Automatic Identification of Human Spermatozoa with Zona Pellucida Binding Capability in Clinical Assisted Reproduction using Deep Learning

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Technology

Sperm morphology evaluation is crucial in semen analysis to assess male fertility potential and determining the appropriate insemination methods in assisted reproduction technology (ART). However, the current manual assessment, which relies on microscopically examining individual sperm based on WHO criteria, has limited predictive power for fertilization outcomes due to its highly subjective, labor-intensive nature, and high inter-/intra-assay variations. Our novel deep learning model offers an alternative approach of assessing sperm functional potential by their capability of binding to the zona pellucida (ZP) surrounding an oocyte, the first step leading to fertilization using image analysis. This novel sperm quality metric can be used to identify couples at high risk of unexpected fertilization failure for personalized clinical management.

Wider Implications

An automated system integrating with our deep learning model can allow real-time identification of patients who may benefit from the alternative insemination methods to improve the chances of fertilization success in clinical ART.

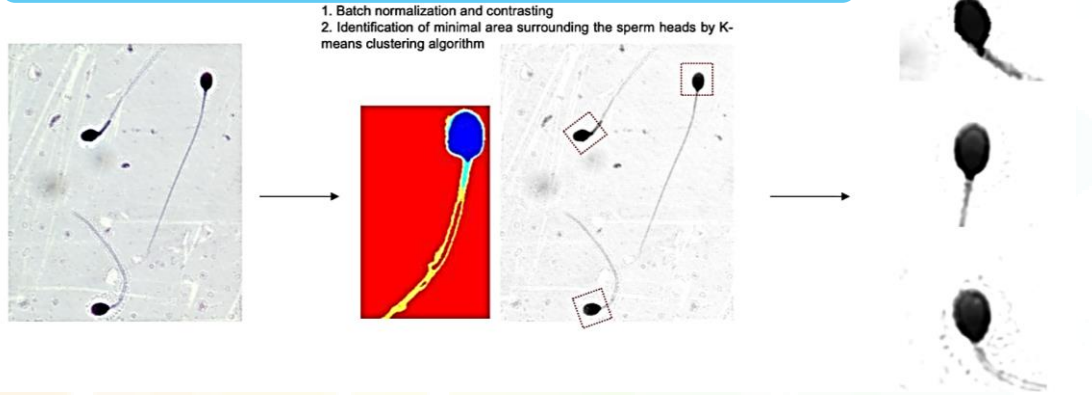
Key Findings

- A deep learning model, irrespective of the conventional semen analysis, was established to identify human sperm capable of binding to ZP for predicting their fertilization potential.
- A clinical threshold of 4.9% can be used to identify patients with defective ZP-binding ability, showing strong correlations with the fertilization outcomes following in vitro fertilization (IVF).

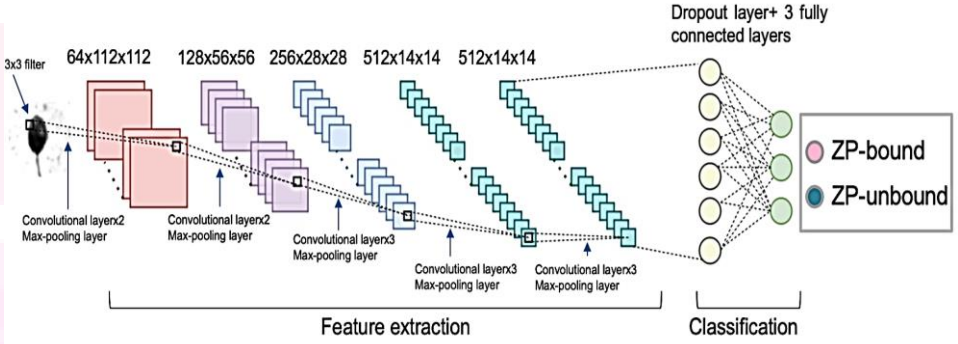
Stage of Development

- Image processing and prediction algorithms: submitted for provisional patent.
- An integrated system for image analysis: undergoing clinical validation with a larger sample size.

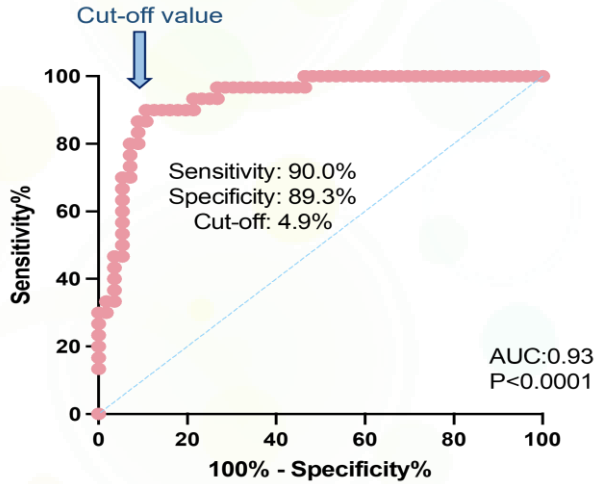
Stage 1: Sperm image processing and extraction



Stage 2: Deep learning model establishment



Stage 3: Identification of a clinical threshold for predicting IVF fertilization outcome



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Intellectual Property

- Provisional Patent No: 63/567,147

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