Clinical, echocardiographic and neurohormonal correlations of global longitudinal strain of the systemic ventricle in adult patients with congenital heart disease.


Congenital Heart Disease Clinic
Second Cardiology Department
ATTIKON University Hospital
Burden of Heart Failure in Adults with Congenital Heart Disease

Alshawabkeh and Opotowsky Curr Heart Fail Rep Aug 2016
Treatment of heart failure in adult congenital heart disease: a position paper of the Working Group of Grown-Up Congenital Heart Disease and the Heart Failure Association of the European Society of Cardiology

Werner Budts\textsuperscript{1*}, Jolien Roos-Hesselink\textsuperscript{2}, Tanja Rädle-Hurst\textsuperscript{3}, Andreas Eicken\textsuperscript{4}, Theresa A. McDonagh\textsuperscript{5}, Ekaterini Lambrinou\textsuperscript{6}, Maria G. Crespo-Leiro\textsuperscript{7}, Fiona Walker\textsuperscript{8}, and Alexandra A. Frojvodaki\textsuperscript{9}
Prognostic implications of global longitudinal strain

- Data: 16 published articles
- n=5721 adults
- 15 prospective and 1 retrospective observational studies.
- Mortality was independently associated with each SD change in the absolute value of baseline GLS ($p<0.002$) and less strongly with LVEF ($p=0.572$).
- Strong evidence of the prognostic value of GLS, which appears to have superior prognostic value to EF for predicting major adverse cardiac events

Kalam K et al Heart 2014
Congenital Heart Disease

Systemic Right Ventricular Fibrosis Detected by Cardiovascular Magnetic Resonance Is Associated With Clinical Outcome, Mainly New-Onset Atrial Arrhythmia, in Patients After Atrial Redirection Surgery for Transposition of the Great Arteries

Composite end point
new-onset sustained tachyarrhythmia (atrial/ventricular)
or decompensated heart failure admission/transplantation/death

Rydman et al Circ Cardiovasc Imag 2015
Myocardial deformation parameters predict outcome in patients with repaired tetralogy of Fallot.

- 372 Fallot patients
- combined endpoint of death, successful resuscitation or documented ventricular tachycardia was employed
- Myocardial deformation correlated with NYHA class
- LV Longitudinal S, Radial S, Circumferential S and RV Longitudinal S were related to the risk of death and nearly missed death (p<0.05)
- Myocardial deformation parameters, derived from standard CMR studies relate to symptoms and clinical deterioration in patients with ToF.
- Prognostic markers of adverse outcome independent of established risk markers

Orwat et al Heart 2016
Systemic right ventricular longitudinal strain is reduced in adults with transposition of the great arteries, relates to subpulmonary ventricular function, and predicts adverse clinical outcome.

- 129 patients (87 with TGA and atrial switch and 42 with ccTGA, age 35 ± 12 years)
- Significantly reduced longitudinal strain (approximately -12% vs 21%)
- Systemic 2D-LS (hazard ratio 1.31, p =0 .01) was related to adverse clinical outcome (symptomatic progression to New York Heart Association class ≥3, clinically relevant cardiac arrhythmia, or death) in patients with TGA and atrial switch
AHA SCIENTIFIC STATEMENT

Role of Biomarkers for the Prevention, Assessment, and Management of Heart Failure

A Scientific Statement From the American Heart Association

Chow et al Circulation 2017
Bolger et al. Circulation 2002

**Biomarkers**

**Neurohormonal Stimulation**

**Norepinephrine**
- ANOVA p<0.0002
- ANOVA p<0.05

**BNP**
- ANOVA p<0.0001
- ANOVA p<0.0001
Prognostic Value of N-Terminal Pro-B-Type Natriuretic Peptide, Troponin-T, and Growth-Differentiation Factor 15 in Adult Congenital Heart Disease

Vivan J. Baggen, Annemien van den Bosch, Jannet A. Eindhoven, Anne-Rose Schut, Judith A.A.E. Cuypers, Maarten Witsenburg, Monique de Waart, Ron H. van Schaik, Felix Zijlstra, Eric Boersma and Jolien W. Roos-Hesselink

595 patients
Median follow-up 42 months

Baggen V et al Circulation 2017
Plasma and Cardiac Galectin-3 in Patients With Heart Failure Reflects Both Inflammation and Fibrosis
Implications for Its Use as a Biomarker

Christian Besler, MD; David Lang, BSc; Daniel Urban, MD; Karl-Philipp Rommel, MD; Maximilian von Roeder, MD; Karl Fengler, MD; Stephan Blazek, MD; Reinhard Kandolf, MD; Karin Klingel, MD; Holger Thiele, MD; Axel Linke, MD; Gerhard Schuler, MD; Volker Adams, PhD*; Philipp Lurz, MD, PhD*
Purpose

• We aimed to examine the correlations of GLS with important predictive clinical, echocardiographic and neurohormonal parameters in adult patients with congenital heart disease
Rationale

- Strain reflects fibrosis among other pathologies
- Galectin 3 is a marker of fibrosis
- NT proBNP reflects elevated systemic atrial pressure
- Fibrosis and elevated atrial pressure may be the cause of arrhythmia
Methods

• We studied 57 clinically stable patients with CHD
• 31 men, mean age 37.1±16.9
• Forty-nine had systemic left ventricle, 5 systemic right ventricle and 3 single ventricle physiology.
• All patients underwent echocardiogram and Holter monitoring
• NTproBNP and galectin-3 plasma levels were measured in a week interval from the echocardiogram.
Diagnosis

- Atrial septal defect  n=16
- Ventricular septal defect  n=3
- Atrioventricular septal defect  n=3
- Atrial and ventricular septal defect, criss-cross heart  n=1
- Aortic stenosis (LVOTO)  n=2
- Coarctation of the aorta  n=4
- Pulmonary venous connection abnormality  n=3
- Aortic regurgitation  n=2
- Pulmonary stenosis  n=2
- Tetralogy of Fallot  n=13
- Transposition of the great arteries (post Mustard or Senning)  n=2
- Congenitally corrected transposition of the great arteries  n=3
- Single ventricle physiology  n=3
Global Longitudinal Strain

- Off line GLS measurement of the systemic ventricle (SV) was performed (ECHOPAC GE).
Supraventricular Arrhythmia

- Patients were divided in 3 groups according to the occurrence of supraventricular tachycardia (SVT) in Holter monitoring:
  - A: no SVT, n=16 (28%)
  - B: 1-2 episodes of SVT or SV extra systoles, n=26 (45.6%)
  - C: multiple SVT episodes or atrial fibrillation, n=15, 26.3%
Ventricular Arrhythmia

- Patients were divided in 3 groups according to the occurrence of ventricular arrhythmia:
  - A’: no VT, n=15 (26.3%)
  - B’: extrasystoles or couplets, n=32 (56.1%)
  - C’: triplets or non sustained VT or more than 1000 extra systoles, n=10 (17.5%)
Results

Global Longitudinal Strain

- Left systemic ventricle GLS was 
  -15.83±4.03%.
- It significantly differed in systemic right ventricle patients -11.42±3.37% and in single ventricle patients -1.53±6.13%, p=0.025 for all.
Results

Galectin 3 and NT ProBNP

- Mean galectin-3 value was 16.93±6.39ng/ml.
- Mean NTproBNP value was 265.25pg/ml (range 18.7 pg/ml-3788pg/ml).
Statistical Analysis

Pearson correlation analysis was performed for parameters with normal distribution.
Spearman correlation analysis was performed for parameters with no normal distribution.
Results

Correlations

• Systemic ventricle (SV) **GLS correlated with plasma galectin-3 levels**
  \( r=0.306, \ p=0.029 \)
Results

Correlations

- Systemic ventricle (SV) **Globus lateralis shortening (GLS)** correlated with **LogNTproBNP** \( r=0.46, p<0.001 \).

Left atrial diameter was correlated with **SVGLS** \( r=0.392, p=0.02 \).

**SVGLS correlated with VT incidence** (mean SVGLS: group A’: -18.12%±2.75%, group B’: -14.21%±4.46%, group C’: -13.72%±3.72%, \( p=0.005 \).
Conclusion

- Global longitudinal strain of the systemic ventricle is reduced in systemic right ventricle and single ventricle in adult patients with congenital heart disease.
- First report: Global longitudinal strain of the systemic ventricle correlates with galectin-3 which is fibrosis biomarker, NT pro BNP and systemic atrial diameter (increased systemic ventricle end diastolic pressure) and ventricular tachycardia, indicating that fibrosis of the systemic ventricle may be the cause of ventricular arrhythmia in adult patients with congenital heart disease.