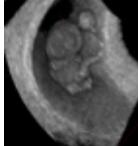


Erasmus MC
University Medical Center Rotterdam
Erasmus

3-D virtual reality in early pregnancy imaging

Niek Exalto and Anton Koning



I-Space

Erasmus MC
University Medical Center Rotterdam
Erasmus

amC

Dept of Bioinformatics

- Anton HJ Koning
- Dept of Obstetrics and Gynaecology**

 - Christine M Verwoerd
 - Eric AP Steegers

- Dept of anatomy and embryology**

 - Maurice JB van den Hoff
 - Dept of Obstetrics and Gynaecology**

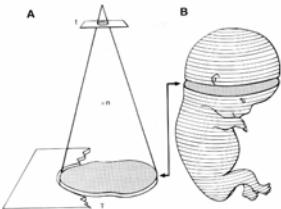
 - Babette AM Lisman
 - Kees Boer

Introduction I-Space Embryology Measurements Vasculogenesis

3-D reconstructions

Gustav Born 1876

- Solid reconstructions of embryos from stacking of wax plates
- 100 (magnification n) x 15 μm (thickness) = 1.5 mm plate thickness



Introduction I-Space Embryology Measurements Vasculogenesis

The collage consists of three distinct images. On the left is a black and white portrait of a man with glasses and a mustache, wearing a suit and tie, identified as Mr. Osborne O'Heard. In the center is the front cover of a book titled 'DE JONGE ZWANGERSCHAP' (Young Pregnancy) by H. Exalto, featuring a large, detailed 3D rendering of a fetal head and brain. On the right is a high-resolution 3D ultrasound image of a fetal brain, showing internal structures like the cerebrum and cerebellum.

Erasmus MC
LUMC

An anatomical illustration of a fetal brain and surrounding structures, likely a drawing by O'Rahilly and Müller. The image shows the intricate folds and grooves of the cerebral cortex. A small scale bar is visible at the bottom right.

3-D Ultrasound

Limitations

- Only an impression
- On a flat screen
- Or on flat paper
- Time consuming



Introduction I-Space Embryology Measurements Vasculogenesis

Virtual reality

- Head mounted display (VR helm)



Introduction I-Space Embryology Measurements Vasculogenesis

Cave concept 1990

- More than one person
- Higher resolution
- Less "simulation sickness"

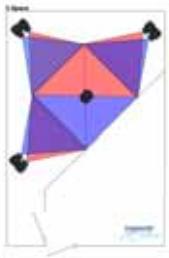


Introduction I-Space Embryology Measurements Vasculogenesis

Dept perception

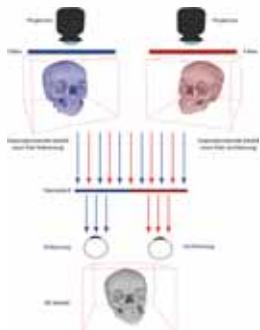
- Stereoscopic projection on walls, floor and ceiling (2x2 m)
- Dept perception by using a pair of Polaroid glasses





Introduction I-Space Embryology Measurements Vasculogenesis

Left and Right Polarised light



Introduction I-Space Embryology Measurements Vasculogenesis

CAVORE (Koning 1999)

- Images are viewed through glasses with polarizing lenses to perceive depth.
 - The “hologram” is manipulated by means of a virtual pointer, controlled by a wireless joystick.
 - Wireless tracking of the viewer’s head allows the computer to provide a correct perspective and motion parallax.

Introduction I-Space Embryology Measurements Vasculogenesis

Joystick



Erasmus MC
Casting

Introduction I-Space Embryology Measurements Vasculogenesis

CAVORE = volume rendering appl

Erasmus MC
Casting

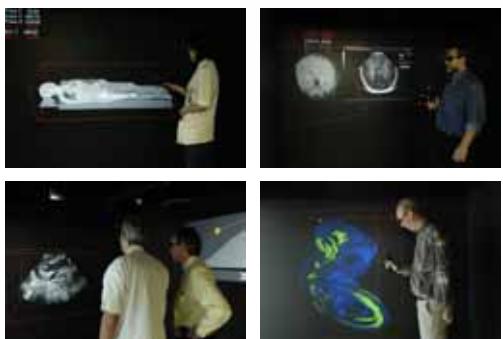
- Computer creates a hologram from the "volume"



Introduction I-Space Embryology Measurements Vasculogenesis

I-Space in Erasmus MC

Erasmus MC
Casting



Introduction I-Space Embryology Measurements Vasculogenesis

3D ultrasound and I-Space

Erasmus MC
Cafémed

- Ultrasound "volumes" (Voluson 730 Exp) were transferred to a computer
- Off line evaluation (4D View, GE Medical Systems) => BARCO I-Space



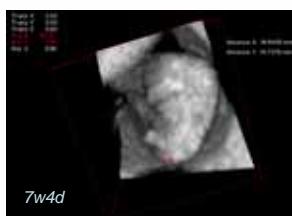
Introduction I-Space Embryology Measurements Vasculogenesis

Embryonic Staging Virtual Embryoscopy

Verwoerd et al 2007

Erasmus MC
Cafémed

- IVF pregnancies 7 - 10 weeks
- CRL measurements
- Carnegie Stages (external morphological features)



Introduction I-Space Embryology Measurements Vasculogenesis

4th dimension

Erasmus MC
Cafémed

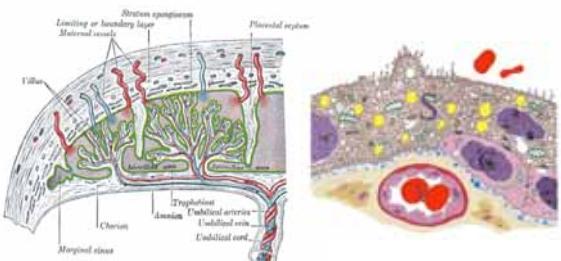
- Film 8w3d

Introduction I-Space Embryology Measurements Vasculogenesis

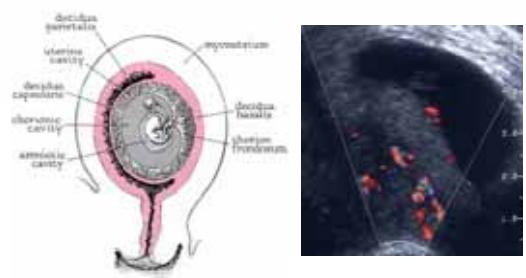
4th dimension

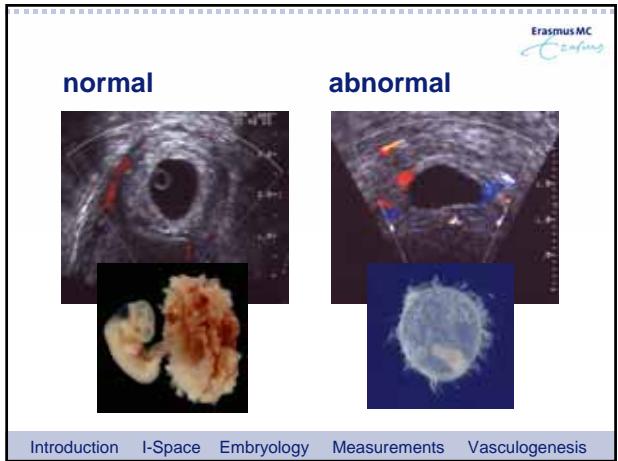
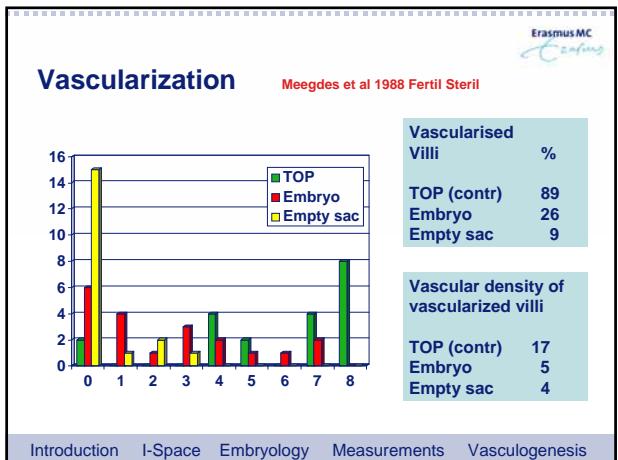
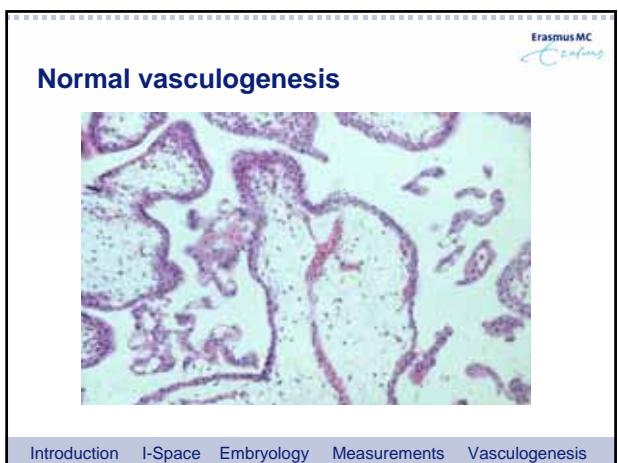
▪ Film 12w3d

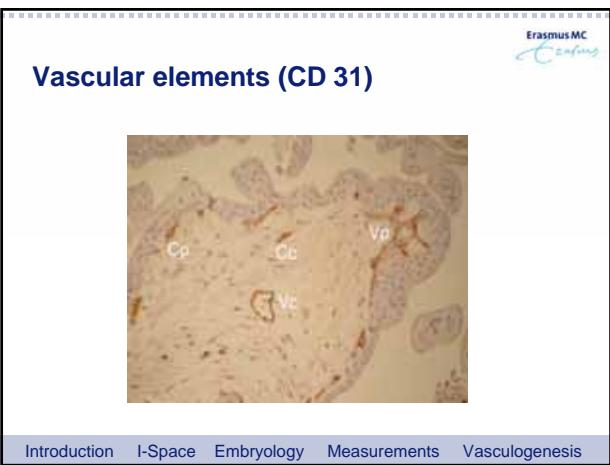
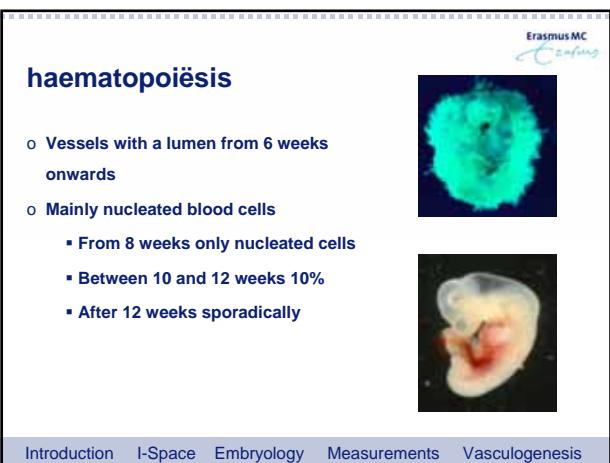
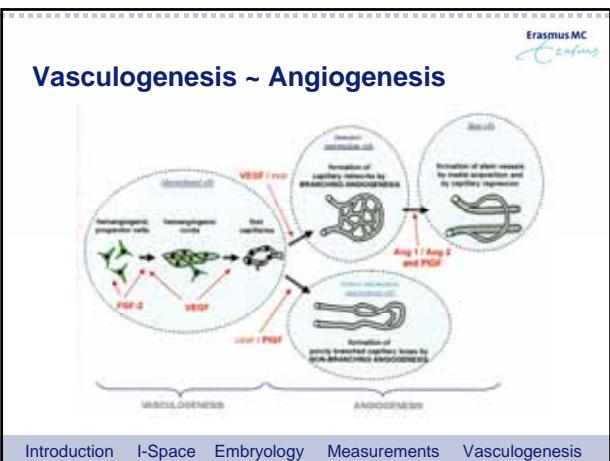
Vasculo-syncytial membrane

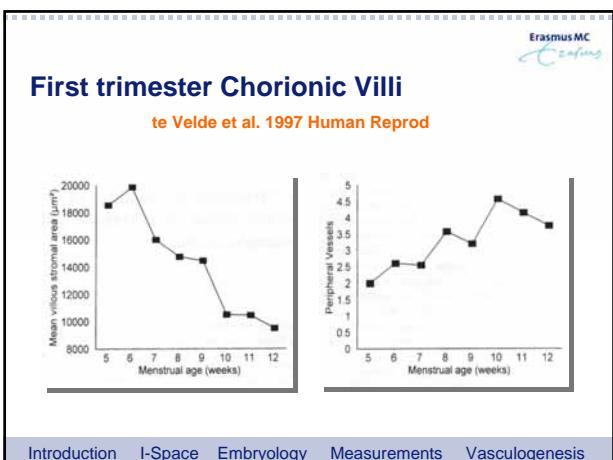


Intervillous space









Vascularization in first trimester

Lisman et al Fertil Steril 2002

The table compares vascular parameters (cords and vessels) across three groups: TOP, Fetal death, and Empty sac. The last column shows the total number of vessels.

Group	cords		vessels		Total	
	n	c	p	c		p
TOP	12	1.5	1.6	2.3	3.0	8.4
Fetal death	12	2.7	0.6	0.6	0.9	4.8
Empty sac	12	3.3	0.6	0.6	0.2	4.7

Vasculosyncytial membrane is not developed

Introduction I-Space Embryology Measurements Vasculogenesis

Late miscarriage

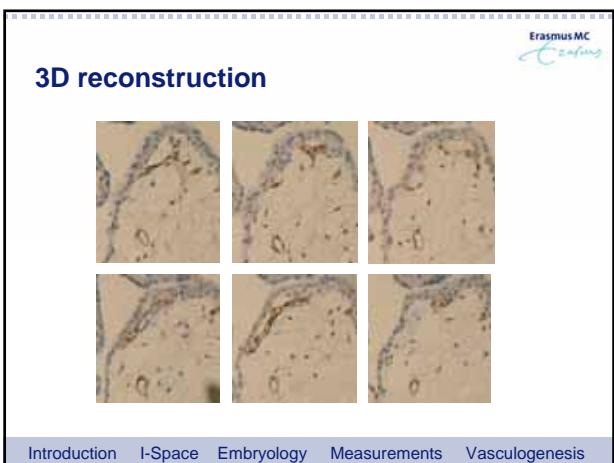
Lisman et al 2002

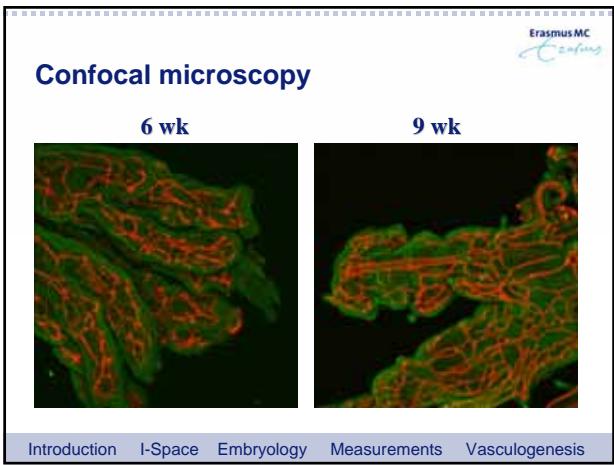
The table compares vascular parameters (cords and vessels) across three late miscarriage categories: Normal, Chrom abn, and IUGR. The last column shows the total number of vessels.

Category	cords			vessels	
	n	c	p	c	p
Normal	4	0.8	0.7	4.5	5.3
Chrom abn	10	2.5	2.7	3.2	2.7
IUGR	13	5.6	3.2	2.9	1.7

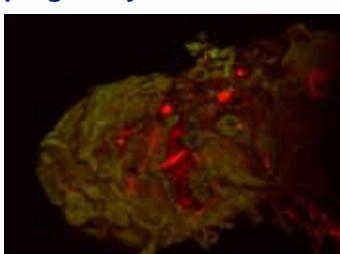
Introduction I-Space Embryology Measurements Vasculogenesis







Molar pregnancy



The image shows a histological section of a molar pregnancy under fluorescence microscopy. The tissue is stained with antibodies against specific markers. Green fluorescence highlights the syncytiotrophoblast layer and the stromal vascular network. Red fluorescence highlights the cytotrophoblast layer and other cellular components. The overall appearance is a dense, somewhat irregular cluster of cells with distinct coloration.

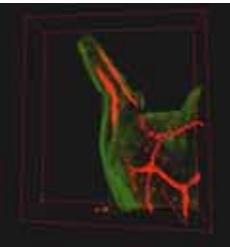
The image consists of two side-by-side confocal microscopy images of a biological tissue section. The left image is a standard 2D projection, while the right image is a 3D reconstruction. Both images show a complex network of fibers stained in red and green. The 3D reconstruction on the right provides a more comprehensive view of the spatial relationships between the different structures.

Microdissection 8 weeks

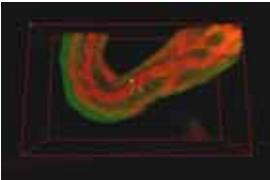
The figure displays two side-by-side 3D surface renderings of microdissected tissue samples from an 8-week-old embryo. Each rendering features a complex, branching structure, likely representing a vascular network or a specific type of tissue architecture. The structures are highlighted with vibrant colors (red/orange, green/yellow) against a dark background, indicating different regions of interest or different types of tissue components. A small watermark for 'Erasmus MC' and 'Leiden' is visible in the top right corner of the slide.

Microdissection

Clip plane



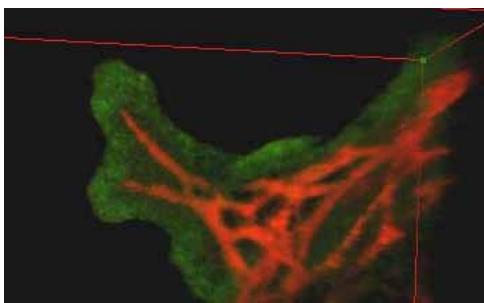
Measurements with callipers



Erasmus MC
Casting

Introduction I-Space Embryology Measurements Vasculogenesis

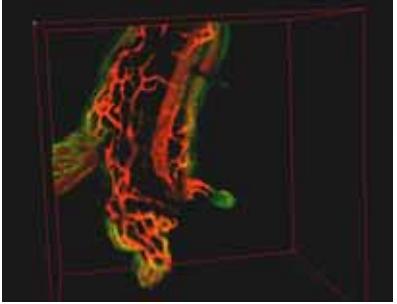
Sprout 12 weeks



Erasmus MC
Casting

Introduction I-Space Embryology Measurements Vasculogenesis

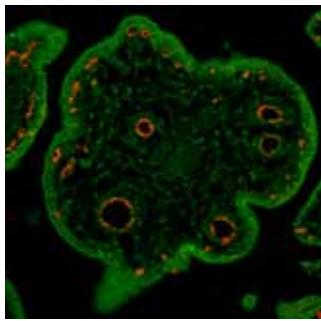
Circulation? 11 weeks



Erasmus MC
Casting

Introduction I-Space Embryology Measurements Vasculogenesis

Conclusion



- I-Space
 - virtual reality
- Ultrasound
 - microscopy
- Organogenesis
 - vasculosyncitial membrane

Introduction I-Space Embryology Measurements Vasculogenesis