Cardiac Magnetic Resonance in pregnant women

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Quantification of haemodynamics and myocardial tissue characteristics in healthy pregnant women and women with pre-eclampsia using cardiac magnetic resonance

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Disclosures

None

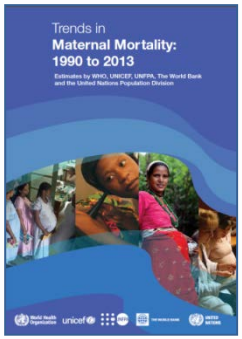
Background

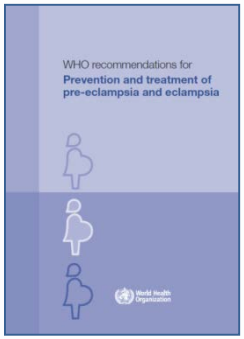
Pre-eclampsia is a pregnancy specific hypertensive cardiovascular disorder

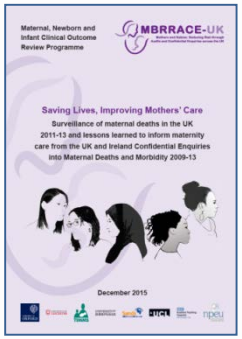
Short term peripartum complications

Long term cardiovascular problems

Prevalence is not changing – millions of women affected each year







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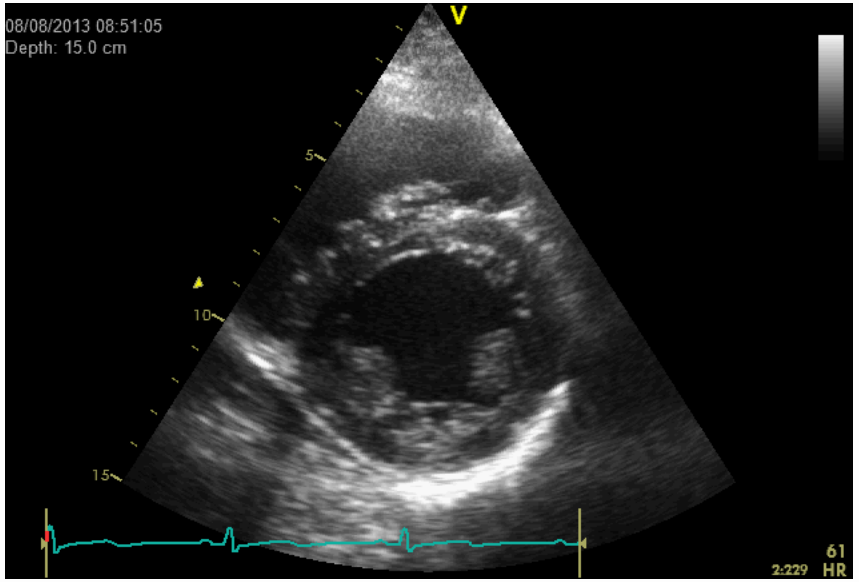
Background

Acute cardiac changes in
women with pre-eclampsia:

preserved ejection fraction
increased cardiac output
pericardial effusions
reduced diastolic function
increased left ventricular wall thickness



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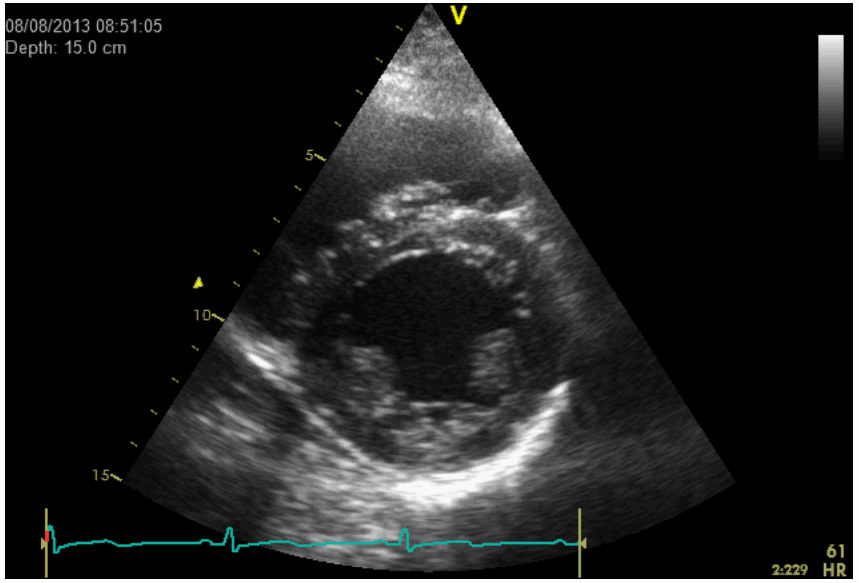

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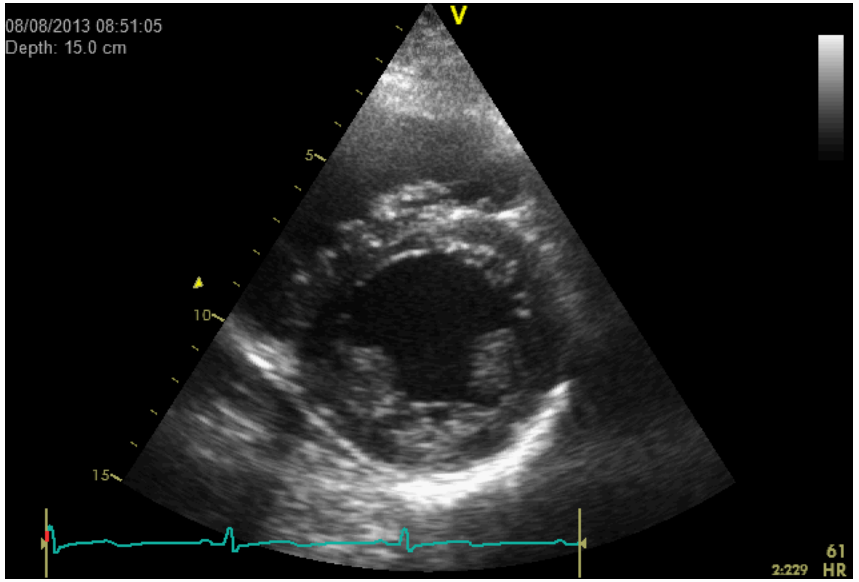

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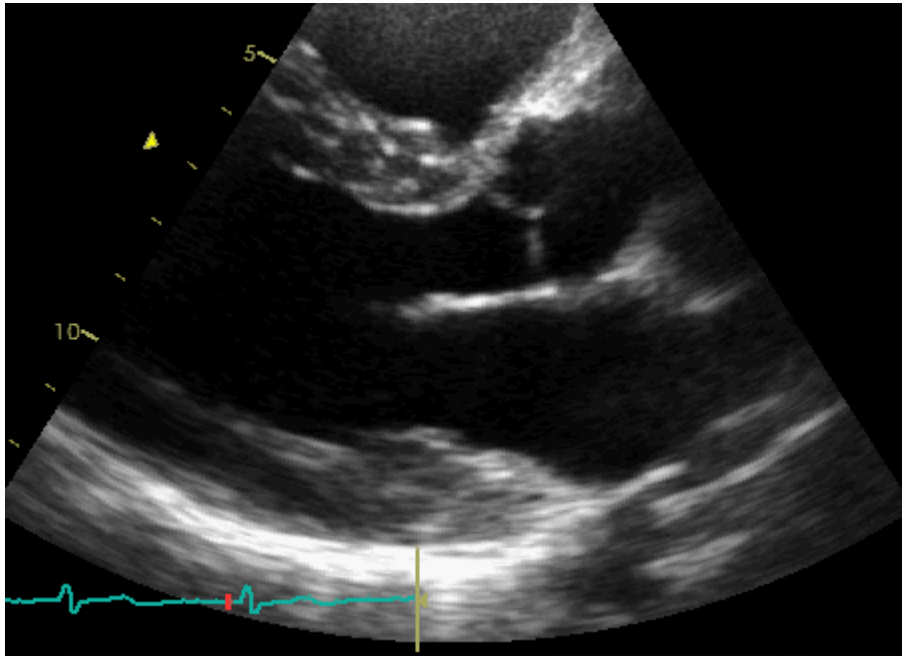

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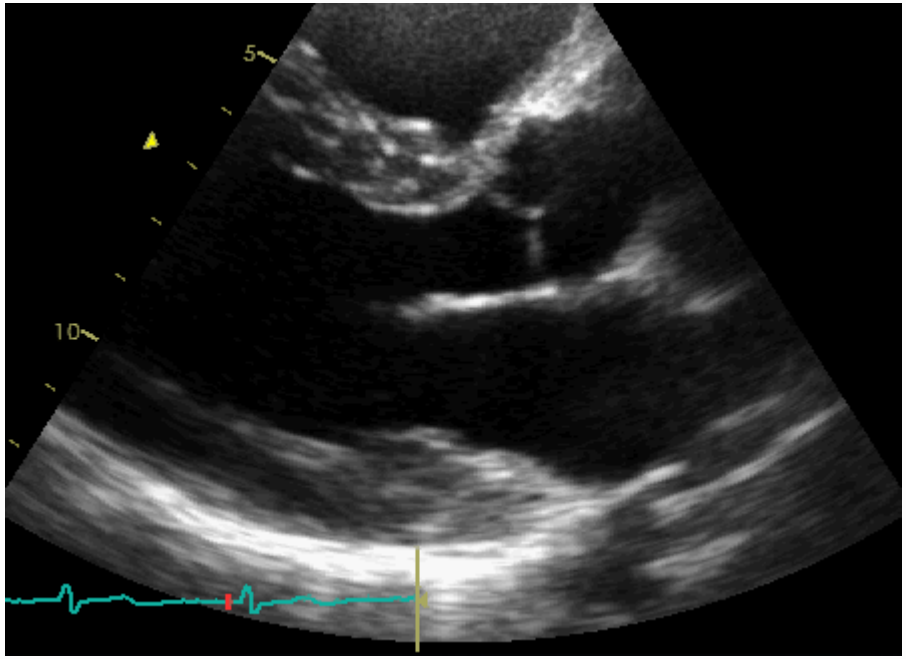
Left ventricular mass = [1.04 × ([LVID + PWT + IVST]^3 – LVID^3)] × 0.8 + 0.6



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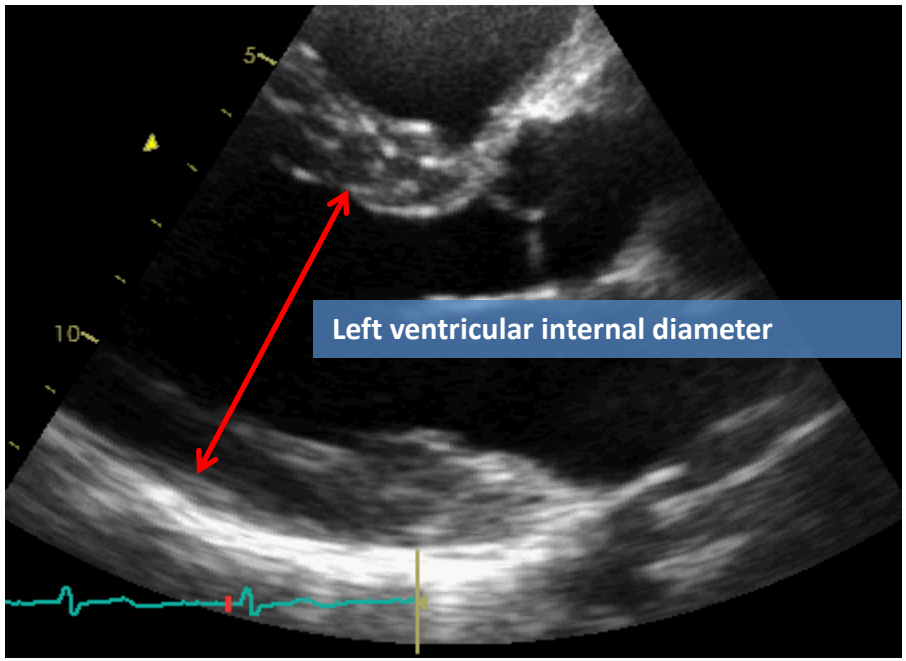

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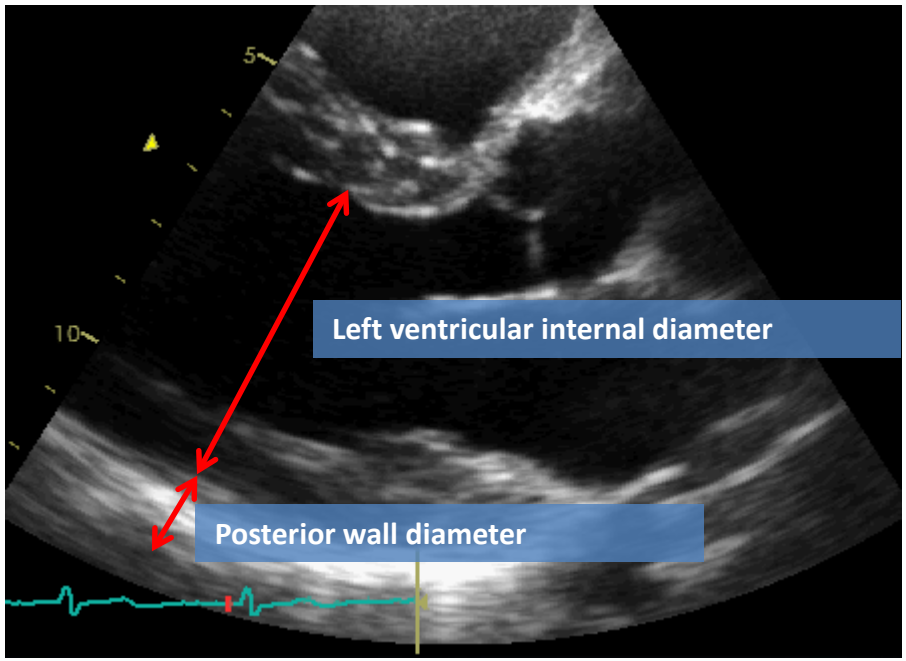

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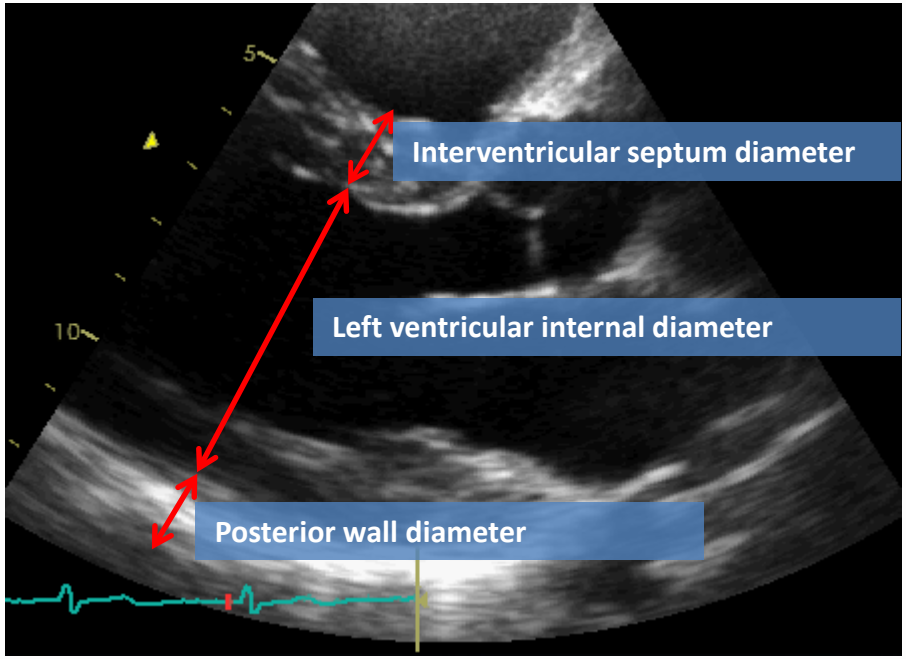

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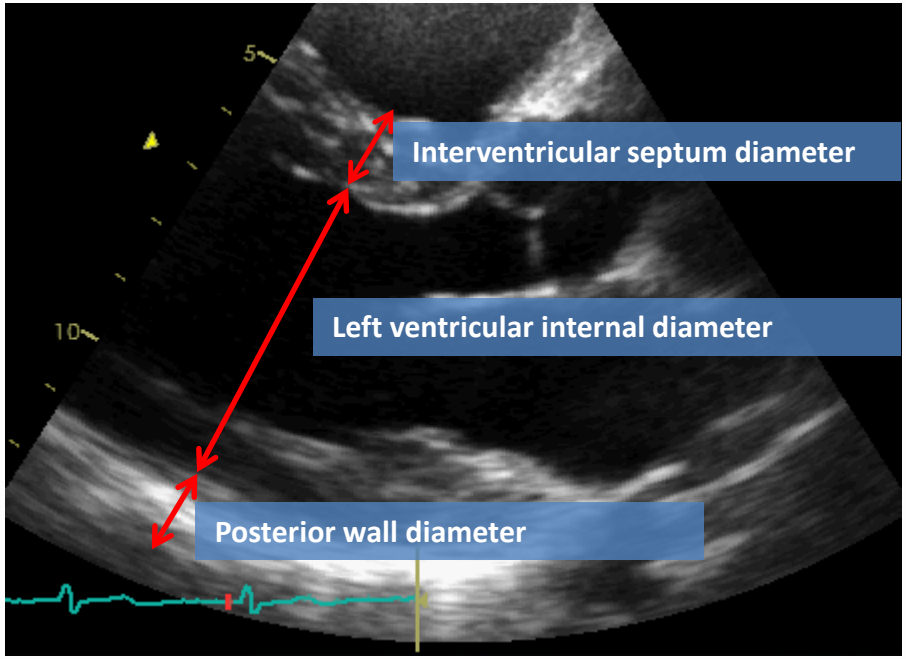
Left ventricular mass = [1.04 × ([LVID + PWT + IVST]^3 – LVID^3)] × 0.8 + 0.6

Where 1.04 = specific gravity of the myocardium (g/ml)

assuming uniformity in structure and composed of muscle



Background

HOWEVER

Echocardiography cannot differenciate between causes of increased wall thickness

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Background

HOWEVER

Echocardiography cannot differenciate between causes of increased wall thickness

?myocardial oedema or
?fibrosis or
?muscle

Background

Short term peripartum problems – ?**Myocardial oedema** may be responsible for the diastolic changes that predispose women to acute pulmonary oedema

Long term cardiovascular problems – **?Myocardial fibrosis** (an acute injury during pre-eclampsia) may predispose women to heart failure, hypertension and ischaemic heart disease later in life

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Short term peripartum problems – ?**Myocardial oedema** may be responsible for the diastolic changes that predispose women to acute pulmonary oedema

Long term cardiovascular problems – **?Myocardial fibrosis** (an acute injury during pre-eclampsia) may predispose women to heart failure, hypertension and ischaemic heart disease later in life

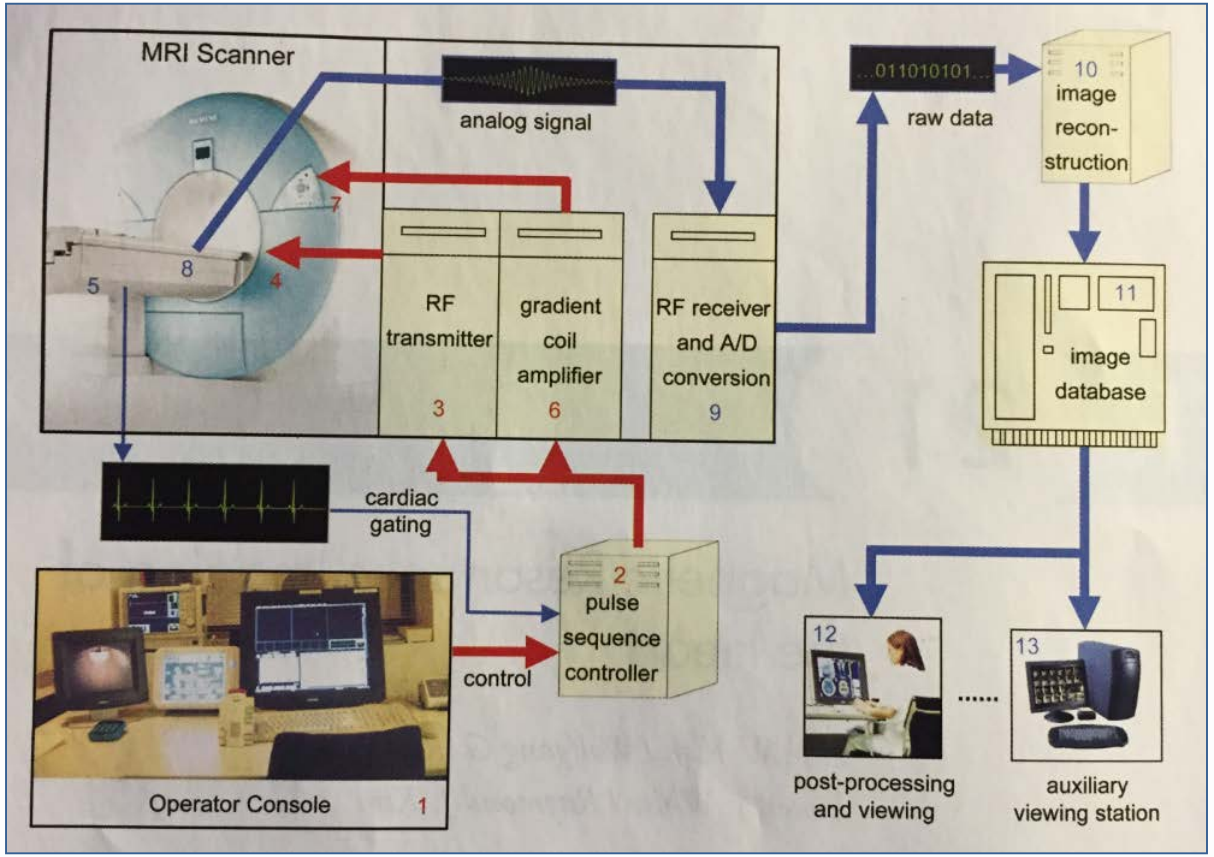
Historically the only way to determine the characteristics of the myocardium was to biopsy it or to examine it post-mortem

Background

Cardiac magnetic resonance (CMR)

a new non-invasive imaging technique

uses magnetic fields and radiofrequency signals with ECG gating to non-invasively image cardiac function and structure



From Hurst's The Heart Chapter 21 Magnetic Resonance Imaging of the Heart. 12th Edition 2008 McGraw Hill

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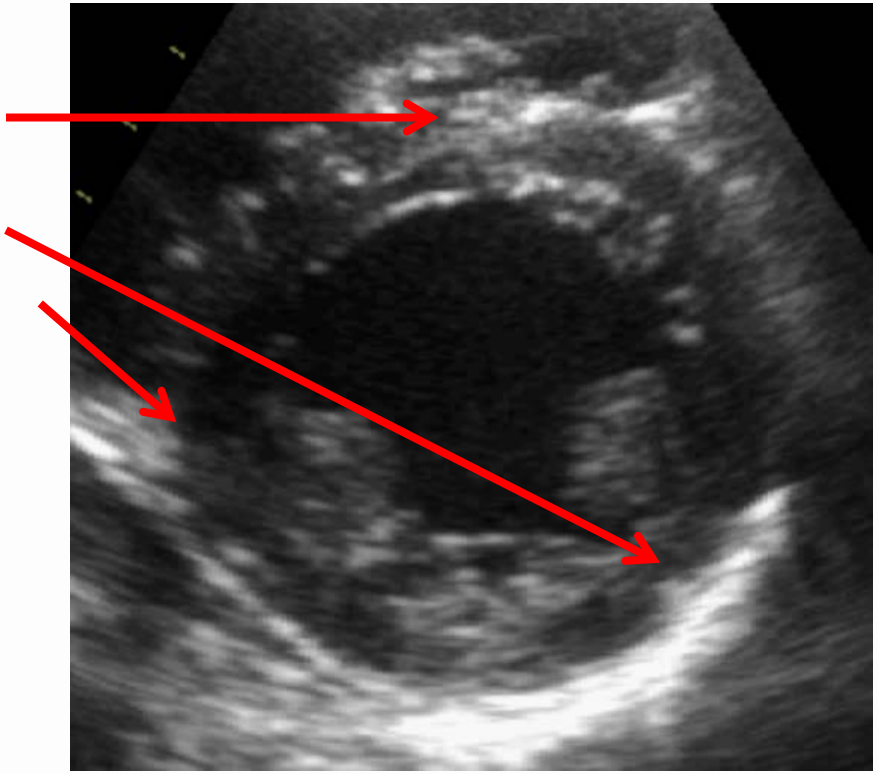
Background

CMR can determine the nature of the myocardial tissue – this is known as **Myocardial Tissue Characterisation**



There are no studies using CMR to characterise the myocardial tissue in women with pre-eclampsia

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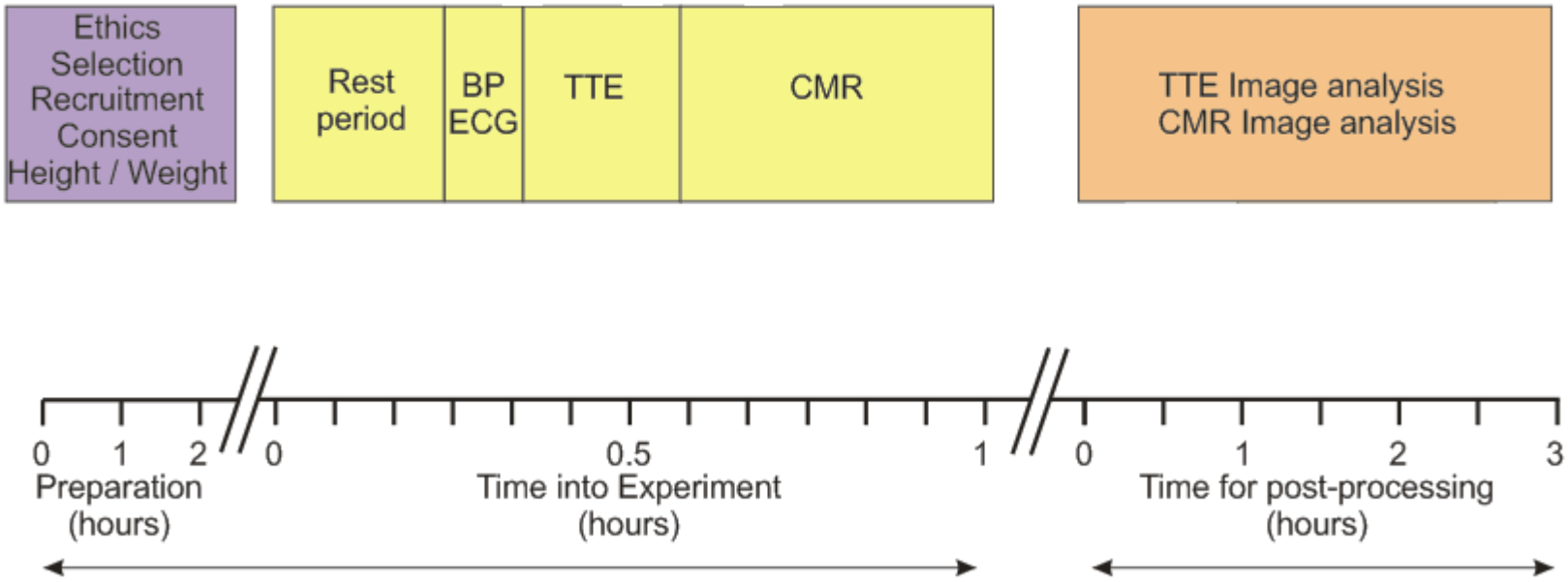
Hypothesis

We hypothesized that the increased myocardial wall thickness observed with echocardiography in women with pre-eclampsia is due to myocardial oedema and not myocardial muscle

Aim

We aimed to determine haemodynamics and myocardial structure (presence of oedema) using CMR in healthy pregnant women and in women with pre-eclampsia

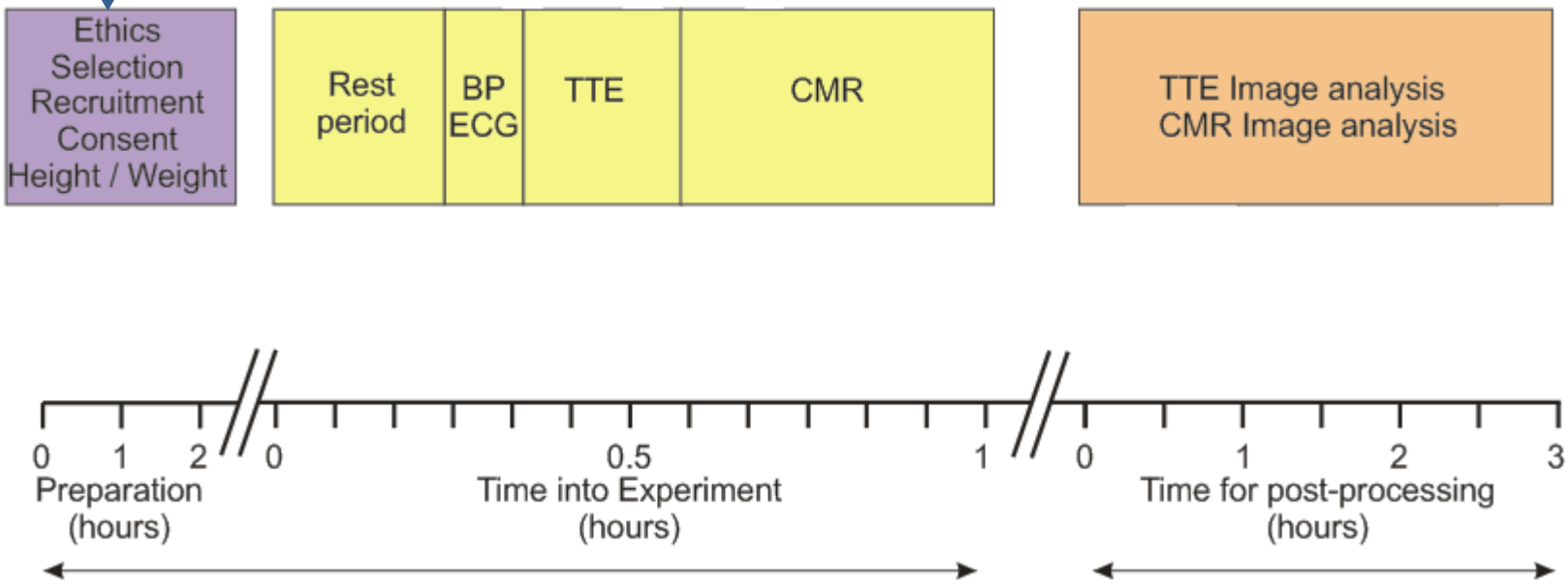
Method



TTE = transthoracic echocardiography

Method

Modified and upgraded our MRI scanner to perform CMR
Upskilled a MRI/CMR radiographer



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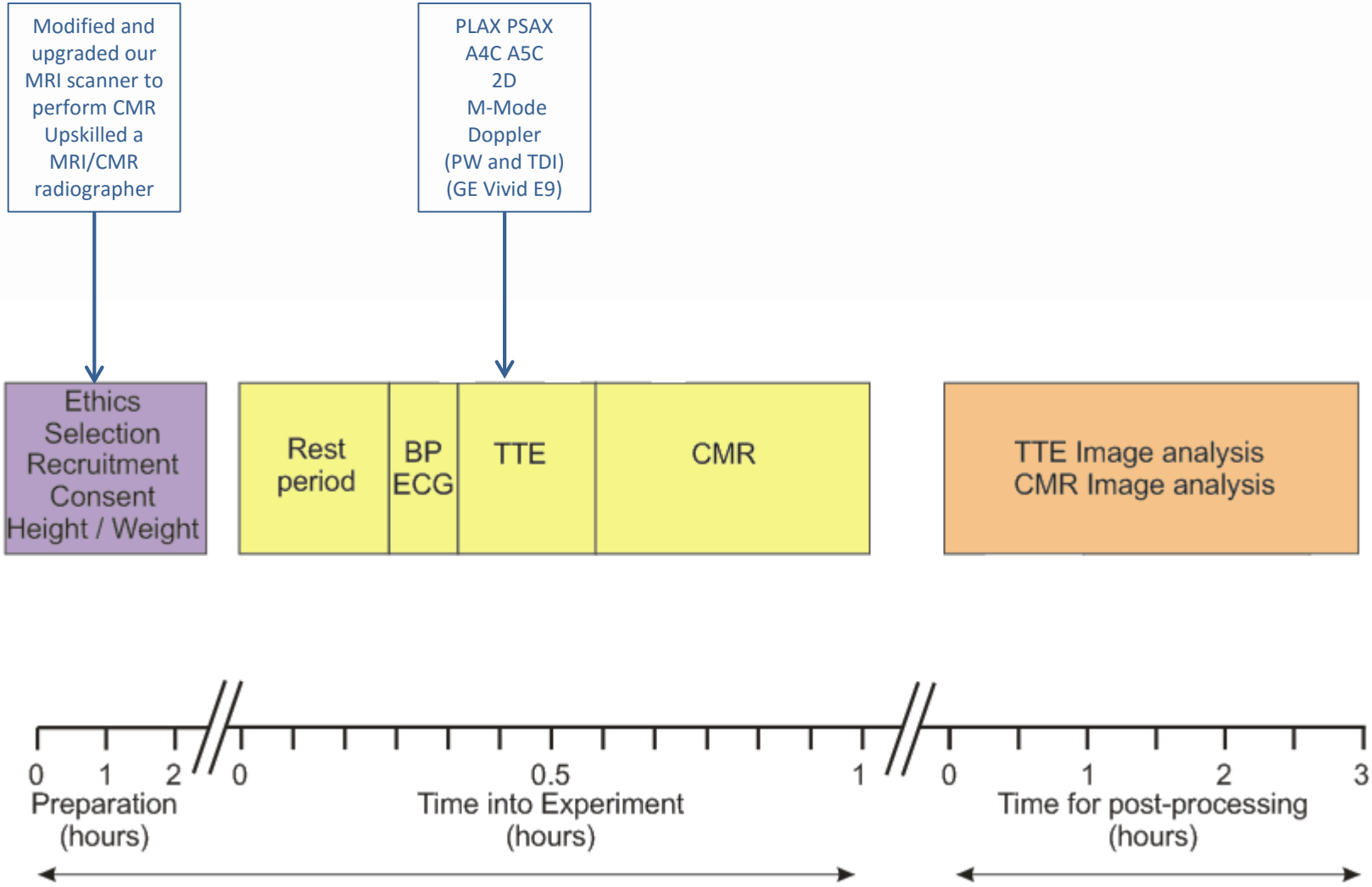
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PLAX PSAX A4C A5C 2D M-Mode Doppler (PW and TDI) (GE Vivid E9)
Ethics Selection Recruitment Consent Height / Weight
Rest period
BP ECG
TTE
CMR
TTE Image analysis CMR Image analysis
0 1 2
Preparation (hours)
0 0.5 1
Time into Experiment (hours)
0 1 2 3
Time for post-processing (hours)

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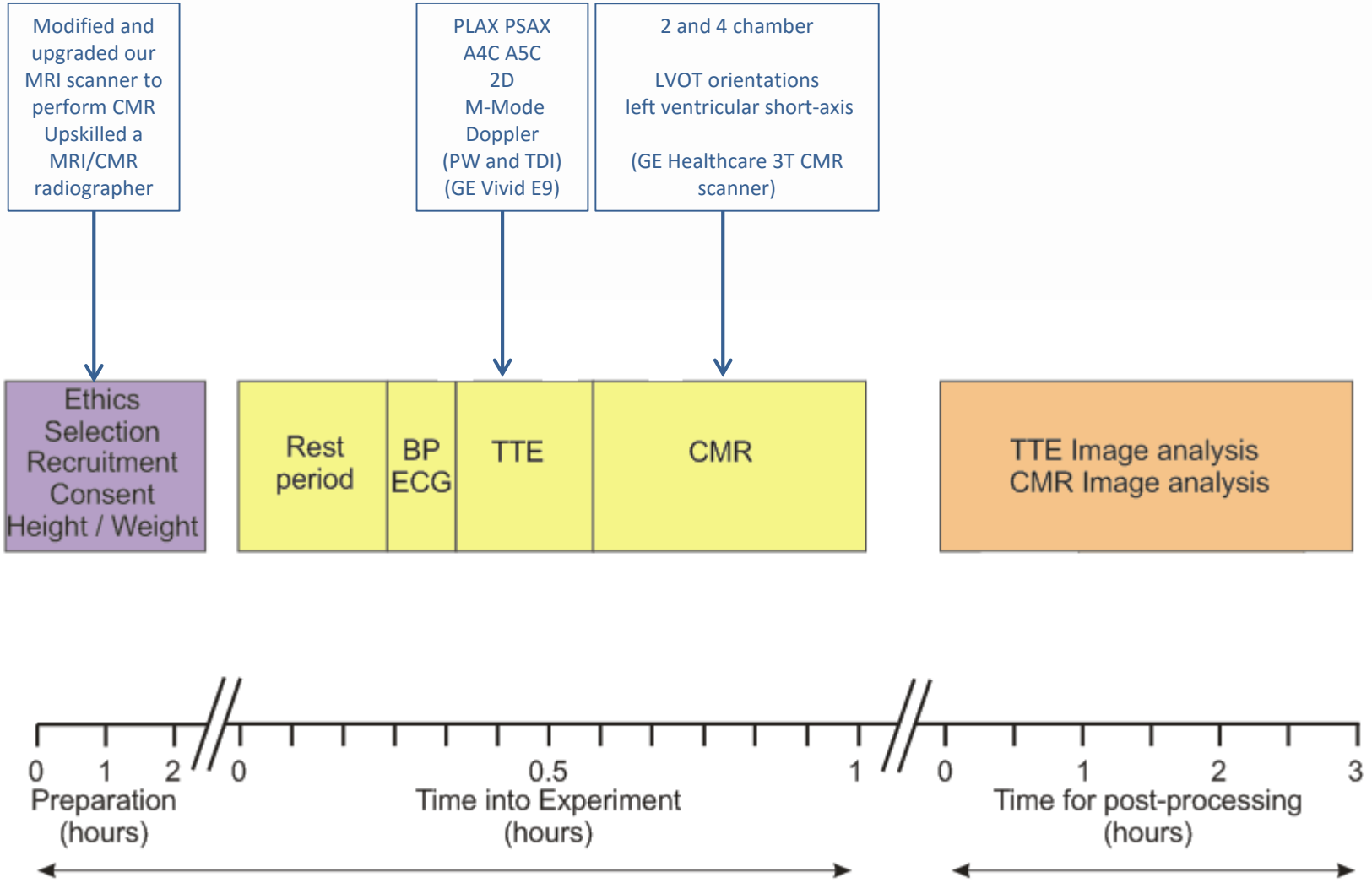
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2 and 4 chamber
LVOT orientations left ventricular short-axis
(GE Healthcare 3T CMR scanner)
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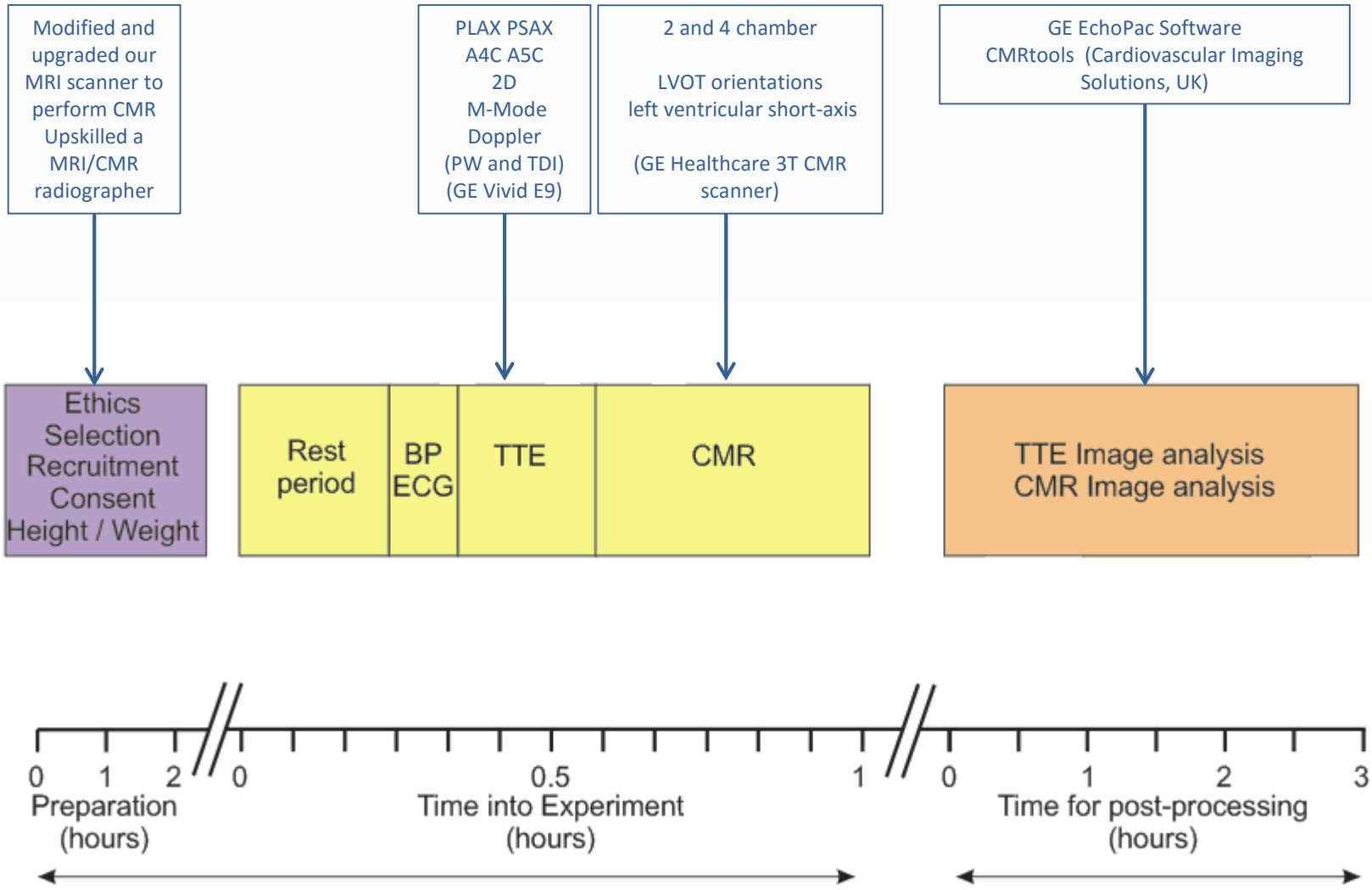
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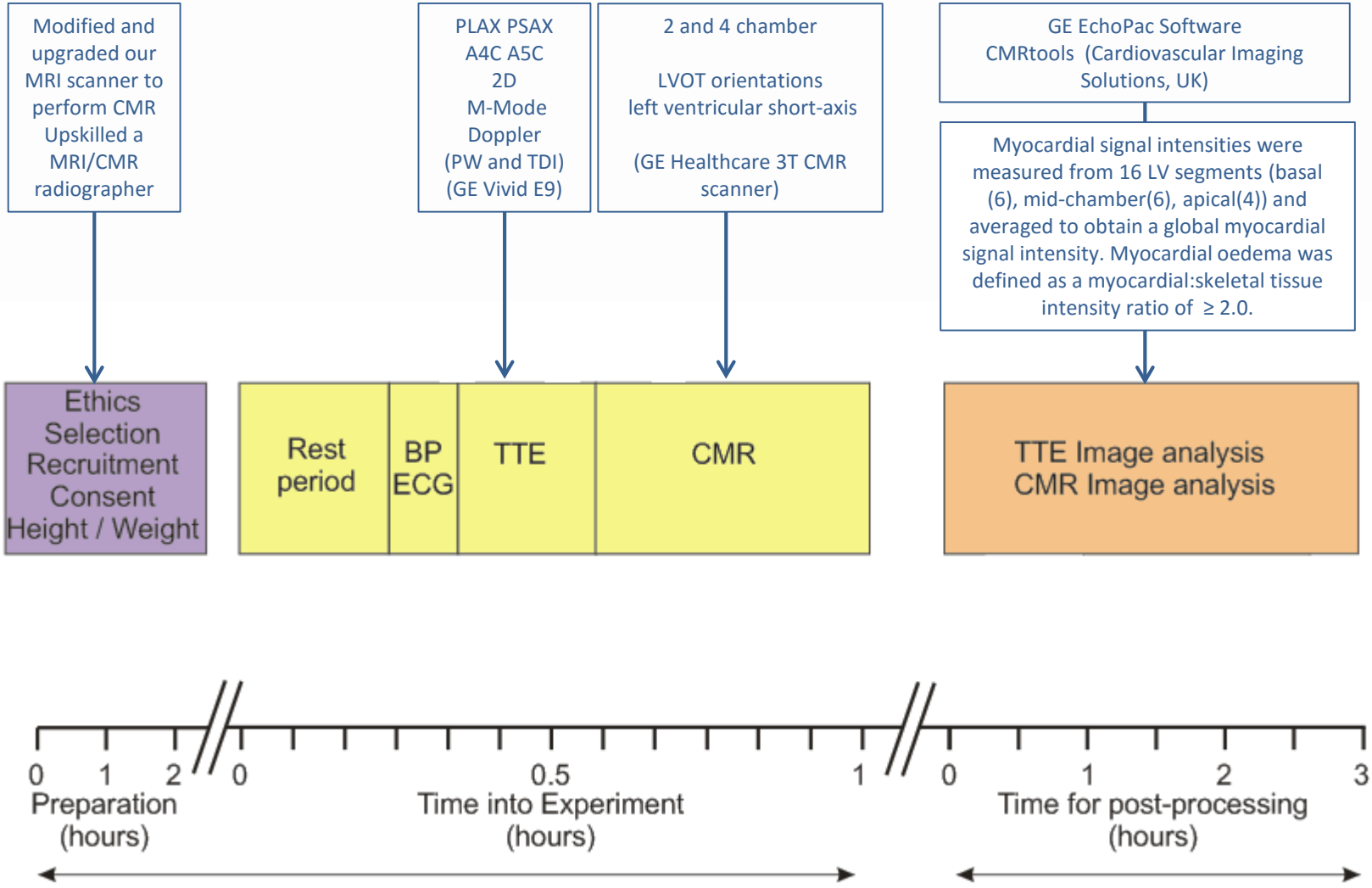
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GE EchoPac Software CMRtools (Cardiovascular Imaging Solutions, UK)
Myocardial signal intensities were measured from 16 LV segments (basal (6), mid-chamber(6), apical(4)) and averaged to obtain a global myocardial signal intensity. Myocardial oedema was defined as a myocardial:skeletal tissue intensity ratio of ≥ 2.0.
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Preparation (hours)
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Results - Demographics

36 women underwent TTE and CMR

(31 healthy pregnant women and 5 women with pre-eclampsia)

Characteristic	Healthy women	Women with pre-eclampsia
Age (years)	33 ± 4.5	34 ± 3.4
Gestation (weeks)	36 ± 3.9	33 ± 5.0
Body mass index ($kg.m^{-1}$)	30 ± 5.0	27 ± 2.1

Results – Haemodynamics and myocardial tissue characteristics

Variable	Healthy pregnant	Women with pre-eclampsia
Systolic Blood Pressure (mmHg)	117 ± 11.1	142 ± 14.7*
Diastolic Blood Pressure (mmHg)	69 ± 9.3	88 ± 9.2*
LV end-diastolic volume (mL)	130 ± 22.1	134 ± 31.5
LV end-diastolic volume index ($mL.m^{-2}$)	65 ± 15.9	74 ± 11.5
LV ejection fraction (%)	64 ± 5.2	65 ± 6.0
LV mass (g)	127 ± 20.1	151 ± 43.8
LV mass index ($g.m^{-2}$)	65.4 ± 9.4	83 ± 20.3
RV end-diastolic volume (mL)	131 ± 30.5	116 ± 35.5
RV end-diastolic volume index ($mL.m^{-2}$)	67 ± 13.3	52 ± 32.4
RV ejection fraction (%)	55 ± 5.1	60 ± 7.6
Cardiac output ($ml.m^{-1}$)	6.6 ± 1.3	6.0 ± 1.2
Cardiac index ($ml.m^{-1}.m^{-2}$)	3.4 ± 0.58	3.3 ± 0.56
Heart rate (BPM)	75 ± 11.0	73 ± 9.4
Myocardial:skeletal intensity	1.1 ± 0.15	1.6 ± 0.47*
Mitral valve E/se' (TTE)	7.7 ± 2.6	11.5 ± 1.1*

*$p<0.05$

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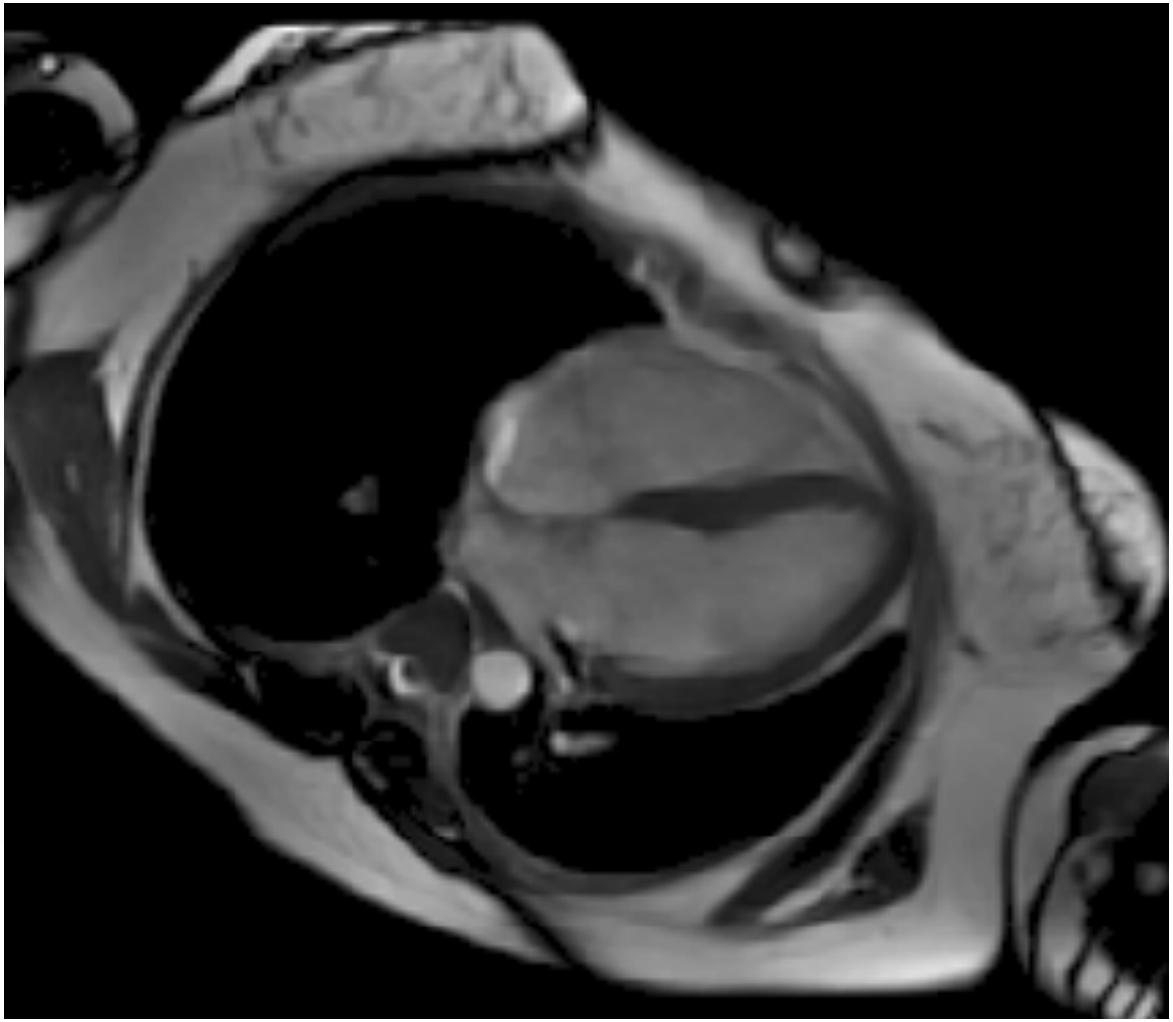
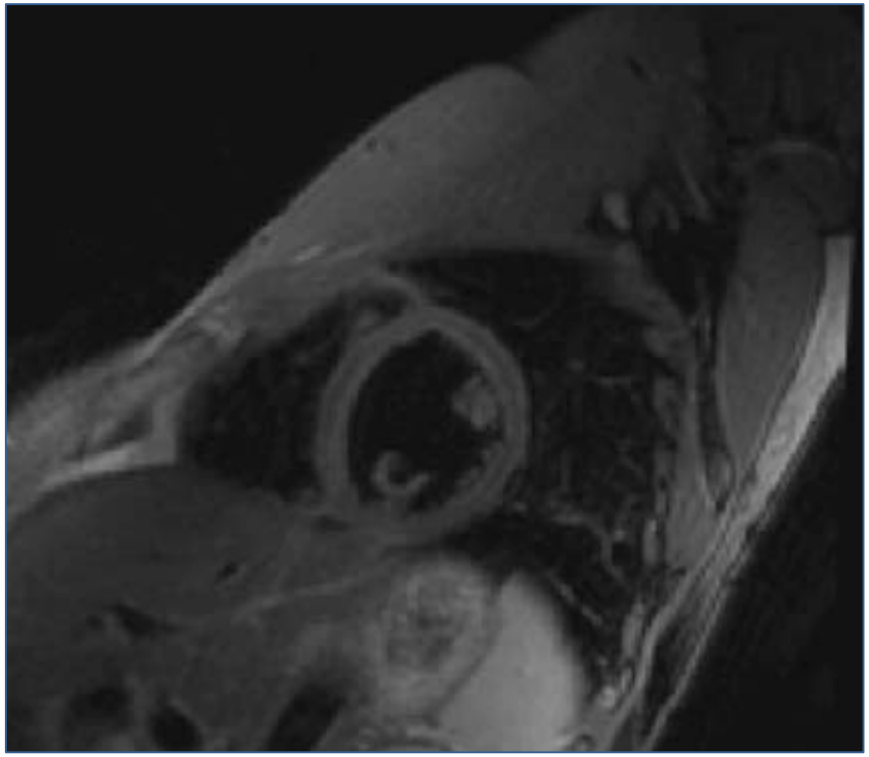
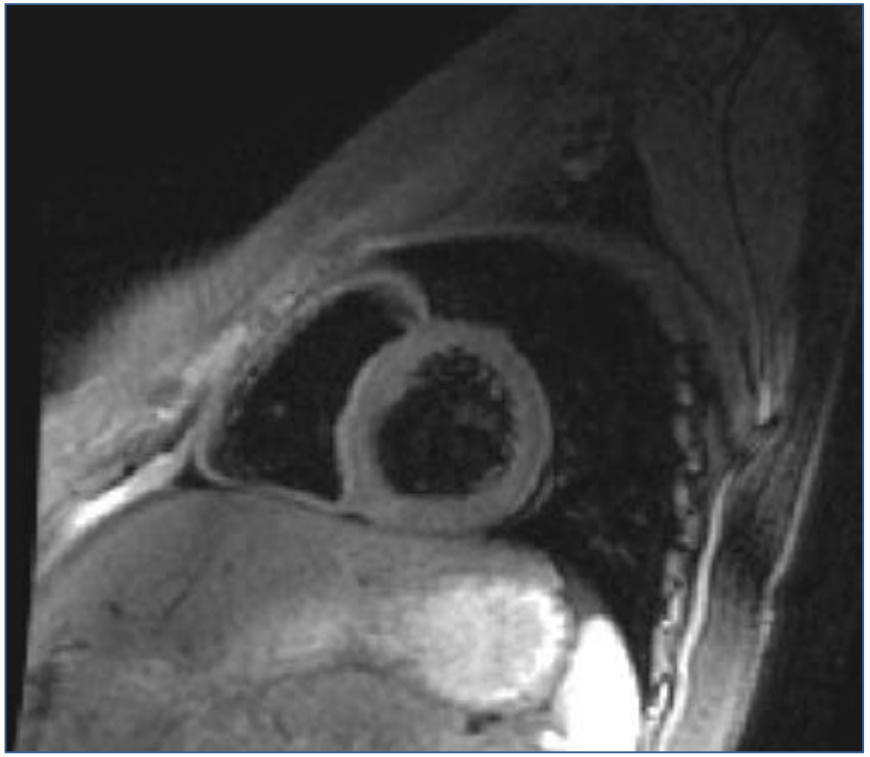
CMR 4 chamber view
Woman with pre-eclampsia



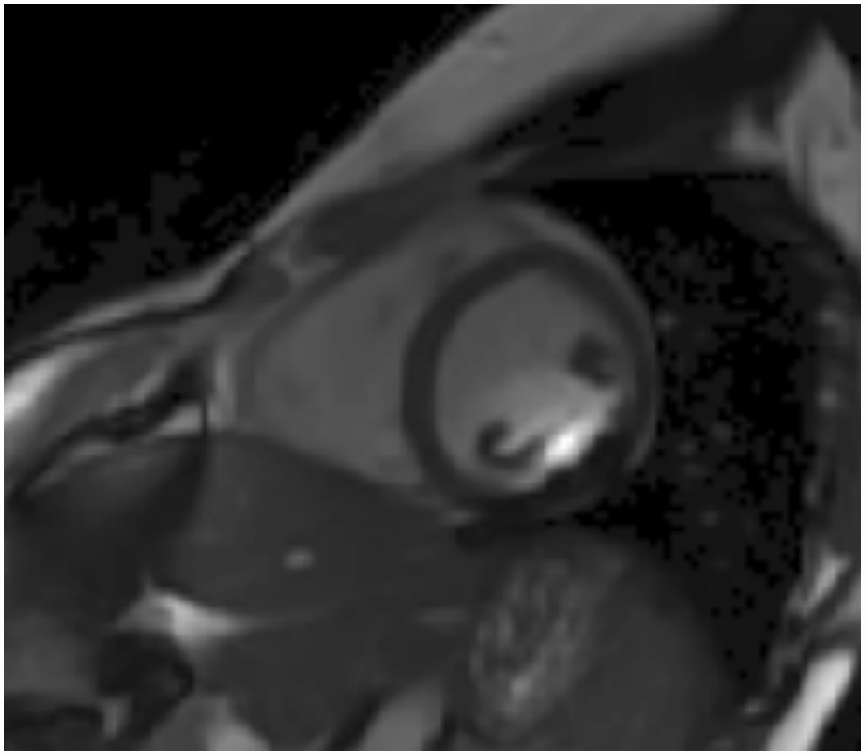
Normal myocardium
Healthy pregnant woman



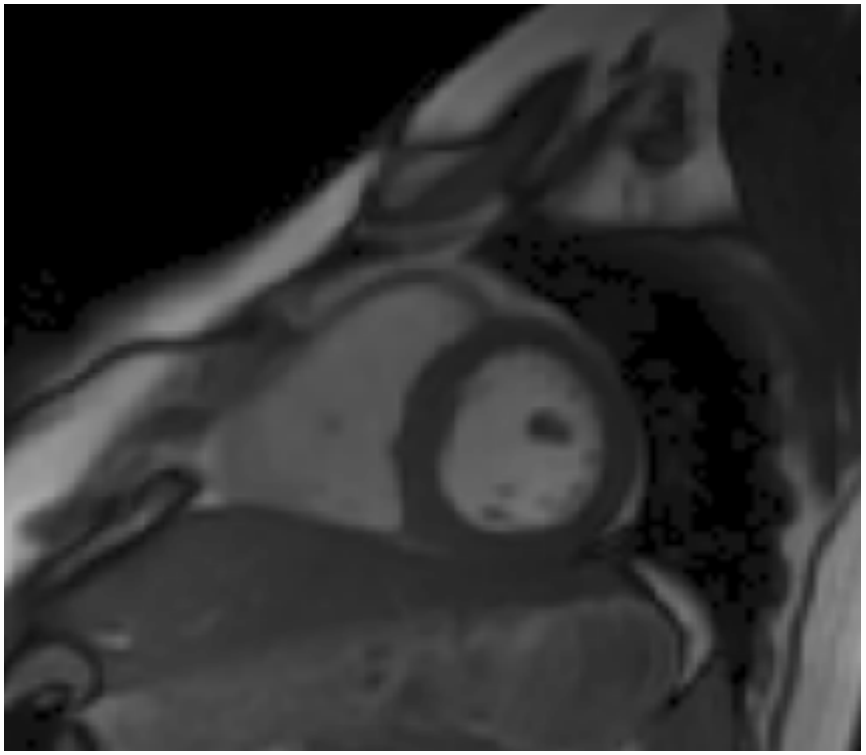
Myocardial oedema
Woman with pre-eclampsia



Healthy pregnant woman
LVEF 55%



Woman with pre-eclampsia
LVEF 75%



Conclusions

We have established a CMR research program and undertaken the first study of CMR in women with pre-eclampsia

Small numbers

CMR can quantify haemodynamics and characterise myocardial tissue in healthy pregnant women and in women with pre-eclampsia

Conclusions

Our data suggests that women with pre-eclampsia have a different myocardial wall composition and this may be due to oedema not muscle

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This may explain the diastolic changes in women with pre-eclampsia

Conclusions

Our next steps:

Larger study including postpartum scanning

Fibrosis studies

Acknowledgments

Co-investigators – Dr Sylvia Chen – CMR cardiologist, Ms Liz Leeton, clinical research midwife

ANZCA Mundipharma Research Award

Royal Women's Hospital Department of Anaesthesia

Royal Women's Hospital Department of Radiology

Thank you