RADIOFREQUENCY CATHETER ABLATION OF FOCAL ATRIAL TACHYCARDIA AS A TREATMENT OF TACHYCARDIA-INDUCED DILATED CARDIOMYOPATHY IN A DOG

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Abstract

A case of a dog with symptoms of weakness and cough caused by very rapid atrial tachycardia (270 bpm) was presented. Electrocardiography showed P wave preceded, narrow QRS complex incessant tachycardia. Echocardiography showed enlargement of both atria and ventricles. Tachycardia-induced cardiomyopathy resulting from permanent atrial tachycardia was diagnosed. The dog was ineffectively treated with metoprolol, digoxin, and amiodarone. The electrophysiological study revealed atrial tachycardia from the coronary sinus ostium. Radiofrequency catheter ablation was performed inferiorly to the coronary sinus ostium and tachycardia was successfully interrupted. After 5 d, electrocardiography showed a recurrence of sustained atrial tachycardia with a rate of 220 bpm (beats per minute) but of different P wave morphology. The electrophysiological study revealed atrial tachycardia from the same region of right atrium. Once again radiofrequency catheter ablation was successfully performed in the roof of coronary sinus ostium and tachycardia was not inducible in electrophysiological study. In the 3 month follow-up, Holter monitoring confirmed sinus rhythm in this dog. Echocardiography showed normal size atria and ventricles, normal shortening fraction, and normal left ventricular ejection fraction.

Key words: dog, heart, arrhythmia, atrial tachycardia, ablation.

Focal atrial tachycardia (FAT) is defined as an atrial activation starting rhythmically at a small focus from which is spreads out centrifugally and without activation over an important portion of the cycle length. FAT is relatively rare in people and dogs. A lot of patients with FAT have tachycardia-induced cardiomyopathy (TICM) (7). Radiofrequency catheter ablation is a method of choice as an effective treatment of FAT in humans. The aim of the study was non-pharmacological treatment of FAT in a dog suffering from TICM.

Material and Methods

History and clinical findings. A 10-year old male French bulldog with weakness, exercise intolerance and three episodes of fainting was presented. The electrocardiographic (ECG) recording showed a very rapid atrial tachycardia (270 bpm) (Fig. 1). The veterinarian administered digoxin (0.0011 mg/m² body surface PO (per os) q12; Digoxin, Teva Pharmaceuticals, Poland). ECG recording after 2 weeks showed an incessant atrial tachycardia with a rate of 260 bpm with 2nd degree AV block. The veterinarian changed the treatment and administered amiodarone (10 mg/kg PO q12h (every 12 h); Cordaron, Sanofi-Aventis, France). ECG recording still showed permanent atrial tachycardia (260-270 bpm). The veterinarian administered amiodaron (10 mg/kg PO q12 h) in combination with metoprolol prolongatum (1 mg/kg PO q24h - every 24 h; Betaloc Zoc 25, AstraZeneca, Sweden). The following ECG recording showed incessant atrial tachycardia (250 bpm). After 3 months of antiarrhythmic therapy, the dog was referred to a veterinary cardiologist in the Department of Internal Medicine and Clinic of Diseases of Horses, Dogs and Cats at the Veterinary Medicine Faculty, Wroclaw.
Fig. 1. Resting electrocardiogram showing focal atrial tachycardia. Speed 50 mm/s, 10 mm/mV.

Fig. 2. Antero-posterior oblique (30° left of the sagittal plane) fluoroscopic view of the thorax in dog obtained during endocardial mapping of the right atrium. An ablation catheter is inserted in Koch triangle region and diagnostic catheter is positioned at the CS.
Fig. 3. Endocardial electrocardiograms from diagnostic and ablation catheter and surface ECG lead I, II, III showing attempt at locating atrial ectopic focus as the site of earliest intracardiac activity in relation to the onset of P wave during atrial tachycardia. Speed 50 mm/s 10 mm/mV.

Fig. 4. Endocardial electrocardiograms from decapolar/ablation catheter and surface ECG lead I, II, III showing atrioventricular nodal escape rhythm with narrow QRS complex and retrograde P wave 1:1. Speed 50 mm/s 10 mm/mV.
ECG, echocardiography examination and blood analysis were performed in the Department of Internal Medicine and Clinic of Diseases of Horses, Dogs and Cats at the Veterinary Medicine Faculty, Wroclaw University of Environmental and Life Sciences. Electrophysiological study (EPS) was performed under general isoflurane anaesthesia after medetomidine premedication (1 mg/ m² body surface). Vascular access was attained in the right and left external jugular vein using the percutaneous Seldinger method. Under fluoroscopy and intracardiac ECG, a multipolar electrode catheter 6F was inserted through the right external jugular vein into the coronary sinus (CS). A 7F ablation catheter was positioned through the left external jugular vein into the right atrium in the Koch triangle region (Fig. 2).

Results

ECG recording showed rapid (260-270 bpm) preceded by P wave, narrow QRS complex, sustained tachycardia with rare single or double sinus rhythm evolution insertions. The echocardiography examination showed enlargement of both atria and ventricles. Tachycardia-induced dilated cardiomiopathy (TICM) was diagnosed (Table 1).

Blood morphology and biochemistry (WBC, RBC, PLT, Hb, Ht, urea, creatinine, ALT, AST, alkaline phosphatase, K⁺, Na⁺, Ca²⁺) showed no abnormalities. A presumptive diagnosis of focal atrial tachycardia was made and the dog was referred for electrophysiological evaluation and radiofrequency catheter ablation.

Intracardiac ECG recording showed permanent low right atrial tachycardia. The atrial ectopic focus was localised at a site of earlier presystolic intracardiac activity in relation to the onset of P wave during atrial tachycardia (Fig. 3). The ablation catheter was used to map and to localise the ectopic foci below the ostium SC. Successful radiofrequency catheter ablation was performed (two applications 60 s, 20 W, 50°C, with no complications). After 5 d, electrocardiography showed recurrence of atrial tachycardia with a rate of 220 bpm but of a slightly different P wave morphology. EPS was performed again under general anaesthesia by using the same method as described previously. ECG recording showed incessant low right atrial tachycardia. The ablation catheter was used to map and to localise the second ectopic focus slightly above the previous one. Once again radiofrequency catheter ablation was performed with cool tip catheter (six application 15-45 s, 45 W, 45°C). The last application was disrupted with a transient IIIrd degree AV block. After a 90 s stimulation and intravenous 1 mg adrenaline administration, recurrence of AV conduction 1:1 was observed. At first we observed an atrioventricular nodal escape rhythm with a narrow QRS complex and retrograde P wave 1:1 (Fig. 4) and then a sinus rhythm with a rate of 150 bpm. In the 3 month follow-up, the dog was asymptomatic. Holter monitoring revealed no evidence of atrial tachycardia. The echocardiography examination showed normal size of atria and ventricles (Table 1).

Discussion

Supraventricular arrhythmias are very common in dogs (2, 7-10). They are observed in healthy dogs and in dogs with systemic heart diseases (1, 2). Among supraventricular arrhythmias predominantly atrial fibrillation and atrial and nodal premature beats are recorded (10, 12). Focal atrial tachycardia (FAT) is defined as atrial activation starting rhythmically at a small area (focus) out of the sinus node and propagating centrifugally (10).

Available information suggests that focal activity can appear automatically, by triggered activity or due to a reentry mechanism (10, 11). In dogs, similarly to humans, the ectopic foci are often localised in the right atrium (5). In the case described above, the ectopic foci were also localised in the right atrium: below and over the CS. Foci of atrial tachycardia of different localisation are described in dogs and human (5, 10). The mechanism of FAT can be diagnosed by performing an in electrophysiological study (5, 10, 11).

Table 1

Data of echocardiography examination in French bulldog, 1 week before frequency catheter ablation, 2 weeks after first ablation and 3 month after the second ablation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1st examination</th>
<th>2nd examination</th>
<th>3rd examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left ventricular end-systolic diameter (cm)</td>
<td>2.8</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Left ventricular end-diastolic diameter (cm)</td>
<td>3.5</td>
<td>3.8</td>
<td>3.0</td>
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<td>Left ventricular wall end-systolic diameter (cm)</td>
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<td>Left ventricular wall end-diastolic diameter (cm)</td>
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<td>0.7</td>
<td>0.8</td>
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<tr>
<td>Intraventricular septum end-systolic diameter (cm)</td>
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<td>1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Intraventricular septum end-diastolic diameter (cm)</td>
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<td>0.9</td>
<td>1.0</td>
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<td>Left ventricular ejection fraction (%)</td>
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<td>63.9</td>
<td>67.7</td>
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<td>Shortening fraction (%)</td>
<td>19.6</td>
<td>34.1</td>
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<td>Right ventricular end-diastolic diameter (cm)</td>
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<td>Aorta (cm)</td>
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<td>1.78</td>
<td>1.81</td>
</tr>
<tr>
<td>Left atrium (cm)</td>
<td>2.8</td>
<td>2.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

1st examination - before frequency catheter ablation. 2nd examination - 2 weeks after first ablation, 3rd examination - 3 month after the second ablation.
Intracardiac electrical activity can be recorded during endocardial mapping. Complete endocardial activation mapping can be performed in the right and left atrium (11). The described FAT was incessant, only with rare single or double sinus rhythm evolution insertions. During the repeated procedure, after the first successfully performed application of radiofrequency (RF) energy, the FAT was induced by premature atrial beat. The mechanism of this FAT was probably a triggered activity, which is rarer than abnormal automaticity in dogs (10). Santilli et al. (10) described that 63% of FATs probably can appear due to automaticity because FATs were inducible only under isoprosterenol infusion. This mechanism may be suspected when a progressive rate increases at tachycardia onset (warm up) and/or a progressive rate decreases before tachycardia termination (cool down) (10). In the described case, the cycle length was regular and significantly slowed down only during application of RF energy.

Radiofrequency catheter ablation is a non-pharmacological method of arrhythmia treatment. It is a safe method but complications are likely. The complication rates vary depending on the type of arrhythmia being ablated and on the experience of the operator (5). The incidence of serious complications is approximately 1%. The major complication in ablation of supraventricular tachycardia is atrioventricular node damage requiring an implantation of a pacemaker (4). In the described case, the IIIrd degree AV block spontaneously recovered after 90 s.

Supraventricular tachycardia can induce tachycardiomyopathy and in this case TICM was represented (3). TICM can be reversible if the cause of TICM is treated effectively and irreversibly (13). The method of the most effective treatment of arrhythmias is radiofrequency catheter ablation (8, 9, 13). In the described case a return of normal left ventricular function appeared 3 months after effective radiofrequency catheter ablation of the second foci of atrial tachycardia. Treatment of tachycardia is very important because chronic rapid pacing leads to myopathy. Rapid atrial pacing induces enlargement of atria documented by echocardiography. Morillo et al. (6) observed under light microscopy focal and early hypertrophy. Under an electron microscopy, these authors observed an increase in the number and size of the mitochondria and the disruption of sarcoplasmic reticulum. Morillo et al. (6) described increased atrial vulnerability (ability to induce sustained repetitive atrial responses during programmed electrical stimulation) during rapid atrial pacing and an increase in atrial fibrillation (AF) induction in dogs after 6 weeks of continuous rapid atrial pacing. Alternations in microstructure and anisotropic properties during rapid atrial pacing may cause inhomogeneous and discontinuous propagation of the impulse and may lead to AF in the future (6).

FAT can be pharmacologically difficult to treat arrhythmia with antiarrhythmic medicines and can lead to an appearance of a tachycardiomyopathy induced tachycardia. Radiofrequency catheter ablation is a method of choice as an effective treatment of FAT, even if more than one focus is present. Permanent termination of the arrhythmia can lead to resolution of morphologic changes in the heart and a return of it normal functionality.

References