spectroscopy provides a plethora of useful information regarding biochemical changes in atomic level. They already have several applications in cancer research and diagnosis, but could be important tools to help all pregnancy and placenta fields of study. Therefore, we aimed to analyze possible biomechanical and biochemical alterations in trophoblast cells incubated with Group B Streptococcus (GBS).
Methods: HTR-8/SVneo cells were incubated with inactivated serotype Ia GBS. F-actin cytoskeleton was stained by phalloidin and AFM was used to access cellular morphology, height, rugosity and elasticity, the latter by Young's Modulus calculation. Raman spectroscopy was employed and principal component analysis (PCA) and linear discriminant analysis (LDA) were applied to search the best cell classification and most significant biochemical differences among raman spectra.
Results: GBS at 10^8 CFU altered F-actin cytoskeleton, as cells lost stress fibers and migratory phenotype, becoming roundish with F-actin aggregates. Topographic images depicted cells with a rougher surface after GBS incubation. Membrane elasticity was increased with GBS incubation, while uvaol increased cellular stiffness. PCA and LDA analysis showed GBS increased cytochrome C resonant raman signals (700-750 cm^{-1}, 1311-1585 cm^{-1} peaks), as well as peaks of phosphatidylserine and phosphodiester, which strongly correlates to apoptosis and necrosis signals, while control cells had higher 608-614 cm^{-1} peaks of cholesterol, 847-856 cm^{-1} peaks of carbohydrates and 1000 cm^{-1} NADH peak, which are related to aerobic and lipid metabolism.
Conclusion: AFM and Raman findings strongly suggest GBS increase cell death, decrease cell migration and metabolism. As such, they are powerful tools that can be extremely accurate in finding cellular atomic events and could help on diagnosis and even undercover hidden changes in placental pathologies.

P2.55.
STRUCTURE-FUNCTION RELATIONSHIPS IN THE FETO-PLACENTAL CIRCULATION FROM IN SILICO INTERPRETATION OF MICRO-CT VASCULAR STRUCTURES

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Objectives: Micro-CT imaging is emerging as a quantitative means to analyse the structure of the feto-placental vasculature, and this imaging technology has elucidated differences in vascular branching structure between normal placentae, and placentae impacted by pathologies such as fetal growth restriction. However, translating quantitative metrics of branching patterns and/or vascular density from micro-CT to the function of the blood vessel network is challenging.
Methods: We derive patient-specific computational models of placental vascular structure from four normal placentae. These models extract graph-based structures representative of the macro-vasculature directly from imaging and extend these structures to statistically-derived representations of the micro-vasculature based on analysis of local vascular density. Using these models we predict the impact of feto-placental vascular structure in an individual on 1) placental resistance, and 2) heterogeneity in flow distribution.
Results: Individual-based vascular trees had a larger number of vessels feeding the exchange surface and lower predicted vascular resistance than idealised trees generated to fill the same volume. This suggests that local asymmetry in feto-placental vascular branching may play a role in maximising gas exchange surface area while minimising placental resistance. Blood flow heterogeneity is altered in placental pathologies. We show that increased asymmetry in macro-vascular branching does not necessarily result in increased blood flow heterogeneity, and predicted that the coefficient of variation in blood flow varies by only 1-3% in normal individual versus idealised placental trees.
Conclusion: We show that it is possible to extract sufficient data from whole-placenta micro-CT imaging to simulate function from macro- to micro-scale. By analysing how quantitative measures of feto-placental vascular branching derived from micro-CT impact on total placental resistance and placental blood flow heterogeneity we are able to demonstrate that in normal placentae, asymmetry in vascular branching is likely to result in a balance between a large gas exchange surface area, and a low vascular resistance

P2.56.
MAGNETIC RESONANCE ASSESSMENT OF THE EFFECT OF MATERNAL POSITION ON FETOPLACENTAL BLOOD FLOW AND OXYGENATION

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Objectives: Maternal supine sleep position is associated with increased risk of late stillbirth. Our previous studies showed 16.4% reduction in maternal cardiac output, and 32% reduction in abdominal aortic blood flow in healthy pregnancy when the woman lay supine, compared to left lateral, suggesting a potentially reduced delivery of maternal blood to the placenta. However, the impact of maternal position on placental function is unclear. This study aims to determine whether maternal position in late gestation impacts on placental blood flow and oxygenation.
Methods: Ten women with uncomplicated pregnancies were recruited for imaging at 34-38 weeks. Magnetic resonance imaging (MRI) phase contrast, T2 and diffusion weighted sequences were used to study internal iliac artery and umbilical venous flow, placental blood flow and oxygen saturation when the mother lay in left lateral decubitus and supine positions. Ethical approval was obtained from the University of Auckland Human Participants Ethics Committee.
Results: Compared with left lateral decubitus, volumetric flow in reduced when supine by 14% in right and 21% in left maternal internal iliac arteries, and 16% in the umbilical vein. Subjects showed a trend for reduced diffusivity within the placenta when supine, consistent with these changes in volumetric blood flow. However, there were no consistent changes in fetal oxygenation between positions, and changes in imaged placental oxygen saturation were small.
Conclusion: This is the first MRI study to describe the effect of maternal position in late pregnancy on maternal and feto-placental blood flow and oxygenation. Our study suggests that fetal oxygenation remains relatively consistent between left lateral decubitus and supine positions despite significant reduction in maternal and placental blood flow when supine. Trends suggest a potential fetal compensatory mechanism to reduced maternal flow within the uteroplacental circulation, with fetal flow rates reducing to match reductions in maternal blood flow in normal pregnancies.

P2.57.
AI-BASED RAPID PLACENTAL ASSESSMENT TOOL

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Objectives: Placentas are tremendously useful in clinical care but the current system relies on placental pathology exams which are costly, have a lengthy multi-phase process, and require high-level training of a

pathologist. Our objective was to test the use of artificial intelligence (AI) to automatically capture and translate data from photographs to create a rapid tool to assess all placentas at birth.
Methods: We curated a dataset from pathology reports and maternal/fetal side photographs from Northwestern Memorial Hospital (n=2941). We used natural language processing to create variables for descriptors and diagnoses from paragraph-form reports. We then used deep learning and statistical clustering-based AI techniques to create a computational pipeline that 1) segments disc and cord; 2) takes morphological measurements; and 3) predicts pathological diagnoses. We used pathology reports or hand tracing as the ground truth; 80% of the dataset was training and 20% was testing.
Results: Mean (SD) maternal age was 32 (5) years and placental weight was 439 (113) g. Twenty percent were preterm. Mean pixel-accuracy for segmenting disc and cord was 98.2% and 94.0% respectively. We automated the capture of disc color, area, and contour/shape and cord insertion point, diameter, and coils. From these visual features, we predicted the following five diagnoses (accuracy): marginal cord insertion (97.6%), irregular shape (94.5%), hypercoiled cord (88.2%), abruption (78.2%), and meconium (76.4%). We also had promising results for classifying incomplete maternal surface (sensitivity=82.6%, specificity=70.7%).
Conclusion: We have developed a preliminary system to automate placental assessment from photographs. We aim to expand this tool to become a rapid, simple assessment for all placentas to provide information for clinical care right after delivery and to triage placentas for full pathology exams.

P2.58.
SPATIAL T2* MRI MEASURES AS A MARKER OF OXYGENATION – ASSESSMENT IN HEALTHY PREGNANCIES OVER GESTATION

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Objectives: Placental insufficiency is a leading cause for major pregnancy complications such as fetal growth restriction and pre-eclampsia, making early identification crucial. MRI-based T2* relaxometry as an in-vivo marker of oxygenation is increasingly used—but was limited so far to whole volume analysis. We present a T2*-based histogram asymmetry measure to assess spatial distribution.
Methods: 71 women with uncomplicated pregnancies, GA=21+5-38+2 weeks (mean 29+6 weeks), had an in-vivo MRI Multi-Echo-Gradient-Echo scan (3mm3 resolution, 4 echo times, 30sec acquisition time) on a clinical 3T-scanner. T2* maps and mean were obtained. The proposed histogram asymmetry measure (HAM) was calculated as the fraction of placental tissue above 10% of the mean value.
Results: The T2* maps show clear spatial distribution of bright (high T2*) centres in each lobule surrounded by increasingly darker (lower T2*) spheres. Over gestation, the lobularity becomes more pronounced, with smaller bright high T2*centres and a faster decay of T2* in the spheres. T2* mean results show a linear decay over gestation with 3.45ms decrease per week. The histograms show a left and upward shift, corresponding to a reduced area of high T2* and a growing area of low T2* values. The HAM measure remains roughly 1 until 32 weeks gestation for most subjects and drops consistently in the last 8 weeks of gestation. A weak correlation between drop in HAM and birth weight centile can be observed.
Conclusion: The bi-phase behaviour of T2* HAM could be indicative of the placenta reaching its reserve capacity in the final weeks of pregnancy. It corresponds well to the visual observation of increased lobularity in the T2*. Next steps will include the systematic evaluation of the HAM measure in data from women diagnosed with growth restriction and pre-eclampsia.

P2.59.
CHARACTERIZATION AND DISTRIBUTION PROFILE OF HEMATOPOIETIC CELLS IN MOUSE PLACENTA

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Objectives: To characterize hematopoietic cells in mouse placenta during midgestation.
Methods: Laser capture microdissection (LCM) and RT-qPCR; kidney subcapsular grafts; and confocal immunofluorescence.
Results: The LCM was effective to isolate CD41+ fetal hematopoietic cells within labyrinthine vasculature. Gene expression analysis on microdissected cells identified several hematopoietic genes, in which some of them were differently expressed within CD41+ cells isolated from niche one (chorionic plate and adjacent vessels) or niche two (labyrinth close to the junctional zone). In addition, we detected trophoblast transcripts in microdissected CD41+ population, including cytokeratin-8, Tpbpa, Cdx2 and Gm1. We next performed immunofluorescence analysis on mouse placenta to confirm the protein expression of some genes identified by RT-qPCR. We confirmed distinct distribution profile of hematopoietic cells within the two niches. Hematopoietic cells in niche one seem to migrate to niche two, where we localized extensive proliferation and maturation of hematopoietic cells. We also observed Tpbpa+/cytokeratin-8+ spongiotrophoblast cells co-expressing mesenchymal and endothelial markers for likely vasculogenesis and hematopoiesis de novo. In this sense, in the absence of Placental Growth Factor (PGF), the epithelial-mesenchymal-transition decreased while hematopoietic cells increased, as revealed by histological examination of PGF knockout mice. To confirm hematopoietic potential of the spongiotrophoblast, the ectoplacental cone from a mouse with GFP background was implanted underneath the kidney capsule of an immunocompromised pregnant mouse. Immunofluorescence analysis of the kidney grafts identified donor GFP+ cells co-expressing the hematopoietic marker Runx1, and the mesenchymal/endothelial markers CD31 and vimentin.
Conclusion: We identified a unique trophoblast precursor for hematopoietic cells in mouse placenta. Trophoblast precursors in the ectoplacental cone persist in the spongiotrophoblast layer where they undergo epithelial-mesenchymal-transition and produce vessels and hematopoietic cells during mid-gestation. The loss of PGF signaling disturb the epithelial-mesenchymal-transition of spongiotrophoblast cells and local hematopoiesis. We localized clonal proliferation and maturation of hematopoietic cells exclusively in niche 2 of mouse placenta.

P2.60.
MORE THAN JUST A CIRCULATORY INTERFACE? HIGH-DIMENSIONAL SINGLE-CELL ANALYSES UNCOVER TISSUE-RESIDENT PROGRAMS IN PLACENTAL LYMPHOCYTES

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Objectives: Immunity has been implicated in many pregnancy processes and disorders. Despite this, our understanding of immunity at the placenta remains limited in both health and disease. To better identify precise immunologic mechanisms that underlie pregnancy disorders, we sought to develop a resource that deeply interrogates placental immune cells during uncomplicated, term pregnancy. Here we probed placenta-specific immune cell programs versus those in maternal and fetal blood.