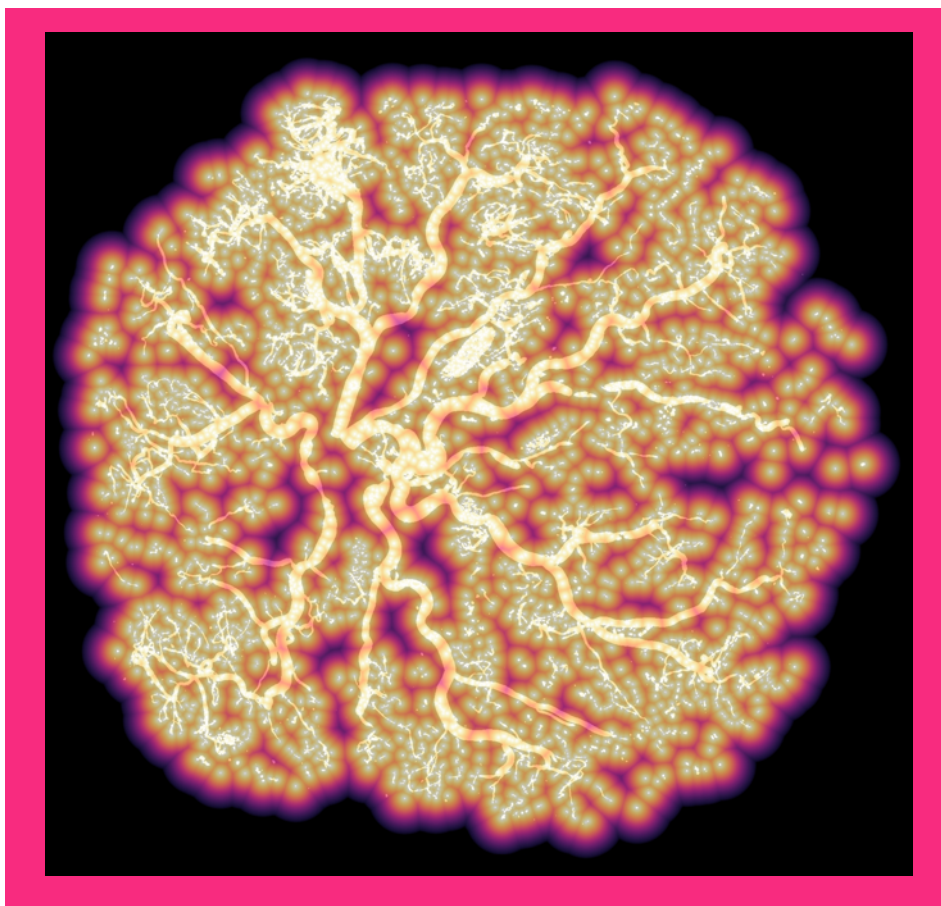




Placenta Imaging Workshop

Centre for Medical Image Computing
University College London

12-13th April 2018





Programme

Thursday 12th April - Room G08 Roberts Building

- 10.30-11.00: Registration and poster set up (Roberts Building Foyer)
- 11.00: Opening remarks
- 11.00-11.40: **Why image the placenta with MR?**
Anna David, University College London
- 11.40-12.20: **Multiscale three-dimensional imaging of the human placenta**
Rohan Lewis, University of Southampton
- 12.20-13.00: Lunch and posters
- 13.00-13.40: **Etiopathology of ultrasound signs in the diagnosis of placenta accreta**
Eric Jauniaux, University College London
- 13.40-14.20: **Optically Generated and Received Ultrasound for Fetal Medicine**
Adrien Desjardins, University College London
- 14.20-14.40: **Functional MRI of the placenta**
Laurent Salomon, Paris Descartes University
- 14.40-15.00: **MRI with Gadolinium for the Diagnosis of Abnormally Invasive Placenta**
Anne-Elodie Millischer, Paris Descartes University
- 15.00-15.20: Coffee and posters
- 15.20-16.00: **Assessment of the utero-placental vascularization by ultrasound approaches**
Vassilis Tsatsaris, Paris Descartes University
- 16.00-16.20: **Image-based modelling of Oxygen Transport**
Romina Plitman Mayo, University of Cambridge
- 16.20-16.40: **Ex vivo dual placental perfusion**
Gareth Nye, University of Manchester
- 16.40-17.00: **Movement of blood within the placenta**
Simon Shah, University of Nottingham
- 17.00-19.00: Poster session and evening reception

Friday 13th April - Room G08 Roberts Building

- 9.30-10.10: **MicroCT for imaging the human placenta**
Rosalind Aughwane, University College London
- 10.10-10.50: **The Placenta Imaging Project and Clinical Indications for Investigating the Placenta**
Mary Rutherford, King's College London
- 10.50-11.10: Coffee and posters
- 11.10-11.50: **Paying attention to the placenta to improve antenatal care**
Ed Johnstone, University of Manchester
- 11.50-12.50: **Panel Discussion – Future Direction of Placenta Imaging Research**
- 12.50-13.00: Closing remarks and prizes



Invited Talks

Why image the placenta with MR?

Anna David, University College London

The human placenta remains an enigma for biologists and clinicians. It's complexity as a dual circulatory system with an integral barrier between the mother and fetus(es) make it the most difficult organ to access in vivo. Great strides have been made in understanding the brain using magnetic resonance imaging. Now this technique is being applied to increase our understanding of placental structure and function. From a purely curiosity perspective the placenta is a fascinating organ that functions as a respiratory, renal, hepatic, endocrine, and vascular system for the developing fetus. The origin of the great obstetric syndromes of preterm birth, fetal growth restriction and pre-eclampsia probably comes down to abnormal placental development and function. These conditions probably affect up to a third of all pregnancies and are a leading cause of neonatal and maternal morbidity and death globally. MR Imaging of the placenta may shed light on the pathology of these complications as well as allow the response to novel treatments to be evaluated.

Multiscale three-dimensional imaging of the human placenta

Rohan Lewis, University of Southampton

Multiscale 3D imaging of the placenta is allowing us to identify novel structures at the tissue, cellular and subcellular level which could not be identified using traditional 2D imaging techniques. Furthermore, the 3D approach allows us to demonstrate the spatial relationships between different features which are allowing us to relate structure to function. The ability to visualise features and cellular spatial interrelationships that could not previously be visualised is leading to a new biological understanding of the placenta and may lead to novel biomarkers and therapeutic approaches.

Etiopathology of ultrasound signs in the diagnosis of placenta accreta

Eric Jauniaux, University College London

Current findings continue to support the concept of a biologically defective decidua rather than a primarily abnormally invasive trophoblast. Prior caesarean sections increase the risk of placenta praevia and both adherent and invasive placenta accreta, suggesting that the endometrial/decidual defect following the iatrogenic creation of a uterine myometrium scar has an adverse effect on early implantation. Preferential attachment of the blastocyst to scar tissue facilitates abnormally deep invasion of trophoblastic cells and interactions with the radial and arcuate arteries. Subsequent high velocity maternal arterial inflow into the placenta creates large lacunae, destroying the normal cotyledonary arrangement of the villi.

Photoacoustic and Ultrasound Imaging of the Placenta

Adrien Desjardins, University College London

Ultrasound imaging can be valuable to visualise the placenta for diagnostic and

therapeutic procedures. Current-generation ultrasound probes that are based on electronic components have several prominent limitations, however. For instance, they are unable to detect tissue colour directly, and it can be challenging to miniaturise them to the sub-millimetre scale for integration into minimally invasive devices. Optical methods for transmitting and receiving ultrasound are emerging as alternatives to their electrical counterparts. They offer several distinguishing advantages, including the potential to generate and detect broadband ultrasound required for high resolution imaging. This talk will focus on recent work on photoacoustic imaging of the placenta, where ultrasound is generated in tissue using pulsed light, and fibre-optic generation of reception of ultrasound from within medical devices for interventional imaging and medical device tracking. Finally, I will highlight recent work on placental phantoms with tuneable optical, ultrasonic, and mechanical properties.

Functional MRI of the placenta

Laurent Salomon, Paris Descartes University

Abnormal placentation is responsible for most failures in pregnancy. Functional MRI (fMRI) of the placenta has not yet been largely validated in a clinical setting, and most data are derived from animal studies. fMRI could be used to further explore placental functions that are related to vascularization, oxygenation, and metabolism in human pregnancies by the use of various enhancement processes: Dynamic contrast-enhanced MRI, arterial spin labeling MRI, blood oxygen level-dependent and oxygen-enhanced as well as diffusion-weighted imaging and intravoxel incoherent motion MRI are various techniques that have been successfully applied to the functional imaging of the placenta. The ability of each fMRI technique to make a timely diagnosis of abnormal placentation that would allow for appropriate planning of follow-up examinations and optimal scheduling of delivery needs to be further investigated. Research programs will benefit from the use of well-defined sequences, standardized imaging protocols, and robust computational methods.

MRI with Gadolinium for the Diagnosis of Abnormally Invasive Placenta

Anne-Elodie Millischer, Paris Descartes University

Ultrasound (US) is the primary imaging modality for the diagnosis of placenta accreta, but it is not sufficiently accurate. MRI morphologic criteria have recently emerged as a useful tool in this setting, but their analysis is too subjective. Gadolinium enhancement may improve the accuracy to diagnose abnormal invasive placenta (AIP). In our experience, the use of dynamic contrast gadolinium enhancement (DCE) MRI emerges as a reliable procedure to diagnose AIP for both junior and senior radiologists. Particularly, the use of a specific pattern of enhancement, by allowing the extraction of tissular enhancement parameters, enables a predictable distinction between placenta accreta and normal placenta.

Assessment of the utero-placental vascularization by ultrasound approaches

Vassilis Tsatsaris, Edouard Lecarpentier, Olivier Morel, Paris Descartes University

The quality of utero-placental vasculature is essential for a proper fetal development and a successful pregnancy. Inadequate remodeling of the spiral arteries resulting in



decreased maternal blood to the placenta has been implicated in the pathophysiology of preeclampsia and IUGR. However, the in vivo assessment of placental vascularization with non-invasive methods is complicated by the small size of placental terminal vessel, its complex architecture, and the very low blood velocities. Maternal utero-placental hemodynamics is currently assessed mainly by means of uterine artery pulsed Doppler, but this imaging modality has limited predictive value for preeclampsia and IUGR. Another approach consists in quantifying the vascularization directly in the placenta or the placental bed using a combined method of three-dimensional (3D) imaging and power Doppler ultrasonography. First clinical studies suggest that the 3D power Doppler indices of the uteroplacental circulation could be helpful to improve the prediction of preeclampsia and IUGR. However, 3D power Doppler angiography of the placenta remains limited to large vessels and does not discriminate the fetal circulation from the maternal circulation. New technologies are emerging such as ultrafast scanners based on holographic imaging using unfocused ultrasonic waves. Recent studies suggest that ultrafast acquisition offers the possibility to analyze the flow with a high spatio-temporal resolution and may allow to discriminate maternal and fetal circulation.

MicroCT for imaging the human placenta

Rosalind Aughwane, University College London

Little is known about the three-dimensional structure of the fetoplacental vascular tree, due to the small size of vessels and complexity of branching structure. Micro-CT can capture this data in 3D volumes and opens a new window into our understanding of the vascular structure both in normal pregnancy and in major obstetric disorders including fetal growth restriction, pre-eclampsia and complicated twin pregnancies.

MicroCT shows us that there is substantial heterogeneity in vascular density within normal placenta, however some trends in the structure of the vascular tree appear to be conserved. The technique applied to the placenta allows the three-dimensional chorionic and deep branching vessel structure to be visualised and quantified and it can transform our understanding and appreciation of this much understudied but vital organ.

The Placenta Imaging Project and Clinical Indications for Investigating the Placenta

Mary Rutherford, King's College London

Paying attention to the placenta to improve antenatal care

Ed Johnstone, University of Manchester

During pregnancy monitoring attention is understandably focused on the fetus and the mother. However, the placenta sits at the interface between the two and examining it is essential if we are to gain a full picture of pregnancy health and well-being. Traditionally antenatal placental assessment has primarily been confined to determining placental location, but more recently attention has focused on trying to



gauge and measure placental function and health in vivo, particularly in pregnancies at risk of poor outcomes.

In this presentation, I will discuss how my group are using imaging technologies to influence antenatal care and improve outcomes. I will then discuss how studies using ultrasound magnetic resonance imaging and microCT will continue to expand the importance of examining the placenta in clinical care and where I perceive the next important advances need to occur.

Posters

Movement of blood within the placenta

Simon M Shah*, Nia Jones, Richard Bowtell, Penny Gowland

**University of Nottingham*

Selected for oral presentation

Image-Based Modelling of Oxygen Transport

Romina Plitman Mayo*, Michelle L. Oyen, Graham J. Burton

**University of Cambridge*

Selected for oral presentation

Ex vivo dual placental perfusion: Novel approaches to understanding placental physiology and structure to aid clinical appraisal of placental function and oxygen transfer

Gareth A Nye*, Saskia Port, Emma Ingram, Ed Johnstone, Rohan Lewis, Igor Chernyavsky, Paul Brownbill

**University of Manchester*

Selected for oral presentation

Efficient interactive segmentation of the placenta from fetal MRI using deep learning

Guotai Wang*, Maria A. Zuluaga, Wenqi Li, Rosalind Pratt, Premal A. Patel, Michael Aertsen, Tom Doel, Anna L. David, Jan Deprest, Sebastien Ourselin, Tom Vercauteren

**University College London*

Diffusion-Weighted Placental MRI in Normal Pregnancies and Those Complicated by Placental Dysfunction

Ditte Nymark Hansen*, Caroline Haals, David Alberg Peters, Jens Brøndum Frøkjær, Astrid Petersen, Marianne Sinding, Anne Sørensen

**Aalborg University Hospital*



Postpartum placental CT angiography in normal pregnancies and in those complicated by diabetes mellitus

Mette Østergaard Thunbo*, Marianne Sinding, Pauline Bogaard, Anne Sofie Korsager, Jens Brøndum Frøkjær, Lasse Riis Østergaard, Astrid Petersen, Anne Sørensen

**Aalborg University Hospital*

Placental baseline conditions modulate the hyperoxic BOLD-MRI response

Sinding M, Peters DA, Poulsen SS, Frøkjær JB, Christiansen OB, Petersen A, Uldbjerg N, Sørensen A*

**Aalborg University Hospital*

Blood flow and solute transfer in feto-placental capillary networks

Alexander Erlich*, Philip Pearce, Romina Plitman Mayo, Oliver E. Jensen, Igor L. Chernyavsky

**University of Manchester*

T2 and T2* imaging of the placenta in pregnancies complicated by chronic hypertension and preeclampsia

Alison Ho*, Jana Hutter, Laurence Jackson, Lisa Story, Paddy Slator, Joseph V. Hajnal, Mary Rutherford, Lucy Chappell

**King's College London*

Respiration resolved placenta imaging using continuous steady state excitation with linear frequency sweeps

Laurence H. Jackson*, Anthony N Price, Jana Hutter, Lucilio Cordero-Grande, Alison Ho, Paddy J. Slator, Ana Dos Santo Gomes, Joshua F.P. van Amerom, Maria Murgasova, Laura McCabe, Mary A. Rutherford, Joseph V. Hajnal

**King's College London*

Towards a two-perfusion compartment model for human placenta

Michele Guerreri*, Amanda Antonelli, Silvia Bernardo, Maria Grazia Porpora, Lucia Manganaro, Silvia Capuani

**Sapienza University of Rome*

Hydrogen Spectra in Normal Placentas at a Range of Gestational Ages – Normative Values

David M. Morris*, Gillian Macnaught, Marian C Aldhous, Scott I.K. Semple, Fiona C. Denison

**University of Edinburgh*

Photoacoustic imaging of the human placental vasculature

Maneas E*, Aughwane R, Xia W, Huynh NT, Ansari R, Singh M.K.A, Hutchinson C, Sebire N, Arthurs O, Ourselin S, Beard P.C, Melbourne A, Vercauteren T, David A.L, and Desjardins A.E

**University College London*



Stereoscopy of the human placenta

Melbourne A*, Pratt R, Hutchinson, JC, Arthurs O, Sebire N, Vercauteren T, Ourselin S, David A

**University College London*

Quantitative Analysis of the three dimensional fetoplacental vascular tree in normal, term placenta

Melbourne A*, Pratt R, Hutchinson, JC, Arthurs O, Sebire N, Vercauteren T, Ourselin S, David A

**University College London*

MicroCT to investigate the heterogeneity of villous vascular density in normal placentae

Pratt R*, Melbourne A, Hutchinson, JC, Arthurs O, Sebire N, Vercauteren T, Ourselin S, David A

**University College London*

Quantifying the structure of the chorionic vascular tree with central and eccentric cord insertion

Pratt R*, Melbourne A, Hutchinson, JC, Arthurs O, Sebire N, Vercauteren T, Ourselin S, David A

**University College London*

Separation of Fetal and Maternal Circulations using DECIDE MRI

Melbourne A*, Pratt R, Sokolska M, Owen D, Bainbridge A, Atkinson D, Kendall G, Deprest J, Vercauteren T, David A, Ourselin S

**University College London*

Exploring placental function over gestation using multi-modal functional MRI

J Hutter, P Slator, L Jackson, A Ho, A Gomes, AN Price, DC Alexander, L Chappell, MA Rutherford, JV Hajnal

**King's College London*

Optimised B-Values and Gradient Directions for Placental Diffusion MRI

Paddy J. Slator*, Jana Hutter, Laurence Jackson, Andrada Ianus, Ana Dos Santo Gomes, Alison Ho, Lisa Story, Laura McCabe, Eleftheria Panagiotaki, Mary A. Rutherford, Joseph V. Hajnal, Daniel C. Alexander

**University College London*

Organising Committee

Paddy Slator, Centre for Medical Image Computing, UCL
Rosalind Aughwane, Centre for Medical Image Computing, UCL
Andrew Melbourne, Centre for Medical Image Computing, UCL