AI-based Assessment of Embryo Viability Correlates with Features of Embryo Ploidy

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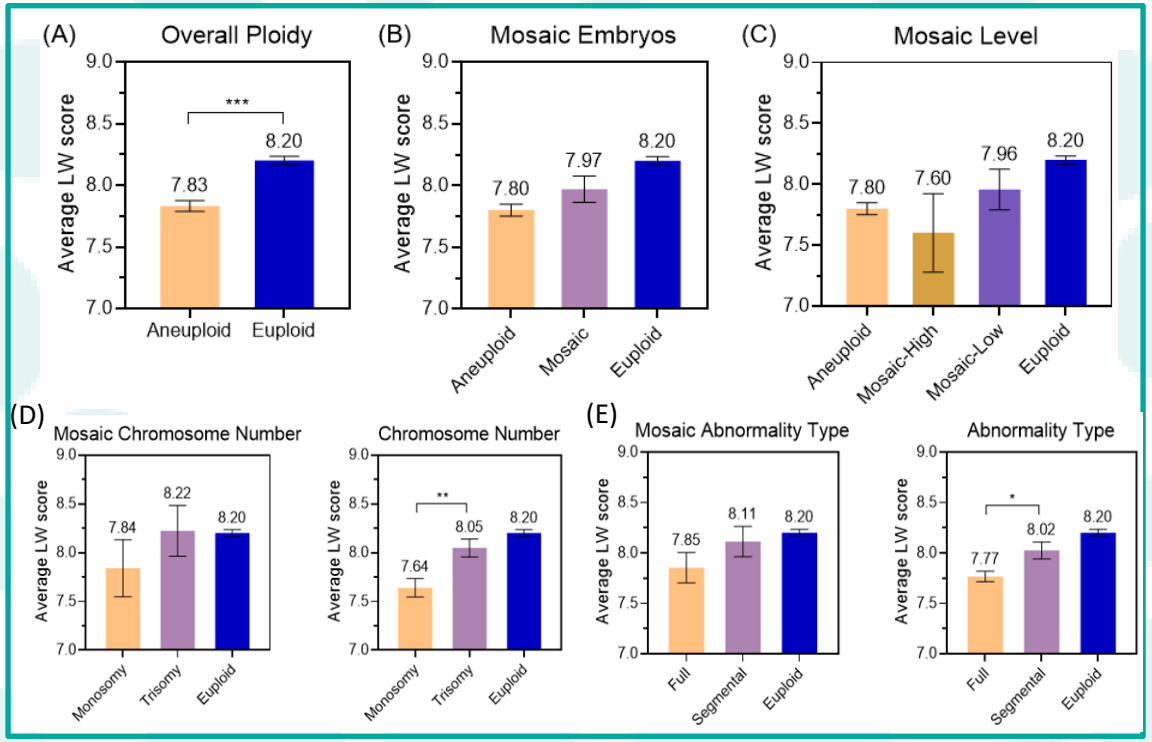
Introduction and Background

One of the main factors that can influence pregnancy success is the genetic integrity of the embryo. PGT-A is commonly used to test for embryo aneuploidies, with the aim of identifying karyotypically normal embryos (euploid embryos), for preferential transfer. Transfer of euploid embryos is associated with more favorable clinical outcomes over aneuploid embryos.

The Life Whisperer Viability AI model was trained to predict clinical pregnancy, and it was hypothesized that the AI score might also correlate with ploidy status, and with different types of aneuploidies.

Study Design and Methods

This study involved analysis of a retrospective dataset of static Day 5 embryo (blastocyst) images with associated PGT-A results and AI viability scores. The dataset comprised images of 5,469 embryos from 2,615 consecutive patients treated at five US IVF clinics between February 2015 and April 2020. The AI was trained and validated on 3,651 Day 5 embryo images with pregnancy outcomes from multiple IVF laboratories across 5 countries, but was not trained on data used in this study. Average patient age was 36.2 years, and average embryo cohort size was 2.1/patient. PGT-A analysis was performed on embryos at time of evaluation. The dataset comprised 3,251 (59.4%) euploid embryos, 1,815 (33.2%) aneuploid embryos, and 403 (7.4%) mosaic embryos. The AI was used to score all embryos, providing a score between 0 (predicted non-viable) and 10 (predicted viable) for each image.



Correlation between the AI viability score and euploid, mosaic and aneuploid embryos was then assessed.

Main Results

Results showed a statistically significant correlation between AI viability score and PGT-A outcome, consistent with a relationship between pregnancy outcome and ploidy status. The average AI score for euploid embryos was 8.20, which was significantly higher than the average score for aneuploid embryos of 7.83 ($p<0.0001$) (Figure – A).

There was a significant linear increase in confidence score from full aneuploid embryos, through mosaic embryos (average score 7.97), to full euploid embryos (mosaic threshold of 20-80%) (Figure – B). High mosaic embryos tended to have a lower average score (7.60) than low mosaic embryos (7.96), consistent with correlation of viability (pregnancy outcome) with the degree of mosaicism (Figure – C). AI viability score also correlated with ploidy features believed to affect pregnancy outcomes.

Trisomic changes had higher average scores than monosomic changes (Figure – D). Segmental changes had higher average scores than full gain or loss (Figure – E). The AI score differentiated euploid from aneuploid status more efficiently in embryos with poorer morphology than those with good morphology. Whilst there was an evident correlation between pregnancy outcome and ploidy status, the AI was only weakly predictive of euploidy, with an accuracy of 57.3% using an AI viability score threshold of 7.5/10. This suggests pregnancy-related morphological features are somewhat (but not completely) correlated with embryo ploidy.

Limitations

This study highlights that viability and genetic integrity are correlated but not entirely overlapping. The AI evaluated here has been trained on pregnancy outcome data, with correlations shown with embryo ploidy. However, an AI trained on embryo images and PGT-A outcomes may provide a better non-invasive embryo ploidy evaluation.

Wider implications

The AI score correlated with genetic features of embryos that are known to correlate with pregnancy, which further supports the efficacy and use of AI for embryo viability assessment. Combination of embryo viability and embryo genetic assessment is a powerful measure of embryo quality and is likely to improve embryo ranking and pregnancy outcomes.