

Evaluation of 4D MRI Flow Quantification

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4D phase-contrast MRI

3D Velocity dataset

2D Slices

3 dimensions

3 directions

W U

Wigström et al. Magn Reson Med. 1996;36(5)

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Cardiac Flow Patterns

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Early vs late ventricular inflow

- Specific paths of flow entering the right ventricle in early and late diastole

Pathlines released at peak E Pathlines released at peak A

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Aim

- The aim of the present study was to validate MRI based 4D LV flow visualization and quantification.

In-vivo validation, in order to include all possible errors

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Semi-automatic analysis of 3D blood flow

LV Segmentation at isovolumic contraction Forward and backward pathlines from segmented LV volume

Eriksson et al. J Cardiovasc Magn Reson 2010;12(1):9

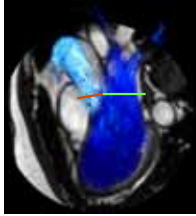
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Quality control: Cardiac blood flow

- Left ventricular (n=9)
Inflow vs outflow (ml)

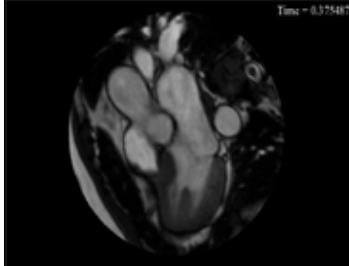
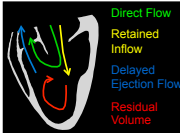
	Inv1a	Inv1b	Inv2
Inflow	68 ± 11	71 ± 9	72 ± 12
Outflow	67 ± 13	69 ± 13	70 ± 15

- Outflow, 2D through plane PC-MR
77 ± 16 ml
- Outflow, Ultrasound Doppler
58 ± 10 ml



¹Eriksson et al. ISMRM 2010, abstract 1364
²Eriksson et al. J Cardiovasc Magn Reson 2010;12(1):

Cardiac flow patterns: left ventricle





61 year old healthy male

Eriksson et al. ISMRM 2010, abstract 1345

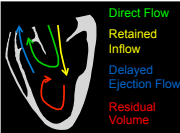
Cardiac flow patterns: left ventricle

% of end diastolic volume

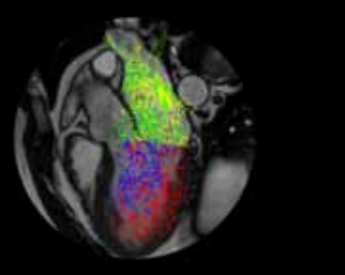
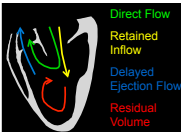


Flow Component	Percentage
Direct Flow	36 ± 5%
Retained Inflow	32 ± 4%
Delayed Ejection Flow	16 ± 4%
Residual Volume	16 ± 3%

Healthy left ventricle
(n=9, age 49±16)



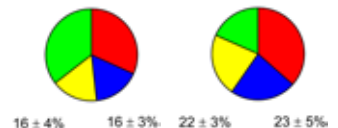
Cardiac flow patterns: left ventricle

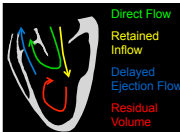
62 year old male with dilated cardiomyopathy

Cardiac flow patterns: left ventricle

% of end diastolic volume



Flow Component	Healthy left ventricle (n=9, age 49±16)	Dilated cardiomyopathy (n=8, age 51±13)
Direct Flow	36 ± 5%	18 ± 4%
Retained Inflow	32 ± 4%	37 ± 6%
Delayed Ejection Flow	16 ± 4%	22 ± 3%
Residual Volume	16 ± 3%	23 ± 5%



Discussion

- These findings indicate that the pathlines analysis method permits characterization of LV flow components with high accuracy.
- The method presented allows for semi-automated user-independent analysis of LV blood flow, including an in-vivo quality control.
- Ongoing studies are directed at the utilization of this method for the improved understanding of intracardiac 4D flow characteristics in health and disease.



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