



# Assessing RV Function

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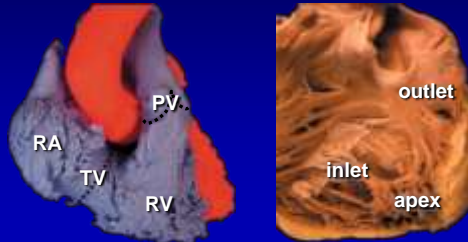
## Right Ventricle

# Structure & Function

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## RV Anatomy

threepart structure

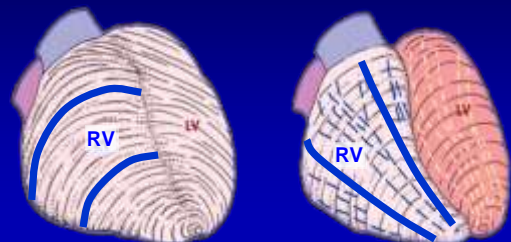


JU Voigt, University Leuven, Belgium Ho, Heart 2006

## Fibre Direction

epicardial

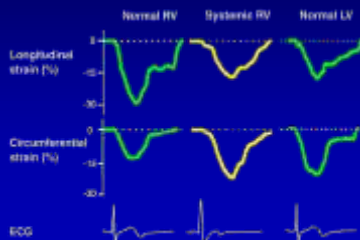
endocardial



JU Voigt, University Leuven, Belgium Ho, Heart 2006

## RV Function

longitudinal vs. circumferential function



JU Voigt, University Leuven, Belgium Pettersen, JACC 2007

## RV Function

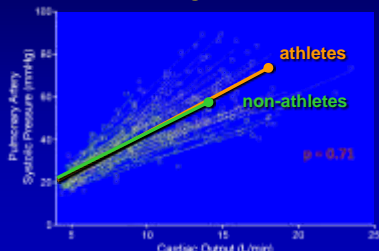
under normal conditions:

- pump for a low impedance circulation  
pumps against 1/6 of systemic resistance  
1/6 of LV mass, 3-4mm wall thickness
- EDV / ESV ca. 150 / 60 ml
- EF ca. 60%

JU Voigt, University Leuven, Belgium

## RV Function

afterload changes with exercise



A. La Gerche et al., J Appl Physiol 2010 University Leuven, Belgium

## RV Function

impairment due to:

- **acute / chronic loading**  
reduced function, dilatation, hypertrophy
- **ischemia**  
involved in 40-50% of inferior infarctions
- **interventricular interaction**  
LV elevated enddiast. pressures, constriction

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## Right Ventricular Function

Does it matter ?

JU Voigt, University Leuven, Belgium

## Does RV Function Matter ?

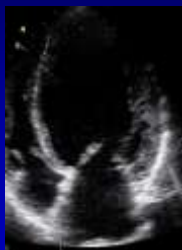
univentricular heart, Fontan circulation



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## Does RV Function Matter ?

RV function in heart failure patients



Study:

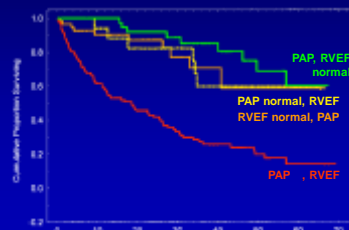
- 377 heart failure patients
- NYHA II-IV
- mean EF 22%
- right heart cath
- 17 9 months follow up

JU Voigt, University Leuven, Belgium

Ghio, JACC 2001

## RV Function Matters !

RV function vs. outcome



JU Voigt, University Leuven, Belgium

Ghio, JACC 2001

## Right Ventricular Function

# How to measure RV Function

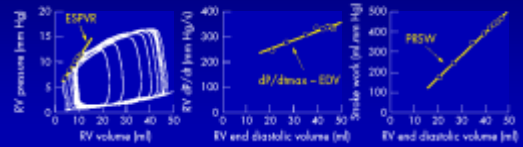
## Global Function

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## RV Function Assessment

gold standard: pressure-volume-loops

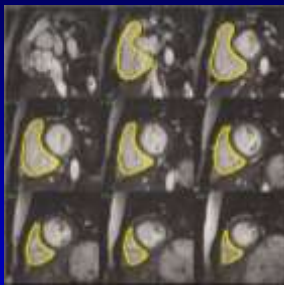
load dependence - always relate to load



JU Voigt, University Leuven, Belgium

Bleeker, Heart 2006

## RV Function Assessment



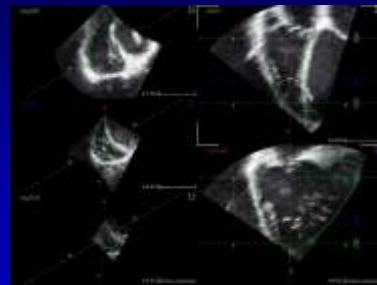
EF as surrogate  
„gold standard“

by MRI

JU Voigt, University Leuven, Belgium

Afakih, J MRI 2003

## RV Function Assessment



3D echo

JU Voigt, University Leuven, Belgium

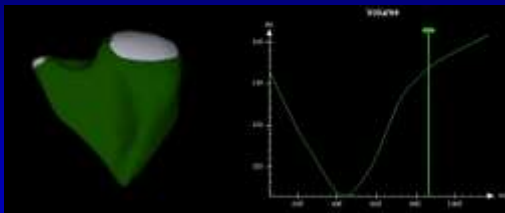
A La Gerche, Leuven

## RV Function Assessment

### 3D echocardiography

RV reconstruction

RV volume curve

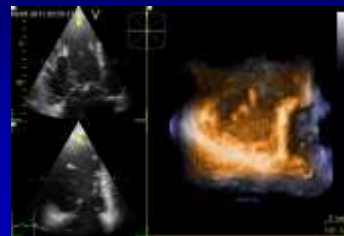


JU Voigt, University Leuven, Belgium

A La Gerche, Leuven

## RV Function Assessment

common problem: anterior wall



JU Voigt, University Leuven, Belgium

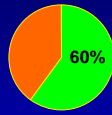
M. Amzulescu, Leuven

## RV 3D Echocardiography

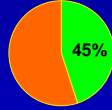
### 3D acquisition feasibility in a clinical study



32 patients with PHT  
(pre-selected for image quality)



20 normal volunteers  
(pre-selected for image quality)

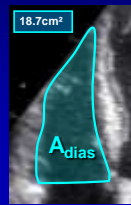


JU Voigt, University Leuven, Belgium Jurcut et al., JASE 2011

## RV Function Assessment

### RV fractional area change

diastole



systole



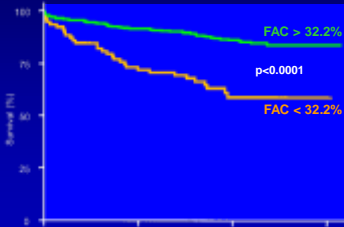
$$FAC = \frac{(A_{dias} - A_{sys})}{A_{dias}} = 42.8\%$$

normal range:  
31 ... 60 %

JU Voigt, University Leuven, Belgium

## RV Fractional Area Change

### prognostic value



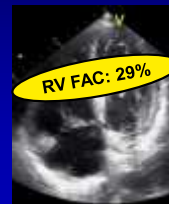
study:  
416 pts  
11 days post infarct  
multivariate analysis:  
RV FAC  
independent predictor  
of mortality

JU Voigt, University Leuven, Belgium Zornoff et al., JACC 2002

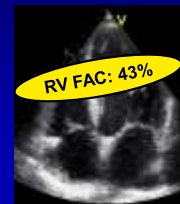
## RV Fractional Area Change

### importance of image quality

oblique



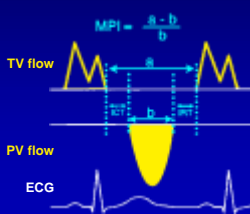
correct



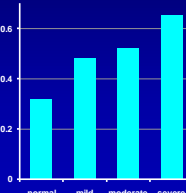
JU Voigt, University Leuven, Belgium

## RV Function Assessment

### „myocardial performance index“ (Tei index)

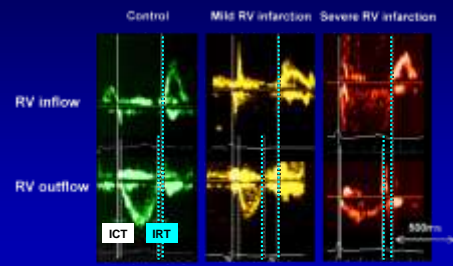


### Tei index in RV dysfunction



JU Voigt, University Leuven, Belgium Eidem, JASE 1998

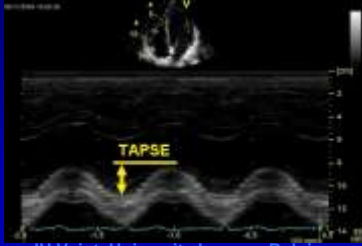
## Pseudonormalized Tei Index



JU Voigt, University Leuven, Belgium Yoshifuku, AJC 2003

## RV Function Assessment

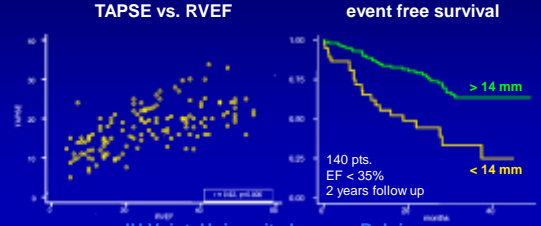
tricuspid annular plane systolic excursion



JU Voigt, University Leuven, Belgium

## RV Function Assessment

tricuspid annular plane systolic excursion



JU Voigt, University Leuven, Belgium

Ghio, AJC 2000

## TAPSE = RV Function ?

changes after pulmonalis TEA

preop

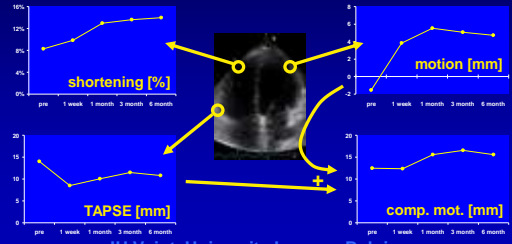
1 week postop



JU Voigt, University Leuven, Belgium S. Giusca, Heart 2009

## TAPSE = RV Function ?

changes after pulmonalis TEA



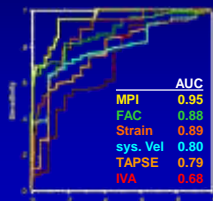
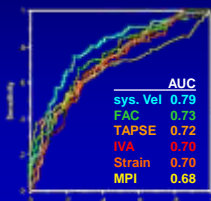
JU Voigt, University Leuven, Belgium S. Giusca, Heart 2009

## RV Global Function Assessment

echo parameters vs. EF by MRI

RV EF threshold 50%

RV EF threshold 30%



JU Voigt, University Leuven, Belgium Pavlicek et al., EJE 2011

## Right Ventricular Function

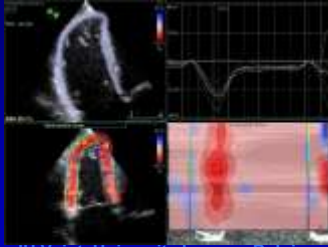
# How to measure RV Function?

## Regional Function

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## Strain Rate Imaging

speckle tracking based strain

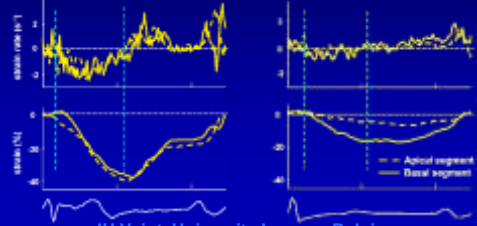


JU Voigt, University Leuven, Belgium

## Regional Differences in RV Function

normal

PHT



JU Voigt, University Leuven, Dombraskaite, J Am Soc Echo 2007

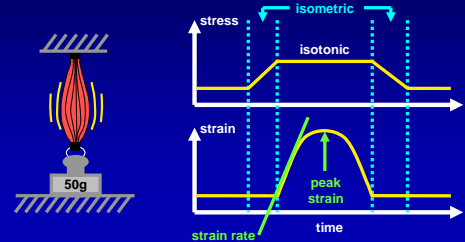
## Right Ventricular Function

### Load Dependence of Function Parameters

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## Describing Muscle Function

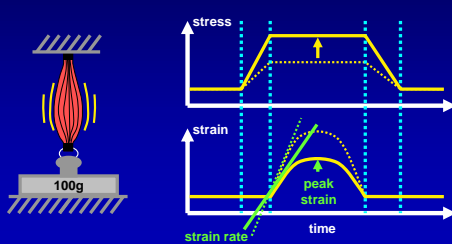
afterloaded contraction



JU Voigt, University Leuven, Belgium

## Describing Muscle Function

afterloaded contraction



JU Voigt, University Leuven, Belgium

## RV Function Assessment

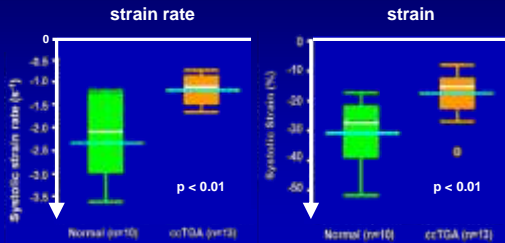
chronic afterload increase: systemic RV, ccTGA



JU Voigt, University Leuven, Belgium J Ganame, Leuven

## RV Function Assessment

normals vs. ccTGA

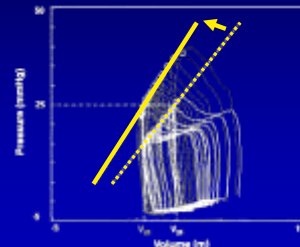


JU Voigt, University Leuven, Belgium

Bos, JASE 2006

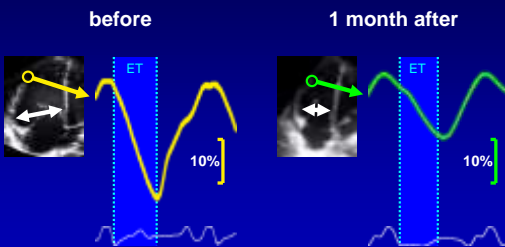
## RV Function Assessment

acute afterload increase



JU Voigt, University Leuven, Belgium; De Wroemen, Am J Physiol 2000

## Preload Decrease after ASD Closure



JU Voigt, University Leuven, Belgium; Van den Broeke, Am J Physiol 2003

## Summary

Right ventricular function is complex and difficult to evaluate.

RV ejection fraction may be estimated by MRI or Echo. Tei index and TAPSE are useful, but need caution.

Strain Rate imaging is a good tool to estimate regional RV function

Besides invasive gold standards, all parameters are subject to geometry and reflect loading conditions.

JU Voigt, University Leuven, Belgium

## Further Reading

European Journal of Echocardiography (2010) 11, 11–16  
doi:10.1093/eje/11.1.11

REVIEW PAPER

**The echocardiographic assessment of the right ventricle: what to do in 2010?**

Ruxandra Jurcut<sup>1\*</sup>, Sorin Gligica<sup>1,2</sup>, André La Gerche<sup>2</sup>, Simona Vasile<sup>1</sup>, Carmen Gîrghina<sup>1</sup>, and Jens-Uwe Voigt<sup>2</sup>

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JU Voigt, University Leuven, Belgium

Jurcut, EJE 2010