

# Measurement of Cardiac Left Atrial Volumes In Healthy Volunteers and Patients with Left Ventricular Hypertrophy and Angina using MRI

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## Overview

The role of the human left atrium is to receive blood from the lungs and pump this through to the left ventricle. The left ventricle is then able to supply the rest of the body with this fresh oxygen-rich blood. In patients with cardiac diseases the left ventricle is commonly found to be dysfunctional - although it is believed that changes to the left atrium may occur earlier and could therefore be an indicator of possible future damage to the left ventricle. The aim of this study was to examine MRI-derived left atrial structure and function in healthy volunteers, and compare these parameters with those from a cohort of patient volunteers with left ventricular hypertrophy and angina. Results demonstrated that the left atrium was typically enlarged in the patient volunteers (relative to the healthy volunteers), although left atrial function appeared to be similar in both cohorts. It is possible that future MRI measures of left atrial structure and function may enable earlier detection of developing problems associated with the left ventricle, and thus allow for more effective clinical or pharmaceutical intervention.

## Background and Introduction

The structure and size of the human left atrium (LA) is postulated to provide a potential early indicator of developing left ventricular (LV) dysfunction<sup>1</sup>. Prior MRI studies have validated the use of MRI methods for measuring parameters associated with the LA<sup>2</sup>.

The aim of this study was to use cardiac MRI for comparative measurement of left atrial volumes in, (i) healthy normal volunteers (HNV) and (ii) patients with left ventricular hypertrophy and angina (LVHA) in order to establish whether left atrial structural and functional differences are detectable.

<sup>1</sup>Abhayaratna WP et al. Left Atrial Size - Physiological Determinants and Clinical Applications. *J. Am. Coll. Cardiol* 2006; 47: 2357-2363.

<sup>2</sup>Hudsmith LE et al. Assessment of Left Atrial Volumes at 1.5T and 3.0T Using FLASH & SSFP CINE Imaging. *J. Cardiovasc. Magn. Reson* 2007; 9: 673-679.

## Study Volunteers

Two cohorts of ten consenting individuals (one an HNV cohort and the other a LVHA cohort) were scanned on a 3T Trio MRI scanner (Siemens, Erlangen, Germany).

Healthy volunteers were recruited if they were < 40 years of age, had no previous medical history of any cardiovascular problem and had no contraindication to MRI. The cohort comprised of 8 M and 2 F, with an age range of 27-39 years (mean 33 years).

Patient volunteers were recruited if they met the following criteria: blood pressure < 150/90, LVH as defined by American Society of Echo (115g for males, 95g for females), and known clinical stable angina. Patients volunteers were excluded if they had any of the following: renal dysfunction (eGFR < 60ml/min), known heart failure, or any other contraindication to MRI (e.g. pacemaker). The patient cohort comprised of 8M and 2F, with an age range of 50-70 years (mean 62 years).



Figure 1: Siemens 3T Magnetom Trio MRI Scanner - Dundee Clinical Research Centre

## Scanning Facility and Imaging

Imaging was performed on a 3T Magnetom Trio (Siemens, Erlangen, Germany - figure 1) using body array and spine matrix coils.

A 2D ECG-gated segmented CINE TrueFISP sequence with retrospective gating was implemented to acquire '2 chamber' images from the lateral side of the left atrium to the interatrial septum, using a four-chamber CINE image for anatomical reference (figure 2).

Two image slices were acquired per breath hold, each breath hold (at end expiration) being <15 sec. Slice thickness was 4mm, with 1mm (25%) slice gap.

Imaging parameters were TR/TE = 3.4/1.5ms, FA = 50°, parallel imaging (GRAPPA) factor of 3, in-plane resolution of 173x256 over field of view of 360-420mm.

A stack of 4mm slices in the two-chamber orientation (prescribed perpendicular to the plane of the mitral valve) was acquired.

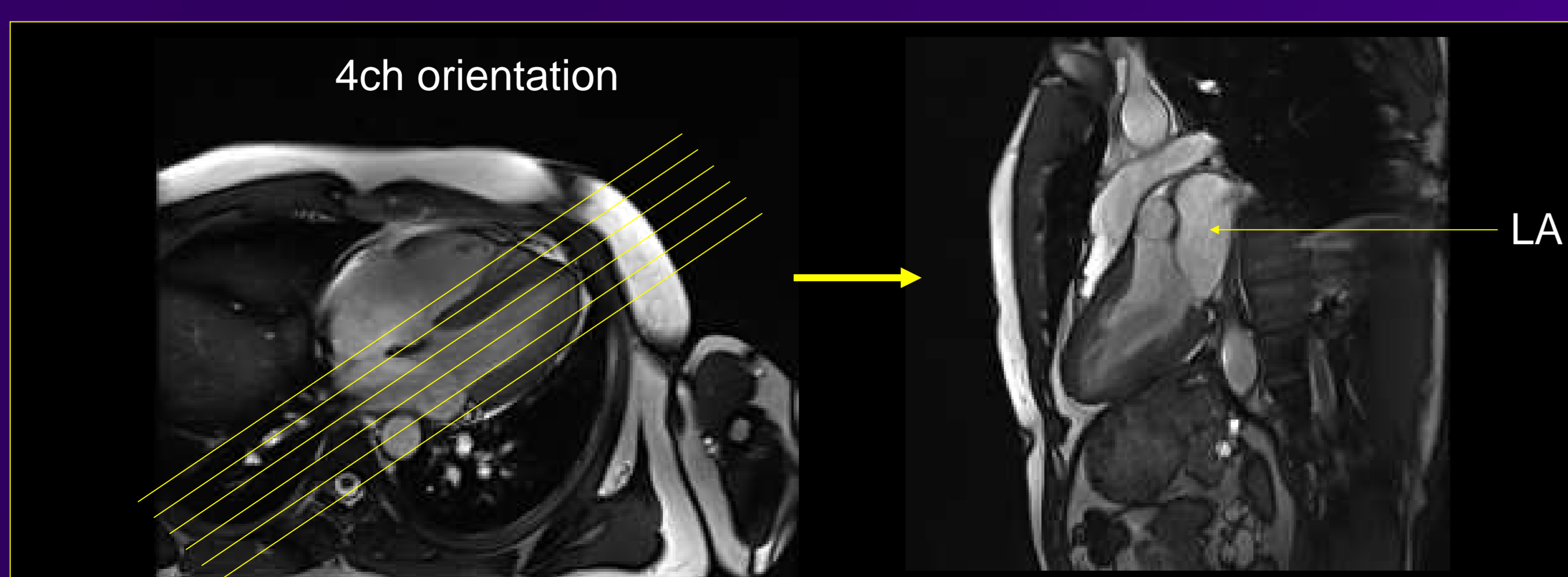


Figure 2 - Image Acquisition of Left Atrial Volumes



Figure 3: Segmentation of the LA Diastole and Systole

## Image Analysis & Statistics

Image segmentation of all atrial structures was performed at atrial diastole and systole by a single intra-observer using commercial software (Siemens), and each dataset was normalised to the respective body surface area for each participant.

Statistical testing was performed using t-tests to examine the null hypothesis that no volumetric differences were observable between the HNV and LVHA cohorts.

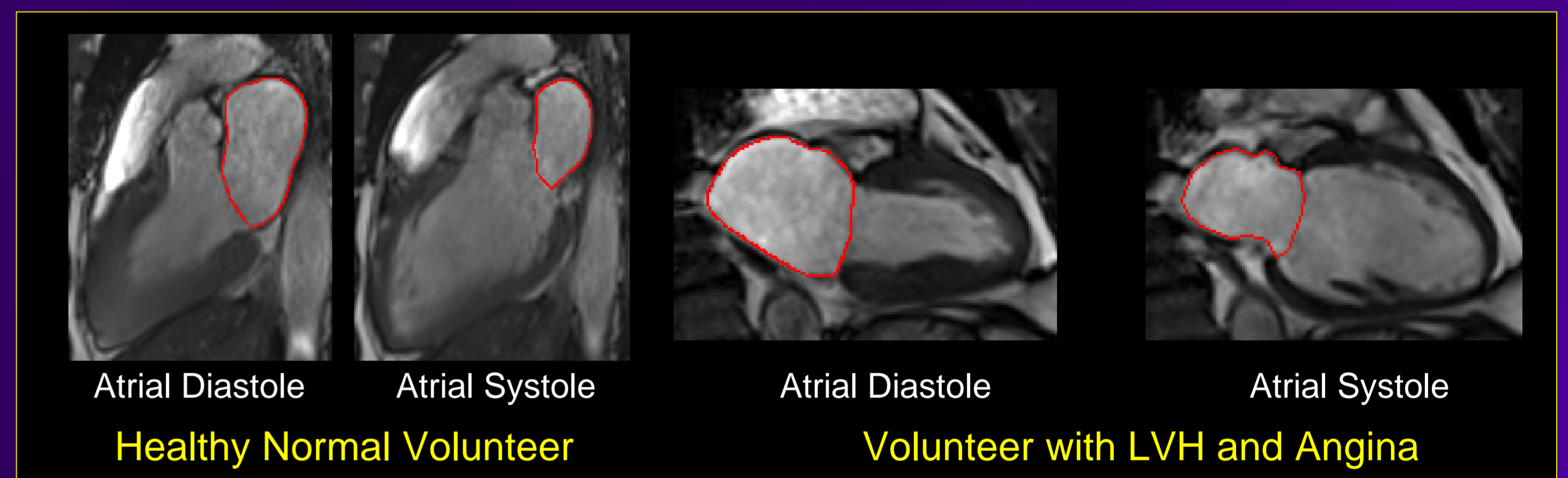


Figure 4: Typical examples of LA structure in HNV and LVHA volunteers.

Cohort	EF (%)	EDV (ml)	ESV (ml)	SV (ml)	CO (ml/min)
HNV	NA	39.0 +/- 7.1	18.3 +/- 4.5	20.7 +/- 3.4	1.4 +/- 0.3
LVHA	NA	46.6 +/- 9.2	24.4 +/- 4.6	22.2 +/- 5.5	1.3 +/- 0.2

## Structural and Functional Comparisons

The mean normalised left atrial end-diastolic volume (EDV) was significantly elevated in the LVHA cohort relative to the HNV cohort - 46.6 ml/m<sup>2</sup> versus 39.0 ml/m<sup>2</sup>, p=0.05, and a similar pattern was also identified for mean end-systolic volume (ESV) - 24.4 ml/m<sup>2</sup> versus 18.3 ml/m<sup>2</sup>, p=0.01.

However the mean normalised left atrial stroke volume was comparable between each cohort (22.2 ml/m<sup>2</sup> for LVHA versus 20.7ml/m<sup>2</sup> for HNV, p=0.47), suggesting that left atrial function is preserved - despite the clear volumetric differences.

## Summary

This pilot study has demonstrated that measurements of left atrial volume are able to distinguish clear structural differences between healthy individuals and patients with LVH and angina. These MRI endpoints show promise as potential early markers of developing LV dysfunction, and may also be useful for monitoring of cardiac structure and function in response to intervention.

## Future Work

For future work, our aim is to compare left atrial structure and function with that of the left ventricle, and to monitor any changes to all of these parameters over time.

Cross-centre reproducibility assessments will also be formally examined in order to establish inter-observer variations. Single centre intra-observer test-retest coefficient of variation measures of left atrial volumes are known to be of the order of 2%.

A comparison of MRI derived measures of LA structure and function may be made with those derived from other imaging modalities such as ultrasound echo.

## Acknowledgments

NHS Tayside MRI Staff  
University of Dundee and St Andrews  
SINAPSE  
MRI Volunteers

## For Further Information

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