Abstract Details

Session title: Session 69: Biomarkers of developmental competence
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An oocyte assessment tool using machine learning; Predicting blastocyst development based on a single image of an oocyte

Biography

Dr. Dan Nayot, (B.Sc., M.Sc., M.D., FRCSC, REI) is a staff physician at TRIO Fertility. He completed his Obstetrics and Gynecology Residency at the University of Toronto, his fellowship in Gynecologic Reproductive Endocrinology and Infertility at McGill University, and his Masters of Science degree in Clinical Epidemiology at Harvard University. He's been awarded several research grants and academic scholarships, authored numerous scientific papers, and presented at international medical conferences. Dr. Nayot is an active reviewer, researcher, and lecturer

D. Nayot[1], J. Meriano[2], R. Casper[1], K. Alex[3].
[1]TRIO Fertility, Reproductive Endocrinology and Infertility, Toronto, Canada.
[2]TRIO Fertility, Embryology, Toronto, Canada.
[3]FutureFertility, Embryology, Toronto, Canada.

Study question:

Can an Artificial Intelligence (AI) based image analysis tool predict the blastocyst development potential of oocytes better than the current standard?

Summary answer:
Our AI image analysis tool outperformed all 17 embryologists by an average of 21.2% in predicting blastocyst development and, unlike the embryologists, was 100% reproducible.

What is known already:
There are no morphological features of oocytes that have been validated to have prognostic value for further developmental competence (Rienzi 2011). Currently there is no standardized or accepted visual oocyte scoring system (Alpha 2011), and therefore limited feedback about oocyte quality is available to patients and clinicians.

Deep learning offers promise for the automation and standardization of embryo quality assessment. There are several studies using machine learning in an attempt to automate embryo grading and improve embryo selection, but this is the first clinical application focusing on oocytes.

Study design, size, duration:
The Violet (an AI image analysis tool) was created with convoluted neural networks based on a retrospective dataset (n=17,659 oocyte images). It's able to predict fertilization and blastocyst development with 91.2% and 63% accuracy respectively in an unbalanced dataset.

In a balanced test set of 300 oocytes, the Violet outperformed all 17 embryologists, from 8 IVF clinics, in accurately predicting fertilization (71.7% vs 58.9±4.3%; 21.8% increase) and blastocyst development (62.8% vs 52.2±3.7%; 20.2% increase).

Participants/materials, setting, methods:
N/A

Main results and the role of chance:

In an unbalanced data set, the Violet was able to predict fertilization and blastocyst development with 91.2% and 63% accuracy respectively. It was especially effective at identifying negative cases with 99% accuracy when the confidence was > 70%

Two validation studies were performed to compare the Violet to embryologists. A balanced data set of 300 oocyte images was randomly selected from the test subset: 100 failed fertilization, 100 fertilized but did not reach blastocyst stage, and 100 reached blastocyst stage.

The Violet outperformed all 17 embryologists, from 8 IVF clinics, in accurately predicting fertilization (71.7% vs 58.9% ± 4.3%; 21.8% increase) and blastocyst development (62.8% vs 52.2% ± 3.7%; 20.2% increase).

In a reproducibility study, 7 of these embryologists underwent the same task 2-3 months later. The average accuracy remained close to chance, 53% ± 3.3% with an intra-observer reproducibility of 81.4% for blastocyst formation, while the Violet was 100% reproducible.

Limitations, reasons for caution:
As with all AI image analysis tools, a larger and more diverse data set is necessary to extrapolate findings. A prospective multi-centre validation study is currently underway to validate the Violet technology

Wider implications of the findings:
The lack of a visual oocyte assessment criteria is congruent with our findings that 17 senior embryologists were essentially unable to predict blastocyst development (average 52.2%). Machine learning image analysis improves our ability to assess oocyte quality in an instantaneous, non-invasive, reproducible and more accurate method than the current standard.

Keywords:
machine learning
artificial intelligence
Oocyte
Blastocyst