Constrictive Pericarditis in the Modern Cardiology Era

Quantitative Analysis of Constrictive Physiology Using Four-Dimensional Magnetic Resonance Imaging

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Heart Failure and Pulmonary Hypertension (Myocardial/Pericardial Diseases, Heart Failure)

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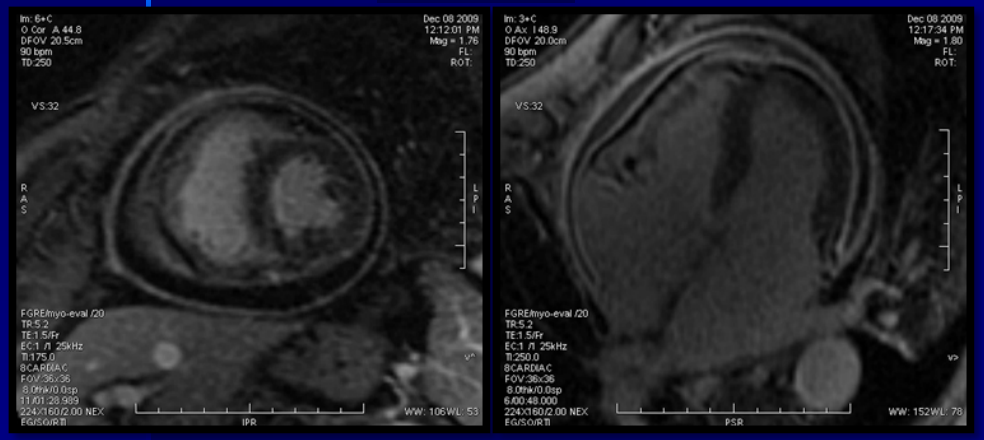
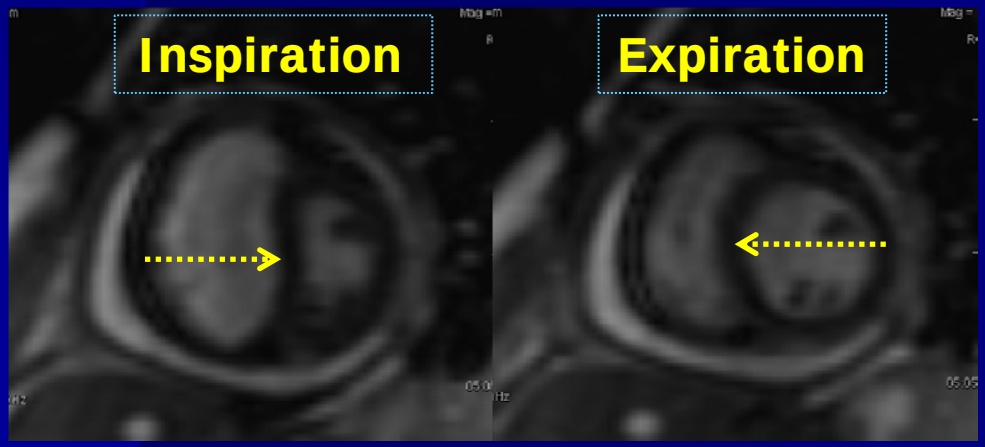
Presenter Disclosure Information

- The authors have no conflicts of interest

Constrictive Pericarditis:

MRI





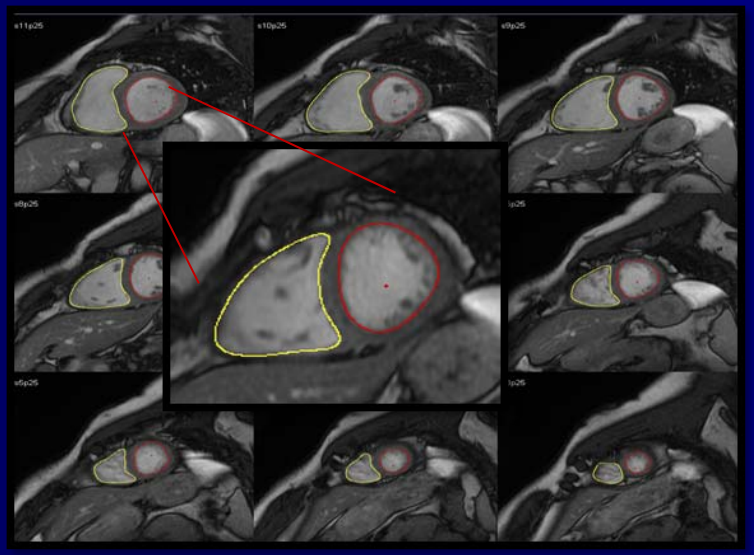
Doppler echo & Cardiac Catheterization

1. **Ventricular interdependence**
2. **Dip and Plateau**

CT: morphology

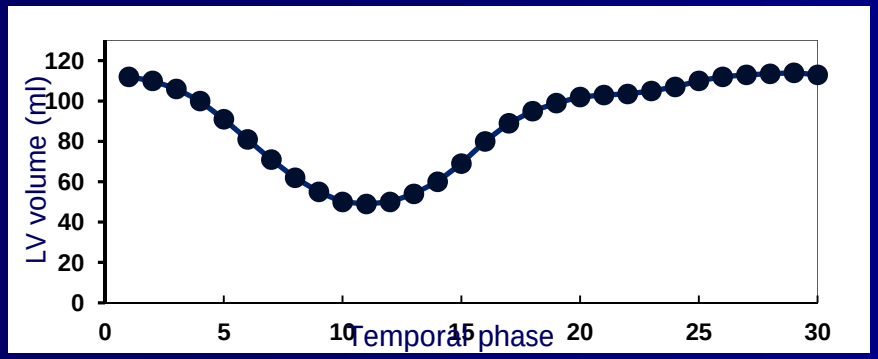
Quantitative Analysis

Phase 1 Phase 2 Phase 3 30



High signal-noise ratio
high temporal resolution
highly accurate and reproducible

MRI is the standard of reference for the assessment LV & RV volumes and function*



4D MRI

2010 expert consensus document on cardiovascular magnetic resonance
J Am Coll Cardio. 2010;55:2614-62

Purpose

- to analyze the effect of constrictive pathophysiology on LV and RV function:
  - Quantitative assessment of LV and RV systolic function and filling parameters
  - Comparison of these parameters between left and right ventricle
  - Diagnostic performance of systolic and diastolic parameters

Methods: Study Population

14 patients
pathologically proven CP

Pericardiectomy

10 normal subjects
referred for cardiac MRI

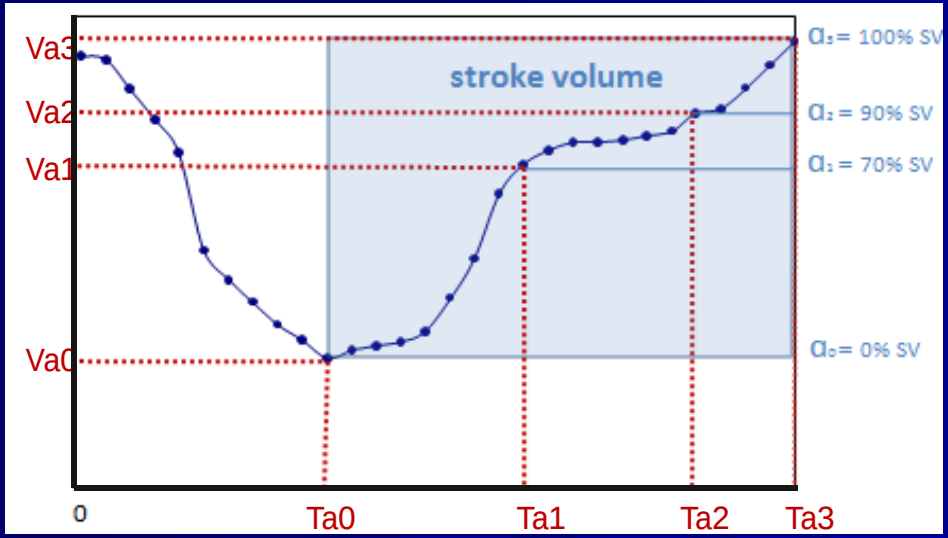
- Framingham risk score < 1%
- Normal ECG
- Normal clinical examination

Baseline Characteristics

	Normal subjects	Pts with CP
Number	10	14
Age, years	55 ± 5.1	62 ± 14.5
Gender, male	10 (100%)	14 (100%)
BMI, kg/m²	25.6 ± 2.3	27 ± 3
BSA, m²	1.99 ± 0.08	1.97 ± 0.2
Heart rate	67.3 ± 9.2	79.3 ± 18.9*

Time volume curve

Filling parameters

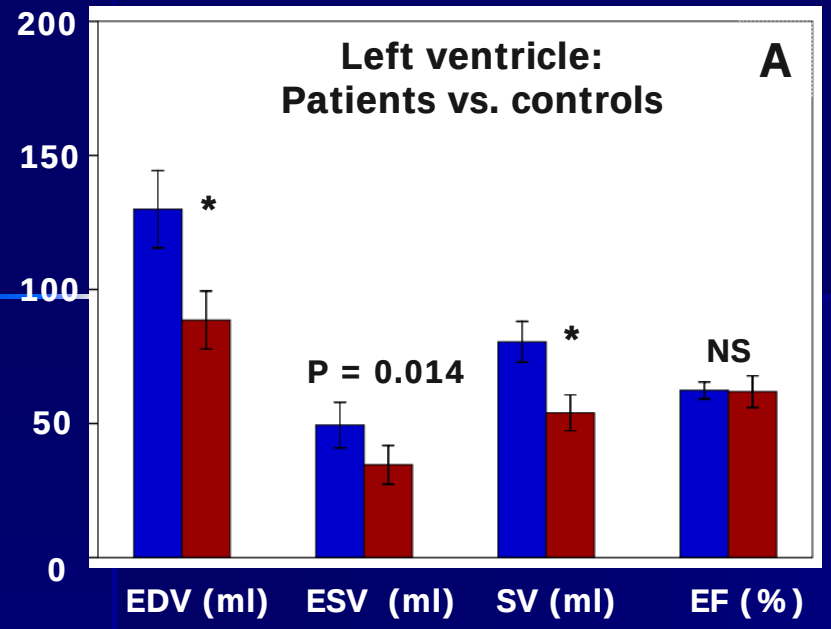


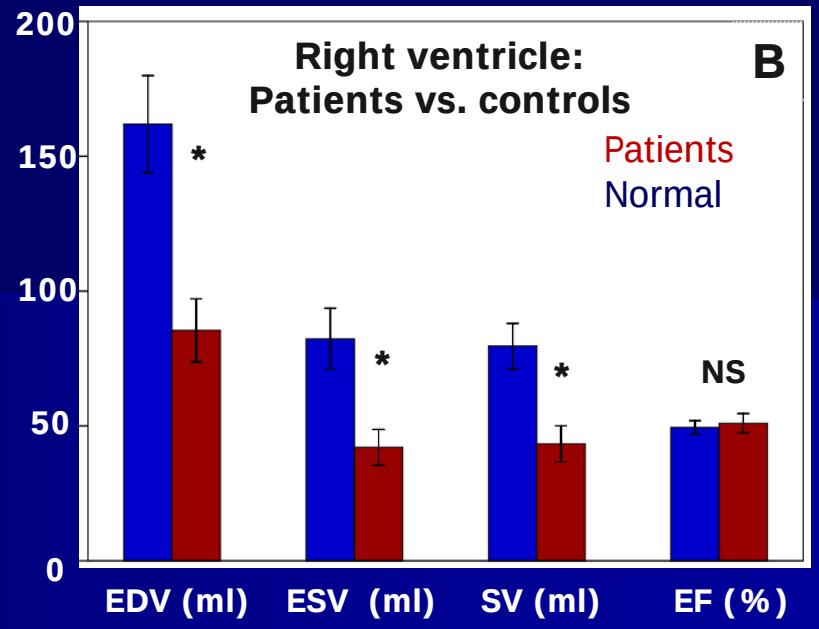
EDV / ESV
SV / EF

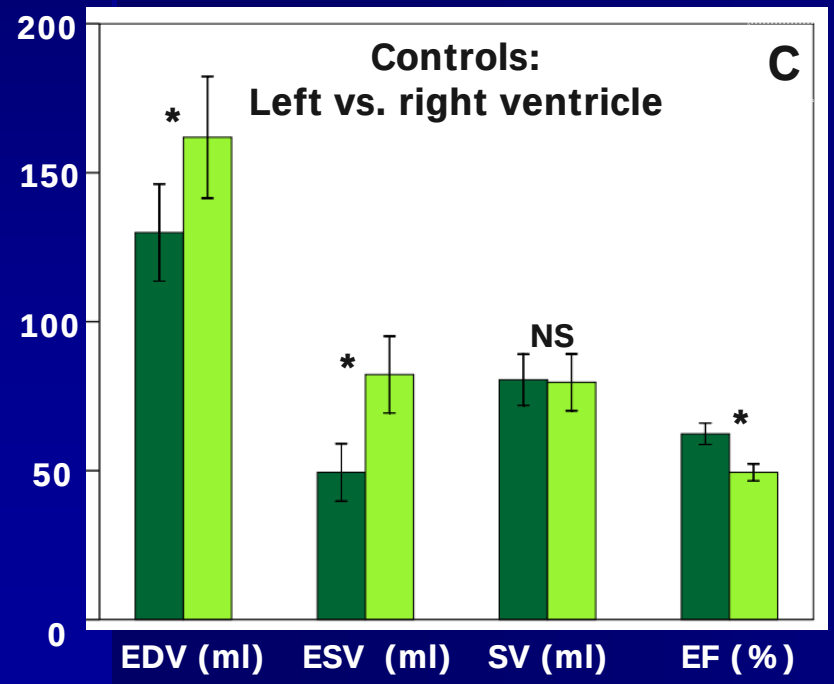
Filling time = $(Ta_2 - Ta_0)/Tcycle$

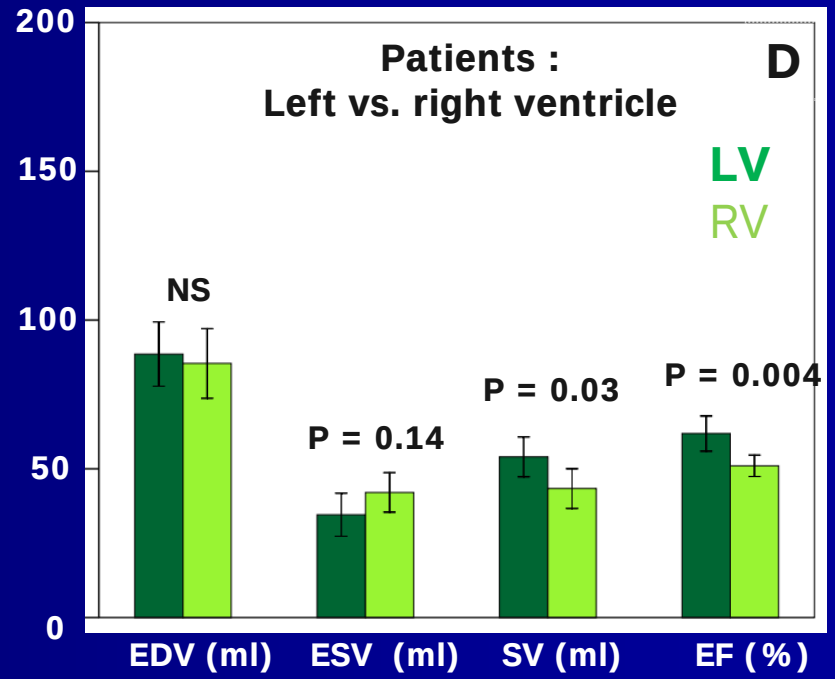
Early filling volume = **$(Va_1 - Va_0)$**

Early filling volume = **$(Va_2 - Va_1)$**

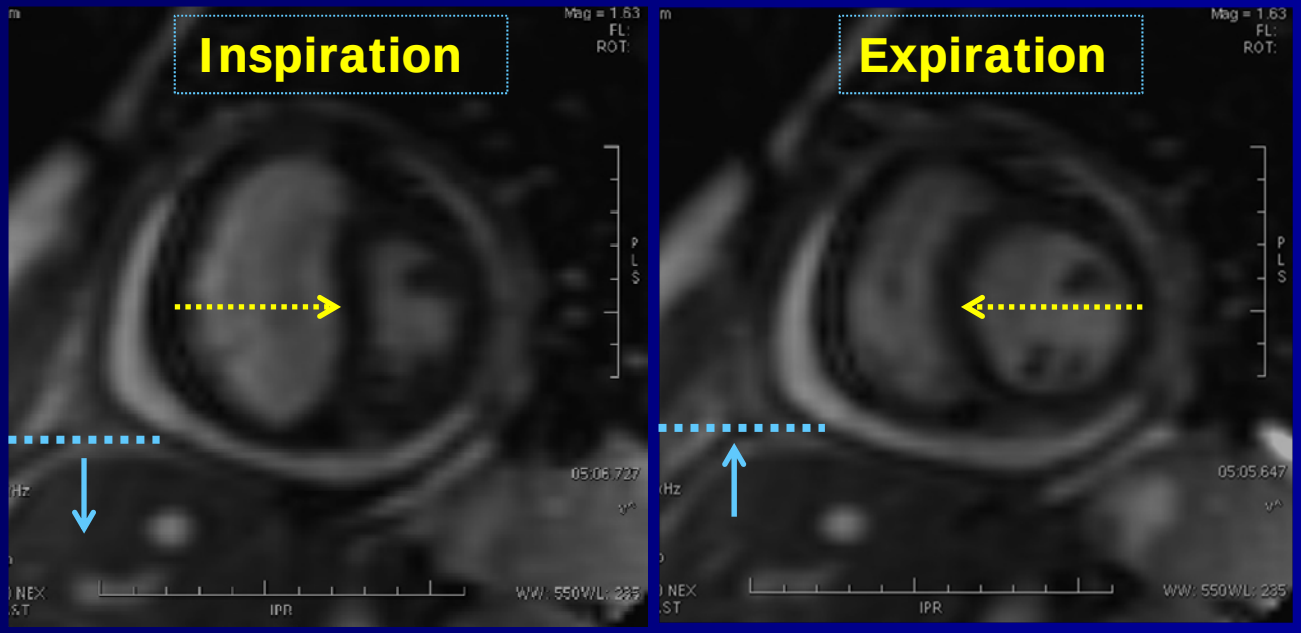

Left ventricle:
Patients vs. controls
A
200
150
100
50
0
*
P = 0.014
*
NS
EDV (ml)
ESV (ml)
SV (ml)
EF (%)


Right ventricle:
Patients vs. controls
B
Patients
Normal
200
150
100
50
0
*
*
*
NS
EDV (ml)
ESV (ml)
SV (ml)
EF (%)


Controls:
Left vs. right ventricle
C
200
150
100
50
0
*
*
NS
*
EDV (ml)
ESV (ml)
SV (ml)
EF (%)


Patients :
Left vs. right ventricle
D
LV
RV
200
150
100
50
0
NS
P = 0.14
P = 0.03
P = 0.004
EDV (ml)
ESV (ml)
SV (ml)
EF (%)

Ventricular interdependence



PV pressure↑ > LA pressure ⟶ LV filling volume↑

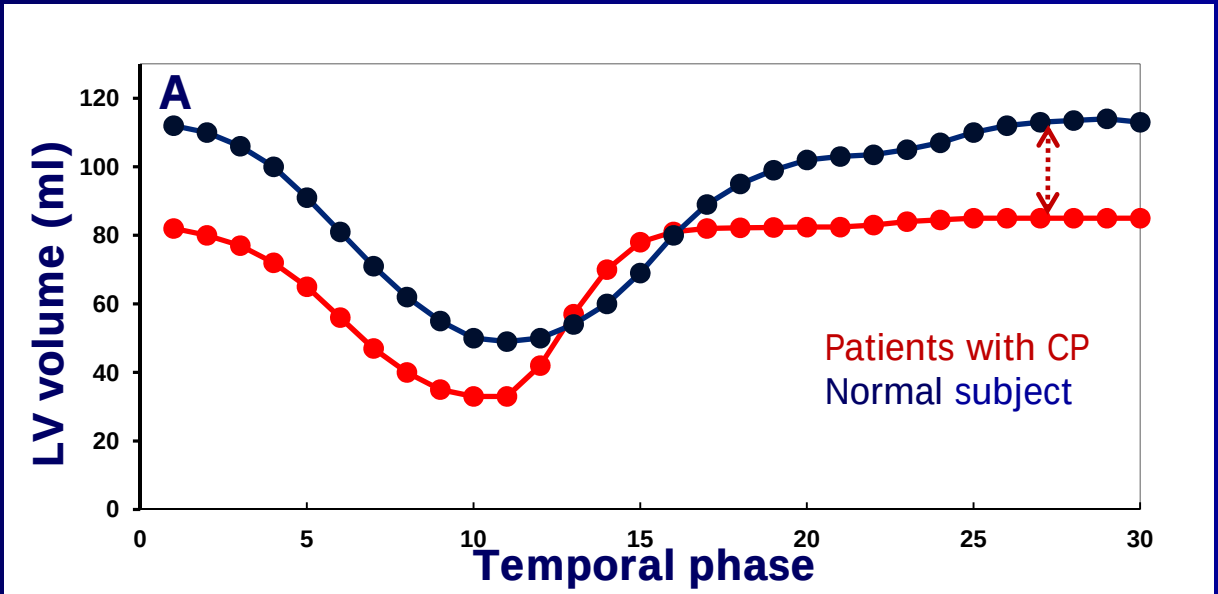
↓

shift the septum toward the right ventricle

Filling Parameters

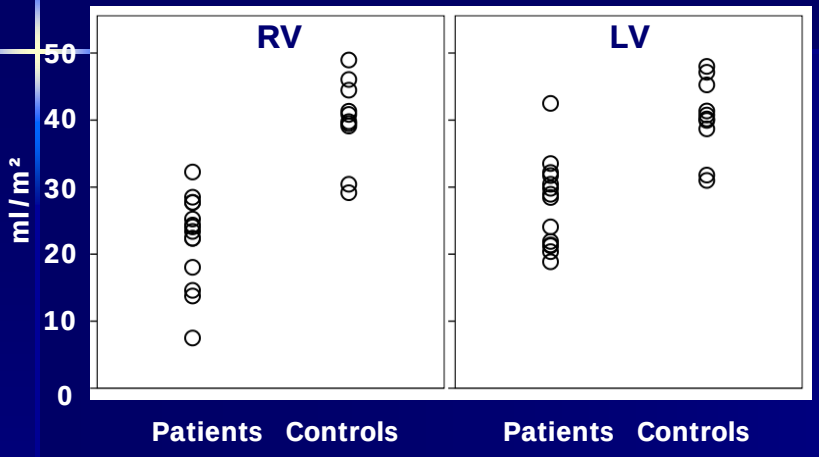
Parameters	Normal subjects	Patients with CP	*P* value
Filling time index			
Left ventricle, % (absolute value in sec)	51.3 ± 4.9 (0.46 ± 0.1)	34.7 ± 7.4 (0.27 ± 0.1)	< 0.001
Right ventricle, % (absolute value in sec)	53.2 ± 3.7 (0.47 ± 0.08)	29.2 ± 5.4 (0.22 ± 0.07)	< 0.001
***P* value**	0.2	0.04	
Early Filling volume index			
Left ventricle, % (absolute value in ml)	76.1 ± 9.8 (61.5 ± 10)	90.3 ± 11.1 (41.5 ± 12.3)	0.004
Right ventricle, % (absolute value in ml)	72.4 ± 8.8 (58.1 ± 12.1)	95.6 ± 2.5 (47.9 ± 13.2)	< 0.001
***P* value**	0.4	0.08	
Late Filling volume index			
Left ventricle, % (absolute value in ml)	22.5 ± 10 (18.5 ± 9.5)	8.9 ± 11 (4.2 ± 4.3)	< 0.001
Right ventricle, % (absolute value in ml)	24.5 ± 8.7 (19.6 ± 8.1)	2 ± 2 (1.1 ± 1.4)	< 0.001
***P* value**	0.6	0.046	

Quantitative Assessment of dip and plateau / square root sign

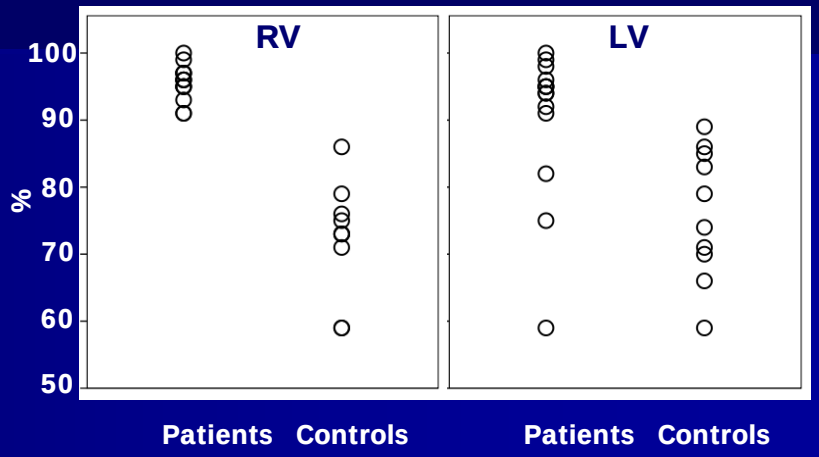


Stroke volume and Filling Parameters

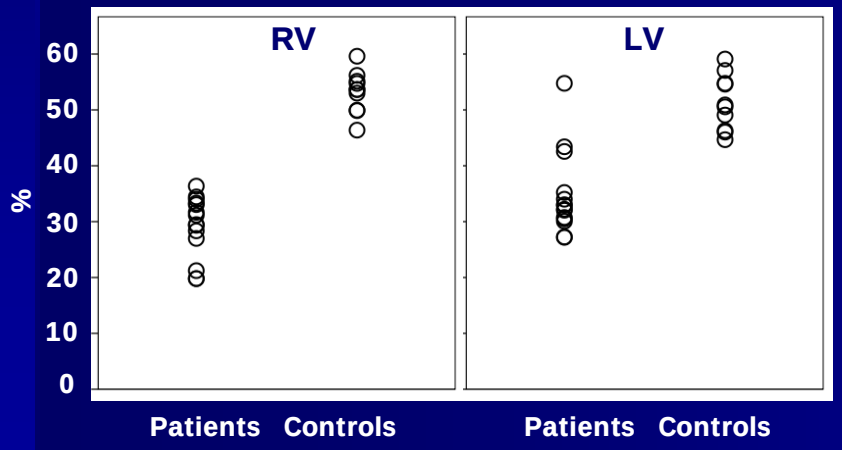
Stroke volume index



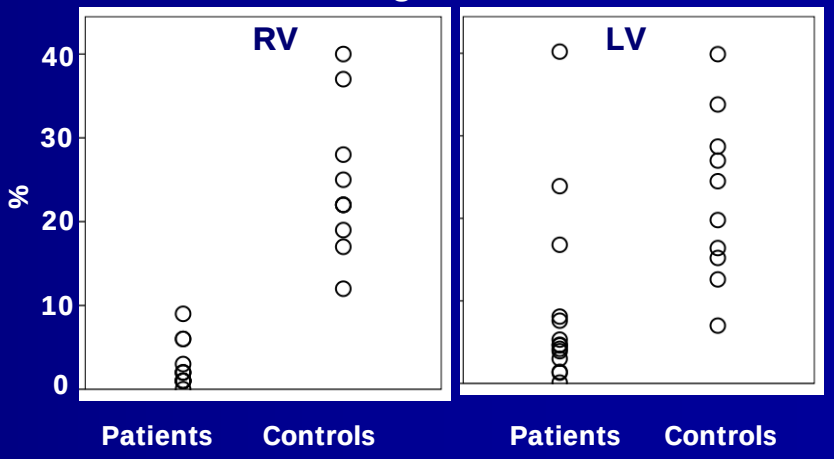
Early filling volume index



Filling time index



Late filling volume index



Diagnostic Performance

Parameters	AUC (95% CI)	Cut off (range)	Sensitivity (%)	Specificity (%)	Accuracy (%)
Stroke volume index					
Left ventricle	0.91 (0.80 - 1.0)	30.7 (30.5, 30.9)	100	71.4	83.3
Right ventricle	0.95 (0.85 - 1.0)	28.8 (28.5, 29.1)	100	92.7	95.8
Filling time index					
Left ventricle	0.95 (0.85 - 1.0)	0.44 (0.43, 0.45)	100	92.8	95.8
Right ventricle	1.0	0.41 (0.36, 0.46)	100	100	100
Early Filling volume index					
Left ventricle	0.87 (0.71 - 1.0)	-0.9 (-0.89 , -0.90)	100	78.6	87.5
Right ventricle	1.0	-0.89 (-0.86, -0.90)	100	100	100
Late Filling volume index					
Left ventricle	0.85 (0.69 - 1.0)	0.10 (0.08, 0.12)	90	78.6	83
Right ventricle	1.0	0.10 (0.09, 0.12)	100	100	100

Conclusions I

- Reduction in left and right ventricular EDV and ESV
- End-expiratory increased LV and decreased RV stroke volume, which might reflect the phenomenon of ventricular interdependence
- The right ventricle is more affected than the left ventricle from the constricted filling pattern
- Patients with CP had significantly shorter LV and RV filling time compared with healthy subjects

Conclusions II

- Four-dimensional MRI studies provide quantitative assessment of hemodynamic criteria used for the diagnosis of CP
- MRI quantitative analysis of systolic and diastolic parameters appears to be helpful in the diagnosis of CP