

Bedside Use of Impedance Cardiography to Document and Monitor Heart Failure with Preserved Systolic Function: Delineation of Impaired Stroke Volume Reserve

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Introduction

Diastolic left ventricular dysfunction plays an important role in the current epidemic of heart failure. Presenting with symptoms similar to that of systolic dysfunction, often the bedside evaluation of diastolic dysfunction is difficult. A variety of underlying disease processes may play a part in microvascular disarrangements leading to ongoing cardiac fibrosis. One of the major limitations of diastolic dysfunction is the ability to increase preload resulting in a fixed stroke volume over a range of exercise conditions. We therefore evaluated a method of using bedside impedance cardiography (ICG), (CardioDynamics, San Diego, CA) non-invasive hemodynamics, to detect the impairment in stroke volume reserve, and our ability to improve stroke volume reserve and functional status with various therapeutic modalities.

Methods

We studied 12 patients (11 women) aged 52–81 years (mean 70 years) who all had symptoms of heart failure with preserved systolic function (LVEF averaged 55% with a range of between 42% to 67%). Patients were on a variety of baseline therapies for their underlying disease (Table 1), but all demonstrated impaired stroke volume reserve. All subjects underwent a baseline measurement of impedance cardiography to determine heart rate, blood pressure, cardiac index (CI), systemic vascular resistance (SVR) and stroke volume (SV). These same determinations were measured immediately following 2 minutes of standardized leg raising exercises.

Following 4–6 weeks of additional pharmacologic therapy (Table 2), the patients returned to the clinic and repeated the rest and post-exercise measurements. All patients were also strongly encouraged to do daily aerobic activity to toleration. Similarly, rest and post-exercise measurement were performed in a group of 6 healthy controls.

Table 1. Underlying Disease States (Note: patient may have had ≥ 1 disease state)

Number of Patients	Systolic Hypertension	Diabetes	Coronary Artery Disease	COPD	Documented Sleep Disorder	Hx. Of Uterine Fibroids	Dyslipidemia
12	12	4	3	9	3	7	6

Table 2. Therapeutics Added (in Addition to Baseline Medications)

(Note: Totals equal more than the total amount of pts., since more than one medication per subject may have been utilized.)

Number of Patients	Angiotensin Receptor Blockers	Beta-Blockers	Extended-Release Nitrates	CoEnzyme Q10 Vitamin
12	2	6	11	6

Results

Following treatment, Functional Class (FC) improved in all patients (mean change from 3 to 2). Compared to controls, patients had more chronotropic incompetence (ChI) and inability to augment stroke volume. Following treatment, there was marked improvement in the stroke volume reserve, but chronotropic incompetence remained (Table 3).

Table 3. Rest and Post Exercise Measurements

	HR (Rest) bpm	HR (Exer) bpm	Mean BP (Rest) mmHg	SVR (Rest) dyne/sec/cm ⁵	SV (Rest) ml/beat	SV (Exer) ml/beat	Stroke Volume Reserve (% Change in SV w/ Exercise)	CI (Rest) l/min/m ²	CI (Exer) l/min/m ²
Pts. Pre Treatment	80	87	108	1684	66	63	-3.7%	2.7	2.8
Pts. Post Treatment	76	82	105	1769	67	74	14.3%	2.7	3.3
Controls	78	95	98	1175	81	83	2.17%	3.5	4.4

Conclusion

Patients with heart failure with preserved systolic function have major limitations in chronotropic incompetence and stroke volume reserve. Conditions that cause this syndrome frequently impact both determinants of cardiac output, only the latter of which can be impacted favorably pharmacologically. These improvements are not reflected in mean blood pressure or SVR alone, but do provide favorable improvement in functional class. A bedside evaluation of stroke volume reserve is extremely useful for identifying these patients and guiding their therapy. This should provide physicians and nurses taking care of patients with heart failure and preserved systolic function a more insightful approach to treatment. An approach targeting both improvements in chronotropic incompetence and stroke volume reserve should provide the most benefit.