Failure of spectro-temporal mapping to detect ventricular late potentials in dogs

Clay A. Calvert, DVM; Gilbert J. Jacobs, DVM; Marc S. Kraus, DVM

Objective—To determine whether ventricular late potentials (LP) identified by time-domain analysis (TDA) of the signal-averaged ECG could be identified by three-dimensional frequency-domain analysis (FDA).

Animals—11 dogs (9 of which subsequently died suddenly) with ventricular tachyarrhythmias (10 with ventricular tachycardia) and abnormal TDA of the signal-averaged ECG.

Procedure—Signal-averaged ECG that were abnormal when analyzed in the time domain subsequently were processed further in the frequency domain. Correlation ratios were calculated, and spectro-temporal maps were plotted, which were then compared with control data.

Results—Three-dimensional FDA did not detect LP.

Conclusions and Clinical Relevance—LP may be detectable by TDA of the signal-averaged ECG and may be a specific marker for VT and sudden death in some dogs. However, FDA by use of the method applied in this study is invalid. (*Am J Vet Res* 1999;60: 396–401)

Ventricular late potentials (LP) are electrical micropotentials that occur in the terminal QRS complex and early ST segment of the ECG in some patients with damaged myocardium.[1-11] Ventricular LP were identified first by direct epicardial recordings during animal experiments.[12-15] Berbari et al[15] first used the technique of signal-averaged electrocardiography to record these low-amplitude potentials from the body surface that correspond to delayed epicardial potentials. These fractionated electrograms result from regions of myocardial fibrosis or separated islands of muscle fibers within fibrous tissue.[11] Delayed fractionated or asynchronous conduction and fiber disorientation are associated with propensity for development of reentry-type ventricular tachyarrhythmias.[11] Surface detection of these fractionated signals by signal-averaged electrocardiography has been frequently reported.[1-11,16]

Multifocal, microscopic myocardial fibrosis develops in Doberman Pinschers and Boxers with cardiomyopathy.[17-19] Ventricular tachyarrhythmias are inherent components of cardiomyopathy in these breeds, and ventricular tachycardia (VT) and sudden death are common consequences.[18,19] When analyzed in the time domain, abnormalities of the signal-averaged ECG consistent with LP in some dogs with cardiomyopathy have been recorded.[16,20] The signal-averaged ECG of most Doberman Pinschers with occult cardiomyopathy do not contain LP, and when suspected, echocardiographic evidence of at least moderate myocardial failure exists.[20] Although the number of dogs identified with possible LP is small, the specificity of the test may be good.[20] However, its sensitivity at identifying dogs at high risk of VT may be poor.[20]

The purpose of the study reported here was to evaluate failure of three-dimensional frequency- domain analysis (FDA) of the signal-averaged ECG to detect LP in dogs that experienced VT and sudden death wherein time-domain analyses (TDA) suggested LP.

Materials and Methods

Dogs and measurements—A subset (n = 11) of dogs in which signal-averaged ECG was performed had evidence of LP by TDA. Each dog of this subset was examined one or more times by use of static electrocardiography, thoracic radiography, long-term (24-hour) ambulatory electrocardiography (Holter recording), transtelephonic[a] electrocardiography, and echocardiography.

Echocardiographic images were obtained, using a phased-array system with a 3.5-MHz convex transducer and a VHS video cassette recorder.[b] Ultrasonographic parameters from the right parasternal sagittal plane that were considered to be consistent with dilated cardiomyopathy were left ventricular shortening fraction < 26%, left ventricular end-diastolic dimension > 45 mm in dogs weighing up to 42 kg or > 49 mm in larger dogs, left ventricular end-systolic dimension > 38 mm, E point to septal separation exceeding 8 mm, and septum wall dimensions < 10 and 7 mm at systole and diastole, respectively.[19,20,c,d] Left ventricular shortening fractions between 26 and 29% were considered equivocal.

Holter recordings were performed, using cassette recorders,[e] and analyzed by a commercial ambulatory monitoring service[f] that maintains a quality-assurance program. A prospective, technician-interactive Holter analysis system[g] was preprogrammed for normal canine variables, including heart rate, PR interval, QRS duration, and QT interval. Holter tape data were transferred to a hard drive, and technician-selected normal and abnormal QRS morphology was programmed by use of computer algorithms for template-matching criteria and artifact rejection level. Technician-supervised, sound- and color-assisted, chronologic ECG analyses with on-line fine tuning for accuracy verification then were performed. Retrospective technician validation of each cardiac cycle and editing were provided for each recording.

Signal-averaged ECG[21] were obtained from nonsedated dogs positioned in left lateral recumbency, using a commercial signal-averaging electrocardiograph.[h] Uncorrected, bipolar, differential orthogonal X, Y, and Z leads[22-24] were recorded simultaneously, using subcutaneous, 26-gauge platinum needle electrodes.[i] Leads were recorded from the right and left (positive) fifth to sixth intercostal spaces at the midre-

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From the Department of Small Animal Medicine, College of Veterinary Medicine, University of Georgia, Athens, GA 30602. Dr. Kraus' present address is the Department of Small Animal Medicine, College of Veterinary Medicine, Cornell University, Ithaca, NY 14850.