



The prevalence of the electrocardiographic J wave in the Petit Basset Griffon Vendéen compared to 10 different dog breeds

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Abstract *Introduction:* To investigate the prevalence and amplitudes of the electrocardiographic J wave in the Petit Basset Griffon Vendéen compared to 10 other dog breeds.

Animals: Electrocardiograms from 206 healthy dogs representing 11 dog breeds were included in the study. Besides Petit Basset Griffon Vendéen (PBGV; n = 23) 10 other dog breeds were included.

Materials and methods: An electrocardiogram ruler was used for measuring the amplitudes of the J waves. The definition of a J wave was a positive deflection at the

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J point of ≥ 0.1 mV in more than 1 lead of the bipolar standard limb leads (I, II, III) or the unipolar standard limb leads (aVL and aVF).

Results: The prevalence of J waves in the PBGV ($n = 23$) was 91% ($n = 21$, standard error (SE) = 5.9%), which was significantly higher compared to seven other dog breeds ($p < 0.05$). The overall prevalence of J waves in all 11 dog breeds ($n = 206$) was 43% ($n = 89$, robust SE = 7.8%). There was no significant difference in the prevalence between male and female dogs ($p = 0.79$). Neither did age ($p = 0.22$) nor heart rate ($p = 0.25$) significantly affect the prevalence of J wave.

Conclusions: The PBGV had the highest prevalence of J waves and the highest amplitudes compared to 10 other dog breeds. However J waves were also seen in other breeds. Therefore, J waves may be considered a normal variant on the canine electrocardiogram and should not be interpreted as cardiac disease.

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Abbreviations

ECG	electrocardiogram
I_{to}	transient outward potassium channels
PBGV	Petit Basset Griffon Vendéen
SE	standard error

Introduction

The electrocardiographic J wave was first observed in rabbits with hypercalcemia in 1920.¹ In 1953, Osborn observed an electrocardiogram (ECG) variant resulting in ventricular fibrillation during experimental hyperthermia in dogs.² J wave was then described as a 'current of injury' and later on as an 'Osborn wave.'²

The J wave is a positive deflection at the J point in the ECG^{3–6} and can be classified as notched, slurred or undetermined (Fig. 1).⁴ Several studies have demonstrated differences in J wave morphology regarding the risk of ventricular fibrillation.^{7,8} The distribution of specific ion channels may also contribute to the differences in J wave morphology.⁹ Furthermore, J waves have been proposed to be a normal variant in the healthy human ECG, without any association to arrhythmias.¹⁰ The prevalence of J waves ranges from 5% to 16% in the general human population^{10–13} and they are more prevalent in young,¹⁰ males,^{3,10–14} athletes^{15,16} and in subjects with lower heart rate.¹⁰ However, J waves have also been associated with hypercalcemia,^{1,17} as well as life-threatening arrhythmias in the Brugada syndrome¹⁸ and the early repolarization syndrome in humans.^{12,13} The broader term J wave syndrome has been suggested for these two conditions.¹⁹

One study in 1949 reported similar positive deflections in dogs, which were referred to as 'R socks.' These were frequently observed in healthy dogs and considered to be a normal ECG variant²⁰ but since then they have only very rarely been reported. However, a recent study in 2015, concluded that J waves constitute a normal finding in approximately 30–40% of geriatric dogs.²¹ It was also found that exercise did not significantly alter the amplitude, shape or duration of the J waves.²¹

The J wave has been suggested to reflect a gradient in action potential shape across the ventricular wall; in the epi- and mid-myocardial action potentials there is a relatively large phase 1 repolarization that is minor/absent in endocardial action potentials.¹⁹ Evidence supporting this hypothesis was found in a study using arterially perfused canine ventricular wedge preparations.²² The amplitude of the phase 1 repolarization is at least partly determined by the amplitude of the transient outward potassium current²³ (I_{to}) and in the wedge model it has been demonstrated that increased I_{to} results in increased J waves on transmural electrograms. It was also observed that hypothermia increased I_{to} and a correlation of the changes of the amplitudes of the action potential phase 1 repolarization and J waves was subsequently observed.²²

A previous population study of epilepsy in the Petit Basset Griffon Vendéen (PBGV)²⁴ revealed a positive deflection (unpublished results) after the QRS complex at the J point on the ECG. This finding suggested a higher prevalence and higher amplitudes of J waves in the PBGV compared to other dog breeds.

The aims of this study were to investigate the prevalence and amplitudes of J waves in the PBGV compared to 10 other dog breeds.

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