# CONDUCTIVITY IMAGING OF AN ISCHEMIC PIG HEART MODEL USING ELECTRIC PROPERTIES TOMOGRAPHY

Tobias Voigt[1], Andreas Schuster[2], Masaki Ishida[2], Christian Stehning[3], Ulrich Katscher[3], Amedeo Chiribiri[2], Eike Nagel[2], and Tobias Schaeffter[2]
[1]*Philips Research, London, United Kingdom,* [2]*King's College London, London, United Kingdom,* [3]*Philips Research, Hamburg, Germany*

## Introduction

Electric conductivity of cardiac tissue plays an important role in the function of the heart. In cardiac resynchronization therapy (CRT) it is desired to place leads of implanted devices into normally conductive tissue. Myocardial conductivity may be a useful parameter to distinguish reversible and irreversible ischemic injury [1]. Ventricular conductivity has been measured in animal studies using measurement probes but so far no non invasive tomographic method has been tested. In Electric Properties Tomography (EPT) the interaction of the transmit field used in MRI with the dielectric properties of tissue is used for non invasive and quantitative mapping of conductivity and permittivity [2]. In this work we present the application of EPT conductivity mapping in two isolated perfused pig hearts using an MR compatible set-up [3]. Conductivity values of normally perfused heart tissue were compared to values in ischemic regions after a blockade of the left anterior descending artery (LAD).

## Methods

We performed the experiments in a system for direct coronary perfusion, in which the left and right coronary artery can be perfused independently of each other as previously described [3]. In one of the hearts the coronary artery (LAD) was occluded for 4 hours to induce severe ischemia/myocardial infarction prior to imaging on a 3T MR-scanner (Philips Healthcare, Best, Netherlands). For conductivity imaging, a volumetric SSFP image (FOV = 300 x 290 x 175mm³, resolution 2.4 x 2.4 x 5mm³, short axis slices, nonselective block RF pulse, $\alpha$=25°, TR/TE = 2.6 / 1.13 ms) was employed. The SSFP sequence was gated to a window of 80ms at 500ms into the cardiac cycle. Conductivity reconstruction was performed using the phase images of the SSFP scan on a voxel by voxel basis [2]. The effect of ischemia was validated using MR perfusion imaging based on a saturation recovery gradient echo pulse sequence (TR / TE = 2.7 / 0.9 ms, $\alpha$=20°, resolution 1.3 x 1.3 x 8 $mm^3$, k–t BLAST).

## Results / Discussion

Conductivity values measured in this study are shown in Tab. 1 and the corresponding images are shown in Fig. 1. Normal values for conductivity at 128 MHz are in agreement with literature values according to [4]. Conductivity in ischemic/infarcted areas was 60% lower than in remote myocardium. A decrease of conductivity in canine two hours after LAD occlusion of up to 35% was observed elsewhere using measurement probes [5]. It is likely that the decrease in conductivity and its relation to perfusion reflects the loss of volume fraction of ion conductivity through loss of extracellular space which would include the intravascular volume [6].

## Conclusions

Non invasive cardiac magnetic resonance conductivity imaging is feasible in isolated perfused pig hearts. A comparison of two pig hearts showed that ischemic ventricular tissue is less conductive than healthy myocardium.

| Pig heart | Remote myocardium [S/m] (lit. [4]: 0.77) | Ischemic region [S/m] |
|---|---|---|
| I (Fig. 1a,b) | 0.86 ± 0.28 | - |
| II (Fig. 1c,d) | 0.95 ± 0.37 | 0.29 ± 0.19 |

Table 1: Quantitative values for myocardial conductivity obtained using phase-based conductivity imaging [2].

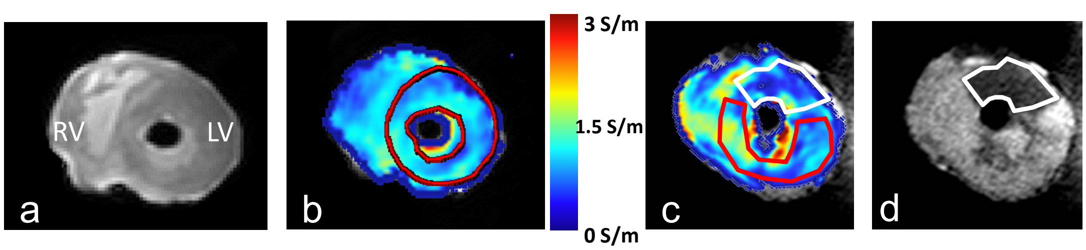


Figure 1: Anatomical image of the normally perfused heart (a) and the corresponding conductivity map (b). Conductivity image 4 hours after continuous LAD occlusion (c) and the corresponding first pass perfusion image (d). Regions of interest used to compute quantitative values are healthy (b) and ischemic/remote myocardium (c, d). The black hole in the left ventricle (LV) is an inflated catheter balloon used to stabilize the set-up.

## References

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