Toward placental region identification and blood vessel classification using machine learning

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Abstract

Background: The placenta is a key driver of diseases of pregnancy and abnormalities in the placenta reflect life-long risk of disease in the mother and infant. Current identification of placental regions (region ID) is fundamental for diagnosis – observations differ depending on whether the region ID is used to recognize abnormal pathology or where it is located in the placenta. For example, thick walled vessels (TWA) in the decidua are evidence of decidual arteriopathy (DAS), whereas thick walled vessels (TWA) in the stem villi are indicative of placental microangiopathy. Identification of placental regions is fundamental for diagnosis, but identification of abnormal blood vessels is critical for understanding disease. Early recognition of abnormal placental blood vessels can aid in the evaluation and diagnosis of diseases of pregnancy and abnormalities in placental morphology.

Objectives: 1. To demonstrate that placental microanatomy is machine recognizable using our region ID classifier. 2. To create an algorithm to detect normal and abnormal blood vessels to aid in the diagnosis of vascular disease. 3. To understand the significance and limitations of pathologic examination of the placenta using machine learning.

Methods and Design

Introduction

- The placenta is the first organ to form, source of fetal O2 + nutrients, endocrine, immune system, excretion functions
- Causes or reflects most diseases in pregnancy and abnormalities are linked with life-long disease
- Less than 20% of placentas receive pathologic examination in the US
- Wide range of inter observer variability among pathologists
- AI can decrease interobserver variability and improve reliability of diagnosis
- We aim to train an AI to recognize abnormal placental blood vessel pathology

Results

1. To demonstrate that placental microanatomy is machine recognizable using our region ID classifier.
2. To create an algorithm to detect normal and abnormal blood vessels to aid in the diagnosis of vascular disease.
3. To understand the significance and limitations of pathologic examination of the placenta using machine learning.

Methods and Design

- We trained a region ID network using 200 WSI of placenta of varying gestational age & scanned & annotated these slides.
- We tested our region ID on whole slides has an overall accuracy of 98.1%.
- Blood vessel segmentation network in conjunction with region ID WSI were trained on labeled regions from our region ID classifier.
- Fed regions called decidua asked to show highest risk areas for abnormal BVs.

Discussion

We have successfully demonstrated that placental regions/microanatomy is machine recognizable with our region ID classifier. We are continuing to develop our algorithm to better classify abnormal blood vessels and vascular disease.

References