Morkaker – ut av mørket?

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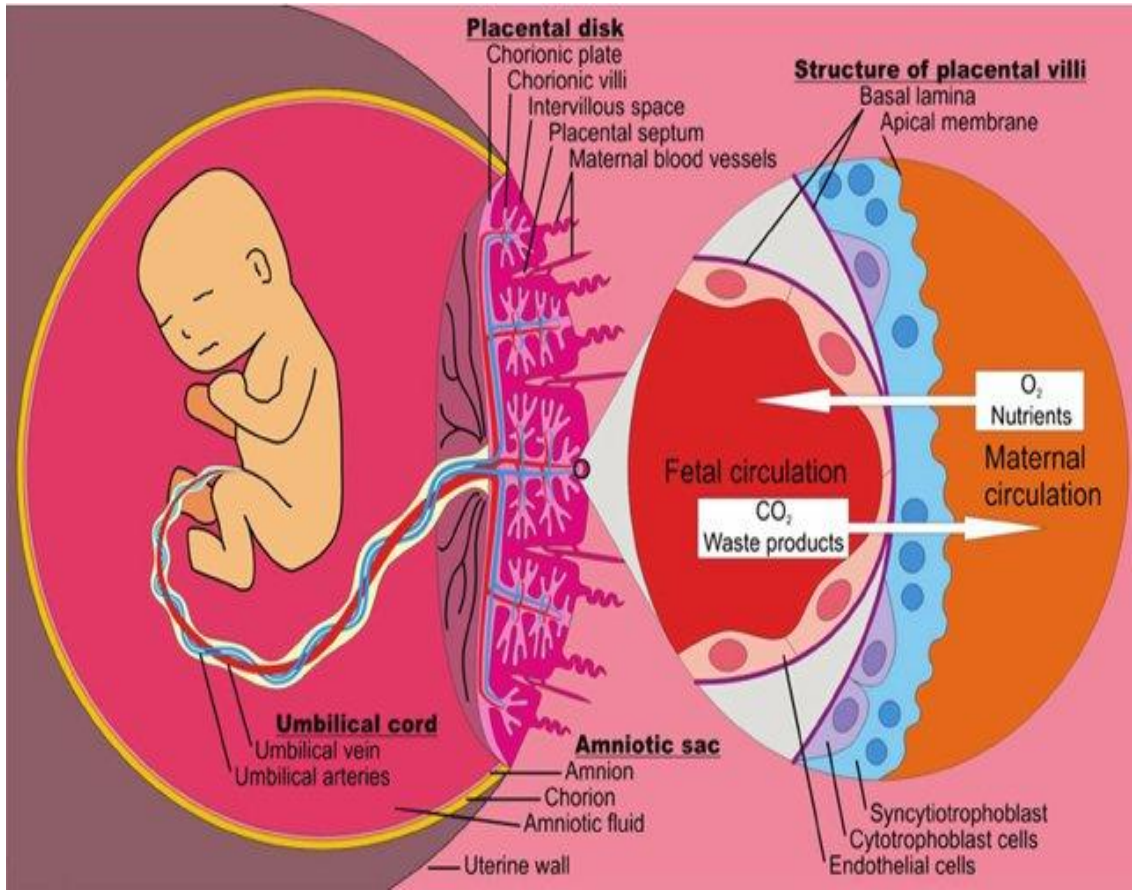
What I will talk about

- What does the placenta do?
- Why should we measure placental size inside the uterus?
- Development of placental visualisation tools

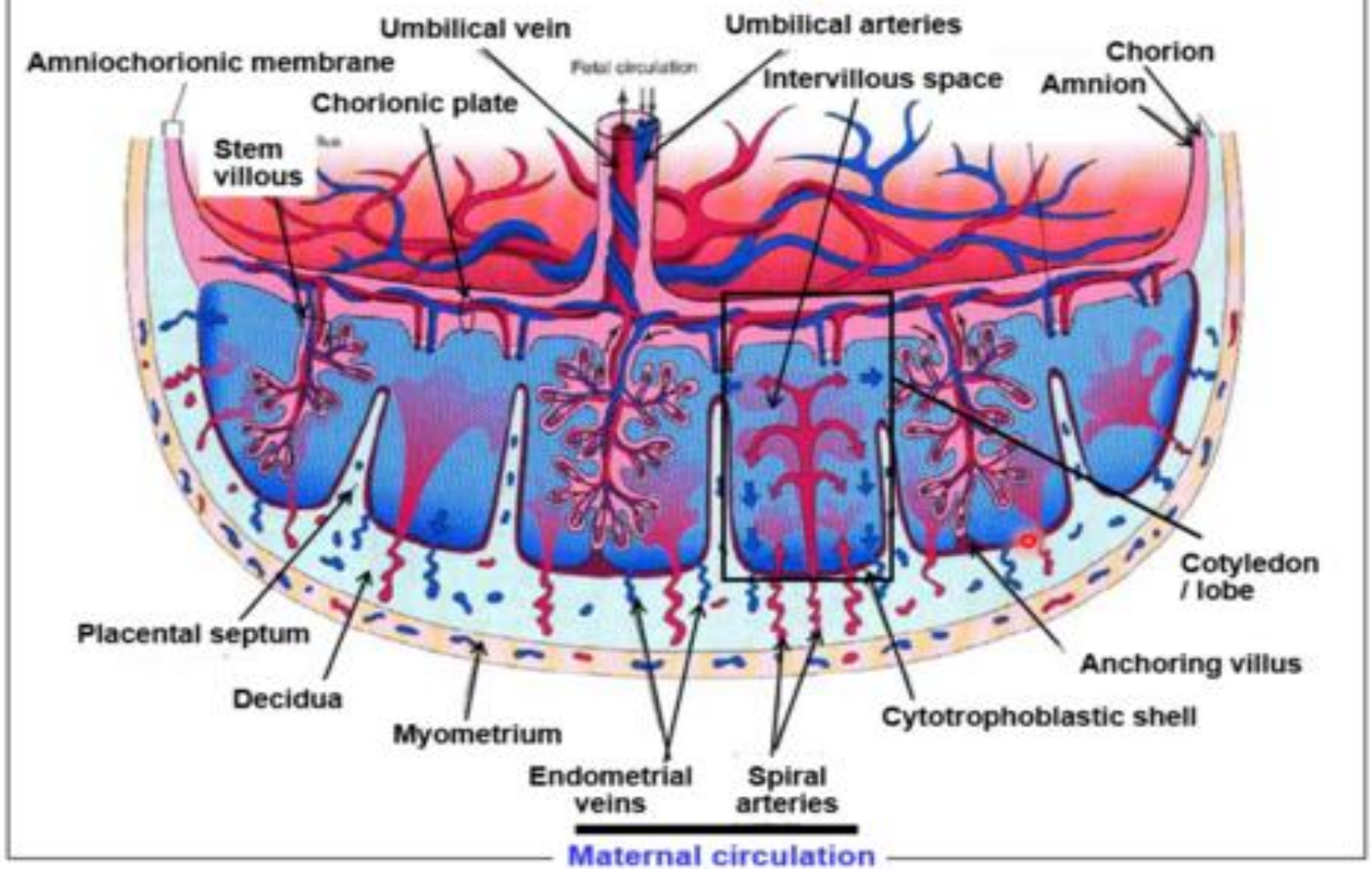
What does the placenta do?

- Uptake of oxygen and nutrition from maternal blood
- Regulation of the angiogenesis and growth of the placenta and the fetus (and the mother?)

The placenta orchestrates the the whole pregnancy

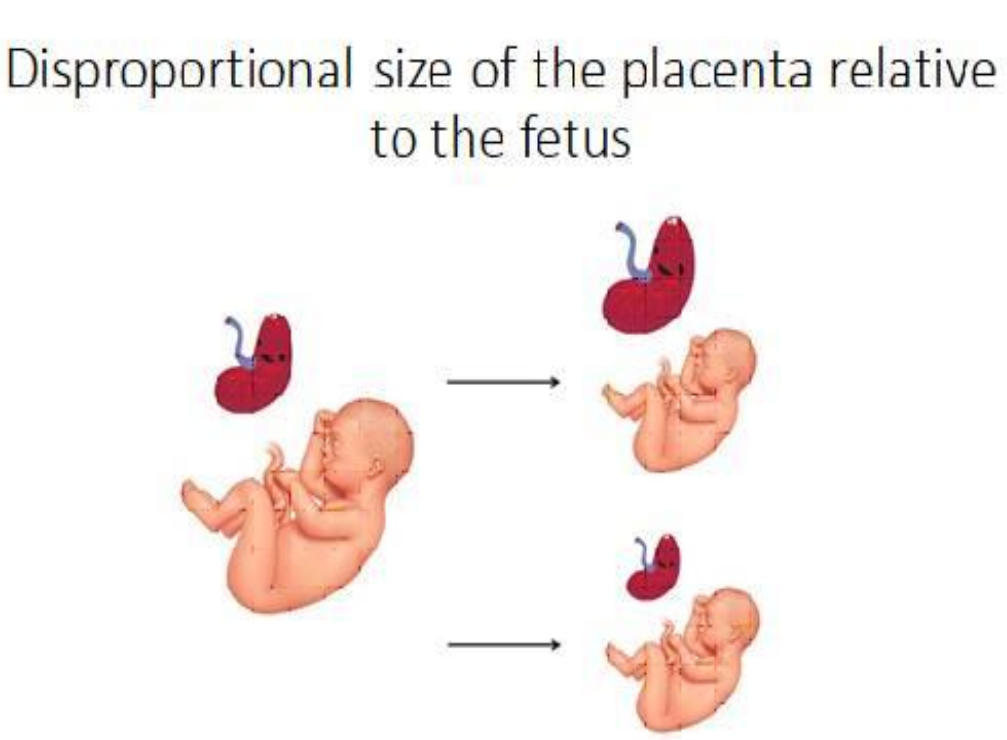


Structure of the placenta



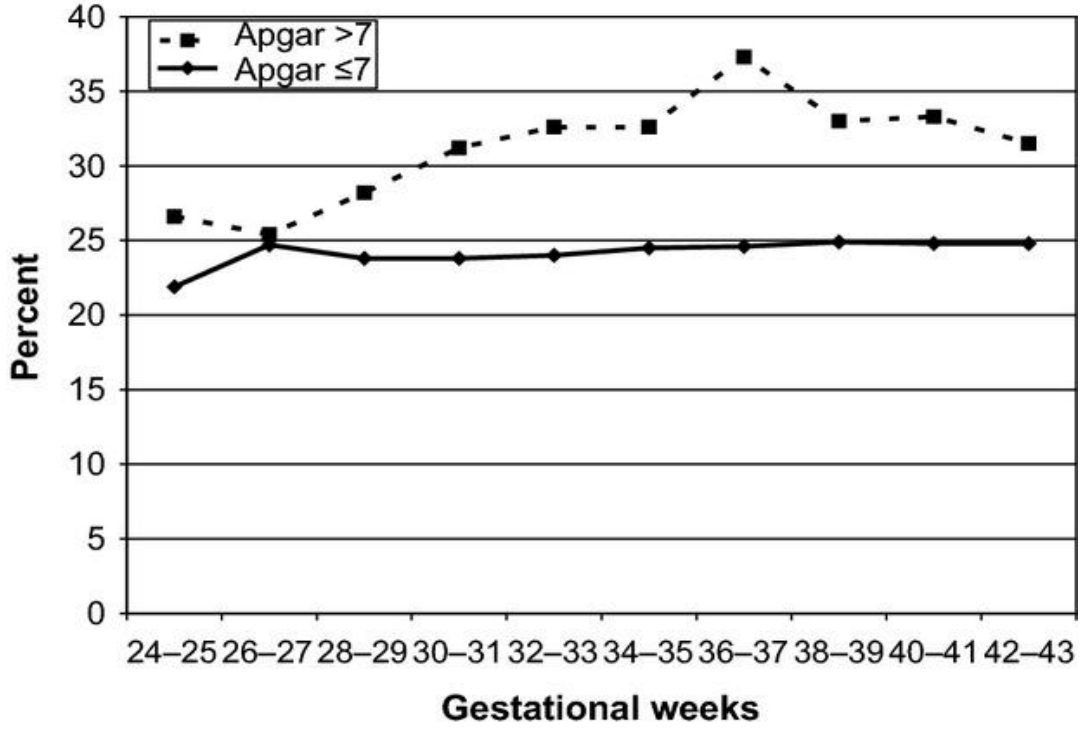
Disproportional placental size relative to fetal size **at birth (ratio)** is associated with

- Fetal death
- Low Apgar score at birth
- Neonatal death
- Cerebral palsy
- Cardiovascular death in adulthood



Results from the Medical Birth Registry of Norway
> 500 000 births

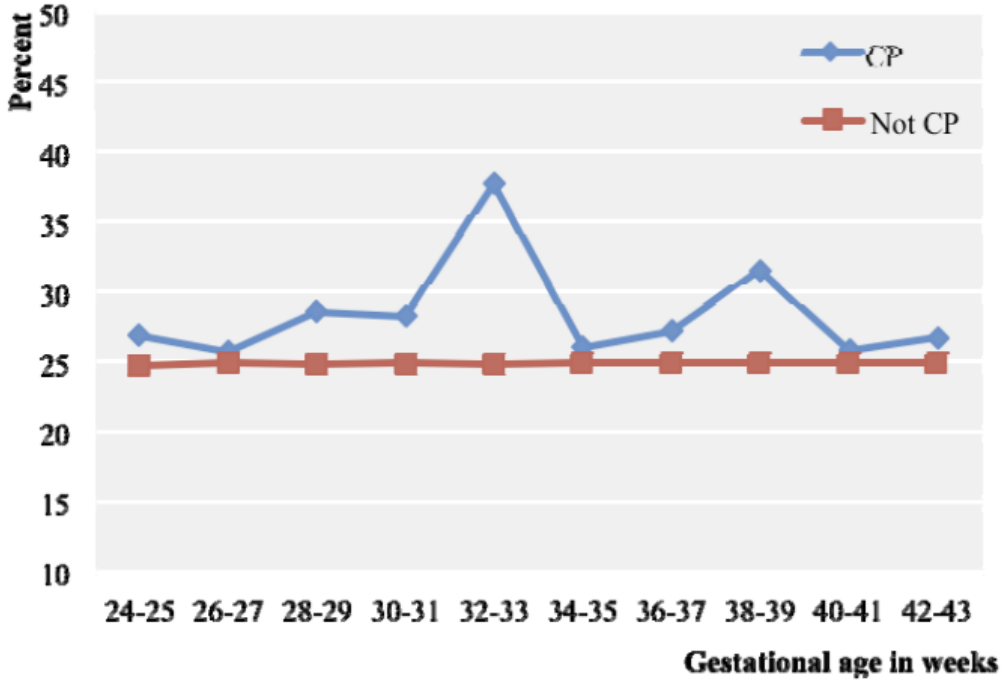
Apgar score <7 after 5 minutes



Fetal death and placental weight/birthweight ratio: a population study.
Haavaldsen C et al. Acta Obstet Gynecol Scand. 2013;92(5):583-90. doi: 10.1111/aogs.12105

Cerebral palsy

Proportions of pregnancies in the highest quartile of ratio



Association of placental weight with cerebral palsy: population-based cohort study in Norway.
Strand KM, et al. BJOG. 2016;123(13):2131-2138. doi: 10.1111/1471-0528.13827.

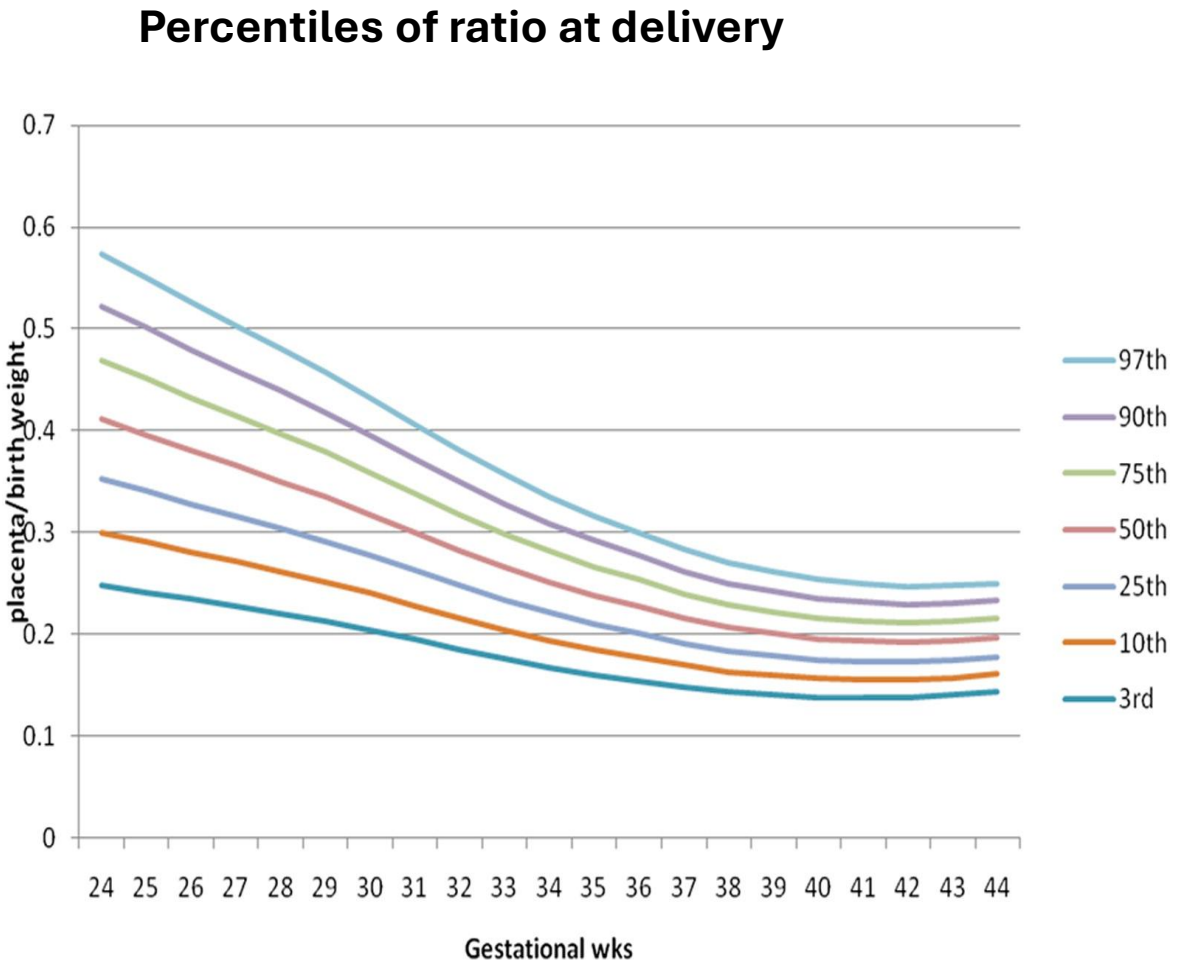
Disproportionate ratio at delivery is associated with adverse outcome for the child

- Disproportionate ratio could be a sign of placental-foetal hypoxia

  Does the Biological Response to Fetal Hypoxia Involve Angiogenesis, Placental Enlargement and Preeclampsia? Eskild A, et at. Paediatr Perinat Epidemiol. 2016;30(3):305-9. doi: 10.1111/ppe.12283.

- Disproportionate ratio does not develop during delivery

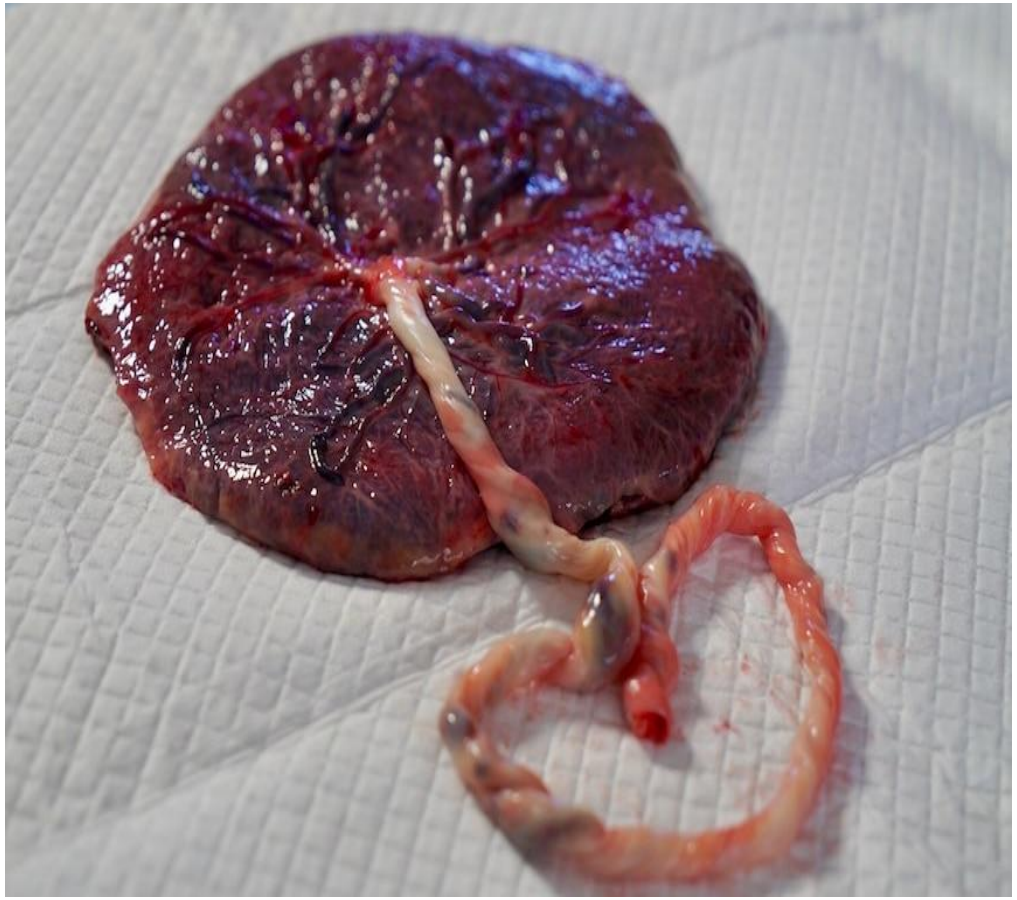
- If a dipropionate ratio is present at delivery, an adverse outcome for the child may not be caused by inadequate health care at delivery



Placenta weight percentile curves for singleton and twins deliveries. https://doi.org/10.1016/j.placenta.2010.10.008 Placenta. Volume 32, 2011, Pages 58-62

- To better identify pregnancies at increased risk of adverse outcome,
- knowledge of placental/fetal size while the pregnancy is ongoing is necessary

How does the intrauterine placenta look?
What is normal intrauterine placental size ?

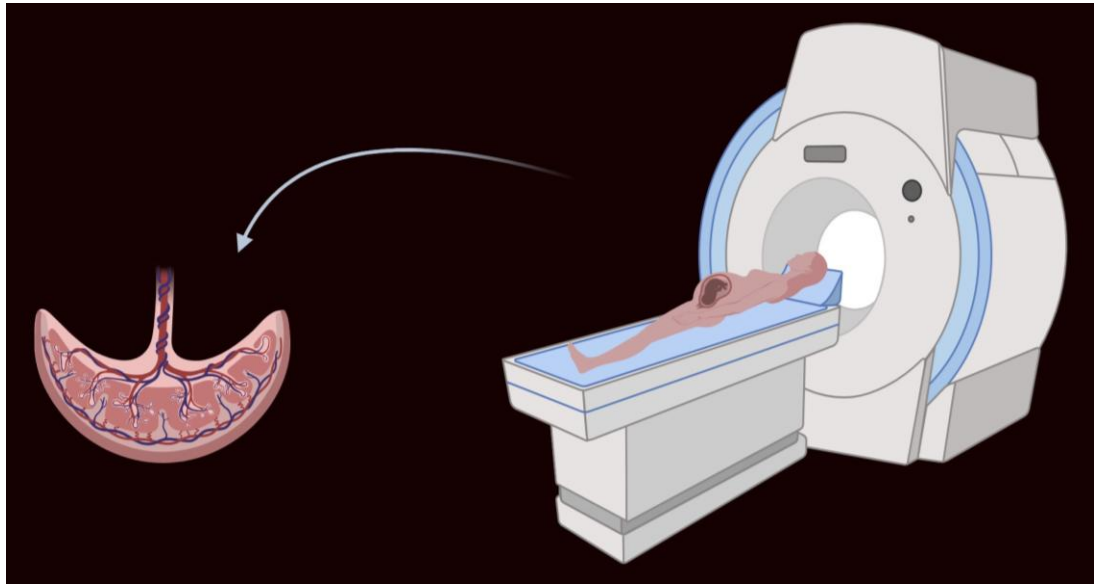


Yet we have (had) no reliable tools to measure placental size in utero

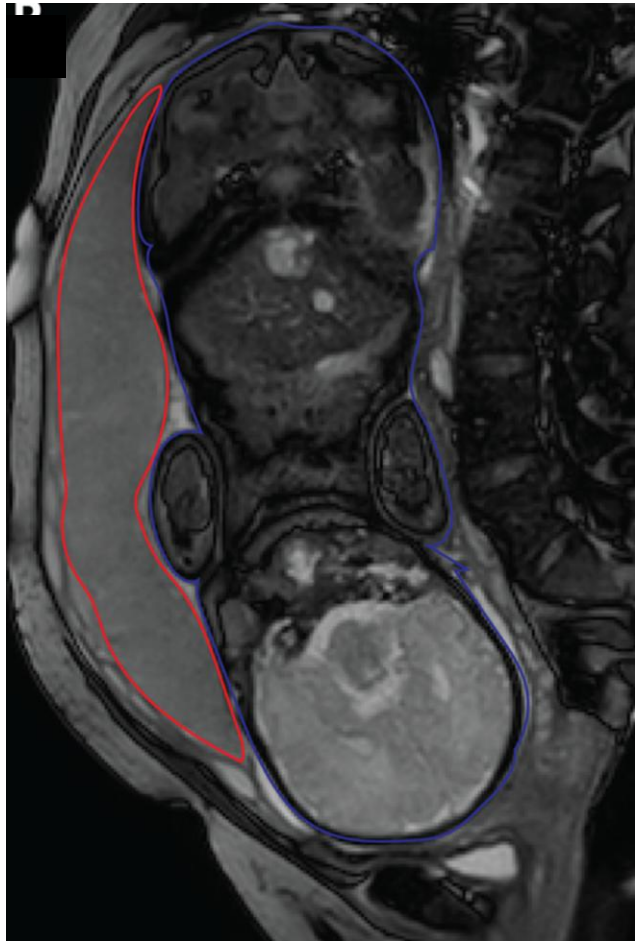
- What does the placenta look like inside the uterus?
- Is it possible to measure the size of the placenta inside the uterus?
- How does the placenta grow?
- To find out, we established the Placenta Volume (PLAVO) Study in 2017, at Akershus University Hospital.
- 100 pregnancies were MRI examined in pregnancy week 27 and 37

Magnetic Resonance Imaging (MRI) of pregnancy

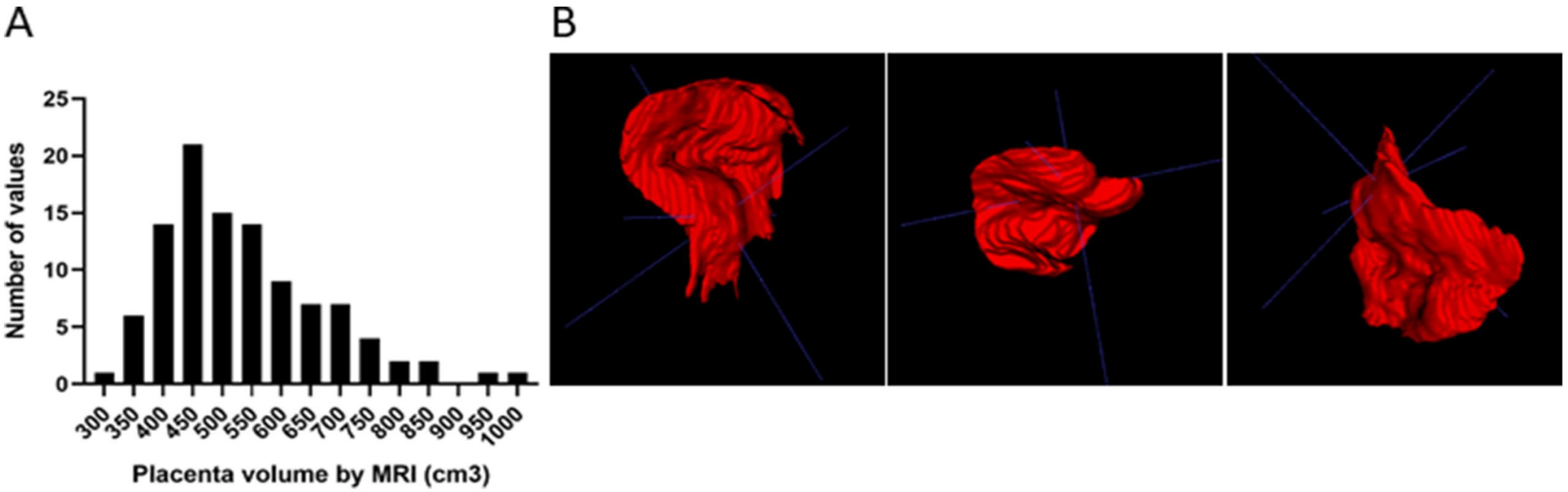
- No risks
- Visualizes the entire pregnancy



Manuell tracing of placental and fetal tissue on MRI images slices every 5 millimeter thru the uterus



MRI revealed that placentas may have very different shapes and sizes at pregnancy week 27



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Percentiles of intrauterine placental volume and placental volume relative to fetal volume: A prospective magnetic resonance imaging study

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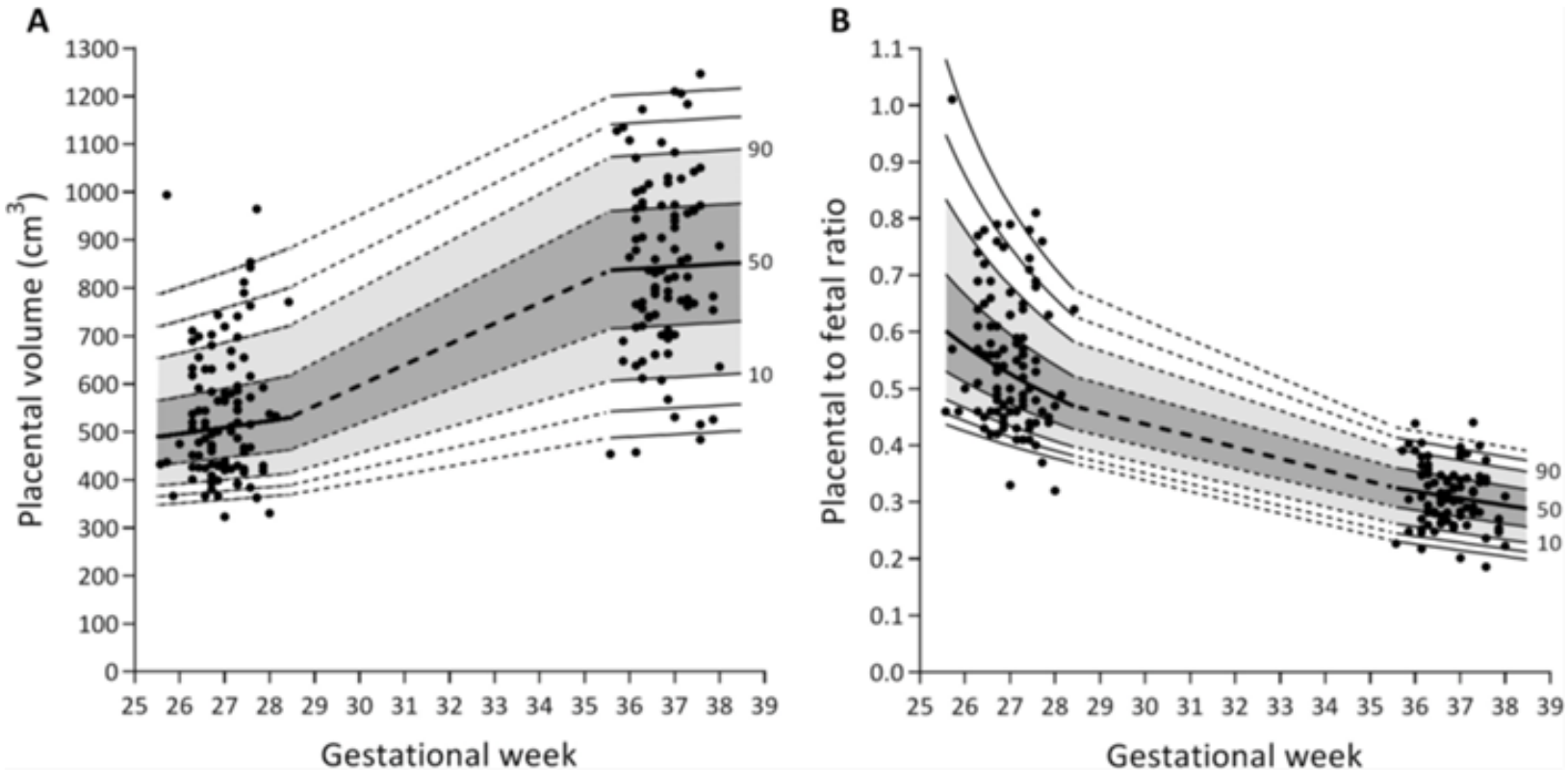

Other results from the PLAVO-study (MRI)

- Placental size and ratio may predict subsequent fetal growth
- Placental size and ratio may predict subsequent duration of pregnancy
- ?? Ratio better than fetal size predicts term date? (no-one delivers at term date)
- The placenta is much bigger inside than outside the uterus

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ORIGINAL RESEARCH ARTICLE

Placental size at gestational week 36: Comparisons between ongoing pregnancies and deliveries

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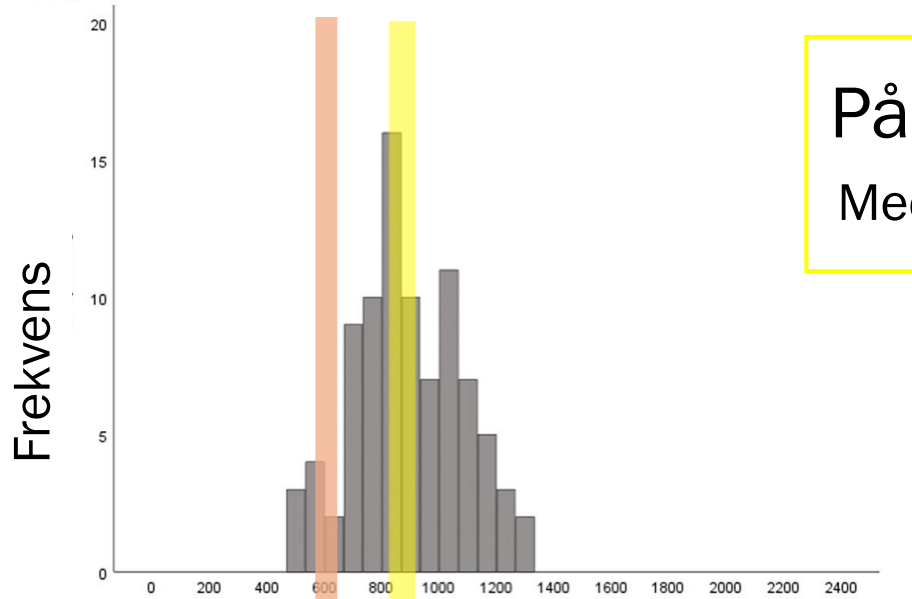
Abstract

Introduction: We aimed to compare placental size and placental size relative to fetal size (ratio) in ongoing pregnancies examined by magnetic resonance imaging (MRI) at gestational week 36 with placental size among all deliveries at gestational week 36 during the same time period.

Material and methods: Ongoing unselected singleton pregnancies (*n* = 89) were exam-

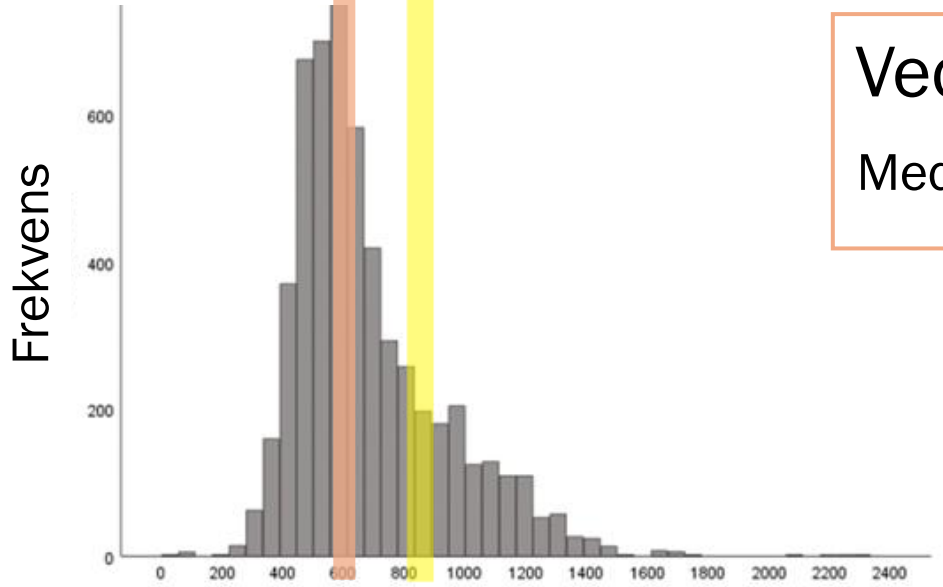
A



Morkakestørrelse, *gram*.

Pågående svangerskap

Median morkakevekt: 873 gram



Morkakestørrelse, *gram*.

Ved fødsel

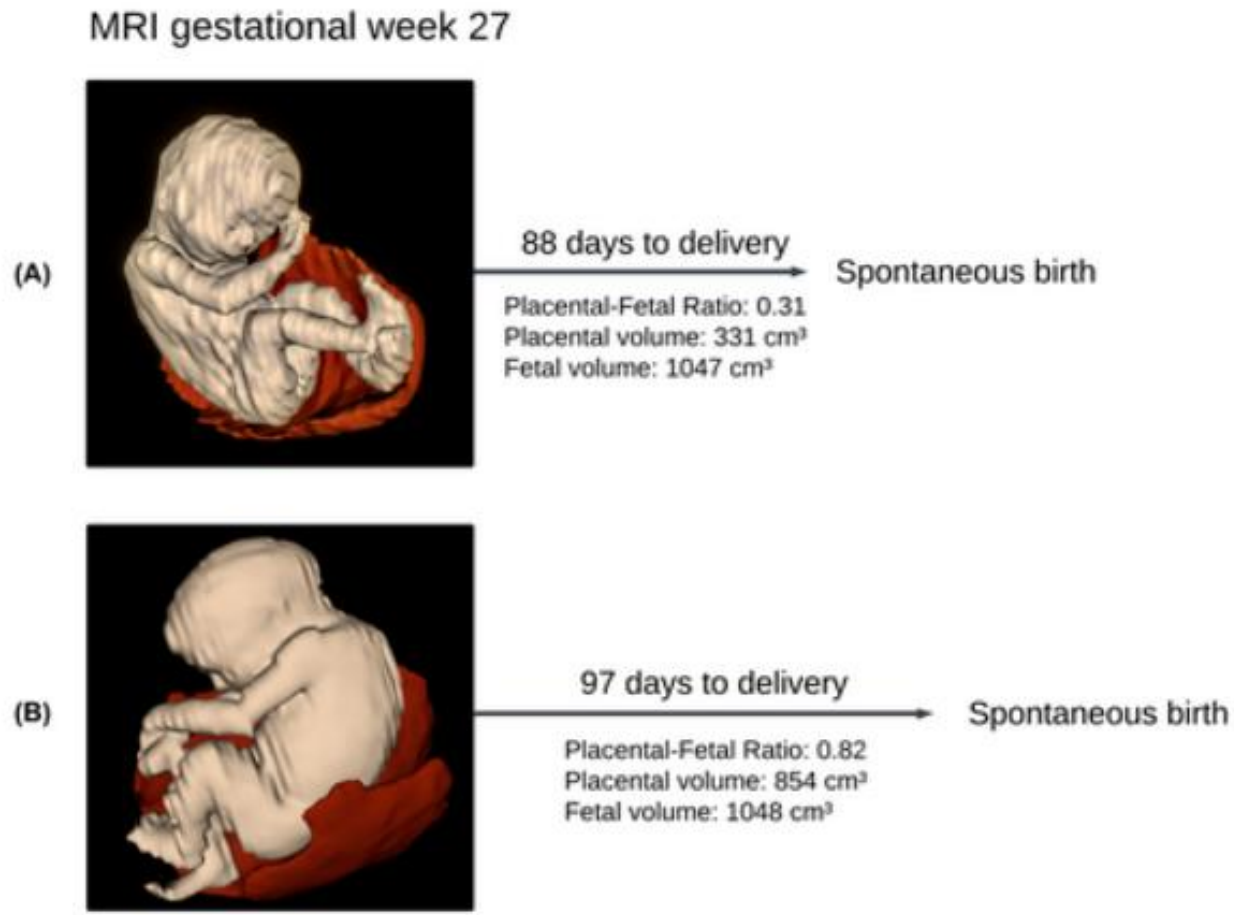
Median morkakevekt: 613 gram

AOGS Acta Obstetricia et Gynecologica Scandinavica
Open Access

ORIGINAL RESEARCH | Open Access

The association of placental to fetal ratio with pregnancy duration

Carl P. S. Kulseng, Silje Sommerfelt, Kari Flo, Kjell-Inge Gjesdal, Helene F. Peterson, Vigdis Hillestad, Karianne Sagberg, Anne Eskild



Can we measure placental size by ultrasound?

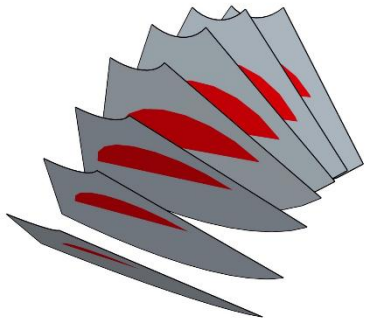
Ultrasound (2D and 3D) failed to measure the intrauterine placenta

Development of AI-technology for ultrasound measurements of the placenta

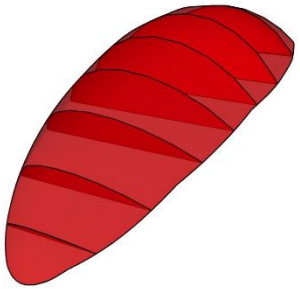
Methods – Volume, tracked 2D ultrasound

Position information

Series of 2D images → **3D volume reconstruction** → **Volume calculation**

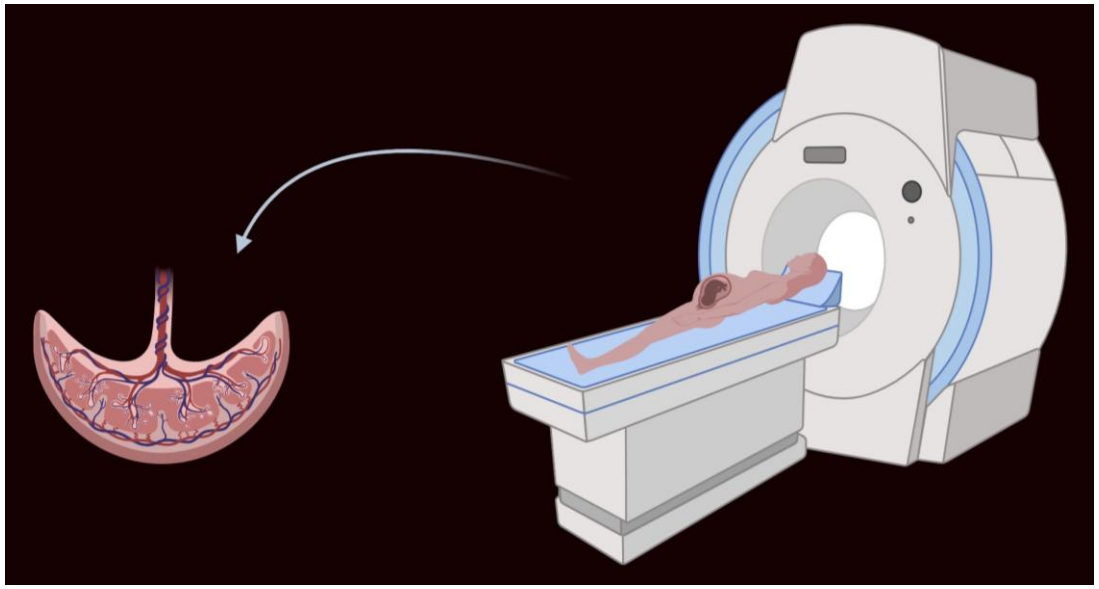


Manually or automatically segmented

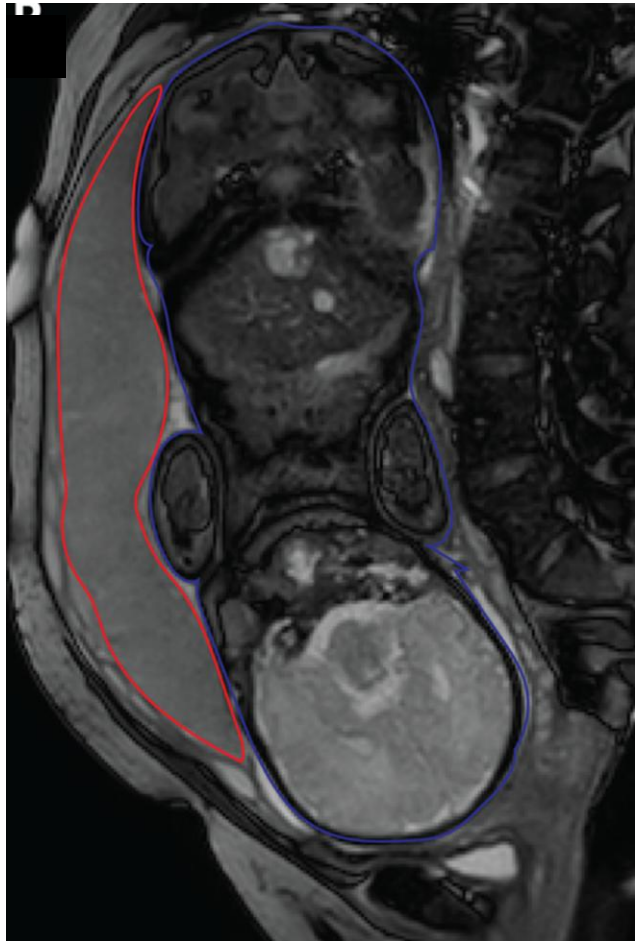


488cm^3

Development of AI-technology for Magnetic Resonance Imaging (MRI) measurements of pregnancy



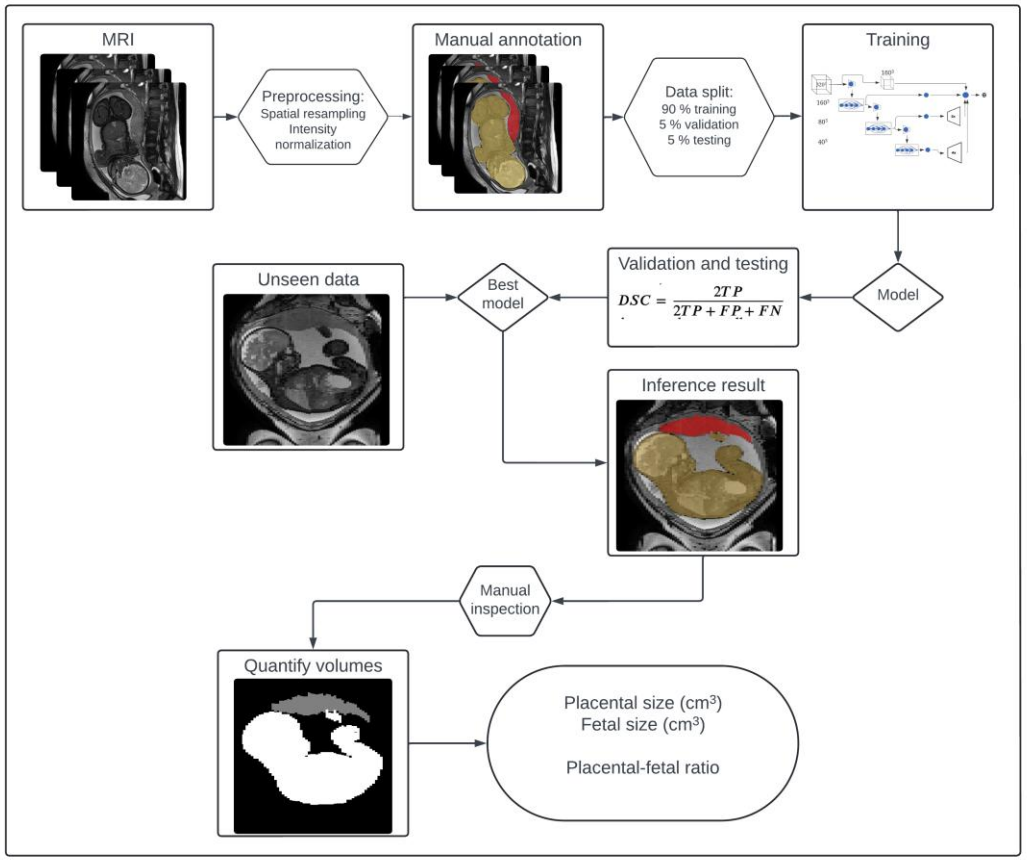
Manuell tracing of placental and fetal tissue on slices/images every <5 mm thru the uterus ------ takes time



MRI

- The whole pregnancy may be visualised
- Gold standard
- Manuell tracing of images takes time

Artificial intelligence (AI) for rapid and valid measurements of fetal and placental size



We trained the nevral network (AI) to recognize fetal and placental tissue on the MR slices/images and calculated size (volume)

The best model was achieved after 22 000 iterations

Comparison between the manual tracing and the AI estimated volumes; Dice Score Coefficient >0.895 (SD 0.041)

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Gestational Week	Class	Mean Volume cm^3 (SD)	Median Volume cm^3 (SD)	Placental/Fetal ratio	DSC
27	Placenta ($N = 5$)	615 cm^3 (SD 155 cm^3)	626 cm^3		0.895 (SD 0.041)
	Fetus ($N = 5$)	949 cm^3 (SD 140 cm^3)	952 cm^3	0.63	0.950 (SD 0.009)
37	Placenta ($N = 5$)	840 cm^3 (SD 264 cm^3)	874 cm^3		0.900 (SD 0.023)
	Fetus ($N = 5$)	2,619 cm^3 (SD 269 cm^3)	2,619 cm^3	0.34	0.970 (SD 0.003)
Total	$N = 20$				0.928 (SD 0.399)

Table 3
Mean DSC (SD) with placental/fetal volumes in cm^3 (SD) and ratio at gestational week 27 and 37 with respect to class of the testing data set.

Artificial intelligence (AI) for rapid and valid measurements of fetal and placental size

Class statistics (selected case)

Structure	Volume (mL)	Volume (L)
Fetus	1096.0 mL	1.096 L
Placenta	591.7 mL	0.592 L
Amniotic fluid	899.0 mL	0.899 L
Umbilical cord	50.4 mL	0.050 L

Future use of MRI –AI (Pregnancy Visualisation Tool)

- Photos of the baby before it is born

- Enables research
  - Differentiate between growth restricted and true small fetuses
  - Study if intrauterine placental size relative to fetal size (ratio), better that fetal size, predicts term date
  - Study if intrauterine placental size relative to fetal size (ratio), better that fetal size, predicts adverse pregnancy outcome, such as perinatal death

To summarize

- What does the placenta do?
  - Regulates the entire pregnancy

- Why should we measure placental size inside the uterus?
  - May give more precise information about fetal wellbeing and fetal age than fetal size solely

- Development of placental visualisation tools
  - May be available within a few years

Thanks to

Silje Sommerfelt

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