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CARDIAC PACEMAKER IN DOGS

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ABSTRACT

The procedures of implanting the permanent cardiac pacemakers was performed in four dogs sent for cardiological consulting because of no progress in the routine treatment. After taking history data, the dogs were clinically examined and then had extra tests made: EKG, Rtg, heart and abdomen echography, morphological tests and some selected biochemical blood plasma parameters. Some dogs had some of these tests performed at their local clinics. Serious disease symptoms, significally restricting the dogs' life activietes, were present in all cases. The dogs required cardiological preparation resulting in the best possible patient's state on the day of surgery. In conclusion we can say, that: 1. implantation of permanent cardiac pacemaker is the only method of treatment in case of some cardiac arrhytmias; 2. cardiac pacemaker used inhuman medicine are suitable for dogs; 3. the procedure can be routinely performed in properly equipped veterinary clinics.

Key words: dogs, cardiac pacemakers

INTRODUCTION

Introduction of pacemakers into medicine was a major breakthrough in the treatment of heart diseases. Since 1958, when they were first used in Stockholm, they have been considered the best therapeutic method when costs and results are taken into account (13). A rapid development of this method is observed, including not only improvement of the device but also constant increase in the number of indications for its use. The idea of the

device is to make it generate impulses transmitted through the electrode to the cardiac muscle. A pacemaker is to normalize the electric heart activity in order to enable its effective mechanical performance and ensure the necessary minute ejection output.

The electric cardiac stimulation is divided into two basic forms:

1. Temporary stimulation with an external pacemaker
2. Permanent stimulation with an internal pacemaker.

Both stimulation kinds require the use of highly specialized equipment and skilled therapeutic team.
Indications for implantation of the pacemaker are now divided into three classes (1)

Class I It is necessary to implant the pacemaker or anti-arrhythmic device	Atrioventricular block III° Symptomatic bradycardia Congestive heart failure Documented, asymptomatic substitutive rhythm with bradycardia Fainting disappearing after temporary stimulation Atrial fibrillation and flutter Supraventricular tachycardia with atrioventricular block III° Recurrent and resistant to pharmacological treatment symptomatic tachycardia
Class II Pacemakers or anti-arrhythmic devices are often implanted but there is no consensus as to the necessity of their use	Asymptomatic atrioventricular block III°and II° with ventricular rate over 40/min Two- or three-compound block with fainting, impossible to attribute with certainty to atrioventricular block P/K III° Dysfunction of sinus node in the course of necessary pharmacotherapy Prolonged QT interval syndrome Alternatively to pharmacolgical treatment of recurrent supraventricular tachycardia
Class III Implantation of the pacemaker or anti-arrhythmic device is commonly considered unnecessary	Atrioventricular block I° Multicompound block without clinical symptoms Frequent, complex ventricular extrasystole with no tachycardia or prolongation of QT interval

Clinically we discern the following slow cardiac rhythms (12):

Bradycardias with regular ventricular action:
- sinus bradycardia
- substitutive nodal rhythm
- substitutive ventricular rhythm
- long QT syndrome

Bradycardias with irregular ventricular action:
- sinus arrhythmia
- bradycardia with extrasystolic beats
- atrial fibrillation with slow
- ventricular action
- partial atrioventricular block
- multicompound blocks

Fast cardiac rhythms (14):
- atrial and nodal tachycardia
- atrial flutter
- atrial fibrillation
- Wolff-Parkinson-White syndrome
- ventricular tachycardia
- ventricular fibrillation and flutter

Slow and fast cardiac rhythms:
- bradycardia-tachycardia syndrome

Cardiomyopathies - They have recently been added to the list of indications for implantation of permanent cardiac pacemaker. Bilocular pacemakers are implanted in these cases to ensure better synchronization of atrial and ventricular beats and to enlarge minute ejection output. These procedures are also performed as an extra method of treatment in case of ineffectiveness of pharmacological treatment (9).

The use of pacemaker allows for elimination of pharmacotherapy with all its side effects, unrequired and permanent costs. The use of cardiac pacemakers in humans significantly prolongs survival – one-year mortality of 35-50% in patients without a pacemaker and 5% in patients with a pacemaker.

The device composing a pacemaker consists of two parts: impulse generator- pacemaker and an electrode transmitting stimuli to the cardiac muscle. Only epicardial electrodes, fastened to epicardium after thoracotomy, were used originally (2,3,5). The pacemaker was usually placed between the abdominal muscles. Endocardial electrodes, inserted through vein like a catheter into the right ventricle and implanted there, have been used recently (11,16).

A significant development can be observed specially in the design of pacemakers. There are so many types of them that, in order to allow doctors differentiation, a letter code has been introduced and recognized by the International Association of Pacemaker Manufacturers.

Until now, a 3 letter code has been used but it is going to be expanded to a 6-letter one because of the further improvements of the device.

Code description:

VOO - ventricular stimulation with steady rate
VVI - ventricular stimulation with steady rate, with ability to sense spontaneous ventricular depolarization; does not send impulses during depolarization which prolongs battery life
AOO - atrial stimulation with steady rate
AAI - atrial stimulation. Senses electric function of the atria and saves batteries
VAT - requires two electrodes; the first sensing atrial impulses (placed in the atrium) and the other one placed in the right ventricle, sending impulses in case of absence of atrial stimulation
DVI – requires two electrodes; the atrium is stimulated and, after a programmed pause, the ventricle. Senses ventricular impulses
VDD - needs two electrodes; senses atrial and ventricular impulses; atrial and ventricular stimulation.

The most important factors influencing permanent pacemaker's work time are as follows:

1. Kind of battery - mercury-zinc ones last for about 3-5 years; lithium ones 8-10 years
2. Kind of material used for pacemaker's housing
3. Surface of the stimulating electrode
4. Degree of the device complexity - the more processors there are, that is the more intelligent the device is, the faster the battery is used up
5. Stimulated heart rate - the faster heart rate, the faster battery use.

Attempts at introducing the pacemakers into veterinary medicine were made almost immediately after introducing this treatment method. Relatively poor experience in this field can be explained by scarcity of arrhythmia cases requiring this treatment method and by the device costs. In most performed cases of artificial cardiac pacemaker implantation in dogs, the epicardial electrodes were used, which necessitated thoracotomy and pericardiotomy as well as laparotomy (2). Some successful procedures of implanting endocardial electrodes with an intelligent pacemaker were also performed, which confirms the possibility of using pacemakers, designed for humans, in veterinary medicine (11).

MATERIALS AND METHODS

The procedure of implanting the permanent cardiac pacemaker was performed in four dogs sent for cardiological consulting because of no progress in the routine treatment. After taking history data, the dogs were clinically examined and then had extra tests made: EKG, Rtg, heart and abdomen echography, morphological tests and

some selected biochemical blood plasma parameters. Some dogs had some of these tests performed at their local clinics. Serious disease symptoms, significantly restricting the dogs' life activities, were present in all cases. The heaviest clinical symptoms were manifested in dachshund, which was treated for pulmonary edema three times. All dogs were earlier symptomatically treated: with antibiotics, steroids (except golden retriever) and furosemide (except mongrel). After the tests an attempt was made to alleviate arrhythmia (bradycardia) with atropin. Since this proved ineffective, the dogs were qualified for surgery.

The dogs required cardiological preparation resulting in the best possible patient's state on the day of surgery.

Table 1. Deviations observed in clinical tests (EKG, RTG, echography, blood tests) in dogs

	History	Deviations observed in clinical tests	EKG	RTG	Echography	Blood tests
Bitch 11 year old Mongrel 12 kg	Temporary faintness, serious weakness.	Heart sounds covered with clear murmur, loudest over mitral valve. Slow, bigeminal heart sounds. Slow irregular, pulse beat, relatively well filled. CRT> 5 s	Atrioventricular block III°. Substitutive ventricular rhythm.	Significantly enlarged heart shadow.	Dilatation of the heart.	E: 7,1 T/l Hb: 15 mmol/l Ht: 51% L: 7,7 G/l OB: 1/3 GOT: 28 U/l GPT: 32 U/l Urea: 7,9 mmol/l Creatinine: 88 μmol/l
Dog 10,5 year old Dach-shund 8 kg	Recurrent infections of upper airways with serious dyspnea. Coughs up frothy-mucous secretion, colored with blood.	Moist rales and bronchial murmur over lung field. Slow heart sounds, covered with murmur with pronounced I sound. Slow, irregular pulse beat. CRT> 5 s	Atrioventricular block III°. Substitutive ventricular rhythm. Dimorphous ventricular complexes.	Significantly enlarged heart shadow. Densifications of lung fields.	Dilatation of the heart.	E: 8,37 T/l Hb: 19 mmol/l Ht: 56% Reticulocytes: 1,2 % L: 8,0 G/l GOT: 26 U/l GPT: 18 U/l Urea: 9 mmol/l Creatinine: 76 μmol/l
Dog 2,5 year old Bavarian blood-hound 13 kg	Pneumonia, ascites.	Emaciation, slight ascites. Moist rales in the lower lung parts. Loud bronchial murmur over the whole lung field. Loud, slow heart sounds. Slow, regular, well filled pulse beat. CRT> 5 s	Substitutive supraventricular rhythm.	Interstitial, posterior pulmonary lobe pneumonia. Enlarged heart.	Dilatation of the heart. Ascites, dilated hepatic veins, hepatomegaly.	E: 7,21 T/l HB: 16,6 HT: 48% L: 14,6 G/l OB: 1/2 GOT: 25 U/l GPT: 41 U/l Urea: 33 g% Creatinine: 1,06 g%
Dog 1,5 year old Golden Retriever 40 kg	Cough and increasing ascites for one month.	Slight lividity of the conjunctivae. Slow heart sounds. Slight ascites. CRT> 5 s	Substitutive supraventricular rhythm.	Significantly enlarged heart shadow.	Dilatation of the heart. Ascites, dilated hepatic veins, hepatomegaly.	E: 4,71 T/l HB: 12,3 HT: 35% L: 18,2 G/l OB: 2 B.C.: 5,6 g% Albumins: 30,8 g/l Kalium: 4,1 mmol/l

All dogs had pacemakers with endocardial electrodes implanted. An external jugular vein branch of suitable size was prepared and after incision a special probe was placed inside. The electrode was placed, with the help of the probe and under RTG control, in the right cardiac ventricle and anchored there. Correct placement was confirmed with RTG and EEG. Under the neck skin, after blunt preparation, a bed was made for the pacemaker. The electrode was connected to the pacemaker and, after electrocardiographic control of its function, the pacemaker was placed in the prepared bed. Both the electrode and the pacemaker were secured with ligatures.

DISCUSSION

After implantation of the pacemakers, the clinical status of all dogs improved very fast and the symptoms regressed completely. The wounds healed quickly, without complications. The possibility of implanting pacemakers constituted a major breakthrough in cardiology but, as any other method, has its specific limitations and disadvantages. First of all, it requires a costly equipment and a skilled team of doctors and technicians. The owner has to participate actively in the postoperative care and comply with specific limitations concerning the dog and related to the implanted pacemaker. All these limitations, for the time being, make this method unsuitable for common use in all physicians' offices. It is appropriate, however, and should be introduced to big clinics equipped with proper diagnostic equipment.

Complications after pacemaker implantation might be divided into two groups:

- Related to the implanting procedure
- Secondary, developing as a result of the implant's function.

A possibility of infection contracted during the procedure must be included into the first group; it is very slight but present even in the renowned cardiological clinics (10). The dachshund after two months developed edema in the area of the pacemaker and subsequently a fistula. In spite of that, the dog felt well during all this time. After rinsing the wound with rivanolum solution and administration of three doses of 0,5 ml/5 kg body mass of duplocyline the fistula healed with no further complications.

Ather complications might be the following: breaking of the electrode while performing maneuvers during the surgical procedure, and while securing the ligatures too tight, improper anchoring in the ventricle or wrong connection with the pacemaker. Pulmonary edema, hemorrhage, thrombophlebitis and arrhythmia caused by the maneuvering catheter are all very rare complications.

Sometimes, directly after implanting the pacemaker with a monopolar electrode, a temporary muscle stimulation in the area of the pacemaker appears, observed in the form of muscular tics. It is caused by too great density of electric charges on the small pacemaker's surface. The pacemaker must be reprogrammed in such cases.

Exit block can develop within 2 weeks after placing the electrode as a result of proliferation of the connective tissue around the electrode. It is observed far more frequently in case of epicardial electrodes.

Inhibition of impulses by active muscle function around the pacemaker.

More intelligent pacemakers have a more favourable effect, since they can adapt to heart and the whole organism activity more precisely; however, they can also cause complications in the form of pacemaker tachycardia (8). This, in turn, might be caused by several mechanisms: atrial fibrillation and flutter, retrograde atrial-ventricular conduction, atrial and ventricular ectopic beats or loss of stimulation/sensation in the atrium. It those cases it is necessary to interrupt tachycardia through the temporary steadying of the pacemaker rhythm or even electric heart defibrillation (7).

A patient with the implanted pacemaker should not be defibrillated, subjected to diathermy, radiation, electric stimulation, magnetic resonans and electric coagulation. He should not stay close to the devices generating strong electromagnetic field, e.g. high voltage lines. Electric household appliances generally cannot cause interference, except when in direct contact with the pacemaker's area. Mechanical injuries of this area shall be avoided since they can damage it. In case of the pacemaker with monopolar electrode, the dog should not be allowed to swim. The pacemaker will be detected by metal detectors (for example at the airports), which may also influence its function.

Three out of four dogs that had the pacemakers implanted are alive, normally active and demonstrate no symptoms of circulatory insufficiency. Only the dachshund, which escaped from its owners by digging a passage under the fence and returned after three days demonstrating symptoms of severe circulatory failure, died of pulmonary edema.

CONCLUSIONS

1. Implantation of permanent cardiac pacemaker is the only method of treatment in case of some cardiac arrhythmias.
2. Cardiac pacemakers used in human medicine are suitable for dogs.
3. The procedure can be routinely performed in properly equipped veterinary clinics.

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