



Il ruolo dell'imaging: la risonanza magnetica cardiaca

Giorgio Faganello

Ambulatorio delle Cardiopatie Congenite dell'Adulto
Centro Cardiovascolare, Trieste



Requisiti preliminari all'indagine CMRI

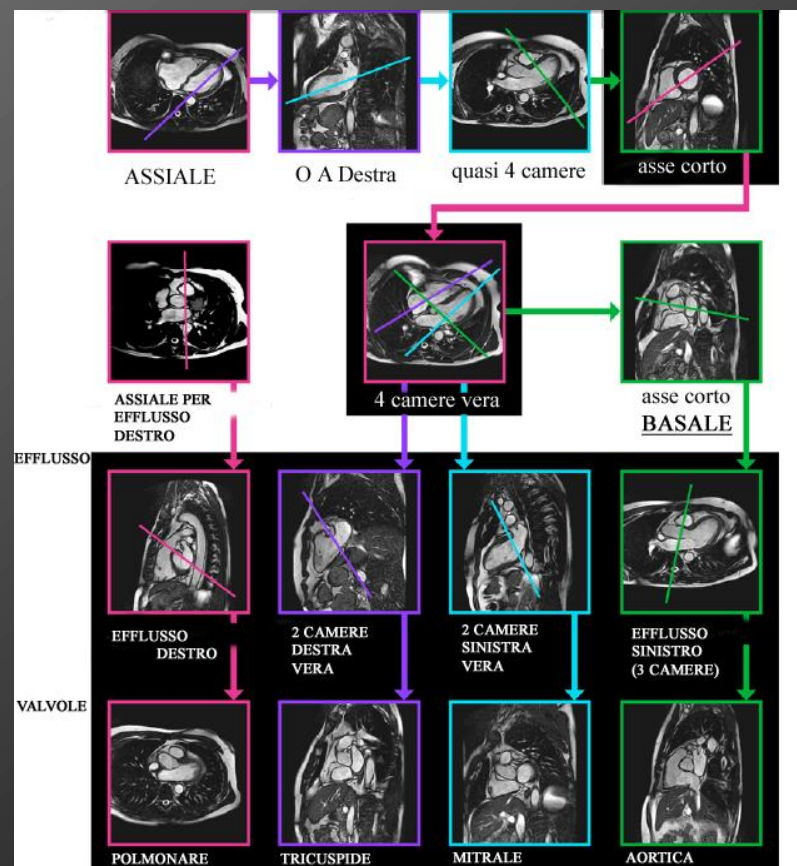
- Tomografo performante (1.5-3 T)
- Radiologo-TSRM dedicati alla cardio-RM (complessità tecnologica)
- Stretta collaborazione col cardiologo inviante (indicazione-indirizzo clinico all'indagine) (Disponibilità monitoraggio)
- Stretta collaborazione col paziente (Claustrofobia - Apnea)
- Esclusione delle controindicazioni assolute
 - All'esposizione a campi magnetici
 - Ai test da stress farmacologici



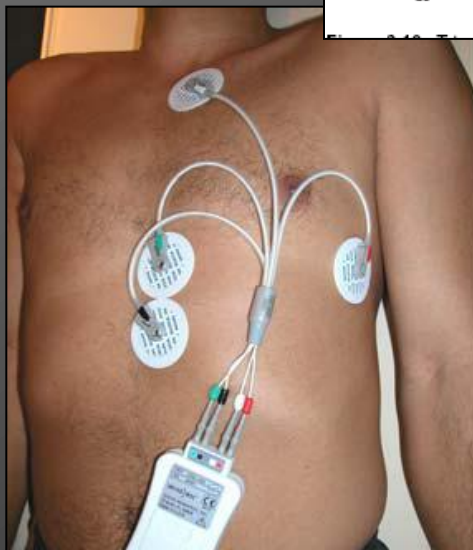
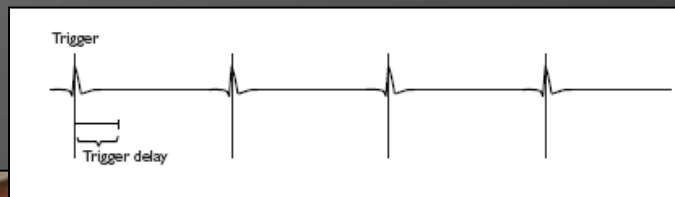
I : 1.5 T
IG : 30.0 mT/m
SR: 75 mT/m/ms
RT: 400 μ s

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Requisiti preliminari all'indagine CMRI



- *Bobine di superficie*
- *Imaging parallelo*
- *VCG gating*
- *Iniettore automatico*



Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



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Indications for cardiovascular magnetic resonance imaging

Current clinical applications

- **Function:** Assessment of left and right ventricular volumes and mass, as well as systolic function
- **Perfusion:** Myocardial perfusion
- **Viability:** Assessment of myocardial viability
- **Congenital** heart disease: shunt calculation
- **Valvular** disease Evaluation and follow-up
- **Cardiac masses**
- **Ischemic** cardiomyopathies
- **Nonischemic** cardiomyopathies
- **Arrhythmogenic right ventricular cardiomyopathy**
- **Dilated** cardiomyopathy
- **Hypertrophic** cardiomyopathy
- **Myocarditis**, sarcoidosis
- **Pericardial** disease
- **Aortic** disease

Emerging applications

- Coronary angiography
- Interventional magnetic resonance

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



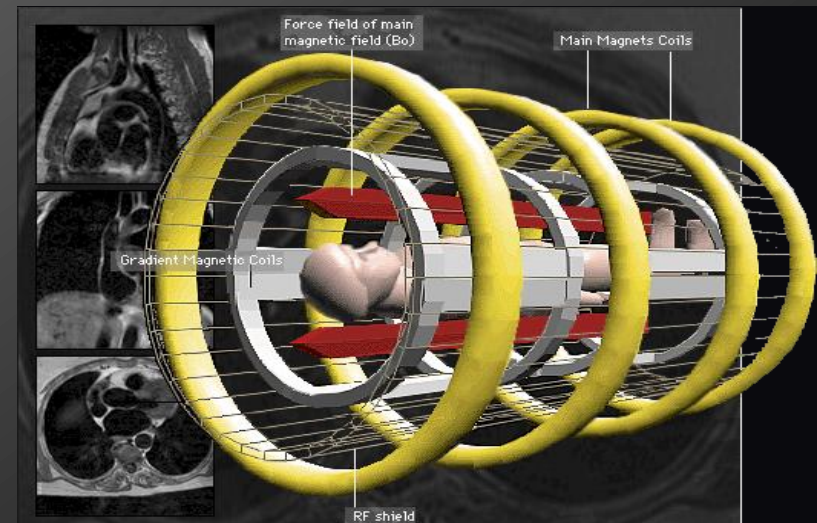
[J Am Soc Echocardiogr.](#) 2013 Aug;26(8):813-27. doi:
10.1016/j.echo.2013.05.006. Epub 2013 Jun 13.

**Can we talk? Reflections on effective
communication between imager and
interventionalist in congenital heart disease.**

[Kutty S](#), [Delaney JW](#), [Latson LA](#), [Danford DA](#).

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Artwork courtesy of Rebecca Cagle, National Library of Medicine-Lister Hill Center for Biocommunication

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 - Disponibilità monitoraggio
- Materiale ferromagnetico
 - Clips neurovascolari
 - Pacemakers
 - Defibrillatori
 - Impianti cocleari
 - Neurostimolatori etc.
 - Valvole, Stent, By-pass (oggi considerati sicuri)
 - www.IMRSER.org
 - www.mrisafety.com

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- Disponibilità monitoraggio



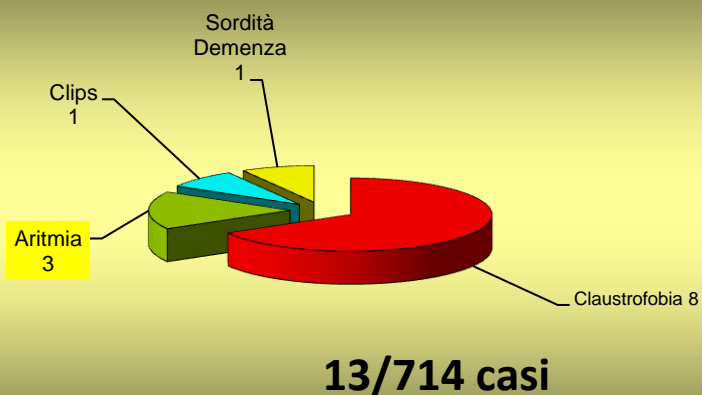
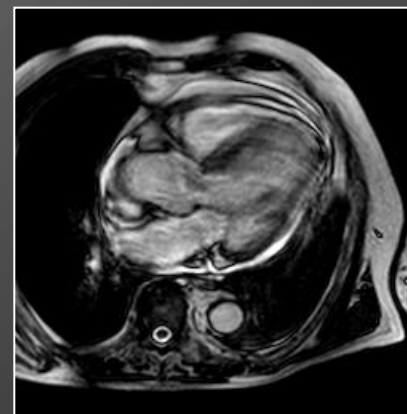
Contraindications to magnetic resonance imaging: Non-invasive imaging

T Dill

Heart 2008;94;943-948
doi:10.1136/hrt.2007.125039

Requisiti preliminari all'indagine CMRI

Aritmia



Capacità di
collaborazione col
paziente

Requisiti preliminari all'indagine CMRI

Fibrosi sistemica nefrogenica

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- Disponibilità monitoraggio

The UK Commission on Human Medicines (CHM) together with the European Pharmacovigilance Working Party (PhVWP) of the Committee for Medicinal Products for Human Use (CHMP) recommend that:

- Use of **Omniscan (gadodiamide)** is **contraindicated** in patients with severe renal impairment (ie, GFR [glomerular filtration rate] or **eGFR [estimated GFR] <30mL/min/1.73m²**) or in patients with renal dysfunction who have had, or who are awaiting, liver transplantation. For patients with moderate renal impairment (ie, GFR or eGFR 30–59mL/min/1.73m²) or neonates and infants up to 1 year of age, Omniscan should be used only after careful consideration.
- Use of **Magnevist (gadopentetic acid)** is **contraindicated** in patients with severe renal impairment (ie, GFR or **eGFR <30mL/min/1.73m²**). Magnevist should be used with caution in patients with moderate renal impairment (ie, GFR or eGFR 30–59mL/min/1.73m²), and should be used in neonates and infants up to 1 year of age only after careful consideration.



Requisiti preliminari all'indagine CMRI

Reiter et al. *Journal of Cardiovascular Magnetic Resonance* 2012, 14:31
<http://www.jcmr-online.com/content/14/1/31>



REVIEW

Open Access

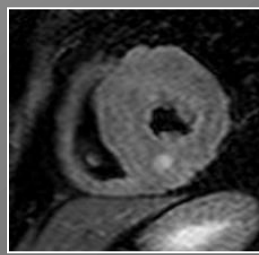
Minimizing Risk of Nephrogenic systemic fibrosis in Cardiovascular Magnetic Resonance

Theresa Reiter^{1*}, Oliver Ritter¹, Martin R Prince², Peter Nordbeck¹, Christoph Wanner¹, Eike Nagel³ and Wolfgang Rudolf Bauer¹

and presents with dermal lesions and involvement of internal organs. Although many cases are mild, an estimated 5 % have a progressive debilitating course. To date, there is no known effective treatment thus stressing the necessity of ample prevention measures. An association with the use of Gadolinium based contrast agents (GBCA)

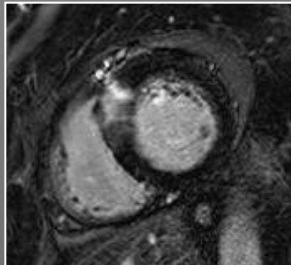


Morfologia

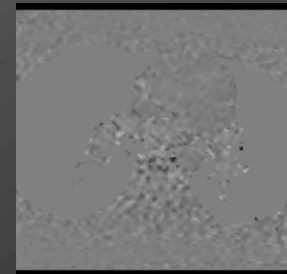


Segnale

Vitalità



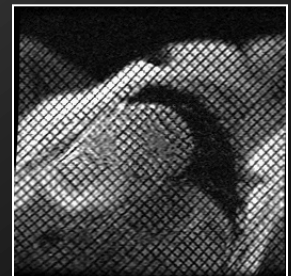
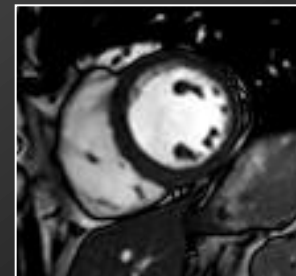
Flusso



Perfusione



Funzione/Cinetica



Coronarografia



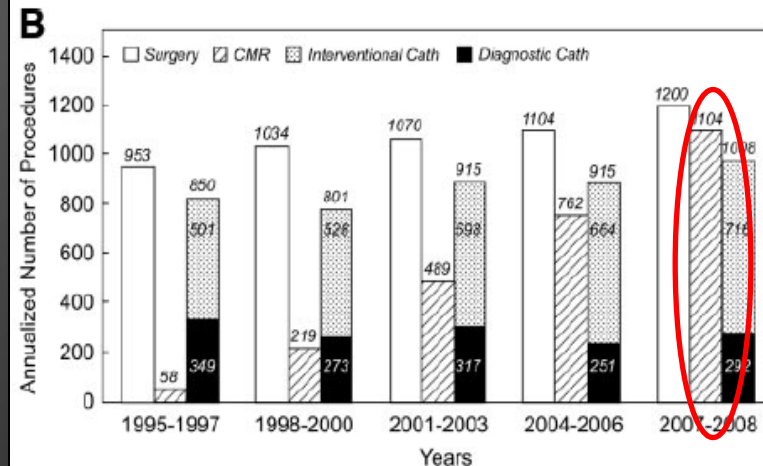
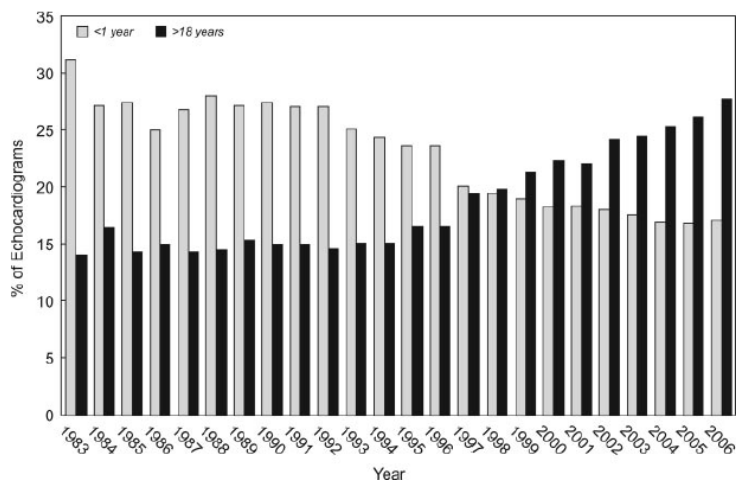
**Necessità di mirare
l'indagine !**

Advances in Cardiovascular Imaging

Multimodality Noninvasive Imaging for Assessment of Congenital Heart Disease

Ashwin Prakash, MD; Andrew J. Powell, MD; Tal Geva, MD

Circ Cardiovasc Imaging. 2010;3:112-125.



Pediatr Radiol (2006) 36 (Suppl 2): 121–125
DOI 10.1007/s00247-006-0191-5

ALARA

Ruth A. Kleinerman

Cancer risks following diagnostic and therapeutic radiation exposure in children

Congenital heart disease

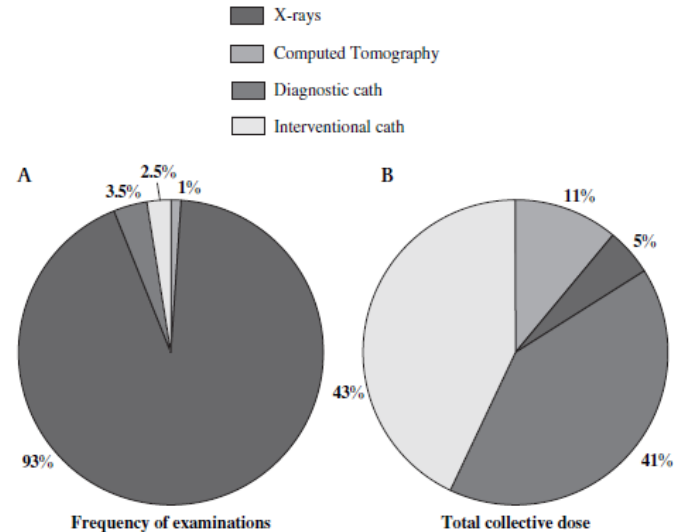
Cumulative patient effective dose and acute radiation-induced chromosomal DNA damage in children with congenital heart disease

Lamia Ait-Ali,^{1,2} Maria Grazia Andreassi,^{1,2} Ilenia Foffa,^{1,2} Isabella Spadoni,²
Eliseo Vano,³ Eugenio Picano¹

Heart 2010;**96**:269–274.

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

Figure 1 The most frequent examinations and total collective dose in congenital heart disease: relative contribution of conventional radiographs, CT, diagnostic catheterisation and interventional radiology to (A) the frequency and (B) the total collective effective dose.



our patients with CHD for three reasons. First, adult grown-up patients with surgically repaired CHD are a large and growing population, estimated to be one million in US in the year 2000, compared with an estimated 300 000 in 1980, and 1.4 million are expected by 2020.³⁹ Second, the long-term outcome of the underlying cardiac disease has been dramatically improved by interventions in the past decade, and now excellent long-term survival is the rule, rather than the exception.^{9 10} Third, and most importantly, children are several times more sensitive to radiation than middle-aged adults.^{1 3 11 12} Therefore, when managing

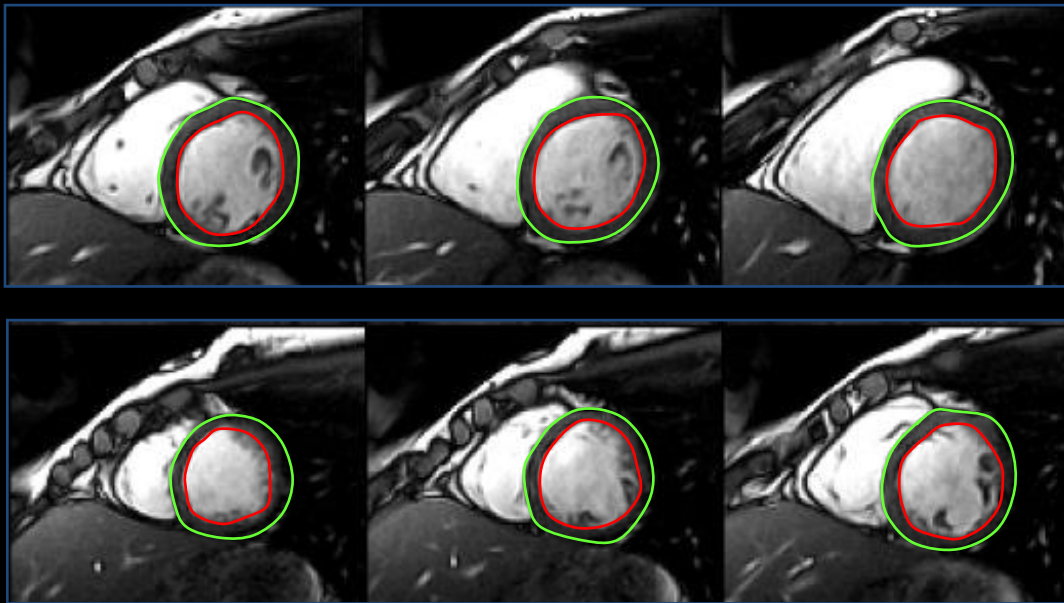
Level 3 Certified			
Family Name	First Name	Country	Certified until
Westwood	Mark	United Kingdom	2018
Wasmuth	Ralf	Germany	2018
WACKER	Christian	Germany	2018
von Knobelsdorff	Florian	Germany	2018
Thiele	Holger	Germany	2018
Steadman	Christopher	United Kingdom	2018
Sorahb	Fratz	Germany	2018
Sechtem	Udo	Germany	2018
Schuster	Andreas	Germany	2018
Petryka	Joanna	Poland	2018
PETERSEN	Steffen	United Kingdom	2018
Pellaton	Cyril	United Kingdom	2018
Paetsch	Ingo	Germany	2018
Muellerleile	Kai	Germany	2018
Marcotte	Francois	Canada	2018
Manka	Robert	Switzerland	2018
Mahrholdt	Heiko	Germany	2018
Maceira	Alicia M.	Spain	2018
LOPEZ	MARIA PILAR	Spain	2018
Lee	Alison	United Kingdom	2018
Kidambi	Ananth	United Kingdom	2018
Kelle	Sebastian	Germany	2018
Karamits	Theodoros	Greece	2018
Jahnke	Cosima	Germany	2018
Groenink	Maarten	The Netherlands	2018
Greenwood	John	United Kingdom	2018
GERBER	Bernhard	Belgium	2018
Gebker	Rolf	Germany	2018
Eitel	Ingo	Germany	2018
Crilley	Jenifer	United Kingdom	2018
Chiribiri	Amedeo	United Kingdom	2018
Bucciarelli-Ducci	Chiara	United Kingdom	2018
Bettencourt	Nuno	Portugal	2018
Bernhardt	Peter	Germany	2018
Bathgate	Brigitte	Germany	2018
Alpendurada	Francisco	United Kingdom	2018
Almeida	Ana	Portugal	2018
Level 2 Certified			
BINDER	Germany	2018	

RISONANZA MAGNETICA CARDIACA

- Valutazione della funzione destra-sinistra e della massa
- Valutazioni flussimetriche
- Valutazione morfologica e tipizzazione tessutale
- Perfusione e Vitalità (late enhancement)



RISONANZA MAGNETICA CARDIACA



- ✓ *Dimensioni*
- ✓ *Spessori parietali (in sistole-diastole)*
- ✓ *Massa*
- ✓ *Frazione eiezione*
- ✓ *Gittata cardiaca*
- ✓ *EDV - ESV (Basale/stress)*

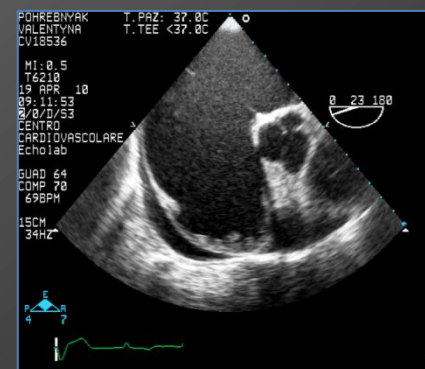
RESEARCH

Open Access

Assessment of atrial septal defects in adults comparing cardiovascular magnetic resonance with transoesophageal echocardiography

Karen SL Teo*, Patrick J Disney, Benjamin K Dundon, Matthew I Worthley, Michael A Brown, Prashanthan Sanders and Stephen G Worthley

	Able to be assessed by CMR (%)	Able to be assessed by TOE (%)
Maximal defect size	(20/20) 100%	(19/19) 100%
Anterior superior margin	(20/20) 100%	(15/19) 79%
Anterior inferior margin	(20/20) 100%	(17/19) 89%
Posterior superior margin	(19/20) 95%	(14/19) 74%
Posterior inferior margin	(20/20) 100%	(12/19) 63%



Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



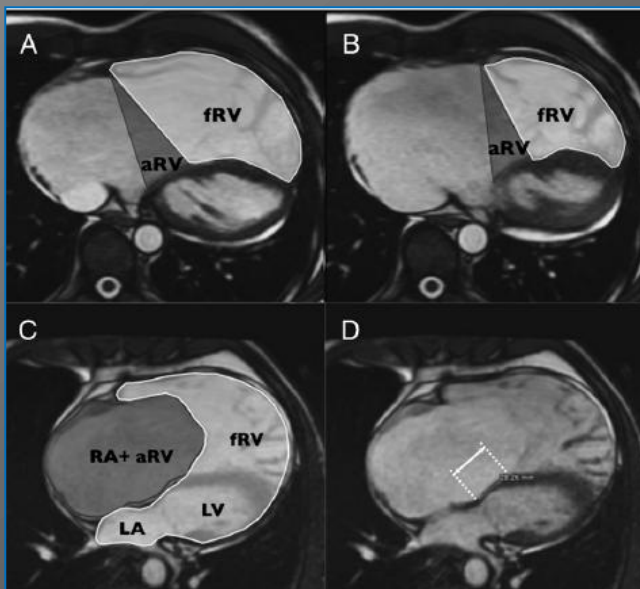
Right heart characteristics and exercise parameters in adults with Ebstein anomaly: New perspectives from cardiac magnetic resonance imaging studies[☆]

Daniel Tobler^a, Sergey Yalonetsky^a, Andrew M. Crean^a, John T. Granton^b, Luke Burchill^a, Candice K. Silversides^a, Rachel M. Wald^{a,*}

^a Division of Cardiology, Toronto Congenital Cardiac Centre for Adults, Peter Munk Cardiac Centre, Toronto General Hospital, University Health Network and University of Toronto, Toronto, Ontario, Canada

^b Division of Respiriology, University Health Network, Mount Sinai Hospital and Women's College Hospital, University of Toronto, Toronto, Ontario, Canada

International Journal of Cardiology 165 (2013) 146–150



27 pts. Malattia di Ebstein
Studio MRI + CPET

Analisi multivariata solo il volume atrializzato
correlava con Vo2 di picco

Conclusion: In adults with unrepaired Ebstein anomaly, atrialized RV volume was independently related to aerobic capacity. The volume of the atrialized RV is a novel CMR measure which may express severity of disease. Further research is needed to evaluate the prognostic relevance of this exploratory work.

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



doi:10.1093/mmcts/mmt001 published online 7 February 2013.

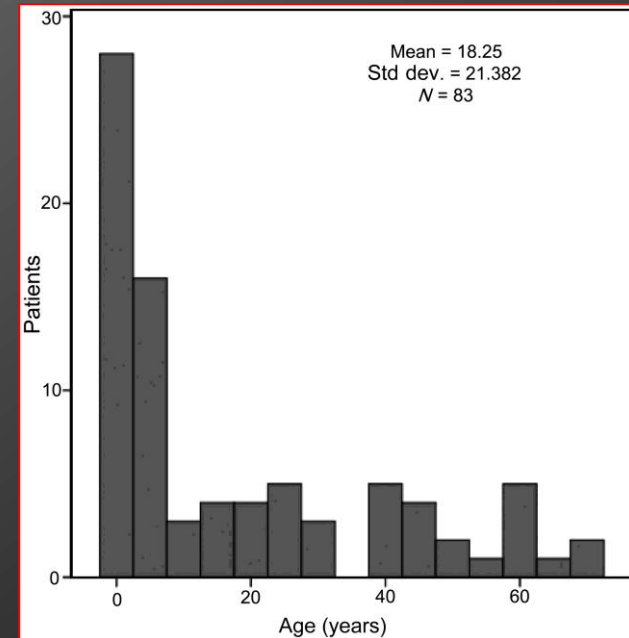
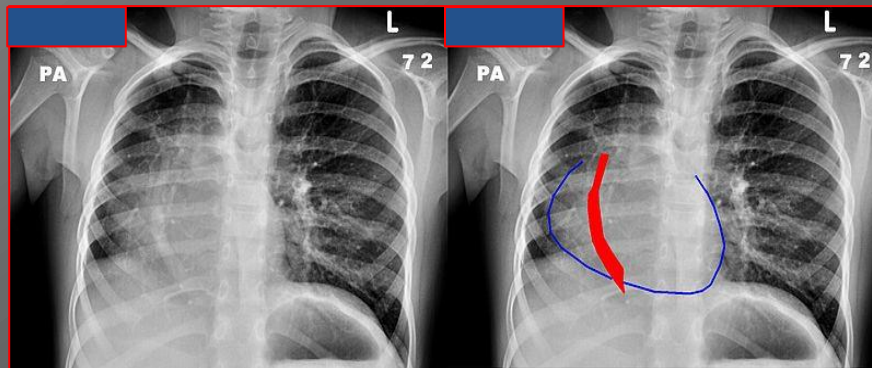


MULTIMEDIA MANUAL OF
**CARDIO-THORACIC
SURGERY**

Partial anomalous pulmonary venous connection (including scimitar syndrome)

Pieter C. van de Woestijne*, Niels Verberkmoes and Ad J.J.C. Bogers

Department of Cardiothoracic Surgery, Erasmus University Medical Center, Rotterdam, Netherlands



Results of Screening for Intracranial Aneurysms in Patients with Coarctation of the Aorta

AJNR 33 | Jun-Jul 2012

117 CoA pts

12 pts (10.3%) -> aneurismi cerebrali

Table 3: Comparison of the aneurysm and no aneurysm groups

	Aneurysm (n = 12)	No Aneurysm (n = 105)	P Value
Age (yr) ^a	37 (16–50)	23 (16–59)	.04
Hypertension	83%	43%	.01
Smoker	25%	16%	.43
BAV or ascending aortopathy	42%	58%	.36
Aortic aneurysm	17%	10%	.36
SBP (mm Hg) ^a	138 ± 12	133 ± 17	.34
DBP (mm Hg) ^a	78 ± 10	74 ± 10	.22

ORIGINAL ARTICLE

The unnatural history of an atrial septal defect: Longitudinal 35 year follow up after surgical closure at young age

Cuypers JAAE, et al. *Heart* 2013;**99**:1346–1352

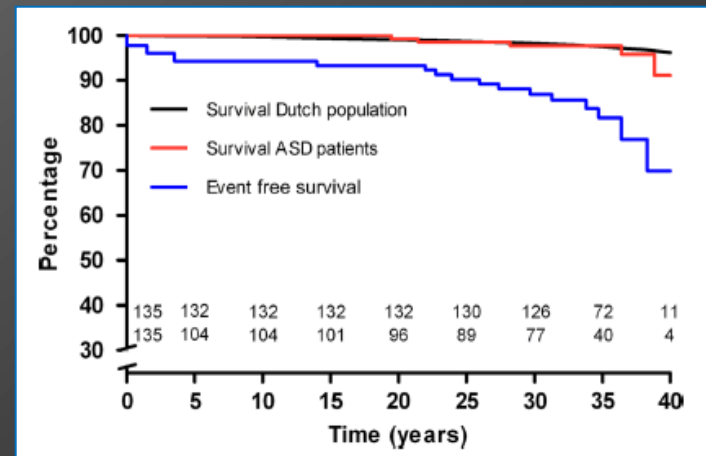
Table 4 Cardiac MRI

	ASD II	Sinus venosus defect	p Value
LV EDV/BSA, mean±SD (mL/m ²)	80±15	83±16	0.6
LV EDV dilation	5%	14%	0.3
LV ESV/BSA	33±10	36±11	0.4
LV ESV dilation	24%	43%	0.2
LV EF (%)	59±7	57±8	0.4
LV EF decreased	17%	29%	0.4
RV EDV/BSA	92±15	96±16	0.4
RV EDV dilation	17%	29%	0.4
RV ESV/BSA	44±10	48±11	0.2
RV ESV dilation	27%	57%	0.05
RV EF (%)	52±6	50±7	0.2
RV EF decreased	24%	50%	0.1

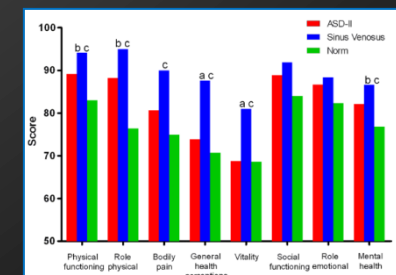
RV EF ≤49% and LV EF ≤54% were considered decreased and RV EDV >107.5 mL/m², RV ESV >47.2 mL/m², LV EDV >102.5 mL/m² and LV ESV >38.7 mL/m² were considered enlarged.
BSA, body surface area; EDV, end-diastolic volume; EF, ejection fraction; ESV, end-systolic volume; LV, left ventricle; RV, right ventricle.

135 pts.
DIA trattati chirurgicamente
Fup 35 yrs

6% deceduti
16% aritmie sopraventricolari
6% PM impiantato
11% RV EDVi >107ml/mq



31% RVEF<49%



pacemaker implantation remains low. Although RVEF was unexpectedly found to be decreased in one-third of patients, the functional status remains excellent.

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

Ventricular size and function assessed by cardiac MRI predict major adverse clinical outcomes late after tetralogy of Fallot repair

A L Knauth,^{1,2} K Gauvreau,¹ A J Powell,¹ M J Landzberg,^{1,2} E P Walsh,¹ J E Lock,¹
P J del Nido,³ T Geva¹

Heart 2008;94:211-216.

88 TOF

Età media alla riparazione: 3 yrs

FuP 4.2 yrs

Outcomes:

morte, TVNS, incremento classe
funzionale a NYHA III-IV

Eventi maggiori: 18 pts (20.5%)

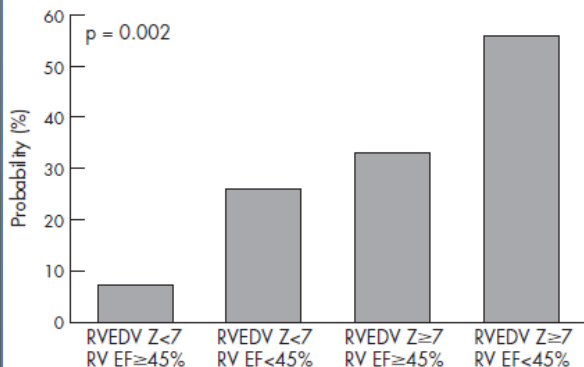


Table 2 Predictors of major adverse outcomes

Predictors	Odds ratio (95% CI)	Area under ROC curve	p Value
<i>Univariate analysis (controlling for time from baseline evaluation to most recent follow-up)</i>			
Age at TOF repair ≥6 years	7.78 (2.26 to 26.7)	0.748	0.001
Era of repair before 1970	4.05 (1.11 to 14.8)	0.591	0.035
RV end-diastolic volume Z ≥7	4.98 (1.47 to 16.9)	0.688	0.01
RV end-systolic volume index >50 ml/m ²	5.82 (1.22 to 27.7)	0.708	0.027
RV ejection fraction <45%	5.31 (1.59 to 17.8)	0.750	0.007
LV ejection fraction <55%	7.13 (2.11 to 24.0)	0.760	0.002
LV mass/volume ratio >1.5	4.56 (1.27 to 16.4)	0.688	0.02
QRS ≥180 ms	6.27 (1.86 to 21.1)	0.673	0.003
Diuretics at baseline evaluation	7.68 (2.03 to 29.1)	0.646	0.003
Digoxin at baseline evaluation	4.67 (1.30 to 16.8)	0.689	0.018
β-Blocker at baseline evaluation	6.88 (1.12 to 42.3)	0.654	0.037
NYHA class II or III at baseline evaluation	5.27 (1.55 to 17.9)	0.724	0.008

Multivariate analysis (controlling for time from baseline evaluation to most recent follow-up)

Model 1

LV ejection fraction <55%	8.05 (2.14 to 30.2)	0.002
RV end-diastolic volume Z ≥7	4.55 (1.10 to 18.8)	0.037
Area under ROC curve for the model: 0.850		

Model 2

RV ejection fraction <45%	5.60 (1.47 to 21.2)	0.011
RV end-diastolic volume Z ≥7	4.00 (1.10 to 14.6)	0.036
Area under ROC curve for the model: 0.807		

CI, confidence interval; LV, left ventricular; ROC, receiver operator characteristic; RV, right ventricular; TOF tetralogy of Fallot.

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Journal of the American College of Cardiology
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Published by Elsevier Science Inc.

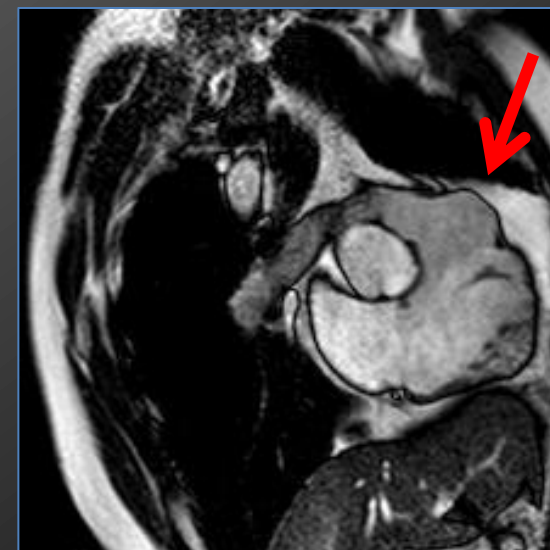
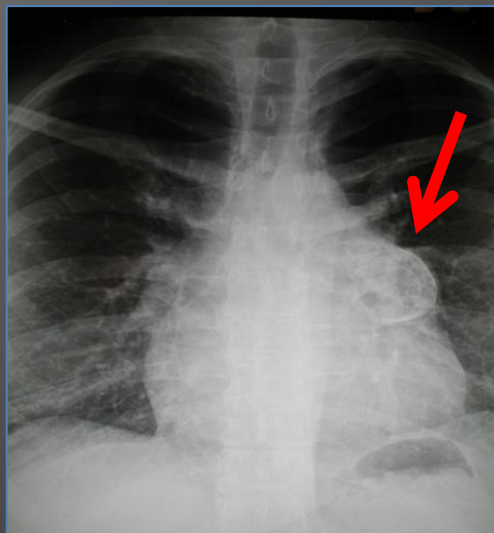
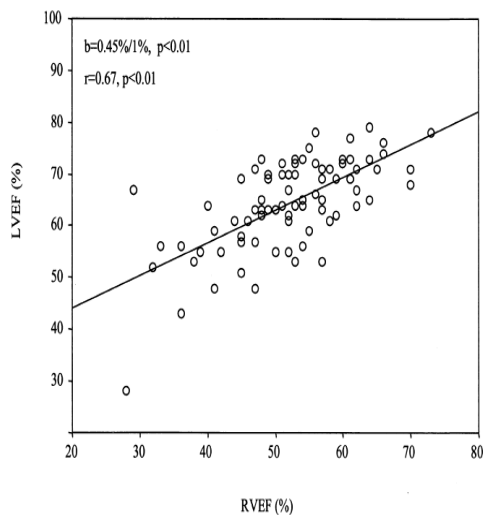
Vol. 40, No. 11, 2002
ISSN 0735-1097/02/\$22.00
PII S0735-1097(02)02566-4

Adult Congenital Disease

Right Ventricular Function in Adults With Repaired Tetralogy of Fallot Assessed With Cardiovascular Magnetic Resonance Imaging: Detrimental Role of Right Ventricular Outflow Aneurysms or Akinesia and Adverse Right-to-Left Ventricular Interaction

Periklis A. Davlouros, MD,* Philip J. Kilner, MD, PhD,† Tim S. Hornung, MD,* Wei Li, MD, PhD,* Jane M. Francis, DCR(R),† James C. C. Moon, MD,† Gillian C. Smith, BSc,† Tri Tat, PhD,‡ Dudley J. Pennell, MD, FACC,† Michael A. Gatzoulis, MD, PhD, FACC*
London, United Kingdom

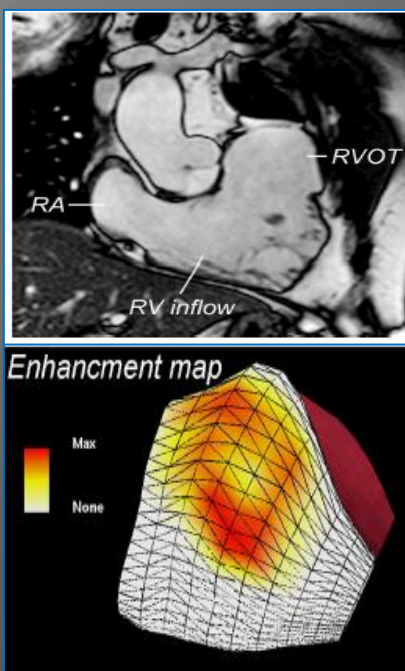
RVOT



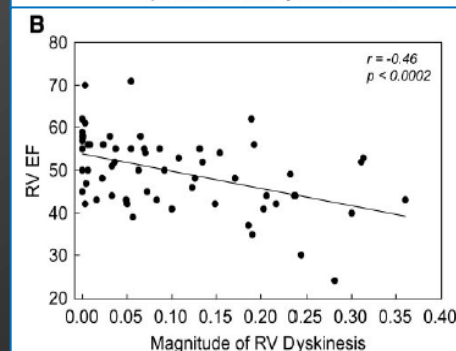
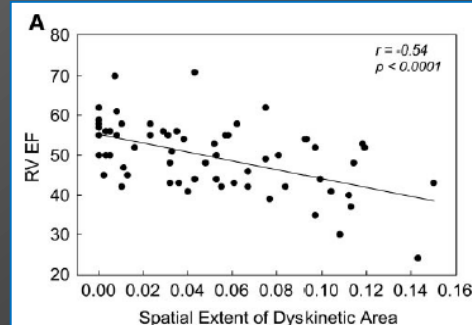
TOF vs controls. Presenza di **RVOT** aneurysm/akinesia è correlato a RVH, Dilatazione Vdx, ridotta RVEF

Effects of Regional Dysfunction and Late Gadolinium Enhancement on Global Right Ventricular Function and Exercise Capacity in Patients With Repaired Tetralogy of Fallot

Rachel M. Wald, MD; Idith Haber, PhD; Ron Wald, MDCM, MPH; Anne Marie Valente, MD; Andrew J. Powell, MD; Tal Geva, MD



RVOT - CPET



Conclusion—A greater extent of regional abnormalities in the RVOT adversely affects global RV function and exercise capacity after tetralogy of Fallot repair. These regional measures may have important implications for patient management, including RVOT reconstruction, at the time of pulmonary valve replacement. (*Circulation*. 2009;119:1370-1377.)

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

Geva *Journal of Cardiovascular Magnetic Resonance* 2011, 13:9
<http://www.jcmr-online.com/content/13/1/9>

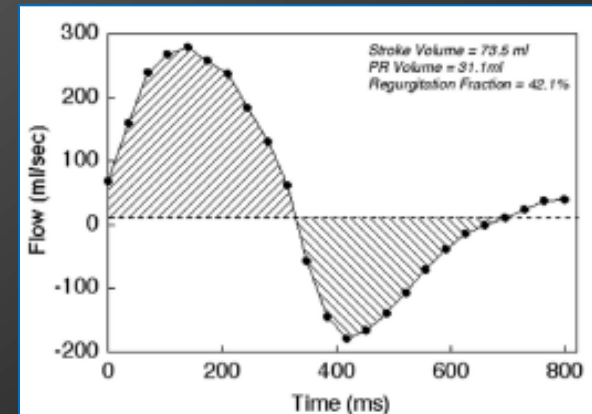
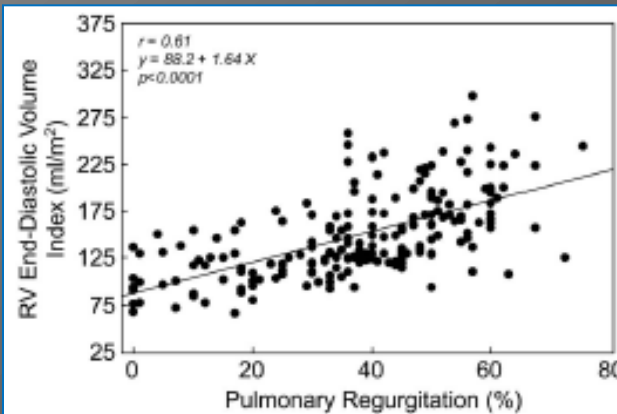


**Journal of Cardiovascular
Magnetic Resonance**

REVIEW

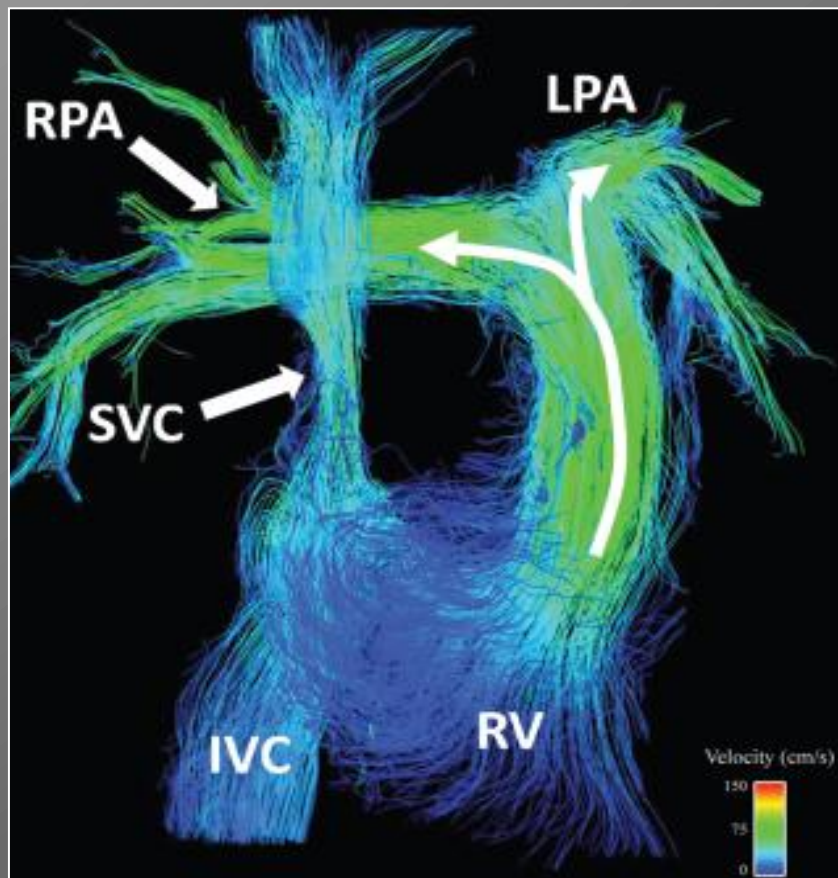
Open Access

Repaired tetralogy of Fallot: the roles of cardiovascular magnetic resonance in evaluating pathophysiology and for pulmonary valve replacement decision support

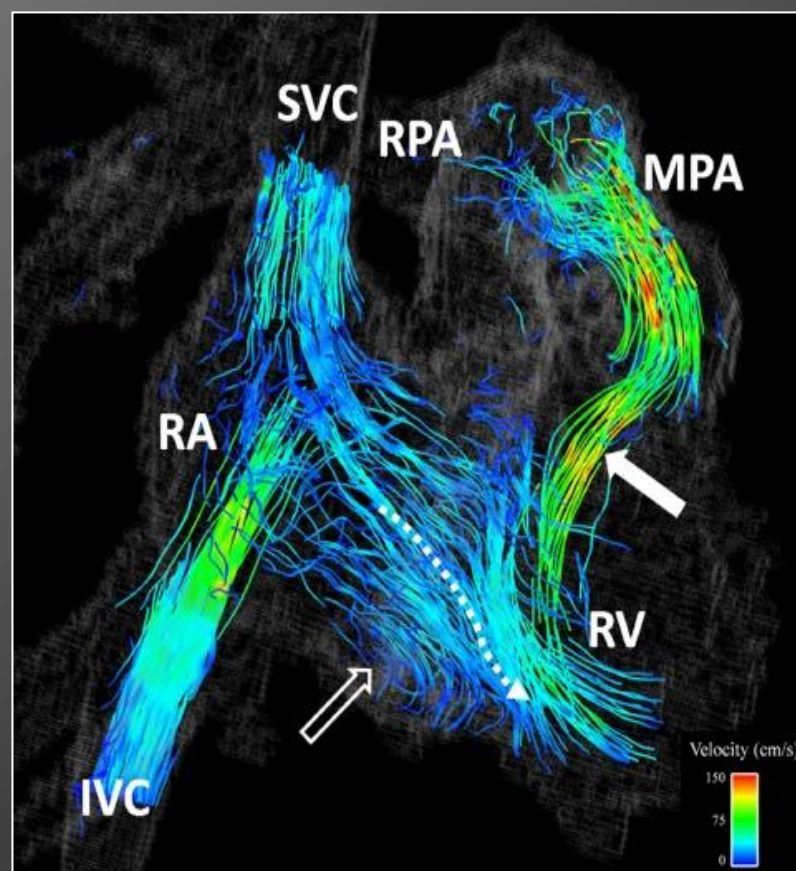


$$150\text{ml/m}^2 < \text{EDRVi} < 170\text{ml/m}^2$$

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



MRI – FUNZIONE VENTRICOLARE E FLUSSIMETRICA

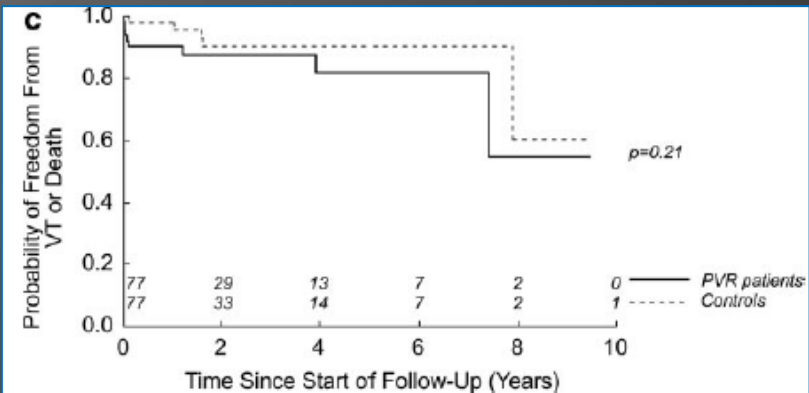
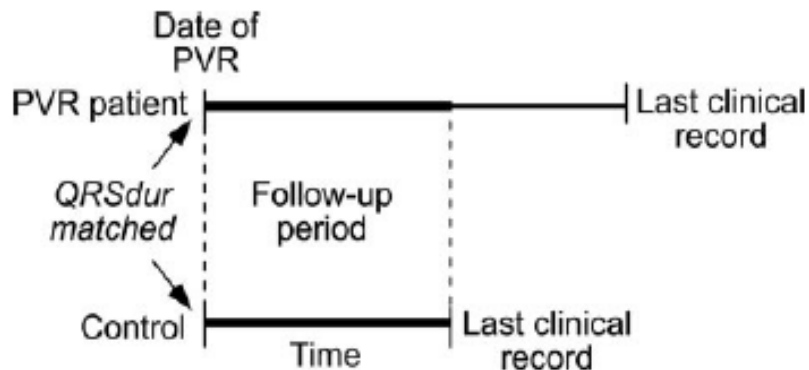


TOF e 4D CMR

Pulmonary Valve Replacement in Tetralogy of Fallot Impact on Survival and Ventricular Tachycardia

David M. Harrild, MD, PhD; Charles I. Berul, MD; Frank Cecchin, MD; Tal Geva, MD;
 Kimberlee Gauvreau, ScD; Frank Pigula, MD; Edward P. Walsh, MD

Circulation. 2009;119:445-451



LATE PVR -> RIDUZIONE DI 30-40% RVEDV/RVRSV;
 MIGLIORA LVEDV; MIGLIORA TR; MIGLIORA NYHA
 NON MIGLIORA SOPRAVVIVENZA, QRS DURATA, VT

Conclusions—This cohort experienced either VT or death every 20 patient-years. In a matched comparison with a similar TOF group, late PVR for symptomatic pulmonary regurgitation/RV dilation did not reduce the incidence of VT or death.

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 52, No. 21, 2008
ISSN 0735-1097/08/\$34.00
doi:10.1016/j.jacc.2008.08.033

STATE-OF-THE-ART PAPER

Role of Cardiac Magnetic Resonance Imaging in the Management of Patients With Pulmonary Arterial Hypertension

Raymond Benza, MD,* Robert Biederman, MD,* Srinivas Murali, MD,* Himanshu Gupta, MD†

Table 3

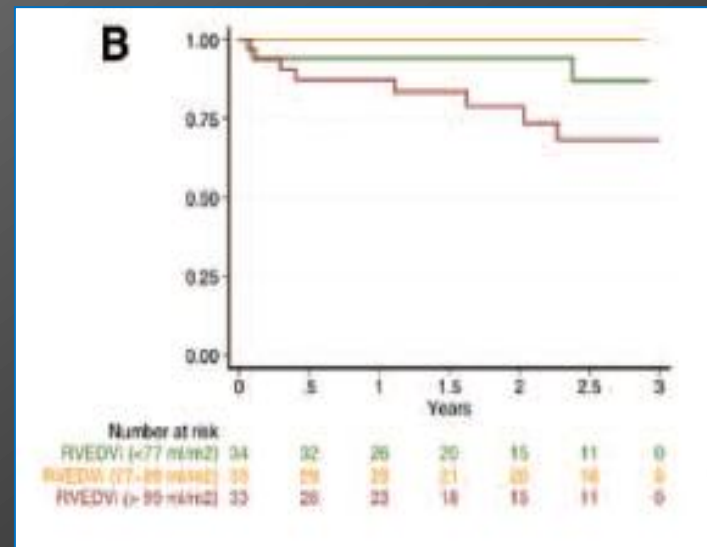
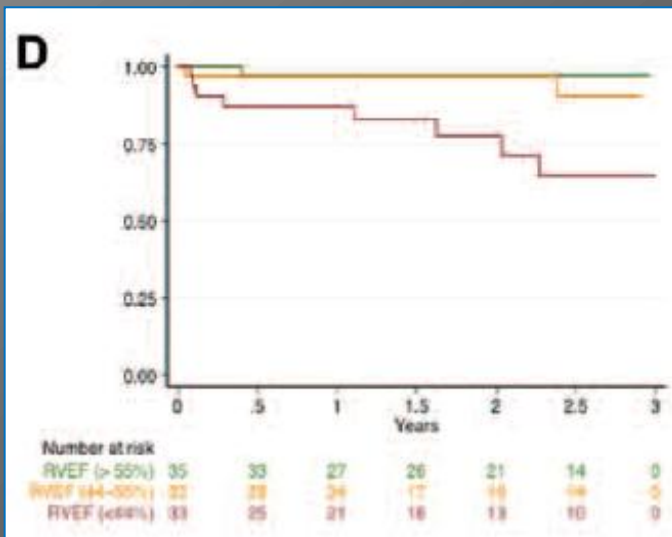
A Comparison of the Usefulness of the Different Imaging Modalities and RHC for Characterizing Different Parameters*

Parameter	Modality		
	Cardiac MRI	Echocardiography (Including 3-Dimensional Echocardiography)	RHC (Including Right-Sided Angiocardiography)
RV assessment			
Volumes	+++	++	+
Ejection fraction	+++	++	+
Strain	+++	++	—
RV pressure	—/+	++	+++
Stroke volume	+++	+	+++
Mass	++	—/+	—
RV remodeling including septal curvature	+++	++	—
Tricuspid regurgitation	++	+++	+
Miscellaneous (pericardial effusion, pulmonary embolism, and other incidental findings)	++	+	+
RA assessment	++	+	—
RA pressure	—	—	+++
PA dimensions	+++	+	+
PA distensibility	+++	+	—/+
PA hemodynamics	—/+	+	+++
Quantitative lung flow	+++	—	—

Prognostic Significance of Cardiac Magnetic Resonance Imaging in Children With Pulmonary Hypertension

Shahin Moledina, MBChB; Bejal Pandya, MBBS; Margarita Bartsota, MD; Kristian H. Mortensen, MD, PhD;
 Merlin McMillan, MBChB; Sadia Quyam, MBChB; Andrew M. Taylor, MD; Sheila G. Haworth, MD;
 Ingram Schulze-Neick, MD, PhD; Vivek Muthurangu, MD

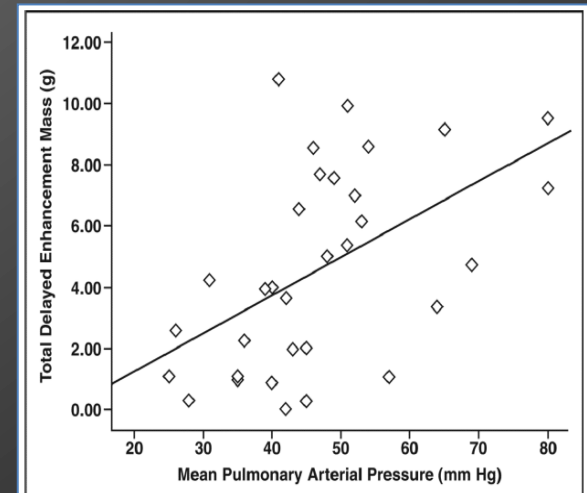
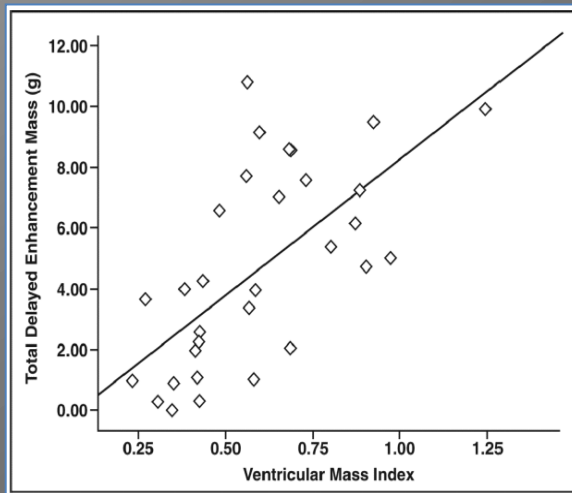
Circ Cardiovasc Imaging. 2013;6:407-414



Conclusions—Cardiac MR measures correlate with clinical status and prognosis in children with pulmonary hypertension. Cardiac MR is feasible and may be useful in clinical decision making in pediatric pulmonary hypertension. (*Circ Cardiovasc*

Myocardial Delayed Enhancement in Pulmonary Hypertension: Pulmonary Hemodynamics, Right Ventricular Function, and Remodeling

AJR Am J Roentgenol. 2011 January ; 196(1): 87–94



38 PHT -> LE + (32 pts) correlato con RVH, dilatazione e disfunzione Vdx,

CONCLUSION—In PH, total delayed enhancement burden at the RV septal insertions is predicted by RV remodeling in response to increased afterload. Local fibrosis mass at the anterior septal insertion is associated with reduced regional longitudinal contractility at the base.

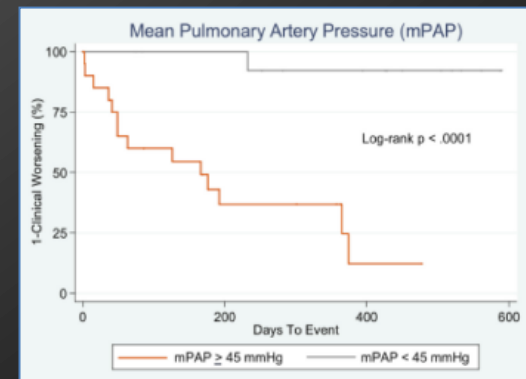
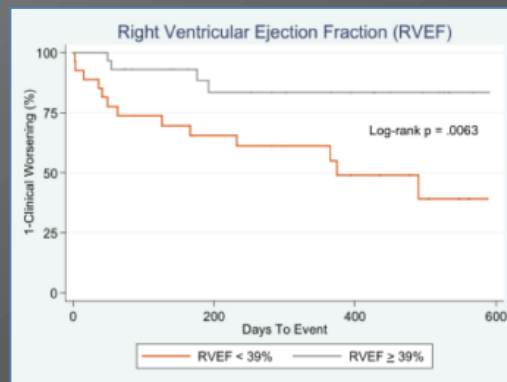
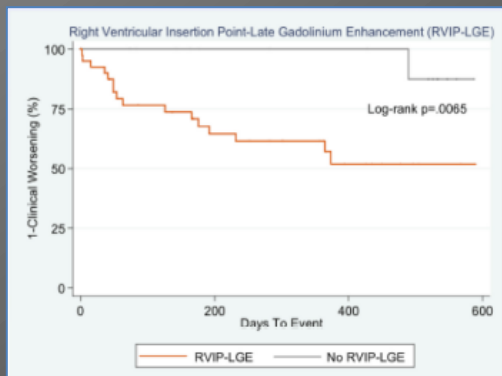
Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



Late gadolinium enhancement cardiovascular magnetic resonance predicts clinical worsening in patients with pulmonary hypertension

Benjamin H Freed¹, Mardi Gomberg-Maitland¹, Sonal Chandra¹, Victor Mor-Avi¹, Stuart Rich¹, Stephen L Archer¹, E Bruce Jamison Jr², Roberto M Lang^{1,2} and Amit R Patel^{1,2*}

Journal of Cardiovascular Magnetic Resonance 2012, **14**:11



58 pts

Pulmonary hypertension

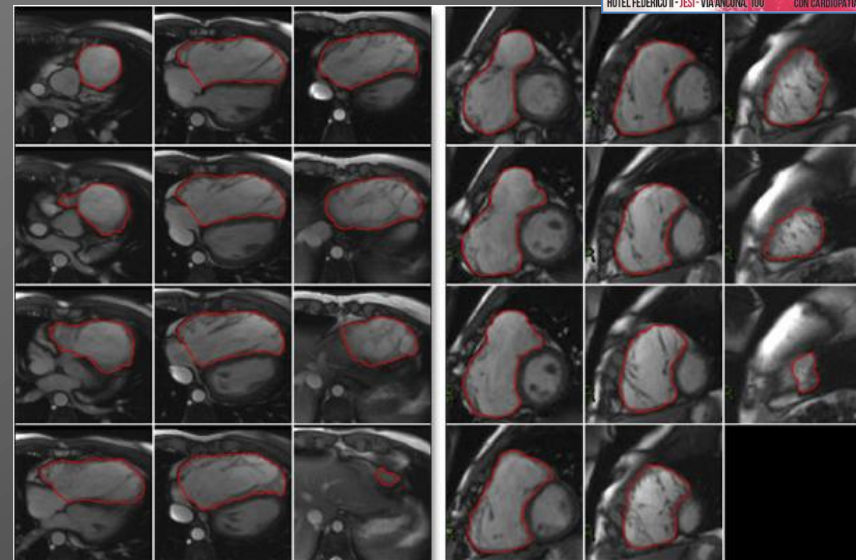
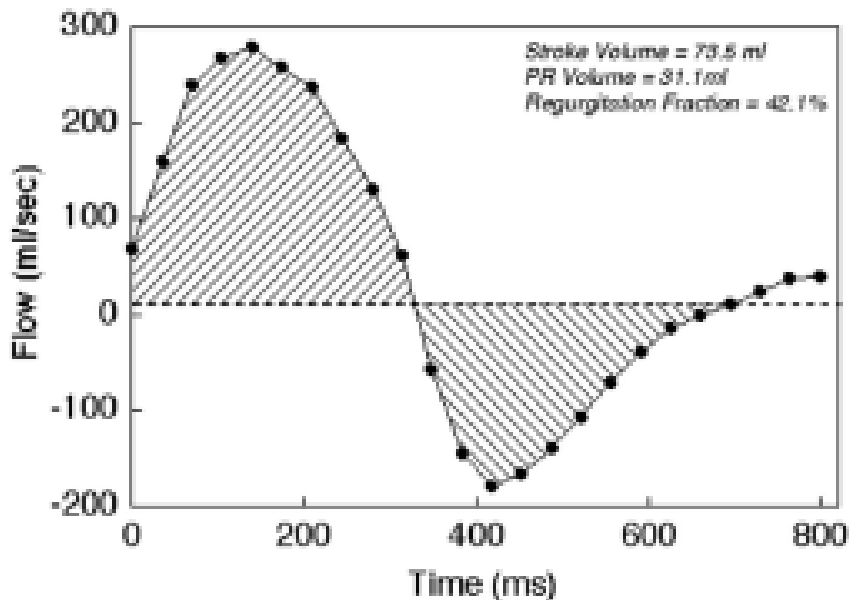
CMRI – LE+ 69% pts

Marker of poor prognosis

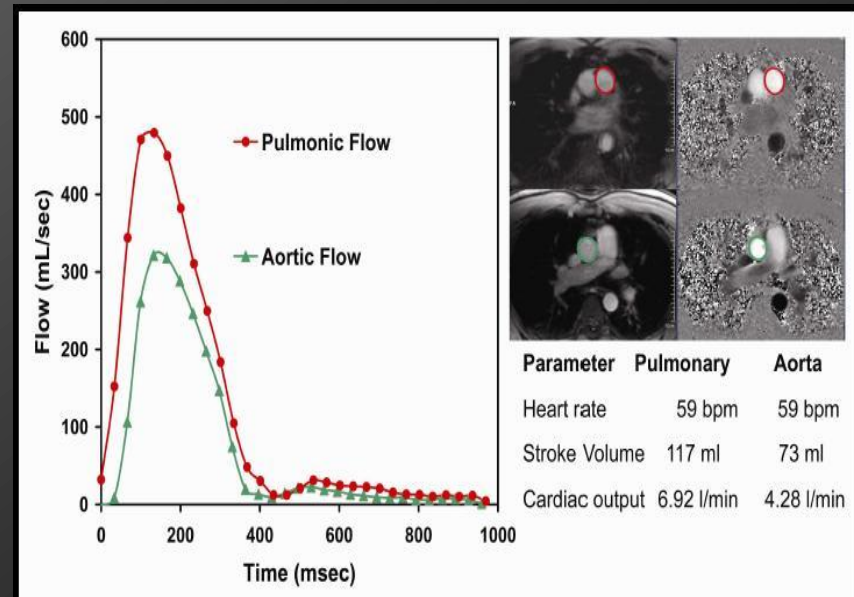
RISONANZA MAGNETICA CARDIACA

- Valutazione della funzione destra-sinistra e della massa
- **Valutazioni flussimetriche**
- Valutazione morfologica e tipizzazione tessutale
- Perfusion e Vitalità (late enhancement)

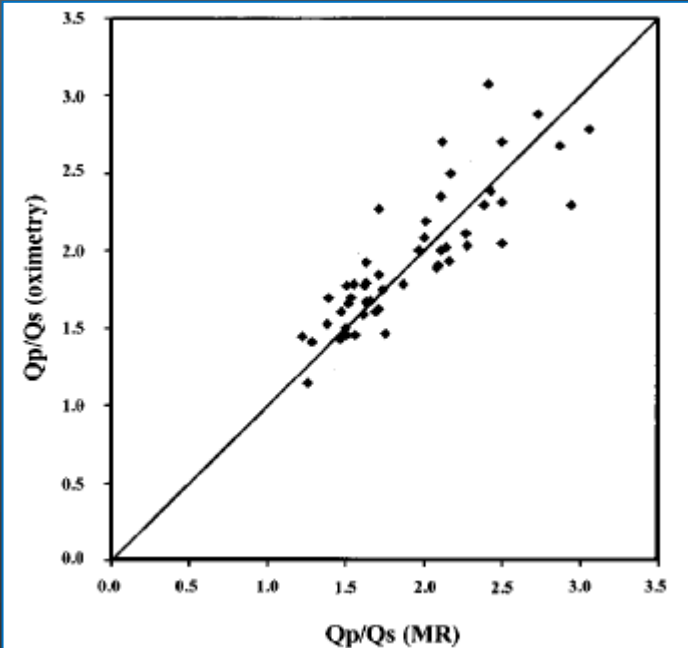
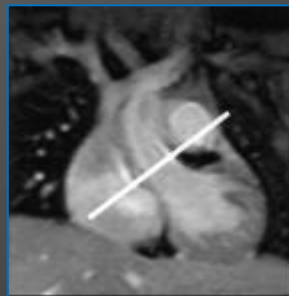
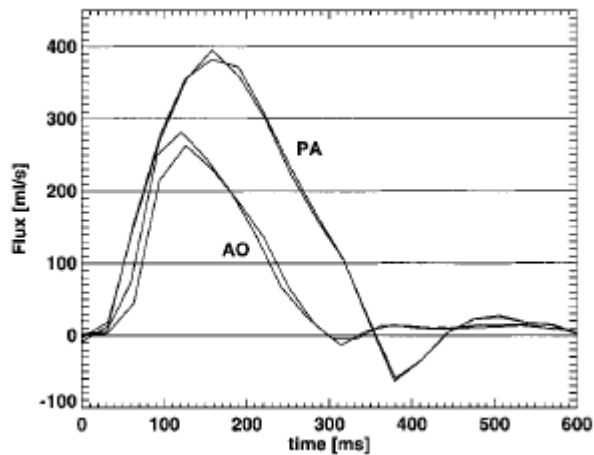
Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



MRI – FUNZIONE VENTRICOLARE E FLUSSIMETRICA

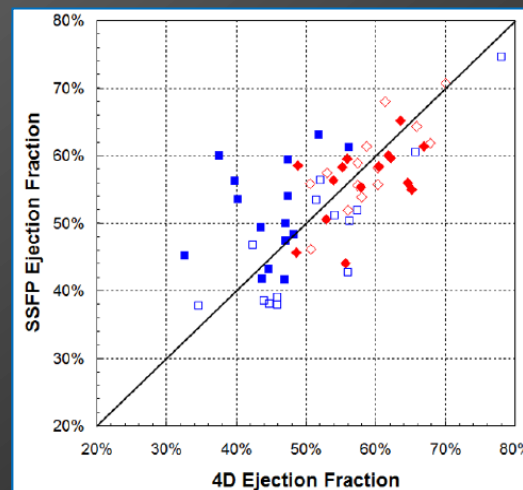
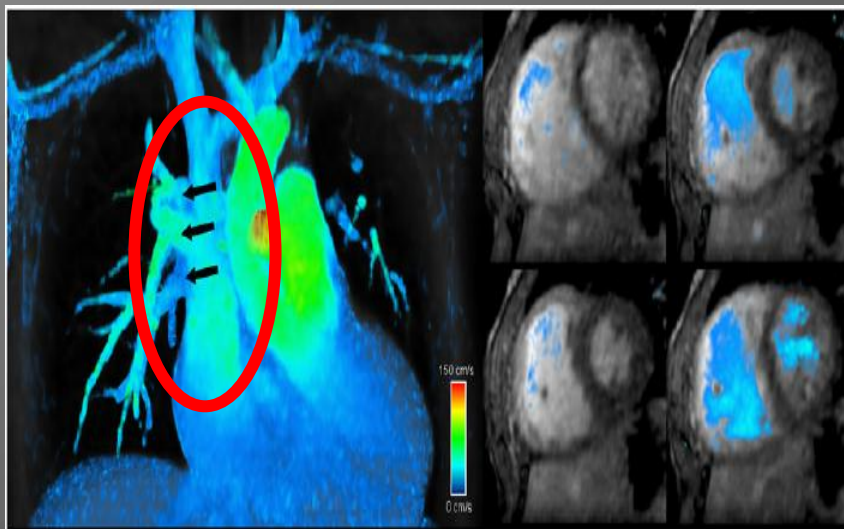


Noninvasive Quantification of Left-to-Right Shunt in Pediatric Patients Phase-Contrast Cine Magnetic Resonance Imaging Compared With Invasive Oximetry *Circulation. 2001;103:2476-2482.*



AJR Am J Roentgenol. 2012 March ; 198(3): W250–W259. doi:10.2214/AJR.11.6969.

Rapid pediatric cardiac assessment of flow and ventricular volume with compressed sensing parallel imaging volumetric cine phase-contrast MRI



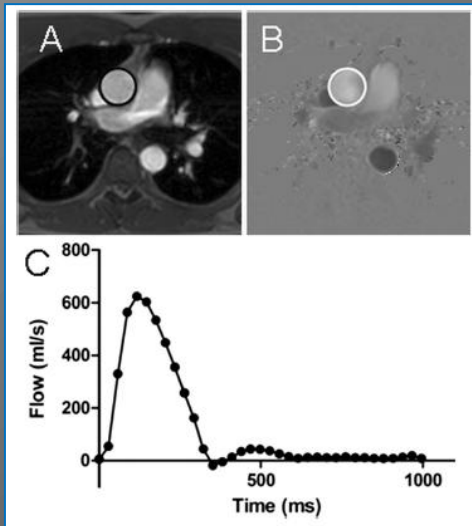
**4 D VOLUME-> OTTIMA CORRELAZIONE SIA IN ANALISI
VOLUMETRICA CHE FUNZIONALE**

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

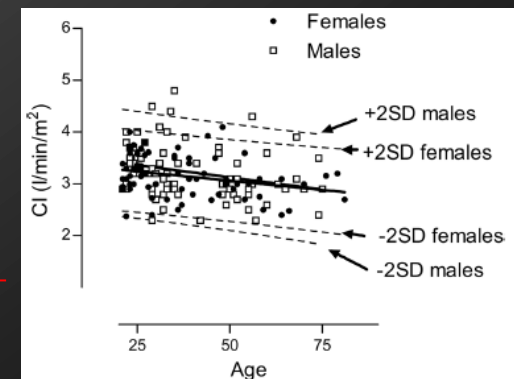
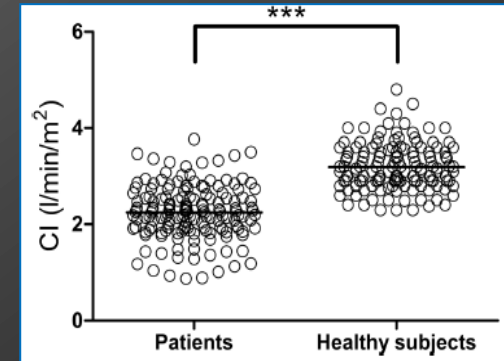
Cardiac output and cardiac index measured with cardiovascular magnetic resonance in healthy subjects, elite athletes and patients with congestive heart failure

Marcus Carlsson^{1*}, Ruslana Andersson¹, Karin Markenroth Bloch^{2,3}, Katarina Steding-Ehrenborg¹, Henrik Mosén¹, Freddy Stahlberg³, Bjorn Ekmeahag⁴ and Hakan Arheden¹

Journal of Cardiovascular Magnetic Resonance 2012, **14**:51

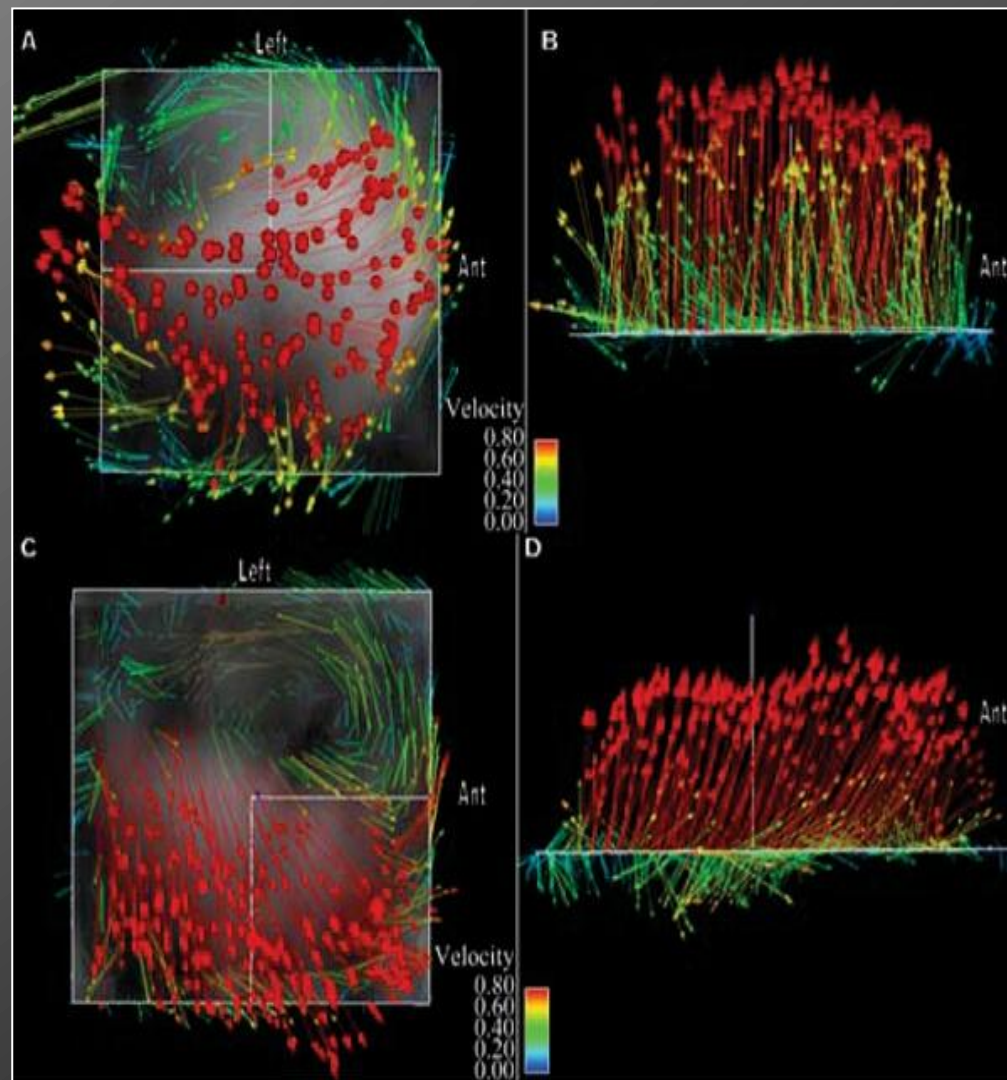
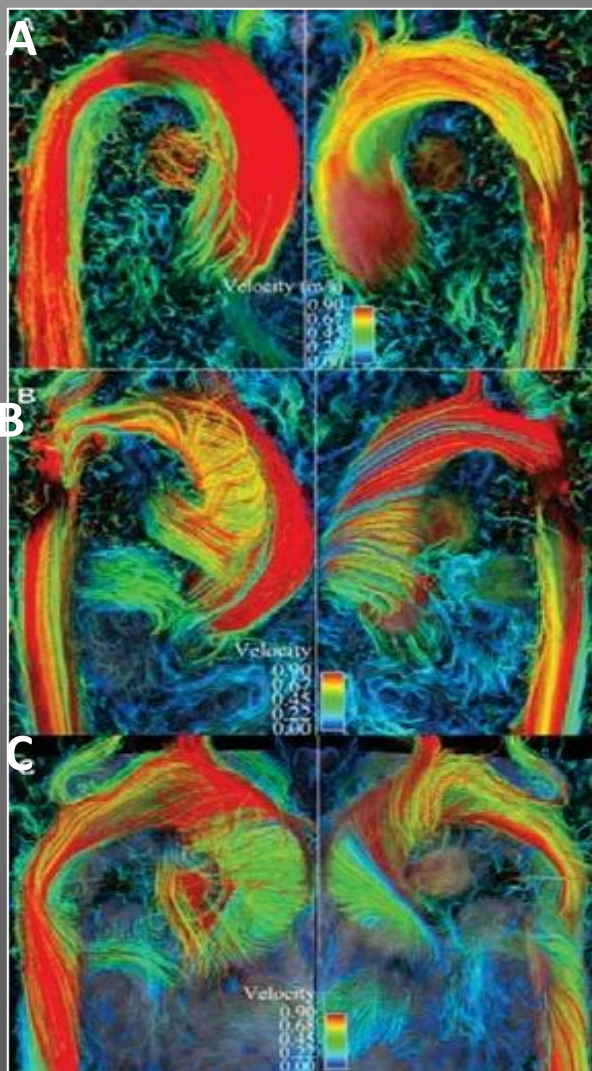


Studio del Cardiac Index in
144 volontari sani
60 atleti
157 SCC pts



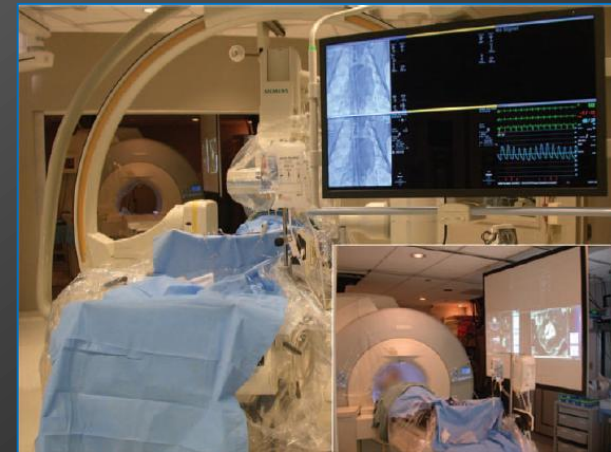
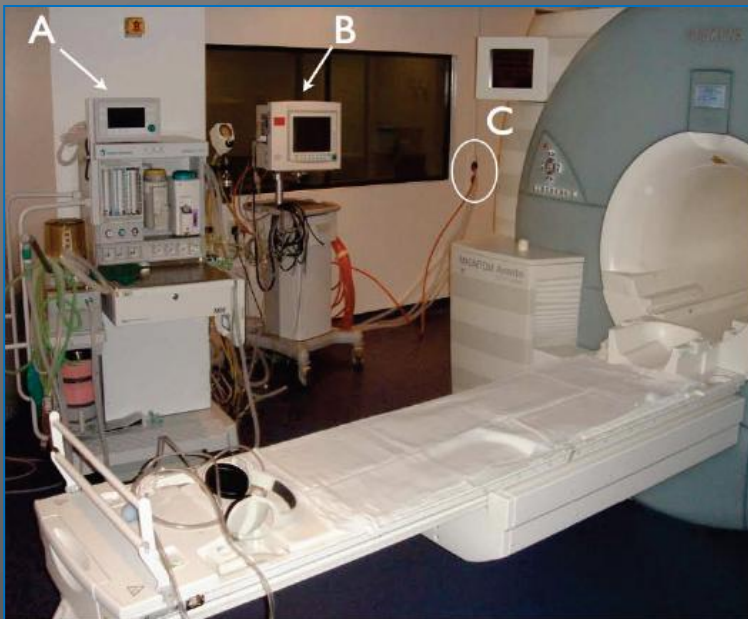
Conclusions: CI decreases in healthy subjects with age but does not differ between males and females. We found no difference in CI between athletes and healthy subjects at rest but CI was lower in patients with congestive heart failure. The presented values can be used as reference values for flow velocity mapping CMR.

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



Real-time MRI-guided right heart catheterization in adults using passive catheters

EHJ 2012



Definizione anatomica + emodinamica
Evitare esposizione a radiazioni

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



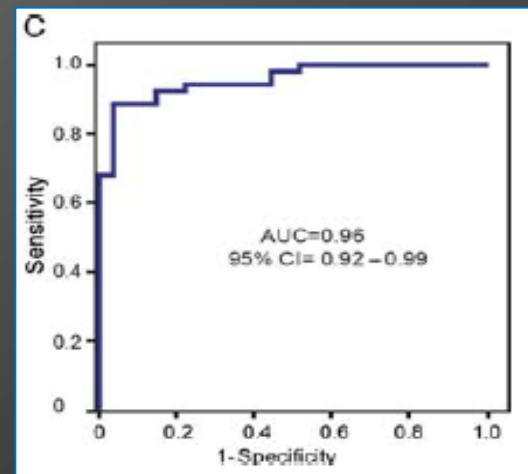
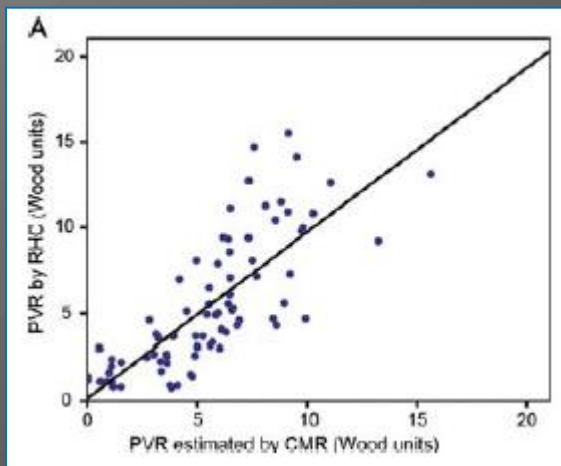
European Heart Journal (2011) 32, 2438–2445
doi:10.1093/eurheartj/ehf173

CLINICAL RESEARCH

Imaging

Non-invasive estimation of pulmonary vascular resistance with cardiac magnetic resonance

Ana García-Alvarez^{1,2,3}, Leticia Fernández-Friera¹, Jesús G. Mirelis^{1,2}, Simonette Sawit¹, Ajith Nair¹, Jill Kallman¹, Valentin Fuster^{1,2}, and Javier Sanz^{1*}



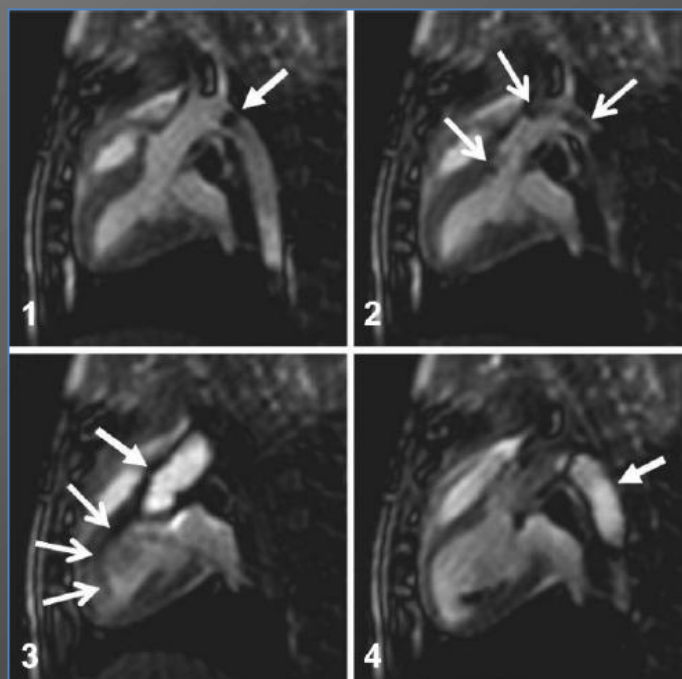
$$\text{estimated PVR (in WU)} = 19.38 - [4.62 \times \ln \text{PA average velocity (in cm/s)}] - [0.08 \times \text{RVEF (in \%)}]$$

100 pts. CMR + Cateterismo dx. Ottima correlazione tra le due metodiche

Magnetic Resonance–Guided Cardiac Interventions Using Magnetic Resonance–Compatible Devices

A Preclinical Study and First-in-Man Congenital Interventions

Circ Cardiovasc Interv. 2010;3:585-592



Conclusions—The described preclinical study and case reports are encouraging that with the availability of the new MR-compatible and safe guide wire, certain percutaneous cardiac interventions will become feasible to perform solely under MR guidance in the future. A clinical trial is underway in our institution. (*Circ Cardiovasc Interv.* 2010;3:585-592.)

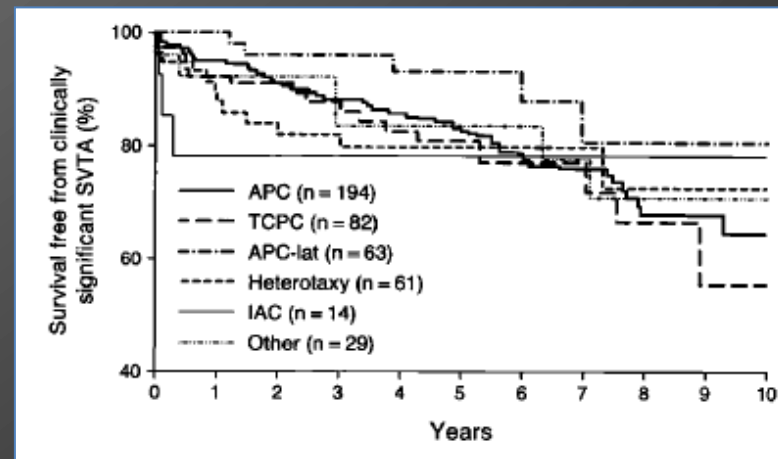
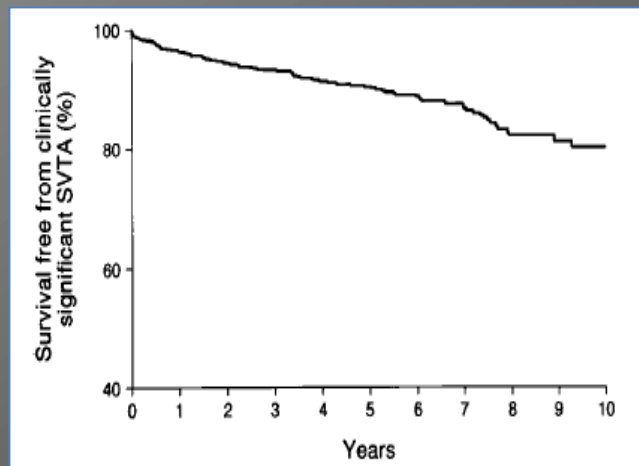
RISONANZA MAGNETICA CARDIACA

- Valutazione della funzione destra-sinistra e della massa
- Valutazioni flussimetriche
- Valutazione morfologica e tipizzazione tissutale
- Perfusion e Vitalità (late enhancement)

Predictors of Early- and Late-Onset Supraventricular Tachyarrhythmias After Fontan Operation

Kritvikrom Durongpisitkul, MD; Co-burn J. Porter, MD; Frank Cetta, MD; Kenneth P. Offord, MS;
Jeffrey M. Slezak, BS; Francisco J. Puga, MD; Hartzell V. Schaff, MD;
Gordon K. Danielson, MD; David J. Driscoll, MD

Circulation. 1998;98:1099-1107.



Conclusions—Postoperative SVTA continues to be a significant problem. Risk factors for SVTA are AV valve regurgitation, abnormal AV valve, preoperative SVTA, and age at operation. Frequency of SVTA does not appear to be related to type of Fontan procedure except for slightly lower frequency in patients with atriopulmonary connection with lateral tunnel compared with those with total cavopulmonary connection. (*Circulation.* 1998;98:1099-1107.)

Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca

Journal of the American College of Cardiology
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Vol. 55, No. 16, 2010
ISSN 0735-1097/10/\$36.00
2009.12.036

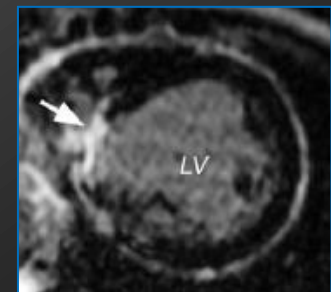
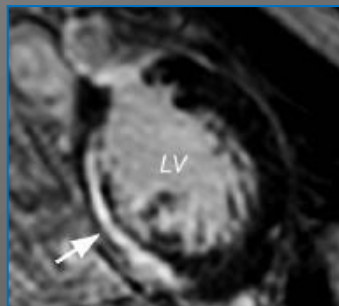
Table 2 Univariate Analysis

	All Patients (n = 90)	LGE Absent (n = 65)	LGE Present (n = 25)	p Value
EDV _I (ml/BSA ^{1.3})	87 [66-108]	82 [63-98]	100 [79-158]	0.004†
EDV _I (ml/BSA)	100 [76-127]	95 [73-115]	123 [92-171]	0.003†
ESV _I (ml/BSA ^{1.3})	36 [27-53]	34 [26-44]	63 [35-87]	<0.001†
ESV _I (ml/BSA)	41 [31-65]	39 [29-52]	66 [40-102]	<0.001†
SV _I (ml/BSA)	55 ± 18	54 ± 17	58 ± 19	0.36*
EF (%)	53 ± 12	56 ± 10	45 ± 14	<0.001*
Mass _I (g/BSA ^{1.3})	50 [41-69]	45 [38-59]	63 [49-89]	<0.001†
Mass _I (g/BSA)	57 [46-76]	52 [42-72]	73 [56-98]	0.001†
Mass/volume ratio (g/ml)	0.6 [0.5-0.7]	0.6 [0.5-0.8]	0.6 [0.5-0.7]	0.72†
RWMA	31 (34%)	18 (28%)	13 (52%)	0.05†
Any ventricular arrhythmia	25 (28%)	13 (20%)	12 (48%)	0.02†
Ventricular ectopy	19 (21%)	9 (14%)	10 (40%)	0.01†
NSVT	17 (19%)	7 (11%)	10 (40%)	0.005†
Sustained ventricular tachycardia	6 (7%)	3 (5%)	3 (12%)	0.3†
Arrhythmia-related cardiac arrest	3 (3%)	1 (2%)	2 (8%)	0.2†
Pacemaker	12 (13%)	10 (15%)	2 (8%)	0.5†
Defibrillator	2 (2%)	2 (3%)	0 (0%)	1†

**Myoca
Reson
Associ
Ventric**

imaging

28% LGE +



Conclusions

In this cohort of late Fontan survivors, myocardial fibrosis was common and associated with adverse ventricular mechanics and a higher prevalence of NSVT. Further studies are warranted to examine the utility of LGE for risk stratification and treatment of ventricular arrhythmia and dysfunction in Fontan patients. (J Am Coll Cardiol

Evaluation of the Extracardiac Conduit Modification of the Fontan Operation for Thrombus Formation using Magnetic Resonance Imaging

Farirai Takawira, FCPaed^a, Julian G. Ayer, FRACP^{a,*}, Ella Onikul, FRANZCR^b,
Richard E. Hawker, FRACP^a, Allan Kemp, Cert Diag Rad^b,
Ian A. Nicholson, FRACS^a and Gary F. Sholler, FRACP^a

^a The Adolph Basser Cardiac Institute, The Children's Hospital at Westmead, Sydney, Australia

^b Medical Imaging, The Children's Hospital at Westmead, Sydney, Australia

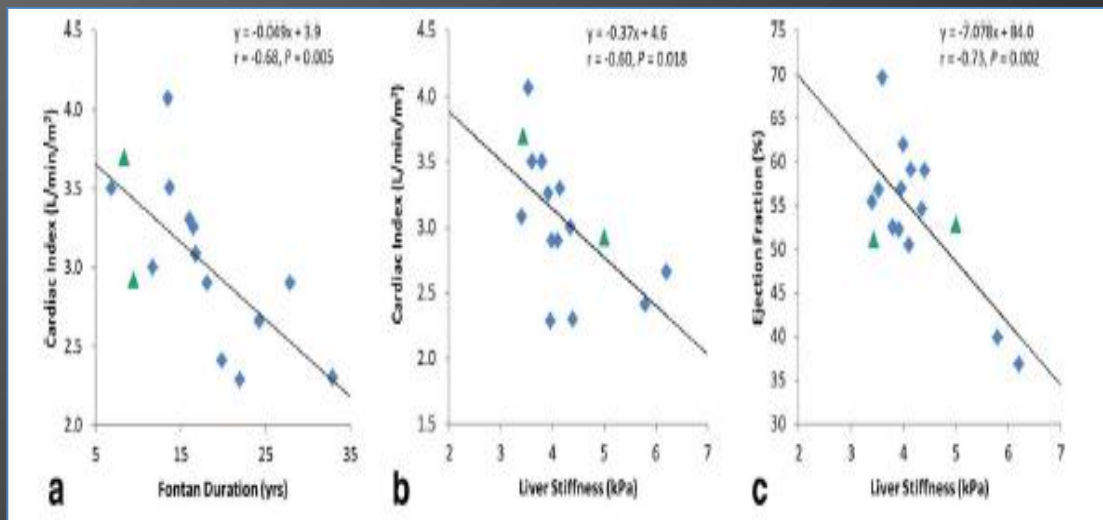
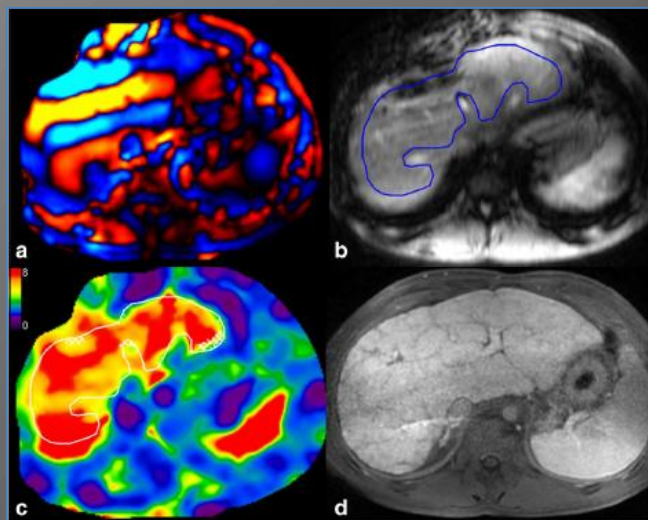
Heart, Lung and Circulation 2008;17:407-410



Conclusions: We conclude that MRI is a potentially useful tool for the detection of thrombus in patients who have undergone the Fontan operation.

Original Research

Relationship of MR Elastography Determined Liver Stiffness With Cardiac Function After Fontan Palliation



LIVER STIFFNESS come marker di danno d'organo

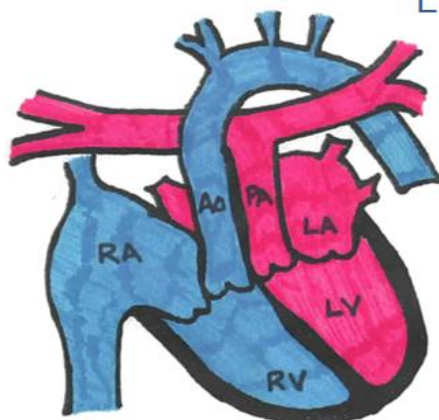
Il ruolo dell'imaging: la Risonanza Magnetica Cardiaca



Fondazione Villa Russiz
Capriva del Friuli (GO)



14 febbraio 2014



LA CARDIOPATIA CONGENITA:

DALLA GRAVIDANZA ALL'ETÀ ADULTA

CON IL PATROCINIO DI
 ANCE Cardiologia Italiana del Territorio
 Azienda per i Servizi Sanitari N. 2 "Isontina"

ECM

7 crediti ECM. Categorie e discipline accreditate:

- Medico Chirurgo
discipline: Cardiologia, Pediatria, Pediatri di libera scelta,
Ginecologia e Ostetricia, Genetica Medica, Medicina
Generale, Cardiocirurgia, Radiodiagnostica, Medicina
dello Sport, Malattie dell'Apparato Respiratorio, Medicina
Interna, Medicina e Chirurgia di Accettazione e di Urgenza)
- Infermiere
- Tecnico di Neurofisiopatologia

NELLA GIORNATA DI CONGRESSO VERRÀ ATTIVATO IL
SERVIZIO DI CONTINUITÀ ASSISTENZIALE NELL'ASS2 ISONTINA
A PARTIRE DALLE ORE 8:00 E FINO ALLE 20:00

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