Correlations among time and frequency measures of heart rate variability recorded by use of a Holter monitor in overtly healthy Doberman Pinschers with and without echocardiographic evidence of dilated cardiomyopathy

Clay A. Calvert, DVM, and T. Michelle Wall, DVM

Objective—To determine correlations between time-domain and frequency-domain variables of heart rate variability (HRV) derived from 24-hour recordings obtained by use of an ambulatory electrocardiographic recorder (Holter monitor).

Animals—59 overtly healthy Doberman Pinschers (41 without echocardiographic evidence of cardiomyopathy and 18 with precongestive heart failure attributable to cardiomyopathy).

Procedure—The HRV was analyzed from 24-hour recordings. Variables were calculated from the entire 24-hour recording as well as 4 user-selected time epochs. Comparisons were made for total power to SD of normal beat-to-normal-beat (NN) intervals (SDNN), ultra-low frequency power to SD of the means of NN intervals, low-frequency power and very-low-frequency power to mean of the SD of NN intervals, and high-frequency (HF) power to the root mean square successive difference of NN intervals (RMSSD) and percentage of NN intervals that varied from the previous NN interval by > 50 milliseconds (PNN50).

Results—58 of 66 (88%) comparisons revealed significant values, indicating that relationships between variables were not random ($r > 0.7$ in 41 of 66 [62%]) comparisons). Strong correlations ($r > 0.8$) were found between the square root of total power and SDNN and between HF power and RMSSD.

Conclusions and Clinical Relevance—Time-domain surrogates for variables of frequency-domain analysis variables that correlated in the dogs reported here are the same ones that reportedly correlate in humans. When 24-hour recordings obtained by use of a Holter monitor are used to calculate HRV, SDNN and total power as well as RMSSD and HF power are interchangeable. (*Am J Vet Res* 2001;62:1787–1792)

Heart rate variability (HRV) describes patterns of variations in instantaneous heart rate that are evident at various intervals or frequencies as well as variations in **normal beat-to-normal-beat (NN)** intervals.[1] There is a relationship between the autonomic nervous system and cardiovascular function.[2-12] Heart rate variability tends to decrease in association with progressive myocardial failure in humans.[2-12] Enhanced sympathetic tone, decreased parasympathetic tone, and decreased baroceptor function can be associated with myocardial failure.[2-6] Perturbances of autonomic modulation and activation of neuroendocrine systems may be proportional to the degree of myocardial failure.[6,7,13,14] In addition to the relationship between cardiovascular function and decreased HRV in humans, a propensity for lethal arrhythmias has been associated with decreased HRV in patients with ischemic and nonischemic cardiomyopathy.[15-20]

The easily obtained derivation of quantitative measures of HRV has popularized its use.[1] Heart rate variability usually is calculated from long-term ambulatory electrocardiographic (Holter monitor) recordings, and numerous software programs are available. The simplest method for evaluation of HRV probably is time-domain analysis.[1] By this method, the **SD of NN intervals (SDNN)** for user-selected time epochs or the intervals between successive NN are determined.[1] Frequency-domain analysis, also termed power spectral density analysis, also is commonly used and provides information about how the time durations (power) of repeating patterns of HRV distribute as functions of frequencies (eg, repetitions per unit of time).[1] Some variables of time- and frequency-domain analyses measured over a 24-hour period have been correlated in studies conducted in humans.[1] For 24-hour recordings, results of frequency-domain analysis are believed to be equivalent to those of time-domain analysis, the latter being easier to perform.[1] The purpose of the study reported here was to evaluate possible correlations between time- and frequency-domain measures of HRV in clinically normal and cardiomyopathic Doberman Pinschers as analyzed from 24-hour recordings obtained by use of a Holter monitor.

Materials and Methods

Animals—Fifty-nine overtly healthy client-owned Doberman Pinschers were included in the study. Dogs were evaluated to determine whether they had cardiomyopathy and, when detected, the severity. Dogs that had received or were currently receiving cardiac drugs were excluded from the study. Various echocardiographic, Holter recording, and survival data derived from the dogs in this study have been included in other studies.[21-24]

Procedure—Echocardiograms and 24-hour Holter recordings were obtained from each dog. Dogs were classified as clinically normal or cardiomyopathic on the basis of accepted echocardiographic measurements and evidence of

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From the Department of Small Animal Medicine, College of Veterinary Medicine, University of Georgia, Athens, GA 30602.

(or lack of) and frequency for ventricular premature contractions detected on Holter recordings. Heart rate variability was analyzed from 24-hour Holter recordings to determine correlations among time- and frequency-domain variables.

Echocardiography—Echocardiography[25-27] was performed in each dog. For the right parasternal sagittal plane, values considered normal for echocardiographic variables were as follows: left ventricular internal diastolic dimension < 47 mm[a] in dogs weighing ≤ 42 kg or < 50 mm in dogs weighing > 42 kg; left ventricular internal systolic dimension < 38 mm[a]; left ventricular fractional shortening ≥ 30%; mitral valve leaflet **E-point to septal separation distance (EPSS)** < 9 mm; and interventricular septum and wall systolic and diastolic thicknesses ≥ 10 and 7 mm, respectively. Values considered abnormal and indicative of dilated cardiomyopathy were as follows: left ventricular internal diastolic dimension ≥ 50 mm; left ventricular internal systolic dimension ≥ 40 mm[a]; left ventricular fractional shortening ≤ 25%; and EPSS > 9 mm. Values for fractional shortening between 26 and 29% were considered equivocal, and dogs with these values were excluded from the study.

Holter recording—Holter recordings[28] were obtained for each dog. Cassette recorders[b] were used, and recordings were analyzed by a commercial ambulatory monitoring service that maintains a quality-assurance program.[c-e] Data were transferred from the cassette tape of a Holter monitor to a computer hard drive, and technician-selected normal and abnormal QRS morphologic characteristics were programmed by use of computer algorithms for template-matching criteria and rejection level. Technician-supervised chronologic ECG analyses with on-line fine-tuning for accuracy verification then were performed. Retrospectively, technician validation and editing of each cardiac cycle were provided for each recording. A scan quality of 100% required 0 minutes of manual scanning, whereas a scan quality of > 90% required < 90 minutes of manual scanning. For a dog to be included in the study, the Holter recording obtained at the time of initial examination had to have a scan quality > 90%. Nonetheless, all cardiac cycles were validated by a scanning technician proficient in analysis of ECG of dogs.

Holter recordings were initiated at our veterinary teaching hospital.[28] Dogs were discharged to owners and taken home such that the majority of each recording was obtained while dogs were in their typical environment. Owners of each dog maintained a patient diary in which activity periods were recorded. Owners were instructed to allow each dog to have routine activity plus prescribed exercise of two 15-minute walks, two 5-minute jogging periods, and 2 episodes of vigorous exercise (1 to 2 min/episode).

Analysis of HRV—Analyses were obtained from 24-hour Holter recordings with > 90% scan quality. The 24-hour Holter recordings were processed for HRV, using methods described elsewhere[29-31] and a proprietary software program.[f] Initial QRS labeling and editing were accomplished by use of algorithms developed at Columbia University.[30,f] A second stage of editing was performed to find errors that could adversely affect measurement of HRV. After classification of QRS morphologic characteristics, the longest and shortest NN intervals on the histogram of RR intervals were manually confirmed until none of the QRS complexes were mislabeled. For HRV analysis, only NN intervals were included. Following editing, **very-low-frequency (VLF)**, **low-frequency (LF)**, and **high-frequency (HF)** bands of the heart-period power spectrum (frequency-domain analysis) were completed in 5-minute segments over a 24-hour interval.[30] First, a regularly spaced time series was derived from the NN intervals by sampling the irregularly spaced series defined by the succession of NN intervals in each 24-hour recording. A boxcar low-pass filter with a window that was twice the sampling interval then was applied. Gaps in the time series resulting from noise or ectopic beats were filled with linear splines. A fast-Fourier transformation was computed, and the resulting power spectrum was corrected for alternating effects of the filter and the sampling frame. Results for each 5-minute epoch were averaged to form a composite spectrum. Cyclic fluctuations in NN intervals were delineated by power spectral measures of the NN time series in terms of frequency and power (duration) of a particular frequency band within each given time epoch. Time-domain analysis[1] also was performed, and correlations were calculated between appropriate variables in the 2 domains.

Variables were calculated for the entire 24-hour recording period as well as user-selected time epochs. Time-domain variables were SDNN, **SD of the means of NN intervals (SDXNN)**, **mean of the SD of NN intervals (XSDNN)**, **percentage of NN intervals that varied from the pervious NN interval by > 50 milliseconds** (PNN50), and **root mean square successive difference (RMSSD) of NN intervals (RMSSD)**. Frequency-domain variables were the **power of NN intervals over 24 hours in the frequency range of ≤ 0.4 Hz (total power)**, 24-hour power in the **ultra-low-frequency (ULF)** range of < 0.003 Hz, power in the VLF range of 0.003 to 0.04 Hz, power in the LF range of 0.04 to 0.15 Hz, and power in the HF range of 0.15 to 0.4 Hz.

Table 1—Summary data for analysis of heart rate variability in 3 groups of overtly healthy Doberman Pinschers during a 24-hour period

	Group 1 (n = 41)		Group 2 (n = 11)		Group 3 (n = 7)	
Variable	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**
Time-domain						
SDNN (ms)	331 (87)	148–521	314 (56)	211–400	272 (68)	143–358
PNN50 (%)	56 (10)	18–75	52 (9)	32–62	48 (11)	31–64
RMSSD (ms)	325 (118)	112–610	295 (72)	177–428	245 (101)	101–394
XSDNN (ms)	260 (76)	88–415	252 (59)	152–343	212 (66)	106–312
SDXNN (ms)	195 (52)	112–322	180 (28)	137–215	160 (30)	88–192
Frequency-domain						
Total power (ms^2)	152,735 (92,863)	32,334–434,135	146,737 (65,465)	47,220–238,617	112,491 (48,915)	37,966–187,777
ULF power (ms^2)	55,258 (37,422)	12,008–192,847	45,495 (21,894)	14,313–88,960	39,130 (13,421)	13,353–65,033
VLF power (ms^2)	14,776 (8,835)	4,150–39,102	14,363 (7,957)	4,882–31,141	11,874 (4,969)	3,579–20,747
LF power (ms^2)	21,403 (20,190)	4,165–100,741	28,879 (20,109)	4,263–71,692	18,247 (11,172)	5,117–42,614
HF power (ms^2)	61,298 (37,695)	9,226–146,739	58,800 (29,147)	18,481–113,636	43,240 (26,999)	12,838–82,839

Groups were as follows: group 1, normal echocardiograms; group 2, abnormal echocardiograms with left ventricular fractional shortening of 18 to 25% and E-point to septal separation distance (EPSS) < 14 mm; group 3, abnormal echocardiograms with left ventricular fractional shortening of 14 to 17% and EPSS > 15 mm.

SDNN = SD for all normal beat-to-normal beat (NN) intervals. PNN50 = Percentage of all adjacent NN intervals that varied by > 50 milliseconds. RMSSD = Root mean square of the successive differences of NN intervals. XSDNN = Mean of the SD of NN intervals. SDXNN = SD of the means of the NN intervals. ULF = Ultra-low frequency. VLF = Very-low frequency. LF = Low frequency. HF = High frequency.

With the exception of SDNN, which was calculated for 24 hours, all other time-domain variables were mean calculations from 5-minute segments among 4 selected time epochs (day, 6 AM to midnight; night, midnight to 6 AM; day-to-night, 6 PM to midnight; and night-to-day, 6 AM to noon). In the frequency domain, total power and ULF power bands were determined from means of 5-minute periods calculated for the entire 24-hour recording period. The VLF, LF, and HF power bands were calculated for day, night, night-to-day, and day-to-night epochs.

Classification of groups—Dogs were classified into 3 groups on the basis of echocardiographic and Holter recording results. Dogs of group 1 had normal values for echocardiographic variables described elsewhere[21,a] and < 50 ventricular premature contractions detected by Holter recording.[21] Dogs with abnormal values for echocardiographic variables and > 100 ventricular premature contractions detected by Holter recording were classified as those with left ventricular fractional shortening between 18 and 25% and EPSS < 14 mm (group 2) and those with fractional shortening between 14 and 17% and EPSS > 15 mm (group 3).

Statistical analysis—The Pearson correlation coefficient was used to assess the strength and direction of the relationship for variables within and between domains. Significance was defined as values of $P < 0.05$.

Results

Of the 59 dogs in the study, 41 (78%) were clinically normal, whereas 18 (22%) were cardiomyopathic. Summary data and HRV for the 3 groups of dogs were determined (**Tables 1–3**). Of the 4 frequency bands

Table 2—Summary data for analysis of heart rate variability of 3 groups of overtly healthy Doberman Pinschers for 2 time epochs (day, 6 AM to midnight; night, midnight to 6 AM)

	Group 1 (n = 41)		Group 2 (n = 11)		Group 3 (n = 7)	
Variable	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**
Day						
Time-domain						
PNN50 (%)	52 (12)	10–74	47 (10)	26–58	43 (12)	26–62
RMSSD (ms)	279 (92)	105–467	265 (65)	161–368	214 (100)	78–377
XSDNN (ms)	226 (63)	81–360	223 (51)	152–305	185 (60)	89–278
SDXNN (ms)	188 (46)	103–288	180 (26)	140–212	153 (35)	79–202
Frequency-domain						
VLF power (ms^2)	17,191 (22,294)	4,458–129,147	11,789 (5,638)	5,345–27,547	10,070 (3,900)	2,560–14,998
LF power (ms^2)	14,162 (12,265)	3,416–60,398	12,864 (8,417)	3,388–33,008	7,579 (3,753)	2,562–14,378
HF power (ms^2)	37,494 (21,492)	5,153–100,411	31,973 (15,075)	6,221–62,793	25,791 (17,571)	5,136–54,467
Night						
Time-domain						
PNN50 (%)	73 (10)	48–87	70 (7)	51-79	64 (12)	39–78
RMSSD (ms)	442 (234)	137–1,221	381 (107)	219–567	325 (116)	152–479
XSDNN (ms)	354 (158)	109–859	330 (96)	154–481	289 (88)	153–410
SDXNN (ms)	136 (51)	48245	120 (37)	62–210	125 (28)	89–176
Frequency-domain						
VLF power (ms^2)	16,660 (11,402)	2,922–45,401	16,282 (9,121)	3,434–33,038	14,474 (5,233)	4,591–22,337
LF power (ms^2)	29,424 (31,792)	2,616–167,116	33,967 (23,858)	3,153–81,884	24,848 (17,363)	5,726–60,563
HF power (ms^2)	77,611 (48,213)	10,184–218,947	65,356 (37,547)	21,447–131,180	54,496 (26,560)	17,896–92,673

See Table 1 for key.

Table 3—Summary data for analysis of heart rate variability of 3 groups of overtly healthy Doberman Pinschers for 2 time epochs (day to night; 6 PM to midnight; night to day, 6 AM to noon)

	Group 1 (n = 41)		Group 2 (n = 11)		Group 3 (n = 7)	
Variable	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**
Day to night						
Time-domain						
PNN50 (%)	55 (15)	9–80	50 (15)	30–68	46 (15)	26–69
RMSSD (ms)	257 (103)	77–489	275 (110)	93–461	213 (121)	71–469
XSDNN (ms)	210 (73)	65–382	231 (85)	119–373	183 (76)	88–349
SDXNN (ms)	149 (46)	68–256	151 (18)	127–191	119 (32)	67–166
Frequency-domain						
VLF power (ms^2)	9,767 (8,481)	2,170–42,503	12,085 (10,209)	3,834–44,261	8,708 (3,695)	2,210–14,898
LF power (ms^2)	10,462 (7,800)	3,056–45,258	13,596 (10,255)	2,556–32,406	6,460 (3,395)	2,433–13,561
HF power (ms^2)	36,955 (27,061)	3,153–104,855	40,784 (26,828)	7,644–94,572	26,966 (25,467)	2,905–91,238
Night to day						
Time-domain						
PNN50 (%)	57 (15)	11–87	50 (15)	30–68	47 (15)	25–66
RMSSD (ms)	340 (143)	147–824	275 (110)	93–461	249 (152)	66–461
XSDNN (ms)	280 (93)	114–577	231 (85)	119–373	213 (96)	105–365
SDXNN (ms)	195 (52)	114–328	151 (18)	127–191	148 (47)	60–203
Frequency-domain						
VLF power (ms^2)	33,589 (78,888)	5,688–46,089	12,085 (10,209)	3,834–44,261	12,098 (7,175)	2,958–22,515
LF power (ms^2)	28,971 (41,148)	3,144–204,460	13,596 (10,255)	2,556–32,406	11,064 (9,673)	3,516–28,669
HF power (ms^2)	52,742 (33,819)	9,441–143,070	40,784 (26,828)	7,644–94,572	33,705 (28,268)	3,090–83,096

See Table 1 for key.

Table 4—Correlations between variables of time- and frequency-domain analyses of heart rate variability among 3 groups of overtly healthy Doberman Pinschers during an entire 24-hour period

		Group 1 (n = 41)		Group 2 (n = 11)		Group 3 (n = 7)	
Time domain	**Frequency domain**	***r***	***P***	***r***	***P***	***r***	***P***
SDNN	Total power	0.8687	< 0.001	0.8774	< 0.001	0.9207	< 0.001
PNN50	HF	0.4912	< 0.001	0.3996	0.1	0.9524	< 0.001
RMSSD	HF	0.8993	< 0.001	0.8739	< 0.001	0.9469	< 0.001
XSDNN	LF	0.6038	< 0.001	0.6837	< 0.004	0.7671	0.001
XSDNN	VLF	0.5588	< 0.001	0.8695	< 0.001	0.9430	< 0.001
SDXNN	ULF	0.7845	< 0.001	0.7219	0.004	0.7262	0.017

See Table 1 for key.
Total power = Square root of total power.

Table 5—Correlations between variables of time- and frequency-domain analyses for heart rate variability among 3 groups of overtly healthy Doberman Pinschers calculated for 4 time epochs

		Group 1 (n = 41)		Group 2 (n = 11)		Group 3 (n = 7)	
Time domain	**Frequency domain**	***r***	***P***	***r***	***P***	***r***	***P***
Day							
PNN50	HF	0.5338	< 0.001	0.3234	0.2	0.9322	< 0.001
RMSSD	HF	0.9201	< 0.001	0.4844	0.07	0.9897	< 0.001
XSDNN	LF	0.5296	< 0.001	0.4822	0.08	0.7664	0.001
XSDNN	VLF	0.2493	0.1	0.8290	< 0.001	0.8825	< 0.001
Night							
PNN50	HF	0.7010	< 0.001	0.5790	0.03	0.7385	0.01
RMSSD	HF	0.8021	< 0.001	0.9656	< 0.001	0.9493	0.001
XSDNN	LF	0.6616	< 0.001	0.7262	0.003	0.6681	0.035
XSDNN	VLF	0.5538	< 0.001	0.9069	< 0.001	0.9259	< 0.001
Day to night							
PNN50	HF	0.7010	< 0.001	0.5790	0.03	0.7385	0.01
RMSSD	HF	0.7897	< 0.001	0.9712	< 0.001	0.9596	< 0.001
XSDNN	LF	0.4779	0.002	0.4822	0.08	0.9514	< 0.001
XSDNN	VLF	0.5431	< 0.001	0.7529	0.002	0.9142	< 0.001
Night to day							
PNN50	HF	0.5250	< 0.001	0.1365	0.6	0.9539	< 0.001
RMSSD	HF	0.9390	< 0.001	0.8915	< 0.001	0.9505	< 0.001
XSDNN	LF	0.6574	< 0.001	0.5872	0.03	0.8364	0.003
XSDNN	VLF	0.2378	0.1	0.5835	0.03	0.9222	< 0.001

See Tables 1–3 for key.

(ULF, VLF, LF, and HF) that constituted the total 24-hour spectrum, 40% of total power was in the HF band, and 36% was in the ULF band. The LF and VLF bands constituted approximately 14 and 10% of total power, respectively.

For the 24-hour analysis of HRV, 17 of 18 (94%) comparisons were significantly correlated, and a value of $P < 0.001$ was detected in 14 of 18 (78%) comparisons (**Table 4**). Strong correlations ($r > 0.85$) were found between the square root of total power and SDNN as well as between HF power and RMSSD. Moderately strong ($r > 0.72$) correlations were found between ULF power and SDXNN. Correlations between VLF or LF power and XSDNN were not as strong. Significant differences were not detected for correlations between SDNN and the square root of total power, RMSSD and HF power, or SDXNN and ULF among the 3 groups.

Of the 48 comparisons of pairs of variables among the 3 groups of dogs and 4 time epochs, 41 (85%) were significantly correlated, indicating that the relationships were not random (**Table 5**). In 30 of 48 (63%) comparisons, values of $P \leq 0.001$ were detected. A value of $r > 0.7$ was reported for 29 of 48 (60%) instances, indicating at least moderately strong correlations. The HF power correlated strongly ($r > 0.78$) with its time-domain surrogate (ie, RMSSD) in 14 of 15 (93%) comparisons. Correlations for the other time-domain surrogate of HF power (ie, PNN50) were not as strong. Excluding 1 poor correlation, mean correlation factor between RMSSD and HF power for all groups was 0.9067. We did not detect significant differences between correlations for RMSSD and HF power among the 4 epochs.

Discussion

Cardiomyopathy is a common disorder of Doberman Pinschers.[22,23,32-34] It is characterized by a long preclinical or occult phase of progressive myocardial failure with disturbances of heart rhythm and increased risk of sudden death.[22-24,34] Echocardiography and long-term ambulatory electrocardiographic (Holter) recordings are useful for the diagnosis of cardiomyopathy in Doberman Pinschers prior to the onset of congestive heart failure.[22,23,34] Holter recordings and signal-averaged ECG are useful in identifying a subset of affected Doberman Pinschers at high risk of sudden death.[22-24] Whether HRV analysis is of value in stratification for risk of sudden death in affected Doberman Pinschers remains to be determined.

Heart rate variability in people has clinical utility in the evaluation of autonomic influence on the heart.[16,35-39] Frequency-domain (power spectral) analysis may resolve parasympathetic and sympathetic influences better than use of time-domain analysis.[40-44] Perceived HF and LF components of variability in NN interval suggest that vagal and sympathetic activities, respectively, are within physiologic ranges.[45-49] High-frequency power is a pure vagal signal, and its frequency is modulated by the frequency of breathing.[48,49] Low-frequency power is a mixed vagal and sympathetic signal.[48,49] Over a 24-hour period, LF and HF bands in the power spectrum predominantly reflect parasympathetic activity.[47] Physiologic interpretation of the lower frequency components of HRV, VLF, and ULF is unclear.[1] Reduced HRV indicates loss or reduction of physiologic periodic fluctuations, which can be caused by many influences and cannot necessarily be interpreted to represent a particular shift in autonomic modulation.[45,46]

Studies in people have revealed that many of the frequency-domain measures of NN variability have corresponding variables in time-domain analysis that correlate strongly (eg, SDNN with total power or the square root of total power, SDXNN with ULF power, XSDNN with VLF and LF power, and PNN50 and RMSSD with HF power).[47] These correlations exist because of mathematic and physiologic relationships.[1,29] However, it is difficult to ascertain the physiologic interpretation of the spectral components calculated over a 24-hour period.[1] If mechanisms responsible for modulations of a certain frequency are unchanged during the 24-hour period, the corresponding frequency component of HRV is a measure of these modulations.[1,29,30] The reality is that these modulations are not stable, and the interpretations of frequency-domain analysis are not completely defined. Spectral analysis for a 24-hour period as well as results obtained from 5-minute segments averaged over the 24-hour period provide averages of the modulations attributable to the LF and HF bands.[29,30,46] Although time-domain methods, especially SDNN and RMSSD methods, can be used to investigate short-duration recordings, time-domain methods are best used for long-term recordings.[1] Components of HRV provide measurement of the degree of autonomic modulations rather than the amount of autonomic tone, and averages of modulations do not represent an average amount of tone.[29,30,46] When long-term recordings of electrocardiograms are used in clinical studies, each subject should be recorded under similar conditions.[1]

In the study reported here, each of the 4 bands in the power spectrum had 1 or 2 corresponding variables in the time domain that correlated moderately well ($r > 0.7$), indicating that they may be controlled by similar influences.[47] Strong correlations ($r > 0.8$) between SDNN and the square root of total power and between RMSSD and HF power indicate that these variables can be used interchangeably when long-term recordings are used. Although PNN50 and RMSSD are known to correlate with HF power,[1,47] as has been reported in studies in people,[1] RMSSD had a better correlation in the dogs reported here. For the entire 24-hour period, correlation between SDNN and the square root of total power and between RMSSD and HF power were approximately 0.9. Correlations between LF power band and XSDNN and between VLF power band and XSDNN were not as strong, which may be attributable to the fact that these power bands constitute the smallest percentages of total power.[47]

Overall correlation tended to be higher in dogs with the most advanced cardiomyopathy (group 3). Values of all but 1 correlation exceeded 0.72, and 16 of 22 (73%) correlations were strong ($r > 0.8$). The reason for this finding is uncertain, but 1 possibility is that HRV in this group of dogs was less than in the other groups of dogs.

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