AI study shows the effect of patient age on embryo quality is inherent in the morphology of an embryo

Summary Results: Age-related effects on embryo quality are inherently captured in embryo morphology. AI algorithms that assess morphology correlate with expected decline in embryo quality with age.

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Study Question

> Does patient age need to be explicitly factored into embryo quality assessment, or does embryo morphology alone capture the age-related decline in embryo quality?

Study Design

The study used a retrospective dataset of static Day 5 blastocyst images taken using an optical light microscope with associated PGT-A or pregnancy outcomes. The dataset comprised images of 4,000 embryos sourced from 1,199 consecutive patients treated between 2011 and 2020 at five IVF clinics (USA). The study evaluated correlation of algorithms Life Whisperer Genetics and Life Whisperer Viability with patient or donor age. Data were excluded in donor cases where age was not known.

4,000 embryo images were used to report a linear correlation between proportion of euploids (%) and pregnancies (%) across six age-brackets, between 20 to 50 years old. Life Whisperer Genetics AI was applied to a blind dataset of 809 images to assess likelihood of euploidy, and Life Whisperer Viability AI applied to a dataset of 556 images to assess likelihood of pregnancy. Scores within each age-bracket were averaged and chi-squared analyses was used to assess significance.

Results

There was a significant negative correlation between the number of euploid embryos (%) and patient/donor age on a dataset of 4,000 images (slope of -13.2±0.2), and on a blind test set of 809 embryos (slope of -11.2±0.2). The Life Whisperer Genetics AI score was then reported on the blind test set, showing a significant negative correlation with age (-0.45±0.16 with a $\chi 2$/dof value of 0.41 – see Figure 1). The significant downward trend indicates that the AI, using morphology alone, can account for the age-related impact in the genetic competence without a corresponding reduction in accuracy, and without needing additional age-related variables in its calculation. The AI was able to generalize correctly, identifying morphological signs of ploidy well, regardless of age.

Regarding cytoplasmic or metabolic competence, we report on a blind dataset of 556 images that the proportion of viable embryos (%) reduces with increasing patient age, although exhibiting a peak in proportion of viable embryos in the 25-29 year bracket (see Figure 2). Similarly, we show that Life Whisperer Viability AI scores within each age-bracket reduce with age.

Our results suggest that both AI algorithms for genetic competence and metabolic competence in terms of viability take into account patient age based on morphology.

Wider Implications

As the age of the patient increases, the morphology of their embryos also changes, corresponding to a decrease in embryo quality. This justifies morphology-based embryo quality assessment, giving credence to generalizable AI that perform robust assessment of embryo quality for patients of all ages, and do not require calibration.

Related literature

1Demko, Z. P., Simon, A. L., McCoy, R. C., Petrov, D. A.,& Rabinowitz, M., Effects of maternal age on euploidy rates in a large cohort of embryos analyzed with 24-chromosome single-nucleotide polymorphism-based preimplantation genetic screening. Fertil. Sertil. 105(5): 1307-1313 (2016).

VerMilyea, M., Hall, J. M. M., Diakiw, S. M. Johnston, A., Nguyen, T. V.,.Perugini, D., Miller, A., Picou, A., Muphy, A. P. & Perugini, M., Development of an artificial intelligence-based assessment model for prediction of embryo viability using static images captured by optical light microscopy during IVF, Hum. Reprod. 35(4): 770-84 (2020).

Figure 1 - Genetics

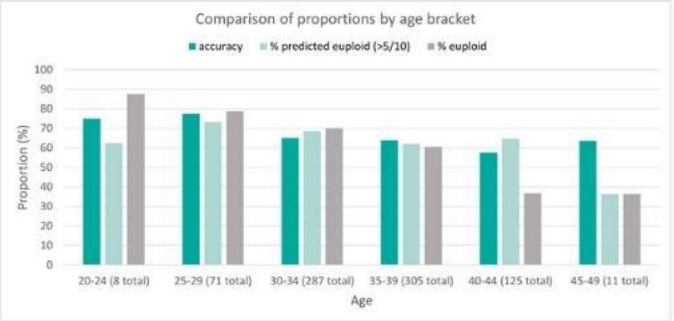

Figure 1 . Comparison of proportions of correctly predicted embryos, embryos predicted as euploid, and actual euploid embryos in each score bracket, on 809 test embryos.

Figure 2 - Viabilty

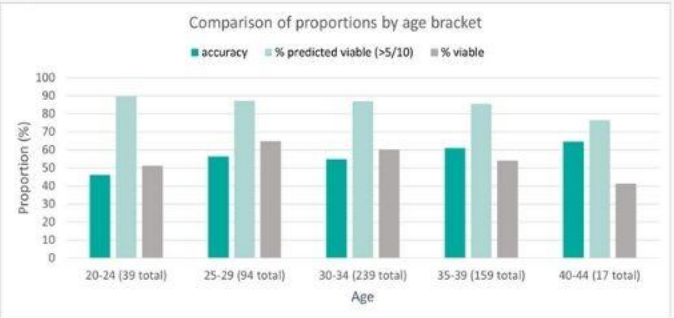

Figure 2 . Comparison of proportions of correctly predicted embryos, embryos predicted as viable, and actual viable embryos in each score bracket, on 556 test embryos.