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SPONTANEOUSLY ARISING DISEASE

The Anatomical Basis of Bradycardia–Tachycardia Syndrome in Elderly Dogs with Chronic Degenerative Valvular Disease

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Summary

The hearts of seven elderly dogs in which bradycardia–tachycardia syndrome (BTS) had been diagnosed electrocardiographically were examined *post mortem*. The clinical basis of the underlying heart disease was invariably mitral or mitral and tricuspid regurgitation. Microscopical examination of the sinoatrial (SA) node and the SA junctional region consistently revealed depletion of SA nodal cells, with a corresponding increase in fibrous or fibro-fatty tissue that interrupted contiguity between the SA node and the surrounding atrial myocardium. The left and right atrial walls showed an increased amount of fibrous tissue in the myocardium and disruption of the muscle bundle architecture (interstitial myocardial fibrosis) to varying degrees. Qualitatively, these changes in the SA node and the SA node region resembled those associated with ageing in elderly people with or without BTS. Thus, it is possible that the pathological process affecting the SA node in these dogs was fundamentally related to ageing and may have caused BTS, in combination with atrial myocardial lesions caused by mitral and tricuspid regurgitation.

Keywords: bradycardia–tachycardia syndrome; dog; sinoatrial node; valvular disease

Introduction

Sick sinus syndrome (SSS) is a general term applied to sinoatrial (SA) node dysfunction that may be manifested electrocardiographically by severe sinus bradycardia and severe SA block and/or sinus arrest. Such electrocardiographical abnormalities associated with the SA node are frequently accompanied by recurrent episodes of atrial tachycardia, atrial fibrillation or atrial flutter, resulting in alternation of paroxysmal rapid regular or irregular supraventricular tachyarrhythmias and slow atrial and ventricular beat rates. This pattern of SSS is termed 'bradycardia–tachycardia syndrome' (BTS) and is the most common form of SSS in dogs (Kaplan *et al.*, 1973; Tilley, 1992).

SSS occurs most commonly in middle-aged to older female miniature schnauzers (Tilley, 1992). Other breeds that are predisposed include older dachshunds, West Highland white terriers, cocker spaniels and pugs (Hamlin *et al.*, 1972; Miller *et al.*, 1999; Moïse, 1999a; Goodwin, 2001; Johnson *et al.*, 2007). The clinical manifestations of SSS are variable. Some dogs are asymptomatic, or the symptoms are mild and non-specific. The most common clinical signs associated with BTS are syncope and weakness. Very occasionally, heart rates may be so slow as to reduce cardiac output and cause cardiac failure, or so rapid as to preclude adequate filling. Sudden death due to BTS is rare (Tilley, 1992; Miller *et al.*, 1999; Kittleson, 1998a). Medical therapy is usually of limited value, so permanent pacemaker implantation is the only viable treatment in symptomatic patients (Moïse, 1999b;

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Carr *et al.*, 2001). Possible causes of SSS include disease affecting the SA node artery or replacement of the SA node with fibrous tissue, the morphological substratum for the arrhythmias, although this has not been clearly demonstrated. Genetic inheritance of this condition is also possible because of its frequent occurrence in female miniature schnauzers (Tilley, 1992).

The aim of the present study was to characterize the histopathological features of the heart in seven cases of canine BTS.

Materials and Methods

Animals

The study materials were the hearts of seven dogs (cases 1–7) in which BTS had been diagnosed electrocardiographically (Table 1). The dogs included two miniature Schnauzers and one each of Pomeranian, West Highland white terrier, American cocker spaniel, Yorkshire terrier and miniature dachshund. There were three males and four females, ranging in age from 10 to 16 years at death (mean age 13.0 years). These dogs had all been diagnosed previously as having mitral or mitral and tricuspid valves insufficiency due to chronic degenerative valvular disease, as confirmed by colour-flow Doppler echocardiography, and the duration of the clinical disease before the development of BTS had ranged from 6 months to 3 years. Six of the seven dogs had a history of intermittent syncope and weakness; the remaining dog (case 3) showed clinical signs of severe left-sided heart failure, including coughing, exercise intolerance and dyspnoea. Electrocardiograms showed long periods of severe SA block or sinus arrest alternating with ectopic atrial tachycardia and/or atrial fibrillation (Fig. 1). Intravenous administration of atropine failed to elicit a marked increase of heart rate in all cases. The periods of the sinus pauses (ventricular asystole) were usually 3–8 sec, the longest being 21 sec. A permanent pacemaker (demand ventricular pacing; Medtronic Japan Co., Ltd., Tokyo, Japan) had been implanted in six of the seven dogs 5–14 days after the initial diagnosis of BTS, and thereafter the animals survived for between 1 week and 6 years. One dog without pacemaker therapy died of acute pulmonary oedema associated with severe mitral regurgitation due to ruptured chordae tendineae of the mitral valve 3 months after admission. Among the six dogs that received pacemakers, death was attributable to chronic congestive heart failure in four, pneumonia in one and old age in one.

Histopathology

The heart was removed from each dog within 24 h of death and subjected to gross examination. The whole heart was then fixed in 10% phosphate-buffered formalin for at least 5 days. The cardiac conduction system was examined as described by James (1962,

Table 1
Clinical summary of the dogs with BTS

No.	*Breed*	*Age (years)*	*Sex*	*Clinical sign(s)*	*Pacemaker/pacing duration*	*ECG*
1	Pomeranian	16	Male	Syncope	+/6 years	Sinus arrest, paroxysmal supraventricular tachycardia
2	West Highland white terrier	14	Female	Syncope	+/4 years	Sinus arrest, supraventricular tachycardia
3	Cocker spaniel	14	Female	Syncope, dyspnoea	+/1 month	Sinus arrest, paroxysmal supraventricular tachycardia, atrial fibrillation
4	Miniature schnauzer	13	Female	Syncope	+/20 months	Sinus arrest
5	Yorkshire terrier	12	Male	Syncope	+/1 week	Sinus arrest, supraventricular tachycardia, atrial fibrillation
6	Miniature schnauzer	10	Female	Syncope	+/1 month	Sinus bradycardia, sinus arrest, supraventricular tachycardia
7	Miniature dachshund	10	Male	Syncope, weakness	–	Sinus arrest, supraventricular tachycardia