Identifying the optimal morphokinetic range for euploid embryos using CHLOE-EQ, an AI-based embryology assistant

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Objective:

To identify the optimal time-range of morphokinetic events in euploid embryos compared to aneuploids using CHLOE-EQ an AI automatic embryo assessment assistant.

Study design:

Retrospective, observational study of 143 time-lapse embryos from a private fertility clinic in Brazil in 2022. Comparator between human and CHLOE-EQ (AI-based embryo assessment tool).

Methods:

Embryo time-lapse videos were automatically annotated using CHLOE-EQ (Fairtility) for morphokinetics, PN number and anomalies. The frequency distribution for each morphokinetic parameter was compared between euploid and aneuploid embryos to establish ranges for optimal euploidy rate. The ranges between optimal (maximum euploidy rate) and all embryos were compared (paired t-test). Level of agreement between CHLOE-EQ and embryologist was assessed for morphokinetics (ICC) and PN assessment (Kappa). Efficacy of predictions of CHLOE-EQ scores were assessed (AUC).

Results:

For each morphokinetic event, an optimal range for identification of euploids compared to aneuploids was identified (**tPNf**:21.6-27.5; **t2:**24.8-30.2; **t3:**35.9-42.5; **t4:**36.8-44.5; **t5**:48.7-65.1;**t6:**49.6-66.3; **t7:**52.5-68.8; **t8:**56.6-79.5; **t9:**65.9-90.4; **tM**:80.3-96.8; **tsB**:91.6-109.8; **tB:**97.7-107.5). Optimal range of euploid embryos was smaller than the total range for all embryos ($p<0.001$): **tPNf** (5.87 vs 34.99), **t2**(5.37 vs 37.35),**t3**(6.62 vs 74.52), **t4**(7.77 vs 39.21), **t5**(16.4 vs 68.61),**t6**(16.72 vs 67.58), **t7**(16.31 vs 66.36), **t8**(22.89 vs 51.51), **t9**(24.48 vs 44.24), **tM**(16.46-49.03), **tSB**(18.27-53.14), **tB**(9.81-51.1) and a reduced euploid rate was found outside of the optimal range ($p<0.001$). The accuracy of PN assessment was 99% (195/197). Agreement between experienced embryologists and CHLOE-EQ was very strong in all morphokinetic events (AUC 0.928-0.997). CHLOE-BLAST Score was predictive of blastulation (AUC=0.99), whilst CHLOE-EQ Score was predictive of utilisation (AUC 0.96), selection for transfer (AUC=0.85), euploidy (AUC=0.67) and CHLOE Ranking was predictive of utilisation (AUC=0.86) and selection for transfer (AUC=0.86).

Limitations:

Retrospective assessment of a single clinic. Only blastocysts deemed suitable for biopsy were assessed for ploidy, therefore, the ploidy rate of non-blastocysts or inferior quality embryos is unknown, creating a potential bias regarding the lower cutoff threshold for optimal ranges.

Conclusion:

CHLOE-EQ can identify the optimal morphokinetic time range to maximise the chance of an embryo being euploid, a potentially valuable biomarker for embryo selection, especially within the context of a PGT-A program, potentially providing consistency in embryo selection for biopsy.