Springer et al. Journal of Cardiovascular Magnetic Resonance 2015, 17(Suppl 1):P251
http://www.jcmr-online.com/content/17/S1/P251

Journal of Cardiovascular Magnetic Resonance

POSTER PRESENTATION Open Access

Metabolic imaging of *in vivo* myocardium

Charles S Springer[1,2*], Craig S Broberg[3,2], William D Rooney[1,2]

From 18th Annual SCMR Scientific Sessions
Nice, France. 4-7 February 2015

Background

The *equilibrium* cellular water efflux rate constant [k_{io}; mean water lifetime inverse] from contrast agent [CA]-enhanced MRI measures on-going cellular Na^+,K^+-ATPase activity [turnover]. Good literature [4 different labs] agreement shows substantial k_{io} decreases in myocardial ischemia, hypertension, or infarct regions (Table). The 3 methods used differ in extracellular ("outside") CA_o level manipulation to change the MR shutter-speed relative to k_{io} and the MR exchange condition reached: A) CA_o steady-state, slow-exchange-regime; B) CA_o titration, fast-exchange-regime [FXR]; and C) CA_o wash-out, FXR. The independent intracellular volume fraction [ICV] - cell density•volume product and ≈ 1 - ECV [extracellular volume fraction] - also decreases in pathology. We hypothesize that k_{io} mapping shows metabolic compromise most effectively. We report initial experience with tissue near a repaired ventricular septal defect [VSD].

Methods

We acquired serial 1.5T ^1H_2O T_1-weighted data from a 27 yo male before and 3 times after a bolus IV 0.15 mmol/kg CA [Omniscan] injection. Quantitative Look-Locker T_1 measurements [non-selective inversion, 21 recovery times] imaged an 8 mm slice with a mid-ventricular short axis location inferior to the VSD patch. Method C (CA_o wash-out, FXR) determined k_{io} and ICV values in six LV wall segments.

Results

The Figure shows a post-CA T_1-w image: the endo- and epicardial LV wall edges as bright orange and green, respectively [light orange circle, an LV ROI]. Segmental ICV and k_{io} values are given (yellow). Segments S5 and S6 comprise the septum. The ICV values for segments S1 - S4 are reasonable for normal myocardium (Table). Thus, we have indicated (*) a control myocardial k_{io} value [5 s^{-1}, Table], since the CA wash-out data quantity [3 points] and quality from these normal myocardium segments yielded insufficient precision. Interestingly, the k_{io} value is reduced [4.5 s^{-1}] in segment S6, and dramatically so [1.7 s^{-1}; 66%↓] in segment S5, immediately inferior to the VSD patch.

Conclusions

The k_{io} biomarker is a sensitive measure of on-going myocardial metabolic activity. Our result suggests that tissue nearby a VSD patch can be, or become, metabolically compromised.

The ultimate goal is pixel-wise k_{io} and ICV maps. [Here, nominal voxels are 2x2x8 mm^3 = 32 μL.] For this, one needs data with good S/N and more than 3 wash-out points. Also, method C has systematic error absent in methods A and B, which cannot be used for humans. It assumes the CA_o concentration equals that of CA_p [in plasma] during wash-out. This is invalid for finite CA intravasation kinetics, which may be particularly slow in myocardial lesions due to common reduced

report date	method	myocardium		ICV	k_{io} (s^{-1})
2006	A	*ex vivo* rat (perfused/beating)	control		5.6
		(no flow) ischemia			3.7
		change			36%↓
2013	B	*in vivo* mouse	control [n = 13]	0.75	5.3
			chronic hypertension [n = 17]	0.58	2.3
			change	23%↓	57%↓
2013	C	*in vivo* human	control [n = 12]	0.69	
			chronic hypertension [n = 8]	0.55	
			change	20%↓	
2014	C	*in vivo* human	control [n = 4]	0.69	3.2
2014	C	*in vivo* human	control [n = 20]	0.69	10.0
			chronic infarct [n = 20]	0.39	2.5
			change	43%↓	75%↓

Figure 1 Literature reports of active trans-membrane water cycling [k_{io}] and intracellular volume fraction [ICV] values in normal and pathological myocardia.

[1]Advanced Imaging Research Center, Oregon Health & Science University, Portland, OR, USA
Full list of author information is available at the end of the article

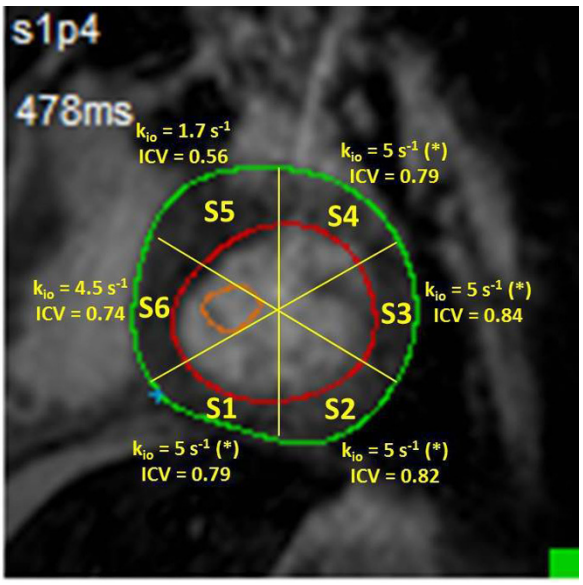

Figure 2 Short axis T_1-w image slice inferior to VSD patch. The k_{io} and ICV values of six LV wall segments are given. k_{io} and ICV are reduced (66% and 30%, respectively) in segment S5,immediately below the patch.

vascularization. Possible k_{io} and ICV underestimations can be corrected using K^{trans} [the CA extravasation transfer constant] from the bolus tissue wash-in time-course to calculate the CA intravasation rate constant.

Funding
NIH: RO1-NS040801.

Authors' details
[1]Advanced Imaging Research Center, Oregon Health & Science University, Portland, OR, USA. [2]Knight Cardiovascular Institute, Oregon Health & Science University, Portland, OR, USA. [3]Division of Cardiovascular Medicine, Oregon Health & Science University, Portland, OR, USA.

Published: 3 February 2015

doi:10.1186/1532-429X-17-S1-P251
Cite this article as: Springer *et al.*: Metabolic imaging of *in vivo* myocardium. *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1): P251.