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LETTER TO THE EDITOR

R-R VARIABILITY FROM STANDARD 12 LEAD ECG MAY BE USEFUL FOR ASSESSMENT OF AUTONOMIC NERVOUS FUNCTION

Sir,

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Many conditions such as aging, diabetic neuropathy and ischaemic heart disease are associated with reductions in heart rate variability (HRV). Reduced HRV, in turn, has been associated with increased mortality (1). There has been discussion of lowered HRV as a potential therapeutic target (2). Traditional techniques of evaluating HRV involve acquisition of continuous ECG recordings for variable periods of time followed by fairly complex computer-based mathematical processing. Attempts have been made to reduce the duration of the ECG recording. The power spectral measures of HRV derived from 2 min recordings are well correlated with those from 24 h recordings (3). In at least one longitudinal epidemiological study, variations in the RR intervals from the 12 lead ECG predicted mortality (4) but, this was not linked to changes in autonomic function. A recent study indicated that the average absolute difference in RR intervals or the root mean square of the standard deviation of RR intervals from a continuous 10 ECG could reasonably predict cardiac vagal tone derived from a 5 min ECG recording (5). HRV derived from a standard 12 lead ECG is cost-effective and will be useful in poor countries. This study therefore evaluated the extent to which RR variability derived from standard 12 lead ECG correlated with HRV in the frequency domain derived from a continuous 5 min ECG recording in supine posture.

Study 1 : In a preliminary analysis, continuous 5 min supine ECG data from 149 healthy males [Young (18–30 yrs) = 115 and Old (>60 years) = 34] collected from different studies were analyzed. The aim of this study was to assess the construct validity of the hypothesis that R-R variability from 12 randomly chosen sites (3 sequential R waves at each of the 12 sites) on a 5 min continuous ECG recording (simulating a standard 12 lead ECG) was correlated with measures of HRV in the frequency domain obtained over the entire 5 min recording, as described earlier (6,7). Correlations between CV-RR (coefficient of variation of the R-R intervals from all 12 chosen segments) and the total, high frequency (HF) in absolute and normalized R-R spectral power were 0.79, 0.78 and 0.18 while the correlations for SD-RR (standard deviation of the R-R intervals from all 12 chosen segments) and the same parameters were 0.78, 0.77 and 0.21, respectively (Spearman's correlation, $P<0.05$). Low frequency (LF) represented in absolute and normalized units showed a correlation of 0.74 and –0.24 with CV-RR spectral power and 0.69 and –0.26 with SD-RR spectral power (Spearman's correlation, $P<0.05$).

Study 2 : Based on the preliminary findings of Study 1 (simulated 12 lead ECG), the study was extended to prospectively to evaluate actual 12 lead ECG's against HRV in the frequency domain in 55 consecutive subjects recruited into the laboratory for a variety of studies. After instrumentation, subject was rested for 30 min and lead II ECG was recorded for 5 min in the supine posture during spontaneous breathing. Standard 12 lead EGG was also recorded subsequently (Cardiart 108T/MK-VII, BPL limited, India). The RR intervals were calculated manually. At least 3 RR intervals were used in each lead to calculate Mean-RR, SD-RR, and CV-RR. All participants gave written consent to the studies which were approved by the Institutional Ethics Review Board.

Table I provides a correlation matrix between standard measures of HRV in the frequency domain, expressed in absolute and normalized units and the measures of RR variability derived from the 12 lead ECG in the second set of subjects (Study 2 : N = 55). The data indicate that R-R variability derived from the 12 lead ECG is positively and significantly correlated with the HF power spectra of HRV when expressed both in absolute and normalized units. In contrast, the LF power spectra showed a positive correlation with 12 lead RR variability when expressed in absolute terms, but negative correlations which were significant when expressed in normalized units. The strength of association between LF power and 12 lead R-R variability was smaller than that between the HF power spectra and 12 lead R-R variability.

The stronger associations between the HF power spectra and 12 lead R-R variability are understandable, given the

TABLE I : Correlation between heart rate variability indices in the frequency domain from a supine 5 minute ECG recording and R-R variability derived from standard 12 lead ECG in Study 2 (n = 55).

	CV-RR	*Mean-RR*	*SD-RR*	*LF abs*	*HF abs*	*LF nu*	*HF nu*	*LF/HF Ratio*
CV-RR	------							
Mean-RR	0.328* (0.015)	------						
SD-RR	0.956* (0.000)	0.570* (0.000)	------					
LF-abs	0.271* (0.046)	0.117 (0.393)	0.292* (0.030)	------				
HF abs	0.460* (0.000)	0.355* (0.000)	0.536* (0.000)	0.652* (0.000)	------			
LF nu	–0.347* (0.000)	–0.241 (0.077)	–0.396* (0.003)	–0.068 (0.623)	–0.482* (0.000)	------		
HF nu	0.331* (0.014)	0.303* (0.025)	0.399* (0.003)	0.042 (0.763)	0.514* (0.000)	–0.957* (0.000)	------	
LF/HF Ratio	–0.180 (0.188)	–0.138 (0.315)	–0.220 (0.107)	–0.042 (0.760)	–0.320* (0.017)	0.831* (0.000)	–0.810* (0.000)	------
TP	0.440* (0.001)	0.339* (0.011)	0.512* (0.000)	0.846* (0.000)	0.923* (0.000)	–0.349* (0.000)	0.356* (0.000)	–0.218 (0.110)

CV-RR, Coefficient of variation RR interval; SD-RR, Standard deviation RR interval; LF, Low frequency; HF, High frequency; abs, absolute units; nu, normalized units; TP, Total power. *=P<0.05.

fact that the R-R variations in a 12 lead ECG reflect sinus arrhythmia which is explained by vagal withdrawal to the SA node during inspiration (8). The reversal of the sign of the correlation coefficient of LF absolute units and LF normalized units vs 12 lead RR variability suggest that the relative contribution of the HF power spectra vs the LF power spectra in absolute terms increased with increasing power.

These data suggest that the R-R variability from 12 lead ECG reflect clearly definable HRV parameters in the frequency domain. Given that HRV in the frequency domain predicts all cause and cardiac mortality, R-R variability from the 12 lead ECG may be useful in prospective epidemiological studies linked to all cause and cardiac mortality, although this needs to be evaluated.

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