An artificial intelligence algorithm demonstrates optimal performance for evaluating embryo genetic status at 120 hours post-fertilization

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Summary: A non-invasive artificial intelligence (AI) algorithm for evaluating embryo genetic status from static, two-dimensional images maintained predictive ability for euploidy when considering embryos of the same expansion grade, and when embryos were imaged across different time-points on day 5. However, optimal performance for ranking and selecting euploid embryos was observed at 120 hours post-fertilization.

Objective

To investigate the effect of expansion grade and time-point on performance of a non-invasive AI algorithm for evaluating embryo genetic status.

Materials & Methods

2,683 images of day 5 blastocyst-stage embryos with matched ploidy outcomes from pre-implantation genetic testing for aneuploidies (PGT-A) were provided by 10 IVF clinics in the USA, Australia, Malaysia, and India. A subset of 182 embryos had images provided at 110, 115, and 120 hour time points, and were sourced from GERI and EmbryoScope time lapse systems.

Images were analyzed by a previously developed AI algorithm which evaluates the likelihood of an embryo being euploid according to PGT-A [1]. Evaluation was performed on embryos of each expansion grade, and at three time-points on day 5. Correlations were assessed using chi-squared test for trend, with pair-wise comparisons conducted using Student's t-test. Performance was evaluated using ROC-AUC, and a simulated cohort ranking analysis method described in [1].

[1] Diakiw, S.M. *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, *Hum. Reprod.* **37**(8), 1746–1759 (2022).

Results

AI scores positively correlated with expansion grade, and expansion grade likewise correlated with an increasing proportion of euploid embryos (Figure 1).

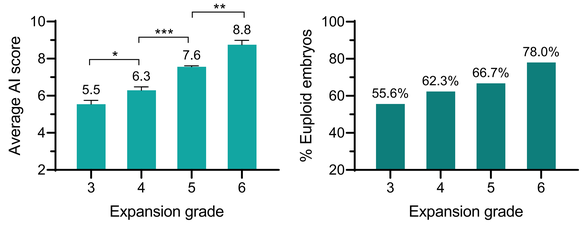

Figure 1: Correlation of AI scores and euploid rate with expansion grade (no grade 1-2 embryos available as these are not usually tested with PGT-A).

AI scores also increased over time on day 5 for a given expansion grade, consistent with continued embryo expansion. Scores for grade 4 (expanded) embryos increased more than for grade 5 (hatching) embryos, indicative of continued expansion becoming limited at later stages (Figure 2).

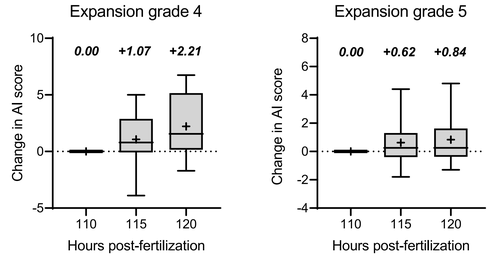

Figure 2: Change in average AI score over time on day 5 for expansion grades 4 and 5.

Despite the valid association of AI scores with expansion grade, the AI could predict euploidy even amongst embryos of the same expansion grade (Figure 3).

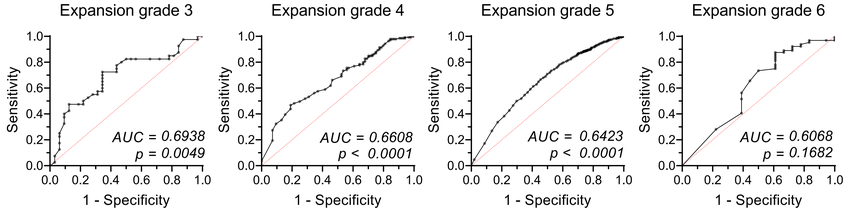

Figure 3: Receiver Operating Characteristic (ROC) curves for predictivity of AI scores within subgroups of embryos of the same expansion grade (AUC = area under the curve).

While predictive ability was maintained at each time-point on day 5, ROC-AUC values were highest at 120 hours (Figure 4). Simulated cohort ranking analyses showed that the AI performed best at 120 hours, selecting a euploid embryo as the top-ranked embryo in 77.1% of patient cohorts (71.4%, 75.1%, and 77.1% for 110, 115, and 120 hours, respectively).

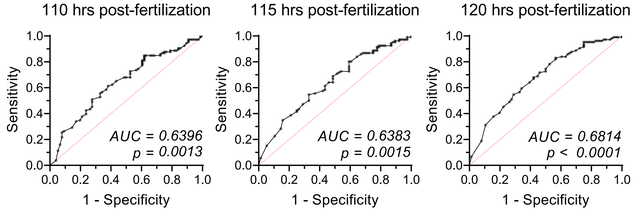

Figure 4: Predictivity of AI scores at different time-points on day 5 post-fertilization.

Wider Impact: These results suggest that the AI is providing additional information regarding embryo genetic status over and above that provided by known morphological parameters. They show that regardless of expansion grade, predictivity is optimized when embryos are assessed at the same time-point on day 5, preferably closer to the 120 hour time-point.