Human oocytes mechanical characterization with a robotics sensing platform based on magnetic springs

Research framework

The human oocytes selection plays a critical role in assisted reproductive technology (ART) success rate. In order to improve this rate, a new instrumentation is necessary to extend the usual ways used by physicians to determine oocytes quality and their maturity level. This new instrumentation must be compatible with ART constraints and physicians habits.

Among the new ways available to determine the maturity level of a human oocyte, the characterization of its mechanical properties is potentially interesting and has to be investigated. This study requires a force sensor with a very low stiffness (to have a high resolution) and also a large measurement range if high deformations have to be characterized. Force sensors based on magnetic springs have such characteristics and can potentially be a part of this new instrumentation.

Proposed approach

Experimental load-unload cycles have been applied on humans oocytes with a magnetic springs based robotics platform. The stiffness of the embedded 2-DOF force sensor is 0.02 N/m. The complex mechanical influence of the IVF culture medium is not negligible and has to be compensated with a specific experimental measurement protocol. The human oocytes elastic behavior is linear for low loading (around 0.01 N/m or less) and non-linear for high loading. After high loading a visco-elastic behavior is associated to the unload stage. This behavior is oocyte dependant and a significant evolution in time has been observed for oocytes getting older.

Major article: J. Abadie, C. Roux, E. Piat, C. Filiatre, C. Amiot, Experimental measurement of human oocyte mechanical properties with a micro and nanoforce sensing platform based on magnetic springs, Sensors and Actuators: B Chemical, 190(2014)429-438.

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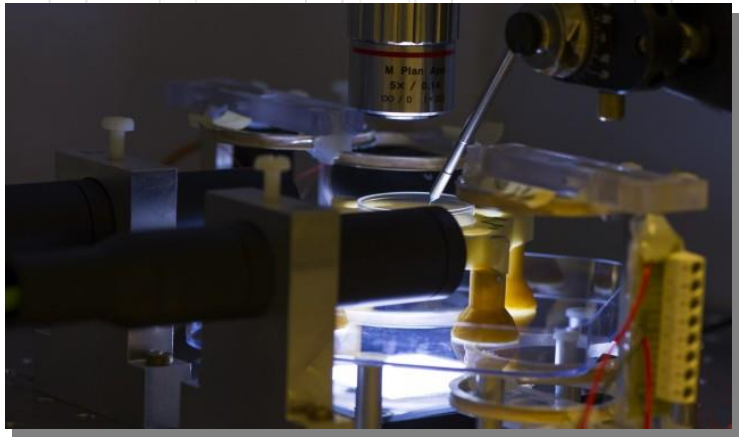
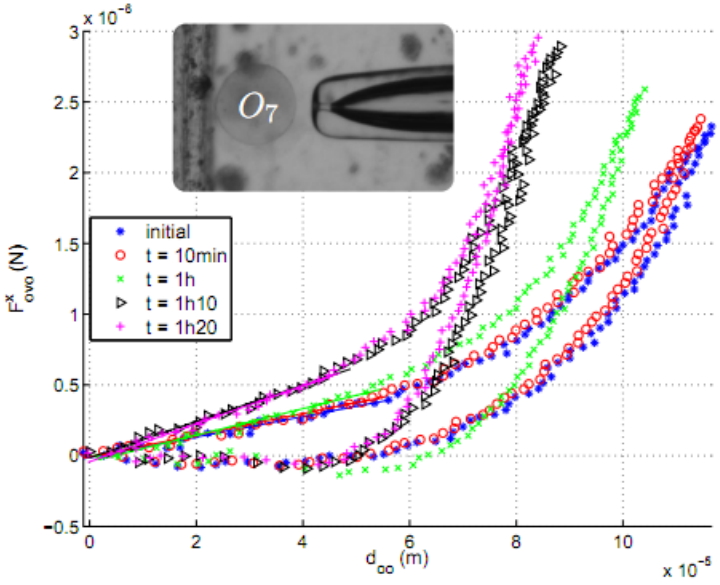


Robotics platform used for oocytes stiffness characterization



Evolution of the stiffness of a given oocyte in M1 state during consecutive loading stages

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