RV evaluation and management before and after L-VAD implantation

Giornate Torinesi di Cardiologia
25-27 Ottobre 2018

Dott Massimo Maiani
U.O Cardiac Surgery-VAD/ECMO Unit
Azienda Sanitaria Universitaria Integrata Udine, Italy

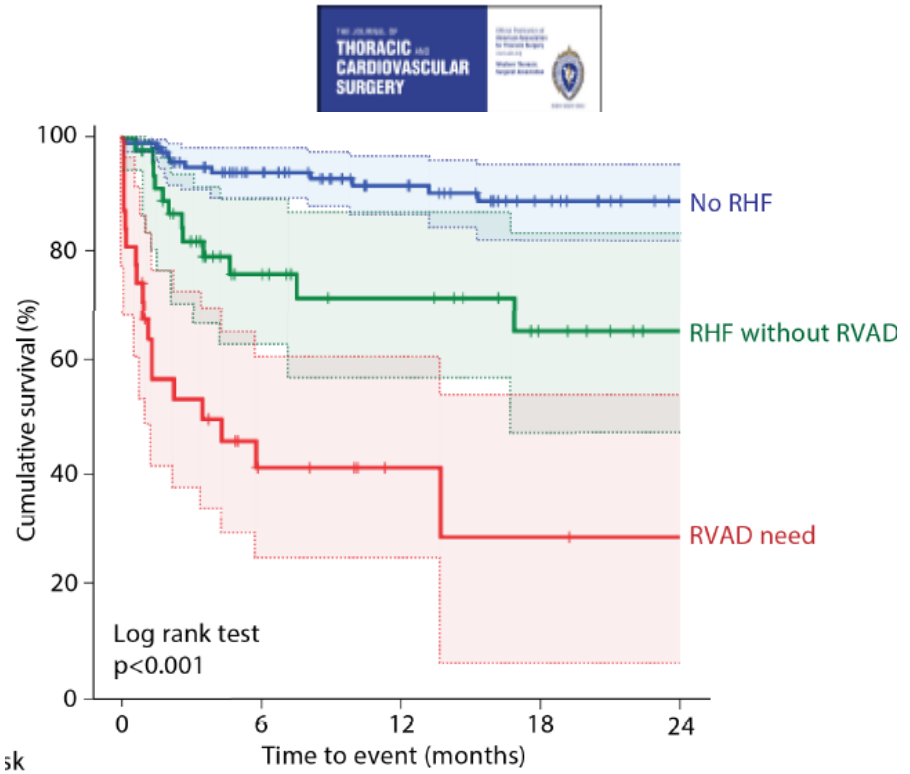
PREOPERATIVE SCREENING

- ✓ **Echocardiography** → LV and RV function and dimensions, anatomical and valvular abnormalities, thrombi
- ✓ **Right heart catheterization** → Hemodynamic evaluation of right heart function, pulmonary hypertension, TPG, RVSWI, Kormos index
- ✓ Chest X-Ray (AP-LL)
- ✓ CT head → Identification of the pedestal site of implantation, thickness and morphology of the skull, flat area of 2 cm^2 is needed
- ✓ Thoraco-Abdominal CT
- ✓ Coronary Angiography - Cardio CT
- ✓ AngioCT
- ✓ Peripheral Vascular US → peripheral access for CPB or ECMO
- ✓ Colonoscopy/Gastroscopy/Capsule Endoscopy → evaluation of bleeding risk

WHY SHOULD WE FOCUS ON PREOP RV FUNCTION

(INTERMACS) defines RVF as (1) need of an RV assist device (RVAD), or (2) requirement of inhaled nitric oxide or inotropic therapy for >1 week any time after LVAD implantation in the presence of symptoms and signs of persistent RV dysfunction, such as central venous pressure >18 mm Hg with a cardiac index <2.3 L/min per square meter in the absence of elevated left atrial or pulmonary capillary wedge pressure (>18 mm Hg), cardiac tamponade, ventricular arrhythmias, or pneumothorax.[33] Most studies have used a variation of this definition combining clinical findings and hemodynamics (Table 1). Severe RVF requiring RVAD has been reported in 9.4% to 23.4% of patients,[8,21,22] whereas definitions incorporating need for inotropes yield estimates ranging from 20.2% to 40%.[5–7,13,14]

Assessment of Right Ventricular Function in Left Ventricular Assist Device Candidates
Circ Cardiovasc Imaging. 2014;7:379-389



MULTIMODAL PREOP RV ASSESSMENT

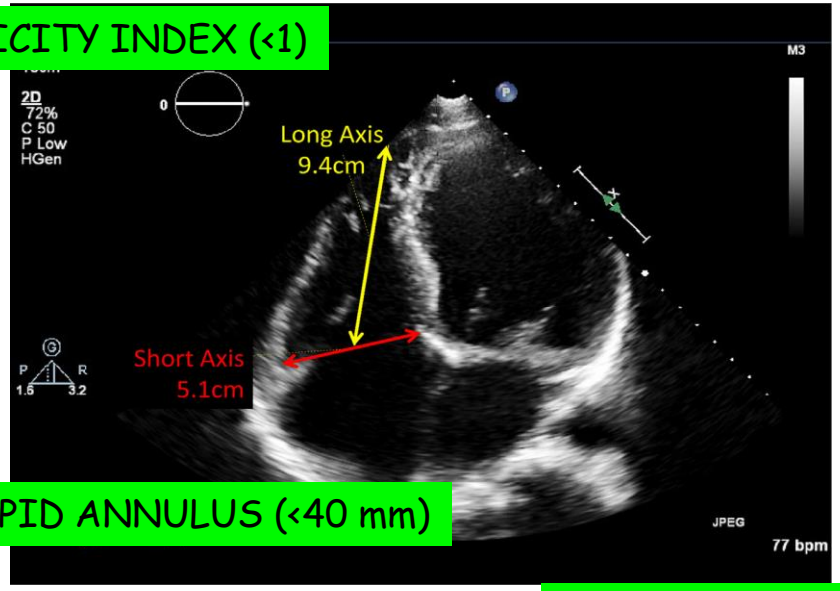
2D-3D ECHO
RH CATH
DSE

FIRST STEP: 2D ECHO RV ASSESSMENT

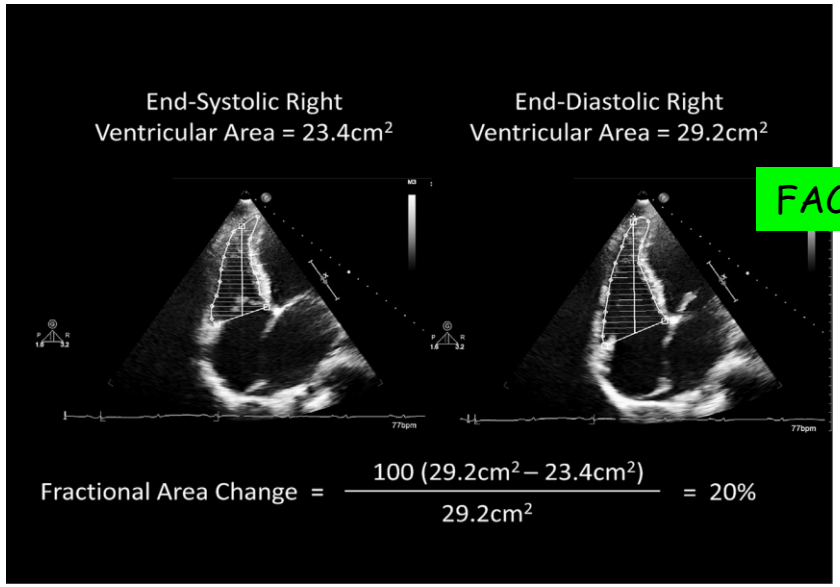
The use of multimodality cardiovascular imaging to assess right ventricular size and function

International Journal of Cardiology 214 (2016) 54–69

SPHERICITY INDEX (<1)



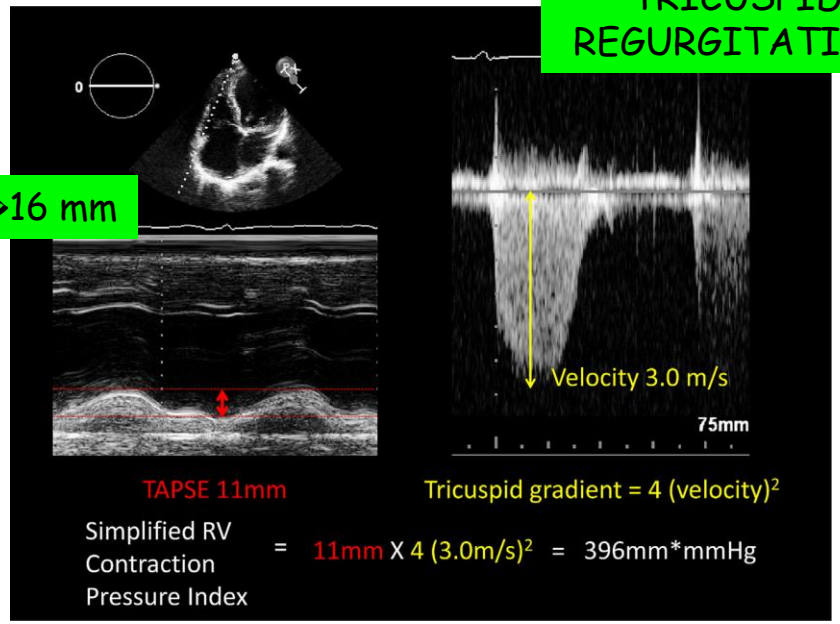
TRICUSPID ANNULUS (<40 mm)

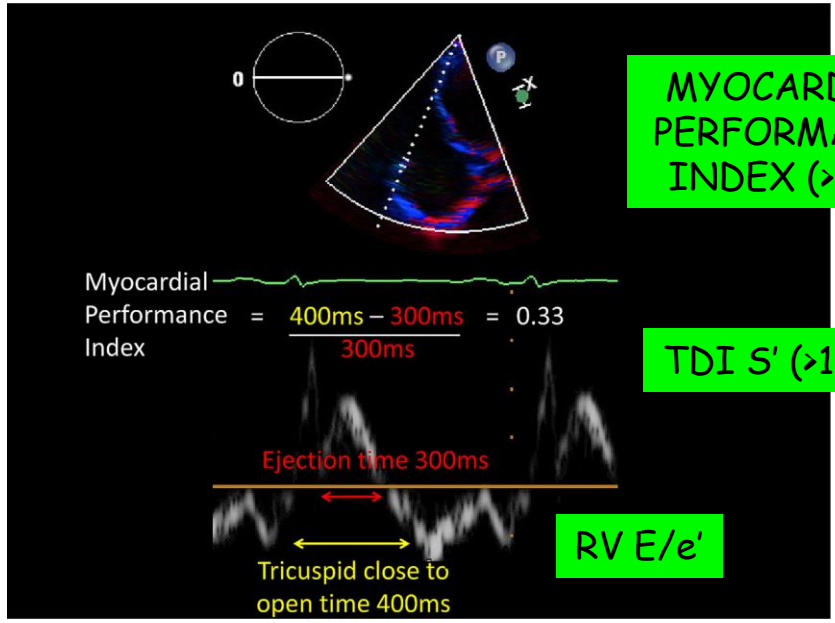


FAC >35%

TRICUSPID REGURGITATION

TAPSE >16 mm





MYOCARDIAL PERFORMANCE INDEX (>400)

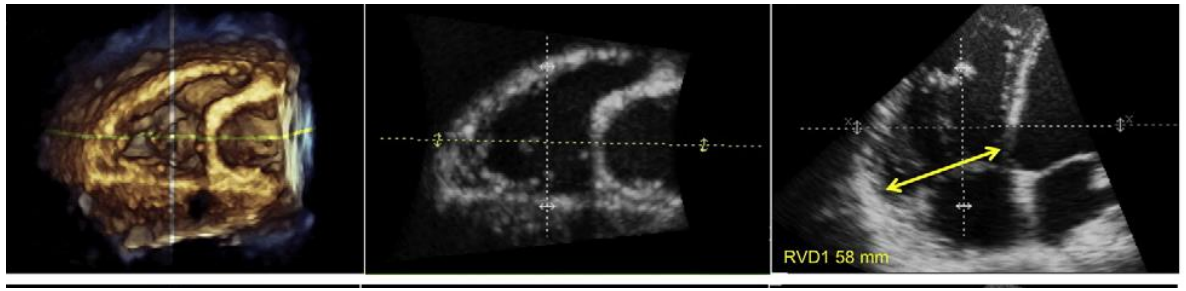
TDI S' (>10 cm/sec)

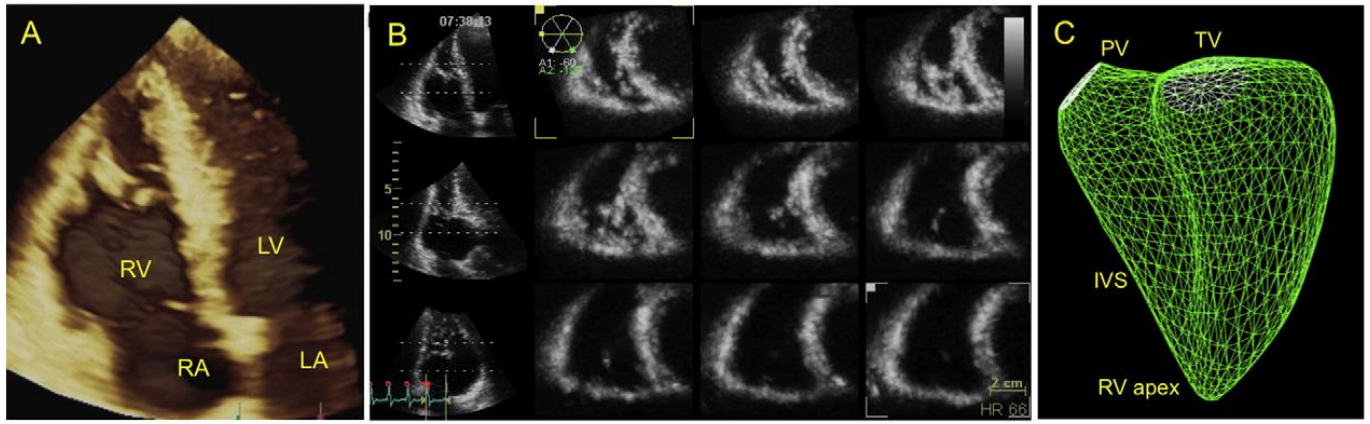
RV E/e'

SECOND STEP: 3D ECHO RV ASSESSMENT

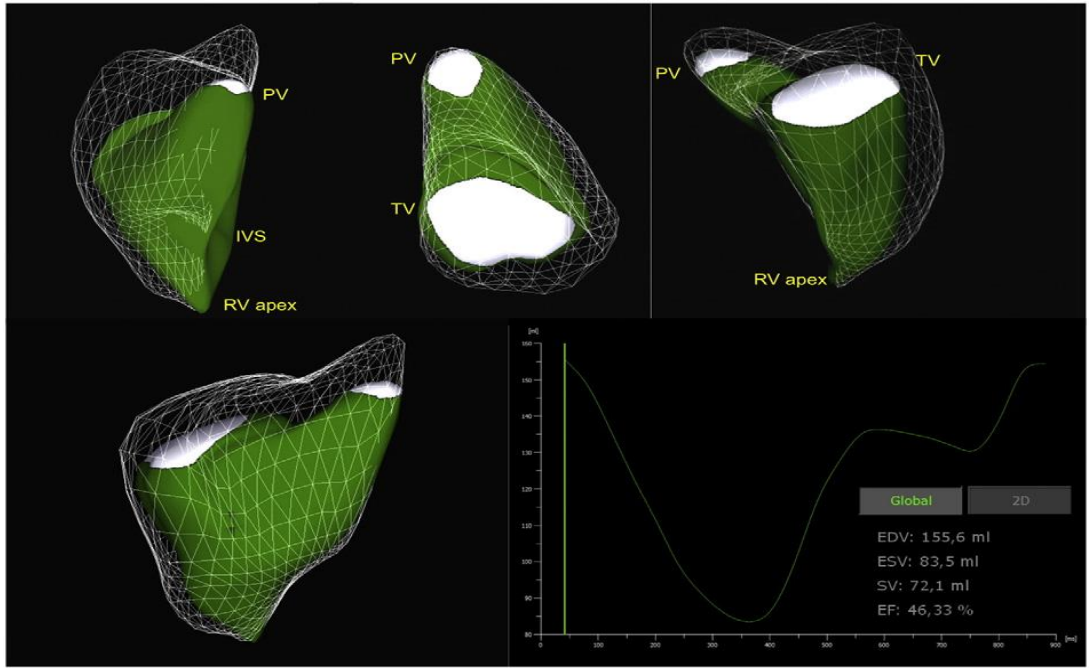
The use of multimodality cardiovascular imaging to assess right ventricular size and function
International Journal of Cardiology 214 (2016) 54–69

3DEcho enables aquisition of all the components of the RV
(**inflow, outflow and apex**)
RV GEOMETRICAL RECONSTRUCTION





En face visualization of the functional anatomy of **tricuspid valve leaflets and annulus**



3DEcho measurements with **TTE and TEE** comparable with **CMR and CT** (appropriate identification of the endocardial surface)

assessment of **RV dynamics**, quantitation of **RV volumes**, **ejection fraction, strain components** and **Regional Wall Motion Abnormalities**

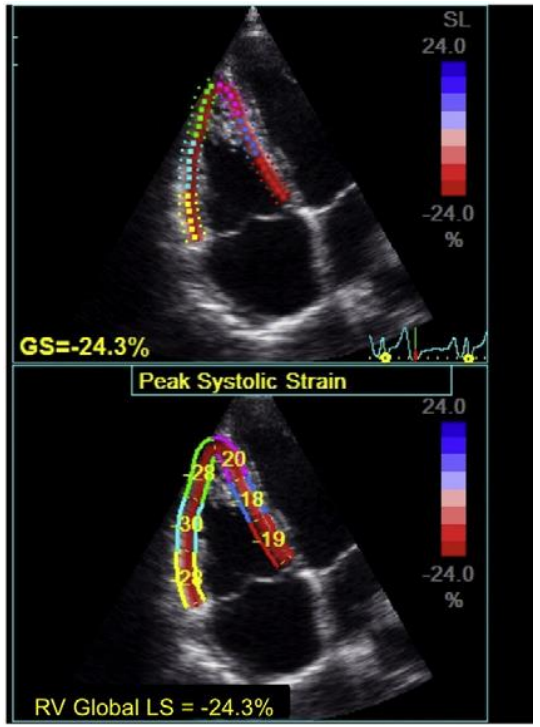
RV MECHANICS AND CONTRACTILE RESERVE

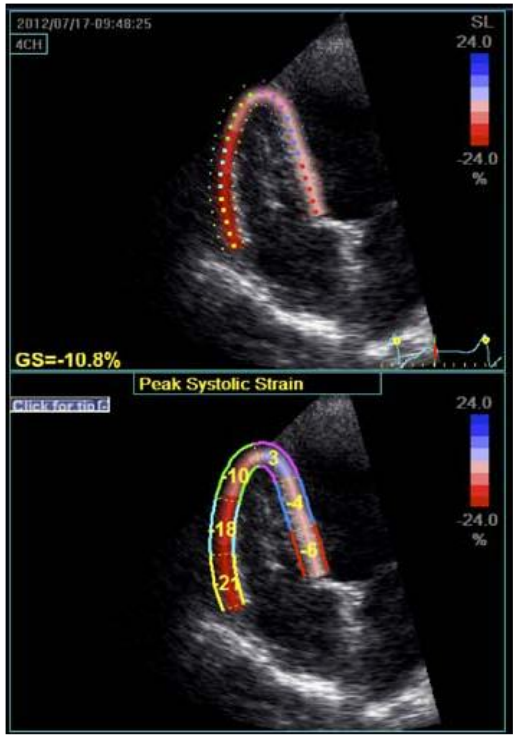
The use of multimodality cardiovascular imaging to assess right ventricular size and function
International Journal of Cardiology 214 (2016) 54–69

PEAK LONGITUDINAL STRAIN <-20%

2D Speckle tracking echocardiography

RV myocardial performance
Better assessment of myocardial contractility than EF or linear measurements





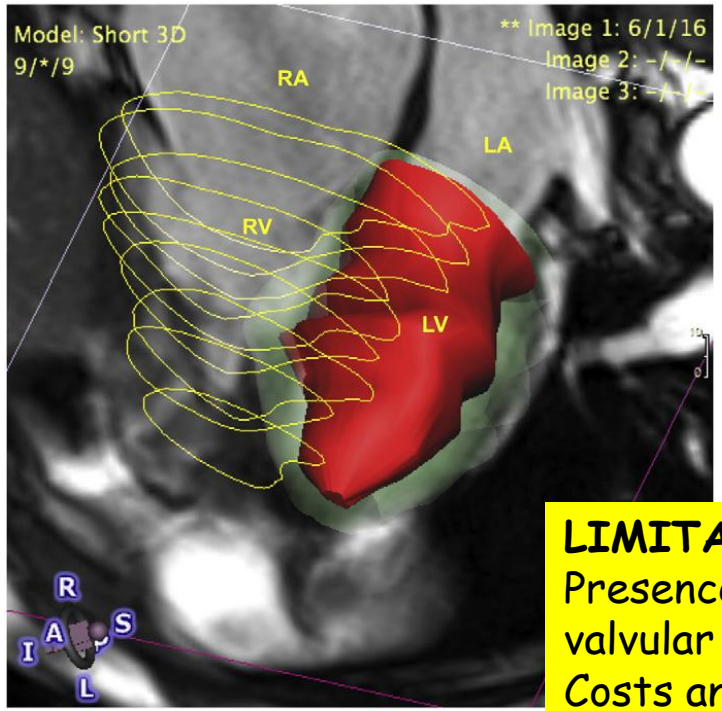
DOBUTAMINE STRESS ECHO (AND RIGHT HEART CATH)

RV systolic function during stress
Unmask mitral valve pathology or non group 2 PH

RIGHT VENTRICLE PREOP ASSESSMENT

The use of multimodality cardiovascular imaging to assess right ventricular size and function
International Journal of Cardiology 214 (2016) 54–69

CARDIAC MR: THE GOLD STANDARD

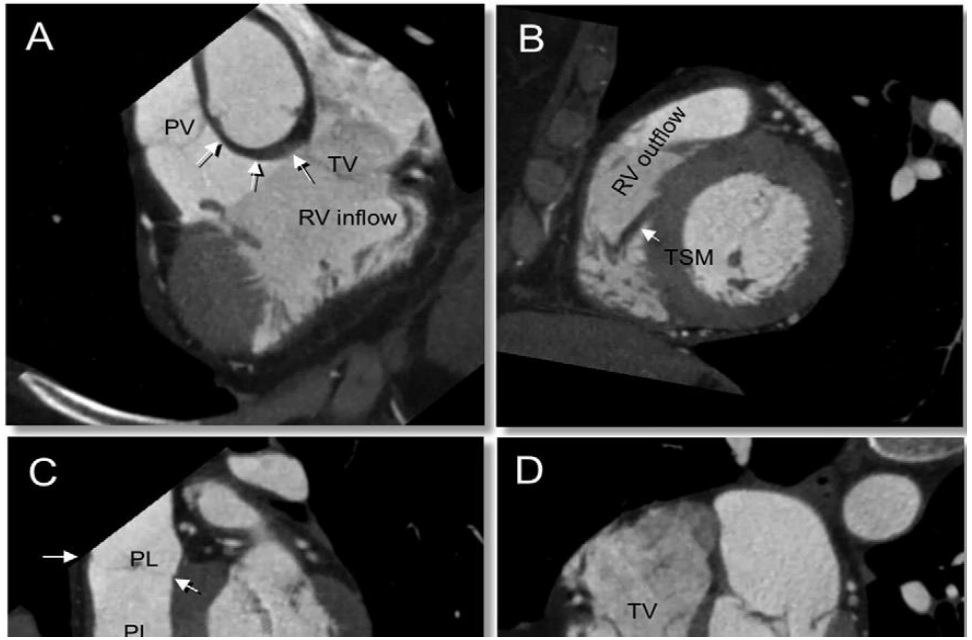


LIMITATIONS
Presence of PM, ICD, valvular prosthesis
Costs and availability

- ✓ RV segmental anatomy
- ✓ RV mass
- ✓ RV volumes and EF
- ✓ Extracardiac structures
- ✓ Low interobserver variability

CARDIAC CT

- ✓ Alternative to MR
- ✓ Significant radiation exposure
- ✓ Nephrotoxic contrast agents
- ✓ Limited use in pts with tachicardia
- ✓ Lower temporal resolution, tends to overestimate RV volumes



RIGHT HEART CATH

Methods for Evaluating Right Ventricular Function and Ventricular–Arterial Coupling

Saad Kubba[a,1], Carlos D. Davila[b,1], Paul R. Forfia[a,c,*]

PARAMETERS DERIVED FROM RIGHT HEART CATH

1. PCWP
2. TPG → MPAP-WEDGE → *<12 mmHg*
3. Kormos index → CVP/WEDGE → *<0.65*
4. *PVR → <3WU*
5. **Pulsatility index** → (PAPS-PAPD)/CVP → *>2.7*
6. RVSWI → (mPAP-CVP)*SVI → *>600 mmHg/mL/m²*

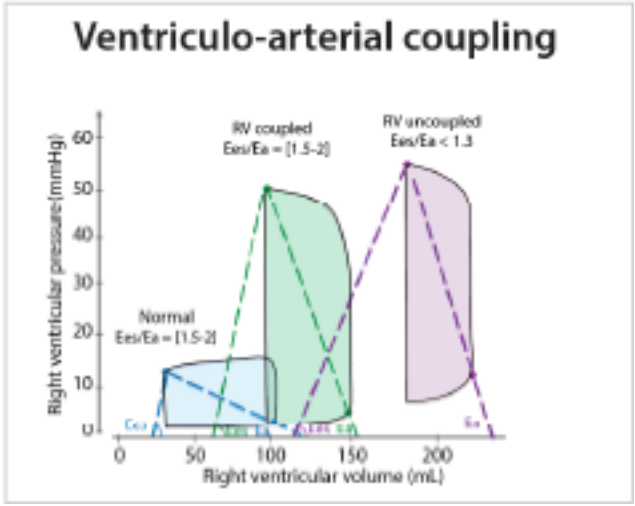
Right ventricular function – pulmonary artery coupling

ELSEVIER

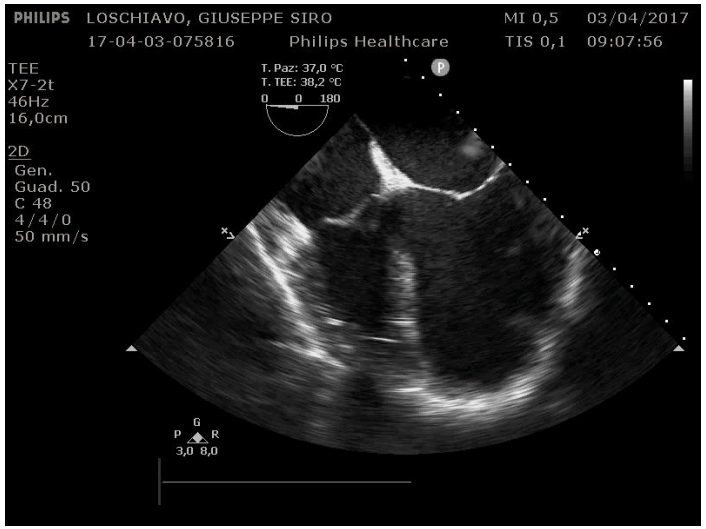
The Journal of Heart and Lung Transplantation
http://www.jhltonline.org

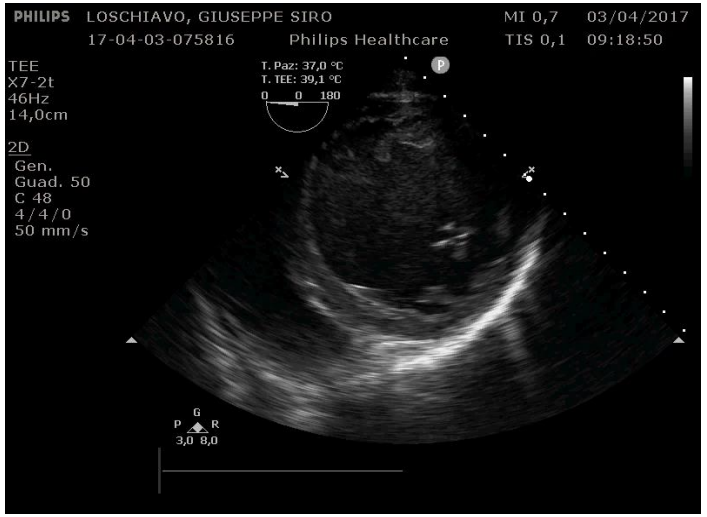
Pulmonary artery pulsatility index predicts right ventricular failure after left ventricular assist device implantation

J Heart Lung Transplant 2016;35:67–73



WHAT DO WE USUALLY DO?





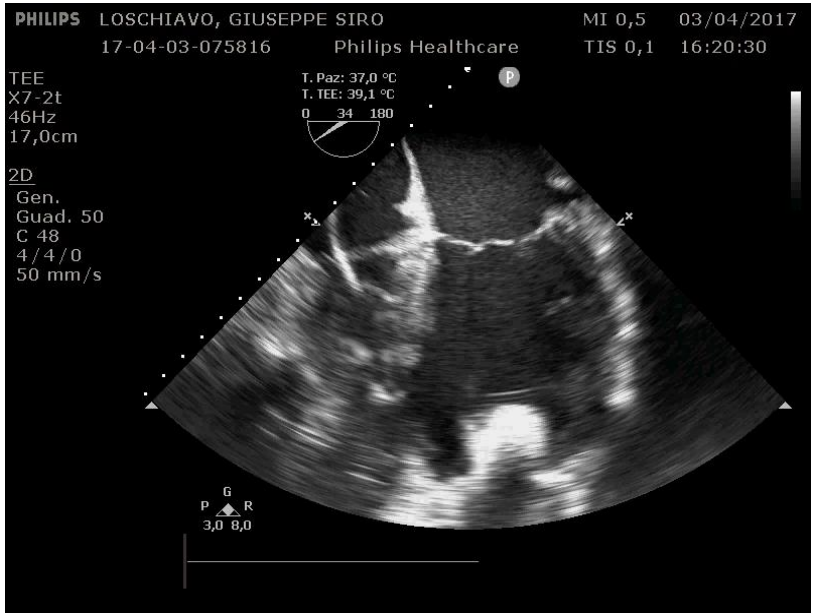
MULTIMODAL PREOP RV ASSESSMENT

2D ECHO
- ✓ TAPSE
- ✓ Sphericity index
- ✓ FAC
- ✓ S'
- ✓ Tricuspid valve

3D ECHO
- ✓ RV volumes and EF
- ✓ (not available RV strain package)

RH CATH

Dobutamine Stress Echo (variation of FAC, TAPSE, RV volumes and dynamic)



HOW WILL MY RV PERFORM AFTER LVAD IMPLANTATION?

(variation in preload, geometry, hemodynamics)

HOW WILL MY RV PERFORM AFTER LVAD IMPLANTATION?
(variation in preload, geometry, hemodynamics)

Circulation

Circulation. 2018;137:891–906. DOI: 10.1161/CIRCULATIONAHA.117.030543

AMERICAN COLLEGE of CARDIOLOGY

The EUROMACS Score: From Reactive to Proactive Approaches to Identify RV Failure After Continuous Flow LVAD Implantation

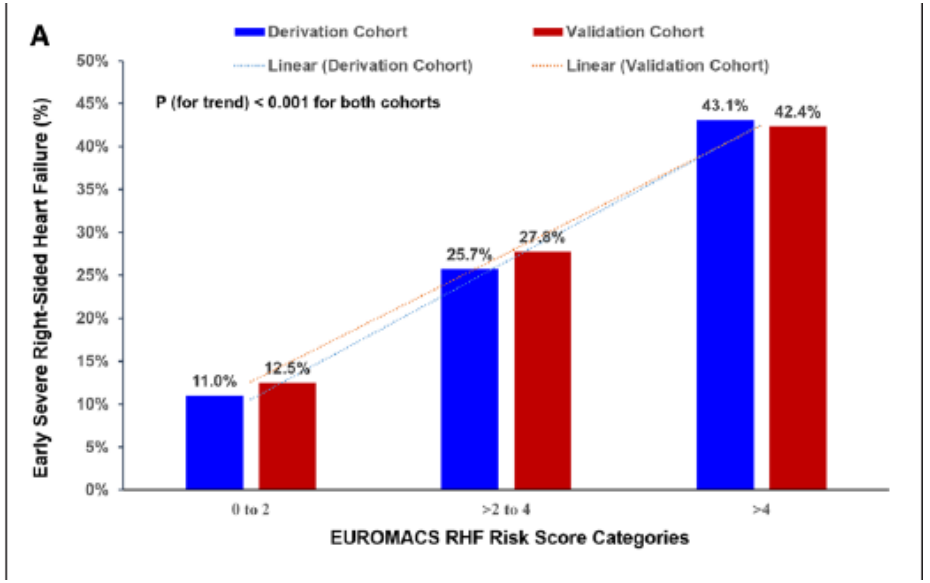
Oct 13, 2017 | Kevin Morine, MD; Shiva Annamalai, MD; Navin Kapur, MD, FACC

ORIGINAL RESEARCH ARTICLE

Derivation and Validation of a Novel Right-Sided Heart Failure Model After Implantation of Continuous Flow Left Ventricular Assist Devices

The EUROMACS (European Registry for Patients with Mechanical Circulatory Support) Right-Sided Heart Failure Risk Score

Variables	OR	Lower 95% CI	Upper 95% CI	χ^2 Value (χ^2=56.9)	Coefficients	Score
Preoperative model						
RA/PCWP >0.54	2.075	1.383	3.112	12.441	0.730	2
Hemoglobin ≤10 g/dL	1.611	1.037	2.502	4.506	0.477	1
Multiple intravenous inotropes	3.197	1.851	5.524	17.355	1.162	2.5
INTERMACS class 1–3	2.903	1.723	4.893	16.014	1.066	2
Severe RV dysfunction*	2.055	1.183	3.57	6.534	0.720	2



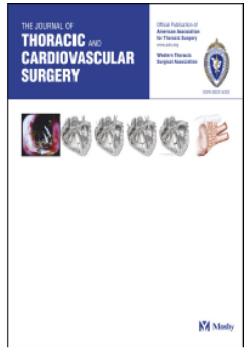
RV MANAGEMENT IN OUR CENTER

PRE-OPERATIVE

- ✓ Maximization of medical therapy
- ✓ Diuretics ci
- ✓ Preop Levosimendan/dobutamine/IABP

Preoperative low right atrial pressure!!!

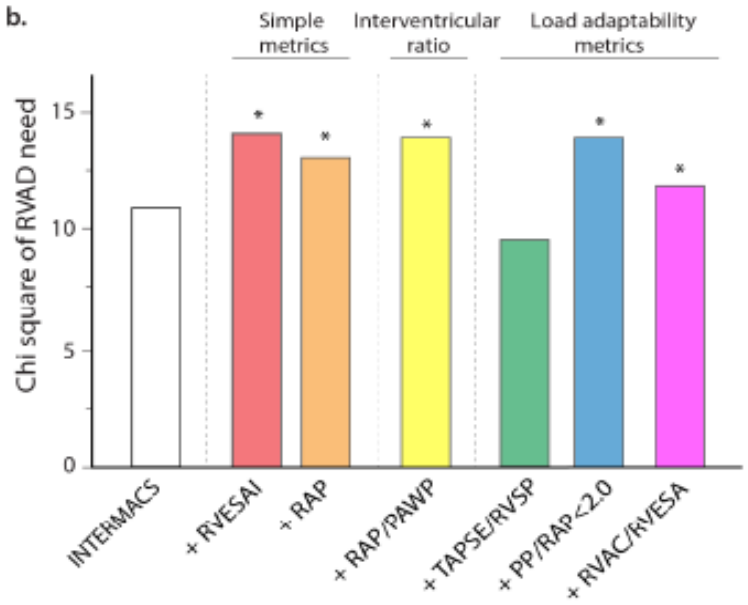
Accepted Manuscript



Right Ventricular Load Adaptability Metrics in Patients Undergoing Left Ventricular Assist Device Implantation

Myriam Amsallem, MD MS, Marie Aymami, MD MS, William Hiesinger, MD, Sanford Zeigler, MD, Kegan Moneghetti, MD, Michael Marques, MD PhD, Jeffrey Teuteberg, MD PhD, Richard Ha, MD, Dipanjan Banerjee, MD, François Haddad, MD

The Journal of Thoracic and Cardiovascular Surgery
10 August 2018



RV MANAGEMENT IN OUR CENTER

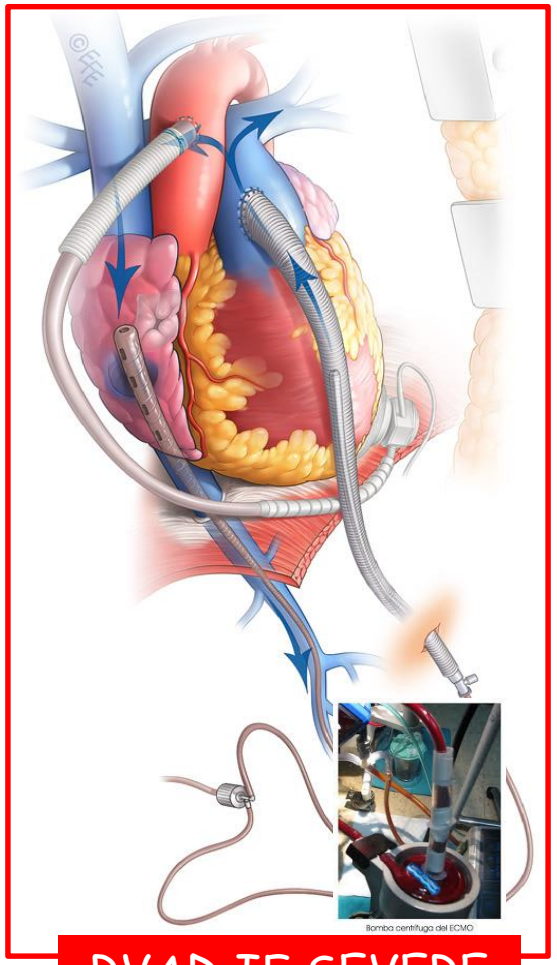
INTRA-OPERATIVE

- Inotropic support with low doses of adrenaline and iNO
- Reduce CPB times
- Prevent bleeding
- Right coronary CABG
- Tricuspid valve repair (careful selection of cases)

- Avoid hypoxia and acidosis
- Prevent atelectasis
- Ventilation with Low Volumes and Pressures
- Preserve kidney function

Post operative RV MANAGEMENT

R-VAD femoro-polmonare centrale



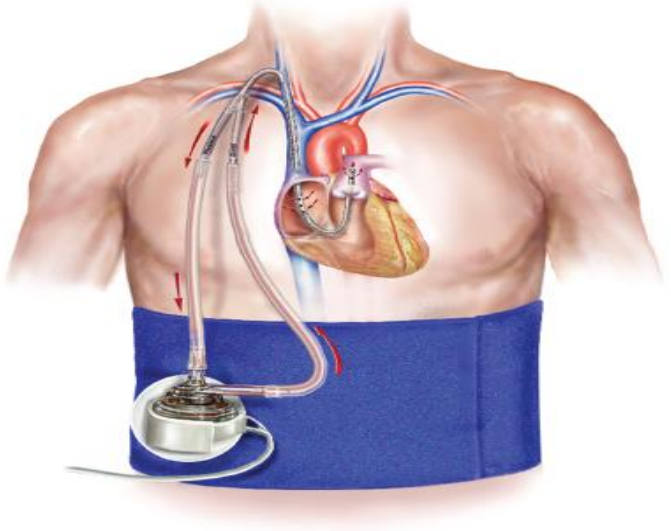
RVAD IF SEVERE POSTOP RV FAILURE

+

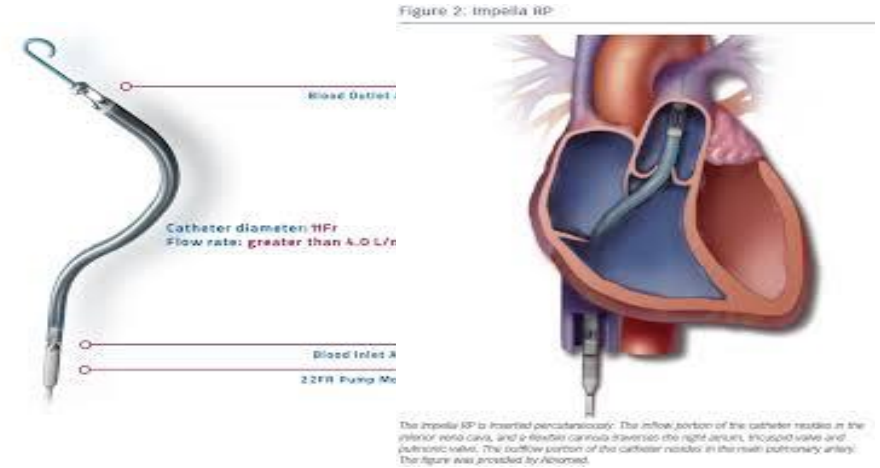
ECMO femoro-polmonare

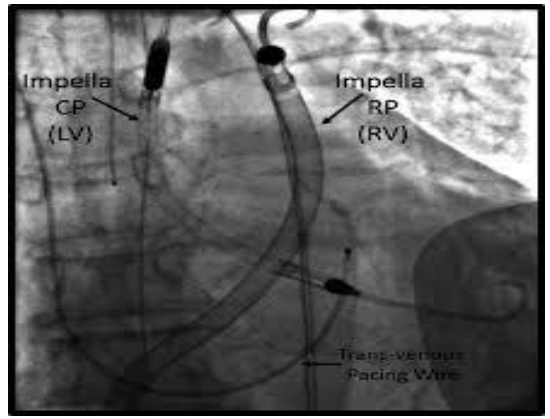
- ossigenzione/rimoz.CO2
- stato acido-base
- ventilazione protettiva

R-VAD giugulo-polmonare percutaneo



Impella RV percutanea





Percutaneous Mechanical Circulatory Support Devices for High-Risk Percutaneous Coronary Intervention
Current Cardiology Reports (2018) 20: 2

Post operative RV MANAGEMENT

Can Perioperative Right Ventricular Support Prevent Postoperative Right Heart Failure in Patients With Biventricular Dysfunction Undergoing Left Ventricular Assist Device Implantation?

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 3 (June), 2016: pp 619–626

Early RV disfunction post L-VAD (high morbidity and mortality)

Early timing of R-VAD implantation

STEMI – primary PTCA
"door to balloon time"

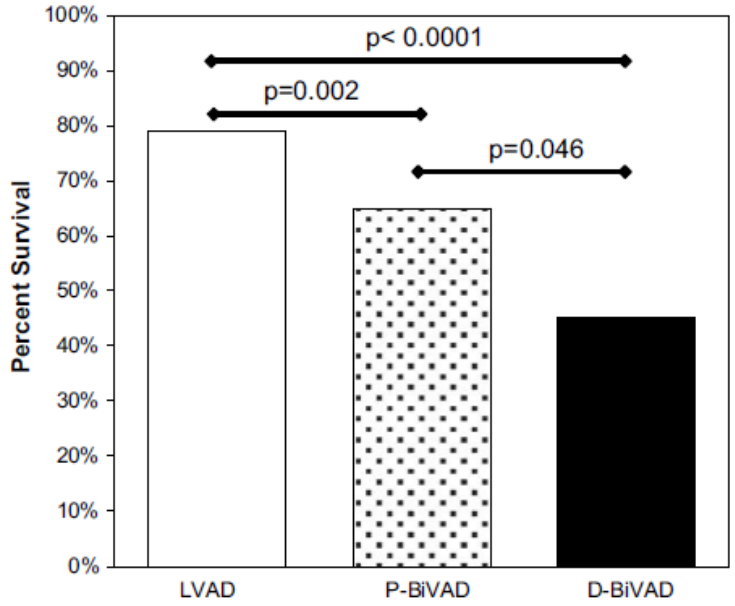
from left ventricle to **right ventricle!!**
door to unloading time"

- Low doses of drugs
- Avoid congestive status
- Preserve of liver and kidney function

Respiratory weaning and after 48-72 h R-VAD

Advanced percutaneous mechanical circulatory support devices for cardiogenic shock E.Miller et al. - society by the critical care medicine - 2017

Fitzpatrick JR III, Frederick JR, Hiesinger W, Hsu VM, McCormick RC, Kozin ED *et al*. Early planned institution of biventricular mechanical circulatory support results in improved outcomes compared with delayed conversion of a left ventricular assist device to a biventricular assist device. J Thorac Cardiovasc Surg 2009;137:971–7.



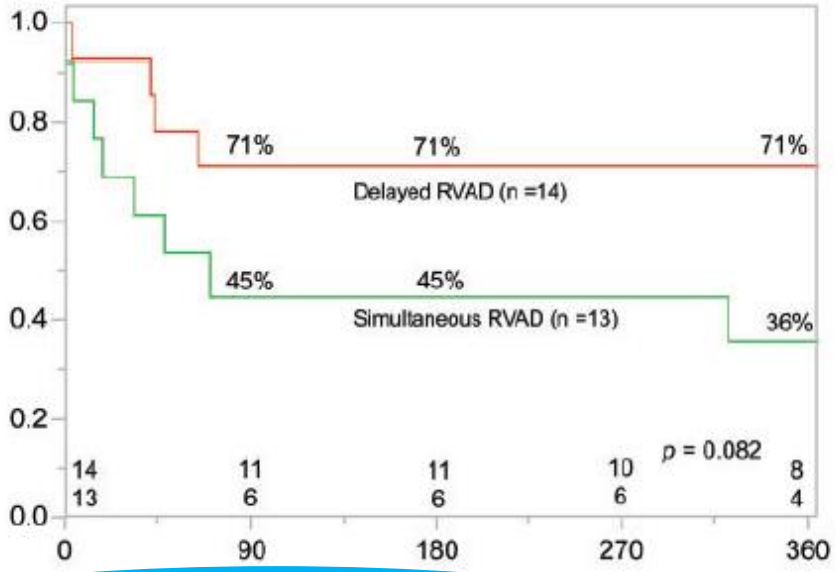
The Journal of Thoracic and Cardiovascular Surgery • April 2009

Contemporary outcome of unplanned right ventricular assist device for severe right heart failure after continuous-flow left ventricular assist device insertion

Daisuke Yoshioka[a], Hiroo Takayama[a], Reshad A. Garan[b], Veli K. Topkara[b], Jiho Han[a], Paul Kurlansky[a], Melana Yuzefpolskaya[b], Paolo C. Colombo[b], Yoshifumi Naka[a] and Koji Takeda[a,*]

Interactive CardioVascular and Thoracic Surgery 24 (2017) 828–834

The timing of RVAD implantation is an important issue because delayed RVAD implantation could deteriorate end-organ function. We have adopted aggressive RVAD implantation strategy without delay if patients developed any sign of severe RHF. In fact, the median time from LVAD implantation to RVAD implantation was only 1.0 day. Fitzpatrick *et al*. [6] reported that early planned RVAD implantation results in improved outcomes compared with delayed RVAD implantation. We previously reported no difference in overall outcomes between patients



reflecting severity of RHF. RVAD should be implanted without delay, however, a new treatment strategy is needed to improve outcomes in this sick population.

TOO EARLY

OPTIMAL

TOO LATE

"door to RV unloading time"

HUB
VAD-ECMO UNIT

LVAD

HR-LVAD

SHORT
TERM
R-VAD