Prediction of live birth using Artificial Intelligence (AI) algorithm developed to evaluate embryo genetic status from Day 5 images

Authors

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Summary: A genetics AI for evaluating embryo images was predictive of live birth, suggesting it may be detecting morphological features correlated with genetic status that are also indicative of live birth outcome.

Objective

To investigate if a non-invasive AI algorithm developed to evaluate the likely genetic status of embryos at transfer is predictive of live birth.

Materials & Methods

1827 Day 5 embryo images with matched clinical pregnancy outcomes (fetal heartbeat at first scan) and live birth outcomes were retrospectively obtained from an IVF clinic in Australia. Images were provided for 1419 patients who underwent single embryo transfer between 2011 and 2017. The proportion leading to live birth was 26.4% (34.5% excluding pre-blastocyst stage images (*n* = 1066).

All images were analyzed by an AI algorithm developed previously, which evaluates the likelihood of the embryo being euploid according to pre-implantation genetic testing for aneuploidies (PGT-A) [1].

Results

The genetics AI score positively correlated with the probability of live birth, which increased 3-fold from the lowest (14.5%) to the highest (47.7%) scores. The AI was also predictive of live birth, with an AUC/ROC of 0.69 (Figure 1).

[1] Sonya M. Diakiw, *et al.* "Development of an artificial intelligence model for predicting the likelihood of human embryo euploidy based on blastocyst images from multiple imaging systems during IVF", Human Reproduction, Volume 37 Issue 8,, August 2022.

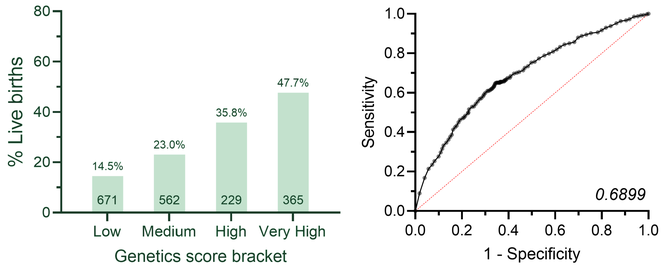

Figure 1: *Left:* Live birth success for each genetics score bracket: Low (0.0-2.5), Medium (2.5-7.5), High (7.5-9.0) Very High (9.0-10.0). *Right:* Corresponding ROC curve.

AUC/ROC was reduced to 0.64 for blastocyst-stage embryos only. Accuracy for predicting live birth on blastocyst-stage embryos was 61.4% using an optimized threshold of 7.6 / 10.0 (sensitivity 61.4%, specificity 61.3%). Accuracy for predicting clinical pregnancy was marginally higher at 62.2% (sensitivity 61.1%, specificity 62.9%) (Figure 2). However, AI score was not correlated with miscarriage after detection of a fetal heartbeat.

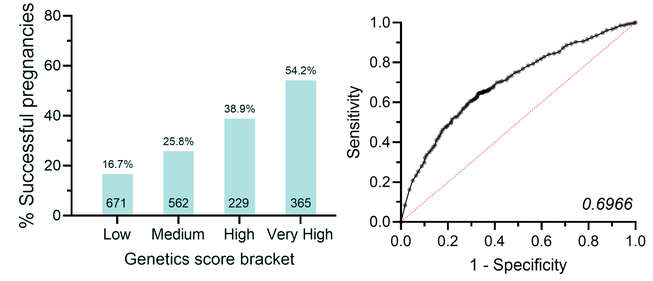

Figure 2: *Left:* Clinical pregnancy success for each genetics score bracket: Low (0.0-2.5), Medium (2.5-7.5), High (7.5-9.0) Very High (9.0-10.0). *Right:* Corresponding ROC curve.

The difference in accuracy between live birth and clinical pregnancy was primarily the result of an increased number of false positives when predicting live birth (+36 cases), possibly due to patient medical factors contributing to pregnancy loss but not necessarily related to embryo quality at transfer.

Average AI scores and probability of live birth were positively correlated with increasing inner cell mass (ICM) and trophectoderm (TE) grades (Figure 3). This provides further observational evidence that the genetics AI may be evaluating embryo genetic features correlated to the likelihood of live birth.

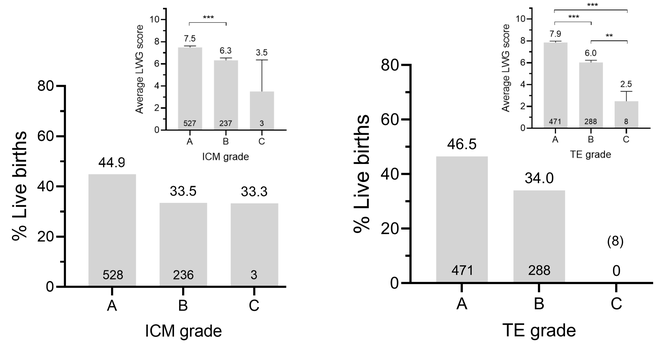

Figure 3: Live birth success rate for quality grades. *Left:* ICM grades. *Right:* TE grades. *Insets:* Average genetics score for ICM and TE grades with statistical significance as shown.

Wider Impact: The genetic status of an embryo at time of transfer is an important factor in determining the likelihood of successful live birth. Non-invasive methods of genetic assessment, such as the genetics AI described here, may provide viable alternative methods for evaluating the likelihood of a live birth outcome.