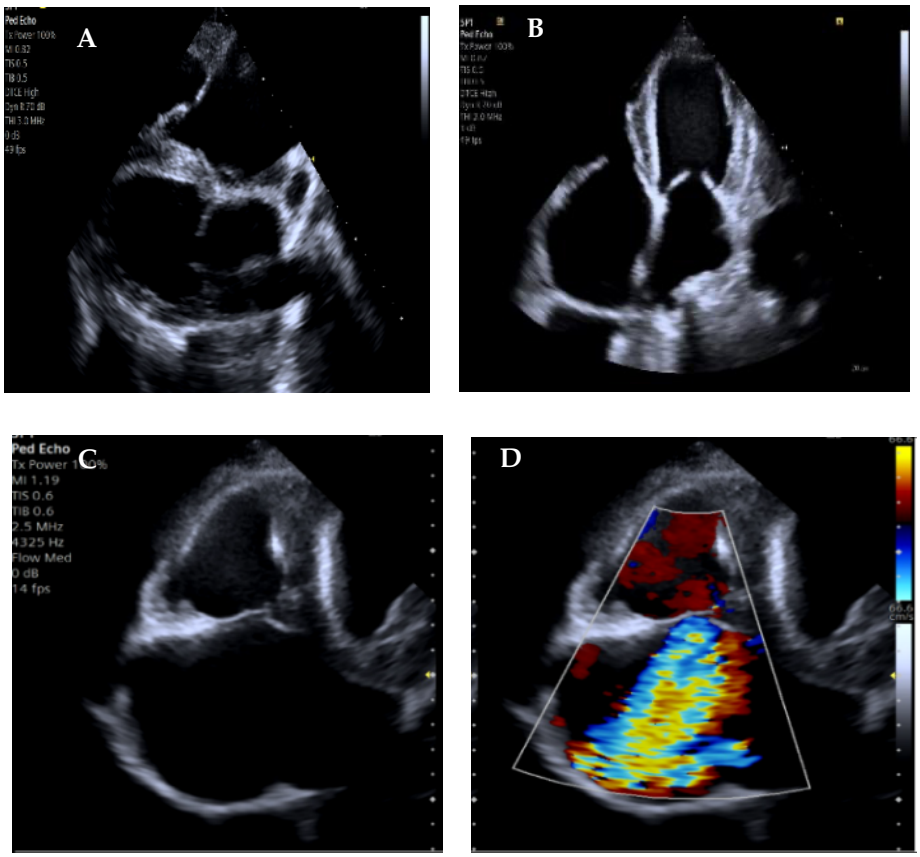

Fig. 2. (A, B, C) Right ventricle and right atrium enlargement - A. Right parasternal long axis 4 chambers view, B. Apical 4 chambers view, C, D. Apical view optimized for right heart side assessment. (D) Severe tricuspid regurgitation – D. CFM (Color Flow Mode) at tricuspid valve level (original photos)

24 hours Holter Examination

On a Dynamic Electrocardiography represented by a Holter (24h ECG) examination an Idioventricular Escape Rhythm was observed, with regular R-R interval and a 34 bpm heart rate (Fig. 3).

Fig. 3. Original ECG trace during Holter examination (original photos)

Therapeutic intervention

The patient was started on Sildenafil 2,5 mg/kg BID (to exclude precapillary pulmonary hypertension and to evaluate response to therapy) and Furosemide 1,5 mg/kg BID, Taurine and Carnitine supplementation by the first cardiologist who performed the examination.

At the one month follow-up the clinical signs were not remitted (as we expected). Ascites, fatigability, exercise intolerance and the patient's clinical condition were not improved.

At this point pacing therapy was recommended as election therapy for chronotropic insufficiency (PAS/Third Degree AVB with Afib.). Apical or Right Mid septal Single Chamber Endovascular Pacing VVI Mode – active fixation is normally recommended in this type of arrhythmia (1)

Pacing Therapy

The procedure was performed by the AvantGard CardioTeam in the "Interventional Veterinary Radiology Laboratory Doctor's Vet Univers", Bucharest, Romania.

Anaesthesia protocol and monitoring

The anaesthesic protocol included premedication with Butorhanol 0,2 mg/kg IV and Midazolam 0,25 mg/kg IV; induction with Ketamine 2 mg/kg iv and Propofol 4 mg/kg IV; maintaining using Isoflurane 1% and local anesthetic blocks with Lidocaine 1 mg/kg

Anaesthesia monitoring measured heart rate (20-24 bpm before pacing, 70 bpm after pacing), Breathing rate (10-14 rpm), Electrocadiograhy (PVCs during the lead fixation, spontaneously remitted after the procedure).

Surgical technique

After optimum anaesthetic depth was obtained, the surgical area was prepared antiseptically (clorhexidine gluconate 4%, povidone-iodine 100mg/ml, etc). The patient was placed in left lateral recumbency to expose the right external jugular vein (EJV). The neck was extended dorsally and the anterior right leg was pulled caudally for a better exposure of the right EJV and also for assuring a straight passage of the pacemaker lead at the level of the confluence of Brachial vein and the Cephalic vein communication with EJV. The skin was pulled dorsally from the projection of the EJV and the cutaneous layer was incised, the EJV was exposed and lifted using two multifilament wires placed cranially and caudally to the incision with a Mixter Hemostatic Forceps. After the blunt dissection of the perivascular layer (using the same clamp and the surgical blade), the vessel was punctured and the 6 F "Peel-away" introducer sheath was prepared for inserting the lead. Using the Modified Seldinger Technique, the sheath was introduced through the EJV and secured with a mutifilament wire to the skin (Fig. 4).

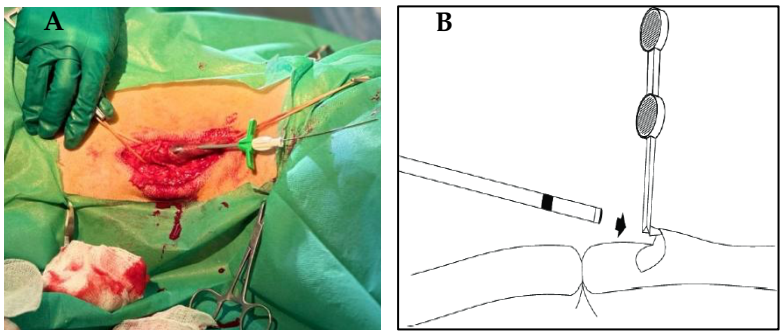

Fig. 4. A. Placing the introducer sheath in the EJV (original photo); B. Another technique is inserting the lead directly into the EJV using the vein picker (Biotronik original photo)

Imaging guidance

Fluoroscopic Image Guidance was provided during the procedure (using a Siemens Cios Select mobile C-Arm). Angiography was performed using a Floating Angiography Catheter (Pulmonary Capillary Wedge Pressure, PCWP) which was positioned using the venous access port (represented by the Peel Away introducer sheath) in the Cranial Vena Cava. Subsequently, by manual injection of a solution of Iohexol (diluted 1:1 with 0.9 % saline solution), the path of the Cranial Vena Cava and Right Atrium were visualized. (Fig. 5)

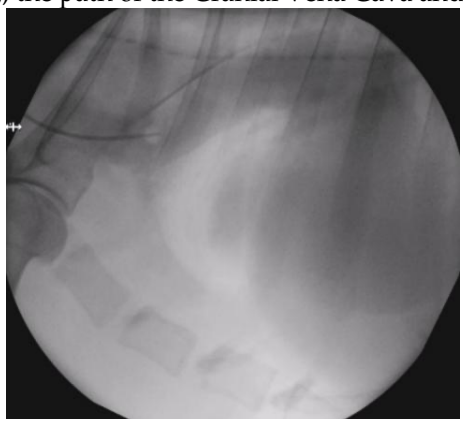

Fig. 5. Positioning the PCWP catheter in the Cranial Vena Cava and contrast administration (original photos)

Placing and securing the pacemaker lead

The pacemaker lead Solia S60 (Fig. 6) used had a diameter of 1.9 mm (5.9 F) at its tip, 1.8 mm (5.6 F) at its body and a steroid (dexamethasone acetate) reservoir at its tip, in the form of a silicone rubber ring, for anti-inflammatory effect. The body of the lead is formed by two coaxial coils made of several wires placed in parallel and the coils are the conductors to the tip and ring. The lead has a coaxially predesigned stylet which has the purpose of facilitating the desired position. Stimulation and detection take place between the distal pole and the annular electrode.

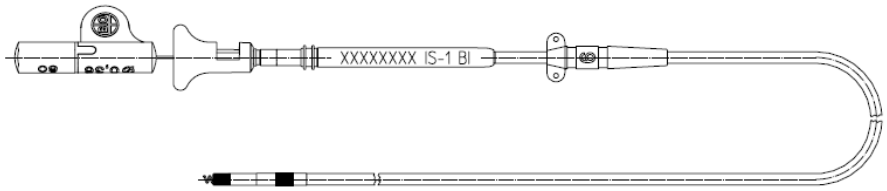

Fig. 6. Solia S lead, active fixation (Biotronik)

At the tip of the lead is a screw (Fig. 7) that can be inserted or withdrawn to actively fix it in the myocardium thickness.

The mechanism is operated by rotating the contact stiff of the probe connector using a plastic clamp (delivered with the lead by the manufacturer). The fixing screw, which is electrically active and forms the distal pole of the probe, is made of platinium-iridium alloy, has a maximum penetration depth of 1.8mm, an electrically active surface of 4.5mm2. The typical number of turns for insertion (and withdrawal) is 5 to 10 turns (maximum/optimum 23).

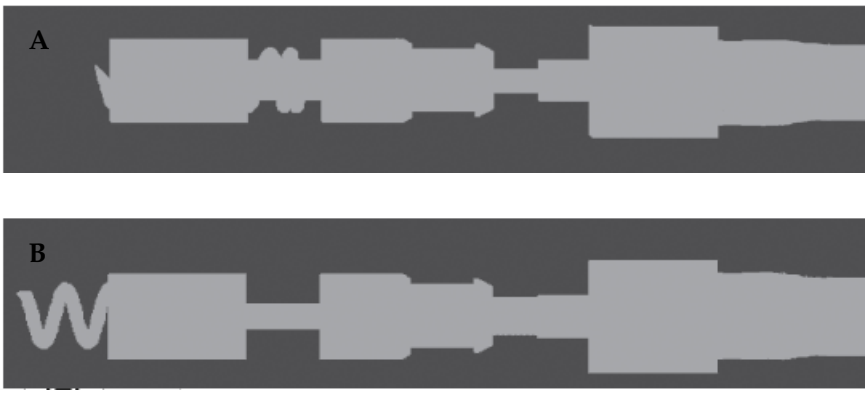

Fig. 7. Rontgen aspect of the unarmed (A) and armed (B) lead's screw (Biotronik original photo)

Inserting the lead through the peel-away introducer sheath and for a proper position the stylet was preshaped (S-shape) in order to obtain a better approach of the mid septal location or for the most perpendicular approach of the interventricular septum. At this point the neck of the patient was extended dorsally to exclude any tension applied to the lead when it will be connected to the pulse generator.

Since the site of this particular arrhythmia (supraventricular) was considered to be at the level of the Atrioventricular Junction, the lead position suited in this case was ideally the mid septal or at least right apical ventricular myocardium. Our team used the right ventricular apical positioning of the lead and secured it into the myocardial layer (Fig. 8). We investigated the response to 2.5 mV stimulation of the myocardium by connecting the lead to the pulse generator and observed no response on the surface ECG; afterwards we increased the voltage in order to obtain a normal response. At this point (due to the high level of electrical stimulation) we decided to reposition the lead, considering the possibility of previously pacing a non-responsive myocardial area (maybe due to fibrosis or other morphological changes of the myocardial tissue). Therefore the screw was withdrawn (23 turns clockwise) and the lead was repositioned targeting

the half distance between mid-septum and right ventricular apex. We reinvestigated the pacing effect over the myocardium and we observed a positive response, represented by a ventricular rate of 70 beats per minute.

Considering that, in this case, this site was proper for pacing therapy (based on ECG surface) our team decided to leave the pacemaker lead in this position.

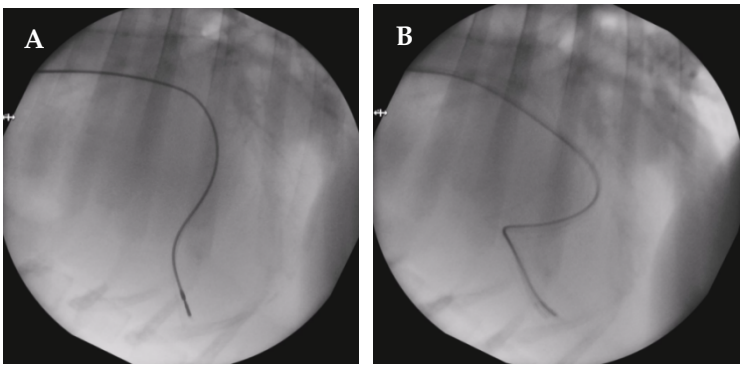

Fig. 8. Positioning the lead at A. the level of right ventricular apex; B. the half distance between mid-septum and right ventricular apex Pulse Amplitude 2.5 V with pacing response (original photos)

Pacemaker programming

In an emergency situation, normally the pulse generator (that is made for human use) comes with pre-defined programming, the heart rate being usually set at 60 beats per minute. Considering we had a large breed canine patient, the heart rate was set at 70 beats per minute (with the possibility to further adjust the settings).

The threshold (minimum amount of energy required to evoke an action potential) reaches its highest level in 2-6 weeks after the surgery, followed by attaining a stable level at approximately 2-3 times the acute level. Intensity of the electrical stimulus is described by its amplitude and duration. Heart Rate was fixed at 70 bpm, the lead impedance increased at 604 Ω, refractory period was set at 250 ms (miliseconds) with the possibility to be increased up to 280-300 ms in the next 8 weeks. After 8 weeks the target was to decrease the pulse amplitude (initially set at 5.0 V, 1.0 ms) and possibly to set the heart rate at a higher value during the day and at effort (70 bpm during the night, approximately 140 bpm during exercise).

Securing the lead to the adjacent connective tissue

After removing the peel-away introducer sheath the next step is to secure the lead in a proper position.

At this point we fixed the external connector of the lead with a monofilament suture material to the EJV and with a second wire we secured the lead to the perivascular connective tissue in order to achieve a fixed position of the external part of the lead (Fig. 9).

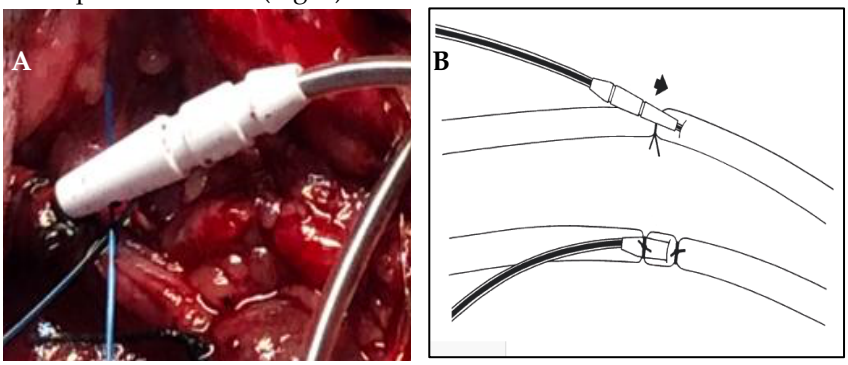

Fig. 9. A. Close-up aspect of lead fixation at the level of the jugular vein, by using the plastic fixation tool provided with the lead (original photo) and B. Biotronik original photo of the same aspects

Surgical placement of the pacemaker

Once the lead was fixed and connected, a small pocket was made by blunt dissection in the caudo-lateral area of the neck, in order to place the pulse generator and afterwards the pocket was ligated routinely.

Pacemaker evaluation

We evaluated the response of the external pacing 24 hours after the surgery by performing 5 minutes (short time) 6 leads ECG (Fig. 10) with the patient positioned in right lateral recumbency. The ventricular rate was in accordance with the intra operatory settings of the pacemaker (70 bpm) (Fig. 11), which produced a secondary improvement of the cardiac output. We also interrogated the 48 hours heart rate trend using the Biotronik programmer and we observed a normal and constant heart rate response to pacing therapy (Fig. 12).

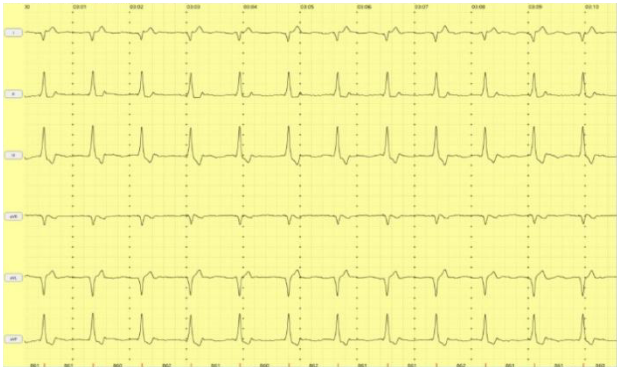

Fig. 10. 6 leads ECG performed 24 hours after pacing, showing R-R intervals and 70 bpm HR (original photos)

Parameters - Overview		(1st interrog.)
Mode		VVI
Basic rate/Night rate [bpm]		70/OFF
Sensor/Rate fading [bpm]		-----/OFF
Upper rate response [bpm]		
Pulse amplitude [V]		5.0
Pulse width [ms]		1.0
Capture control		OFF
Sensitivity [mV]		AUTO
Refract. period [ms]		250
Sensing polarity	↕	BIPL
Pacing polarity	↕	BIPL

Fig. 11. Pacemaker parameters interogation using pacemaker programmer (original photo)

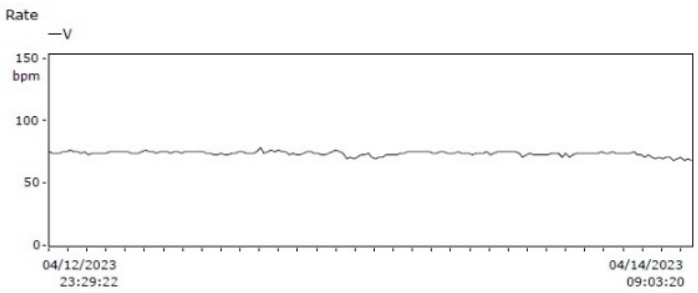

Fig. 12. 48 hours HR trend provided by the programmer (original photo)

The patient was reassessed monthly and no changes from the baseline settings were noted. Six months postoperatively the patient was hospitalized for Acute Abdominal Syndrome and later died. A necropsy

was performed and showed small foci of intestinal necrosis, considered not related to the cardiac disorder. The pulse generator and the lead were in proper initial position confirming that the surgical technique and right ventricular apical fixation were optimal (Fig. 13).

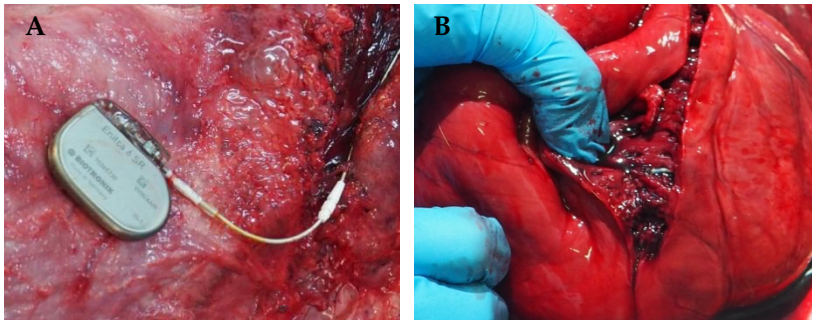

Fig. 13. A, Necropsic images of the Pulse generator and B, Fixed lead into the right ventricular myocardium

3. Results

The suspicion of Persistent Atrial Standstill can be easily made using a 6-lead surface ECG, but there is a possibility that a regular Idioventricular Rhythm, similar to that of PAS, may be found in patients with Atrial Fibrillation and Complete Atrioventricular Block.

The anchoring of the active-fixation pacemaker lead can be easily accomplished by fluoroscopic imaging, where even the corkscrew-like fixation loops at the tip of the lead can be visualized.

The follow up of this procedure showed a stable heart rate and a secondary improvement of the cardiac output which were considered normal for assuring an optimal hemodynamic stability.

4. Conclusions

Using a programmer to detect myocardial viability during implantation can improve outcome

The anchoring of the active-fixation pacemaker lead can be easily accomplished by fluoroscopic imaging guidance, where the corkscrew-like fixation loops at the tip of the lead can be visualized.

The outcome of the patient was positive regarding the cardiac function and the clinical signs went into remission shortly after the pacing.

The survival after the procedure was 202 (6 months and 18 days) days and the patient's death was not due to a cardiac cause.

5. Patents

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

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