



MR Imaging Manual Meso-ORIGINS



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1 Overview

The aim of this manual is to provide instruction for the technical procedures for MRI acquisition pertaining to the MRI sub-study of MESO-ORIGINS Arm A. This guidance should be followed for all study patients.

2 Contact Information

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When contacting, please include the following information:

- Study name (Meso-ORIGINS)
- Your name, email address and telephone number
- Your centre details
- Participant study number (if applicable)

3 Pre-MRI assessment and safety procedures

- Check renal function and ensure eGFR >60ml/min
- Medical review before sign-off for contrast if eGFR 30-59 ml/min
- Complete MRI safety questionnaire (see Appendix 1)
- Review plain orbital radiograph if any history of previous orbital injury involving metal fragments where evidence of removal cannot be clarified
- Full resuscitation equipment, including a defibrillator and emergency drugs should be available

4 Patient registration

Only patients registered to Arm A of MESO-ORIGINS study are eligible for the MRI sub-study. No sub-study procedures should be performed until:

- the patient has provided written informed consent to participate in the MRI sub-study
- the participant has been registered with the CRUK Glasgow CTU

Instructions for MRI sub-study patient registration are provided in Section 6.4 of the MESO-ORIGINS protocol.

5 Scanner

The pulse sequences in this MRI protocol were designed for 3T scanners.

6 MRI Acquisition Procedures

6.1 General principles

The following sequence parameters should be used consistently for each subject's scan. Several aspects of the MRI acquisition procedures are particularly important:

- Complete coverage of the thorax
- Minimal subject motion
- Consistent imaging parameters over time
- Isotropic image acquisition

6.2 Anonymising subjects on the imaging console

The guidance describes the process of anonymising patient MRI scans before transfer to the lead centre.

6.2.1 Procedure

- Two site staff with NHS IT access will be involved in the process to transfer the data from MRI Console or Workstation to the University of Glasgow Transfer System (see Section 8.4)
- Using the MRI Console or workstation, the relevant identifiable subject will be selected in the browser and anonymised
- Team of two to confirm the anonymisation is correct and the relevant MESO-ORIGINS Patient Identifier Number has been added (e.g. 001, 002, 003)
- The transfer can then be completed
- If more than one subject is being transferred, each dataset must be anonymised as above and sent as a separate file
- Scan data can then be dispatched to the Glasgow University server
- Confirmation of successful transfer should be sought

6.3 Acquisition protocol overview

The MRI protocol consists of scout views followed by a series of thoracic acquisitions designed to image the pleura. The T1 3D Fat-Sat VIBEs (see (5)) are repeated at several time points following IV contrast administration (see sections 6.5.5 and 6.5.6). A summary of the acquisitions as deployed on Siemens scanner are provided here, with more detail on each sequence in the following pages. An equivalent summary for GE and Philips scanners is provided below, although the reader should note the Siemens nomenclature has been used for simplicity in the more detailed later sections.

6.3.1 Siemens

- 1) Fast localizer scan
- 2) T2-weighted HASTE axial scan 5mm
- 3) T2-weighted HASTE coronal scan 5mm
- 4) Diffusion weighted imaging (DWI axial 5mm) b0; b400; b800 – respiratory gated (6-7min) and ADC map
- 5) T1 3D Fat-Sat VIBE (coronal 2mm T1-weighted, fat saturated, 3D spoiled gradient echo sequences, acquired during a short breath-hold at end-inspiration.
 - 5.1 Baseline (pre-contrast) Coronal – inspiratory phase
 - 5.2 Injection of Gadolinium contrast (0.1 mmol/kg Gadovist or equivalent)
 - 5.2 Six time-specific post-contrast acquisitions Coronal – inspiratory phase at: 40 s, 80 s, 4.5 min, 9 min and 13.5 min

6.3.2 General Electric

- 1) Fast localizer scan
- 2) T2-weighted Single-shot fast spin echo, SS-FSE axial scan 5mm
- 3) T2-weighted Single-shot fast spin echo, SS-FSE coronal scan 5mm
- 4) Diffusion weighted imaging (DWI axial 5mm) b0; b400; b800 – respiratory gated (6-7min) and ADC map
- 5) T1 3D Fat-Sat lava (coronal T1-weighted 2mm, fat saturated, 3D spoiled gradient echo sequences, acquired during a short breath-hold at end-inspiration.
 - 5.1 Baseline (pre-contrast) Coronal – inspiratory phase
 - 5.2 Injection of Gadolinium contrast (0.1 mmol/kg Gadovist or equivalent)
 - 5.3 Six time-specific post-contrast acquisitions Coronal – inspiratory phase at: 40 s, 80 s, 4.5 min, 9 min and 13.5 min

6.3.3 Philips

- 1) Fast localizer scan
- 2) T2-weighted Single-shot turbo spin echo, SSH-TSE axial scan 5mm
- 3) T2-weighted Single-shot turbo spin echo, SSH-TSE coronal scan 5mm
- 4) Diffusion weighted imaging (DWI axial 5mm) b0; b400; b800 – respiratory gated (6-7min) and ADC map
- 5) T1 3D Fat-Sat THRIVE (coronal T1-weighted 2mm, fat saturated, 3D spoiled gradient echo sequences, acquired during a short breath-hold at end-inspiration.
 - 5.1 Baseline (pre-contrast) Coronal – inspiratory phase
 - 5.2 Injection of Gadolinium contrast (0.1 mmol/kg Gadovist or equivalent)
 - 5.3 Six time-specific post-contrast acquisitions Coronal – inspiratory phase at: 40 s, 80 s, 4.5 min, 9 min and 13.5 min

6.4 Patient preparation and positioning

- Patients should be asked to remove any metal clothing or accessories, such as watches or belts, and should be provided with a patient gown to change in to
- Insert a 20 or 22-gauge cannula for intravenous contrast administration
- Position patient head or feet first and supine on the MR examination table
- Place a phased array coil across the patient’s chest. Secure with straps
- Supply the patient with an emergency buzzer and headphones, allowing them to hear instructions during the scan
- Test communication via headphones and that the emergency buzzer is functioning
- Practice breathing instructions with patient, check adequate understanding and ability to repeat

6.5 MRI sequence specifications

6.5.1 Fast Localizer scan

- 3 plane scout scans, used for planning the subsequent sequences

Slice Group 1	
Slices	5
Dist. factor	150%
Position	L 0.0 P 30.0 H 0.0 mm
Orientation	Transverse
Phase encoding direction	A >> P
Slice Group 2	
Slices	3
Dist. factor	300%
Position	L 0.0 P 30.0 H 0.0 mm
Orientation	Coronal
Phase encoding direction	R >> L
Slice Group 3	
Slices	1
Dist. factor	50%
Position	Isocenter
Orientation	Sagittal
Phase encoding direction	A >> P

- FOV 430mm
- FOV Phase 100%
- Slice thickness 6.0mm
- TR (3T) 1000ms
- TE (3T) 84ms
- Flip angle 160 degrees
- Fat/Water suppression – none
- Bandwidth 476 Hz/Px
- Turbo factor 179

6.5.2 T2-weighted HASTE scan (axial)

Slice Group 4	
Slices	55
Dist. factor	20%
Position	Isocenter
Orientation	Transverse
Phase encoding direction	A >> P

6.5.3 T2-weighted HASTE scan (coronal)

Slice Group 5	
Slices	34
Dist. factor	20%
Position	Isocenter
Orientation	Coronal
Phase encoding direction	R >> L

Additional sequence parameters for both the transverse and coronal HASTE scans are summarised in the table below (based on a Siemens 3T scanner).

FoV read	380mm
FoV phase	100.0%
Slice thickness	5mm (no gap)
TR	1400.0ms
TE	95ms
Flip angle	160 degrees
Base resolution	256
Phase resolution	70%
Phase partial Fourier	6/8
Echo spacing	3.8ms
Bandwidth	781 Hz/Px
Turbo factor	179
Fat suppression	None
Water suppression	None

6.5.4 Diffusion Weighted Imaging

- This is a navigated (breathing-triggered) scan. Sequences will therefore be acquired during normal patient respiration with no specific breathing instructions required.
- The navigator trigger should be positioned over the dome of the hemidiaphragm
- Sequence parameters are summarised below (based on a Siemens 3T scanner)

Slice Groups 6, 7 and 8 (separate groups for each B-Value)	
Slices	38
Dist. factor	10%
Position	Isocenter
Orientation	Transverse
Phase encoding direction	A >> P
FoV read	380 mm
FoV phase	80.6%
Slice thickness	5 mm
TR	4000 ms
TE	41.0 ms
Base resolution	134

Phase resolution	100%
Phase partial Fourier	Off
Echo spacing	0.49 ms
Bandwidth	2488 Hz/Px
EPI factor	108
Fat suppression	SPAIR
Physio – PACE – Resp control	Trigger
Scout type	Liver dome scout
Diffusion mode	4-scan Trace
Diffusion scheme	Monopolar
b-value 1	0 s/mm ²
b-value 2	400 s/mm ²
b-value 3	800 s/mm ²
Distortion correction	On

6.5.5 T1-weighted VIBE scan (coronal)

- These sequences will be acquired immediately before IV gadolinium contrast administration and at specific time-points post contrast administration
- For contrast injection and dosing, see section 6.5.6
- Post-contrast sequences should be acquired at 40 seconds, 80 seconds, 3 minutes, 4.5 minutes, 9 minutes and 13.5 minutes after intravenous contrast administration
- If preferred the 40s and 80s scans can be run as a dual measurement single acquisition with the appropriate pause in between to make the gap 40s e.g. 40s after injection a 16s breath hold with a 24s pause and the 80s scan
- All sequences should be acquired under breath-hold at the end of inspiration
- Sequence parameters are summarised below (based on a Siemens 3T scanner)

Slice Groups 9 (pre-contrast), 10 (40"), 11 (80"), 12 (3'), 13(4.5'), 14 (9') and 15 (13.5')	
Position	Isocenter
Orientation	Coronal
Phase encoding direction	R >> L
FoV read	400mm
FoV phase	100.0%
Slice over-sampling	6.7%
Phase over-sampling	20%
Slices per slab/slabs	120/1
Slice thickness	1.8mm
Voxel size	1.8 x 1.8 x 1.8 mm
Inter-slice gap	None
TR	2.83ms
TE	1.03ms
Flip angle	9.0 degrees
Base resolution	224
Phase resolution	100%
Phase partial Fourier	6/8
Slice partial Fourier	6/8
Bandwidth	620 Hz/Px
Fat suppression	Q-fat sat.
Water suppression	None

6.5.6 Contrast dosing and injection

- Use intravenous gadobutrol contrast (e.g. Gadovist, Bayer Healthcare Pharmaceuticals, Berlin, Germany)
- Use a standard dose of 0.1mmol/kg
- Administer via the peripheral venous cannula at an injection rate of 2 ml/second

6.5.7 Tips and troubleshooting

- Complete scan time is typically around 40-50 minutes
- The breath-hold time typically varies between 16 – 20 seconds, depending on the size of the patient's thorax and breath hold ability
- If patient reports difficulty with the breath-hold or initial MR images have evidence of significant breathing artefact, then slice thickness should be increased to reduce the breath-hold time. The field of view should be adjusted if required to ensure all image acquisitions remain isotropic despite any required adjustments in slice thickness
- If your scanner allows, enable Distortion Correction (2D)

7 Data export and secure transfer

7.1 Electronic transfer system

Linked anonymised data in the agreed format will be transferred using the University of Glasgow Transfer Service (<https://transfer.gla.ac.uk/>). This is a secure system with all files transferred in an encrypted format and access strictly controlled and logged.

It is requested that images are sent individually as soon as possible after collection.

Please email the PREDICT-Meso Project Manager Alexandrea.MacPherson@glasgow.ac.uk who will arrange a drop off request for files transfer.

7.2 Data upload format

Imaging data should be transferred as DICOM files.

Files should be labelled as follows:

MO Patient study ID number. Visit (eg A1). MRI

Example: MO-001.A1.MRI or MO-123.B2.MRI

All DICOM images for a single participant should be packaged into a folder labelled with the appropriate Participant Study ID (e.g MO-001, MO-002). Given the large size of this folder, for transfer purposes each folder should be compressed and sent as a zipped file (e.g. using *WinZip* or *7-Zip*).

7.2.1 Virus checking

Please note that the uploaded files are scanned for viruses but the recipient should still exercise as much caution in downloading and opening them as is appropriate.

7.2.2 Confidential information

Whilst the transfer service has features that make it more secure than email, any information that is confidential should be encrypted.

The request will be set up so that data files uploaded to the service will be in a password-protected encrypted archive format. The password will be set by the requestor and sites do not have to action this.

7.3 Glasgow transfer service user instructions

You will receive an email from [UofG Transfer] that contains details of the request and a link to the transfer platform for file drop off. Example below:

[UofG Transfer] Meso-ORIGINS Image files transfer request

University of Glasgow File Transfer <filetransfer@gla.ac.uk>
Mon 06/09/2021 16:40
To: You

This is a request from Alexandra MacPherson of University of Glasgow.
Please click on the link below and drop off the file or files I have requested. The link is only valid for 7 days from the time of this email. More information is in the note below.
<https://transfer.gla.ac.uk/req?req=144974529>

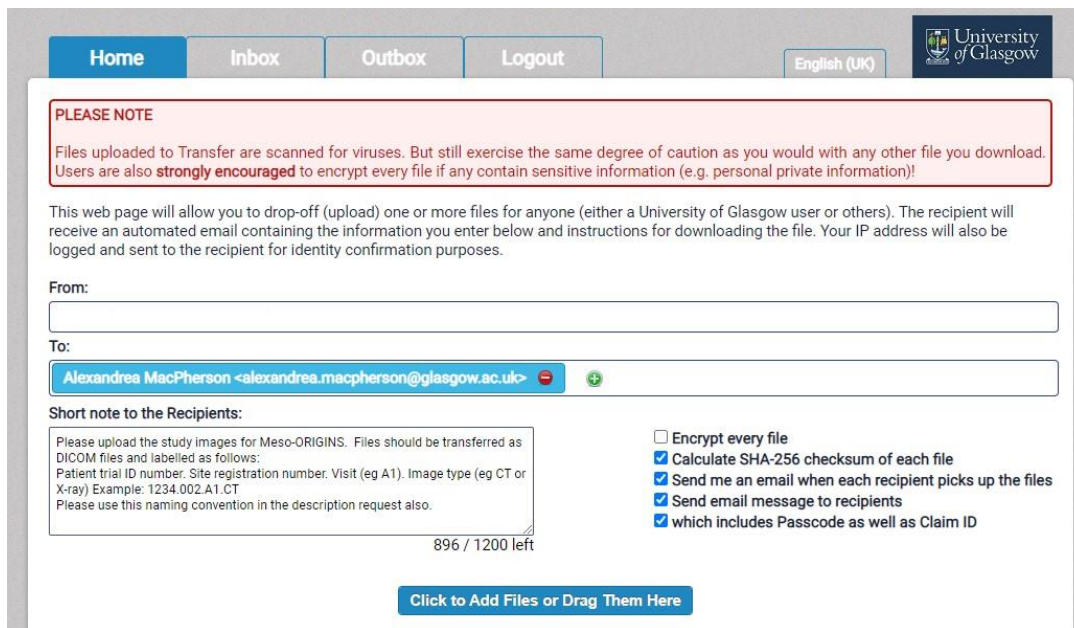
If you wish to contact Alexandra MacPherson, just reply to this email.
* Note *

Please upload the study images for Meso-ORIGINS. Files should be transferred as DICOM files and labelled as follows:
Patient trial ID number. Site registration number. Visit (eg A1). Image type (eg CT or X-ray) Example: 1234.002.A1.CT
Please use this naming convention in the description request also.

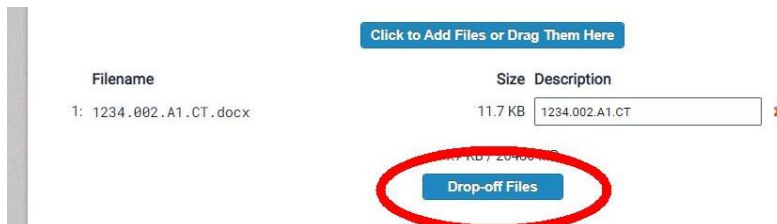
--
Alexandra MacPherson
alexandrea.macpherson@glasgow.ac.uk
University of Glasgow

Requests are valid for 7 days, please complete in this window.

Upon clicking the link, you will be taken to the following page:



1. Click the blue button to add your files, or drag them over the button.
2. A file description is requested- please use the file name using the naming convention above.
3. Once complete a new blue 'drop off files' button will appear. Press this to drop-off files.



If the files are successfully uploaded, an email is sent to the recipient explaining that a drop-off has been made with a link to access the drop-off.

Other information (the internet address and/or hostname from which the drop-off was created, for example) is retained, so that the recipient can verify the identity of the sender.

Once the recipient has collected the files, you will be sent an automated email to let you know your drop off has been collected.

8 Appendices

8.1 Appendix 1 – MRI Safety Questionnaire

	<h1>MRI Safety Checklist</h1>	
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Patient Name:	Date of Birth:	Date of Scan:
Address:	Investigator:	Study ID:
CHI/NHS Number:	Weight:	Height:

Have you ever:		
Had a cardiac pacemaker?	YES	NO
Had any surgery to your heart?	YES	NO
• If yes, give details.....	YES	NO
.....		
Had any surgery on your head, brain or eyes?	YES	NO
• If yes, give details.....	YES	NO
.....		
Had any surgery involving the use of metal implants, plates, or clips?	YES	NO
• If yes, give details.....	YES	NO
.....		
Had any surgery involving the use of electronic, mechanical or magnetic implants?	YES	NO
• If yes, give details.....		
.....		
Had any other surgery?	YES	NO
• If yes, give details.....	YES	NO
.....	YES	NO
Had metal fragments in your eyes or any other part of the body?	YES	NO
	YES	NO
	YES	NO
Do you:		
Have any kidney problems, kidney failure or ever had dialysis?		
Have asthma, eczema, hayfever or any known allergies?	YES	NO
Have metal dentures/dental plate, hearing aid or wig?		
Wear a false limb, calliper or brace?		
Have any tattoos, permanent makeup or body piercing?	YES	NO
Wear any type of skin patch?	YES	NO
Ladies:		
Could you be pregnant?		
• LMP date:		
Are you breast feeding?		
Have you been sterilised or have an IUD fitted?		

Before entry into the examination room all metallic objects must be removed: Metal tools, scissors, keys, watches, pagers, credit cards, coins, hair clips, hearing aid etc. **Have all objects been removed?**

I confirm that the answers to the above safety questions are correct and I will accept a contrast agent injection if required.

Signature of patient _____ Date ___/___/___

Signature of Authorised Scanning Staff Member

Refer to supervising doctor that a patient is safe to image if:

- An implant or operation is not included in safety literature

The **supervising doctor** should sign here if they now consider the scan to be completely safe.

MRI Drug and Contrast Administration Record

eGFR _____

Date of eGFR _____ *If eGFR <59ml/min consult Supervising Doctor*

Contrast Details

Contrast Label: Expiry Checked By:

Contrast Type: Total Contrast Injected:

..... Total Saline Injected:

Signature of Person Administering Contrast:

Images Checked for Contrast

Drug reaction/ extravasation details:

Post Processing

PACS	Sent - Checked
CRIS	Yes/No
WHITE FOLDER	Yes/No
BHF	Sent - Checked
CRF	Yes/No
Daily Activity	Yes/No
DVD No	Sent/Checked
Upload.....	(Please note method i.e. SFTP/Web Upload)