Echocardiographic, Neurohormonal and Invasively Measured Correlates of Third and Fourth Heart Sounds Determined by Audioelectric Cardiography

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Background

The presence of third (S3) and/or fourth (S4) heart sounds may reflect increased left ventricular (LV) filling pressure and is associated with adverse clinical outcomes. The aim of this study is to examine echocardiographic, neurohormonal and invasive correlates of an S3 and/or S4 using computerized detection assessed by audioelectric cardiography (computerized detection of heart sounds on an acoustic signal collected in the V3 or V4 position).

Methods

Adult patients referred for cardiac catheterization were enrolled. Patients with atrial arrhythmia were excluded. Within a 4-hour period, each subject had left heart catheterization for LV end-diastolic pressure (LVEDP), measurement of serum B-type natriuretic peptide (BNP) and echocardiography for LV ejection fraction (EF) and diastolic function. E/E\` ratio was computed and diastolic function was categorized according to standard transmitral and pulmonary venous patterns as normal (group 1) and impaired relaxation, pseudonormal, or restrictive patterns (group 2). The presence of an S3 and/or S4 was determined by correlated audioelectric cardiography (Audicor, Inovise Medical).

Table 1. Hemodynamic and Neurohormonal Correlates of S3 and S4

	S3 Only N=12	S4 Only N=20	S3 and S4 N=9	No S3, no S4 N=49
LVEDP (mmHg)	18.1 ± 8.2 p = 0.034	18.0 ± 7.0 p = 0.003	19.8 ± 5.1 p = 0.002	12.1 ± 7.3
BNP (pg/mL)	904.7 ± 1217 p = 0.04*	597.3 ± 1025 p = 0.008*	1168.7 ±1359 p = 0.04*	218 ± 606
E/E’	9.8 ± 5.2 p = 0.07*	6.9 ± 4.3 p = 0.34*	13.5 ± 7.5 p = 0.01*	6.0 ± 3.0
EF (%)	42.6 ± 20.2 p = 0.004	53.9 ± 18.4 p = 0.04	46.2 ± 17.6 p = 0.02	64 ± 15
Diastolic dysfunc	67% p = 0.72	63% p = 0.77	71% p = 0.68	55%

Table 2. Diagnostic Accuracy For S3 and S4

	S3 Only		S4 Only		S3 and S4		S3 or S4	
	Sens	Spec	Sens	Spec	Sens	Spec	Sens	Spec
LVEDP (AUC)	41% (.688)	92%	46% (.642)	80%	38% (.804)	97%	68% (.692)	73%
BNP	28% (.648)	93%	34% (.573)	76%	26% (.701)	96%	56% (.623)	70%
E/E’	60% (.665)	88%	33% (.511)	75%	67% (.763)	93%	80% (.611)	65%
EF	57% (.744)	91%	50% (.565)	75%	50% (.718)	93	77% (.648)	67

* P value performed for mean log values.

Results

100 patients were enrolled. The mean age was 62±14 (range 24-91) years, 65 were male, 29 were diabetic, 81 had hypertension, 37 had a history of heart failure, and 68 had coronary artery disease. Accurate assessment of an S3 and/or S4 was not possible in 10 patients and therefore data is presented for 90 subjects. Forty-one subjects had abnormal heart sounds [S3 only (n=12), S4 only (n=20), or both (n=9)]. Mean ± SD data for LVEDP, BNP, E/E\`, EF and diastolic function group 2 for extra heart sounds is presented (Table 1). The sensitivity (%), specificity (%), and area under the curve (AUC) for an extra heart sound is shown for LVEDP >15mmHg, BNP >100 pg/mL, E/E’>12, and LVEF <50% (Table 2).

Conclusions

The presence of an S3 and/or S4 determined by audioelectric cardiography reflects invasively measured increased LV filling pressure, routine echocardiographic measures of LV dysfunction (LVEF and E/E’), and elevated serum BNP levels.

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