OCM imaging and assessment of oocyte/embryo developmental potential

Approximately 15% of couples in a reproductive age suffer from fertility problems and *in vitro* fertilization (IVF) is one of the most popular methods of treating infertility. In spite of a great advancement in IVF procedures that took place in the last decades, their efficiency reaches 50% in young patients, but is several times lower in older patients. Apart from clinical use, IVF plays also an essential role in livestock breeding programmes and in preservation of endangered species. To increase the efficiency of this procedure, only the most viable embryos should be selected for transfer to mothers. This, in turn, puts a constant pressure on scientists and physicians to develop novel, reliable methods of evaluating embryonic developmental potential. In the current project, we plan to examine whether optical coherence microscopy (OCM), a novel method of cell imaging, can provide information useful for assessing developmental abilities of mammalian oocytes/embryos. Moreover, as aging strongly affects efficiency of IVF procedure, we will extend our study to include oocytes subjected to maternal (related to female's age) and postovulatory (related to time between ovulation and fertilization) aging, and we will determine whether the OCM-obtained parameters can help in evaluation of aged oocytes. We will conduct our experiments on mouse oocytes/embryos, which are commonly used as a model in developmental and reproductive biology.

Mouse oocytes/embryos will be scanned by OCM in order to collect selected morphological parameters (i.e. internal structure of a nucleus, localization and shape of a division spindle, distribution of organelles, number of nuclei, dynamics of nuclear growth and migration in zygotes) and then (i) cultured *in vitro* for 5 days in order to assess their early (so called preimplantation) development, or (ii) transferred to the female oviducts for evaluation of their late (so called postimplantation) development. (When OCM measurements are conducted on oocytes, oocytes will be first subjected to insemination - its effectiveness of will be also assessed). Then, we will examine the relationship between the tested parameters and embryonic developmental capacity and we will try to create algorithms that predict developmental potential of the embryo. All imaging protocols useful in evaluating quality of oocytes/embryos will be tested for oocyte/embryo safety. As mentioned before, in part of the experiments we will use, apart from freshly ovulated oocytes from young females, oocytes subjected to maternal or postovulatory aging.

To our knowledge, no one has tried yet to use the OCM technique to evaluate developmental capacity of mammalian oocytes/embryos, although it can undoubtedly provide useful information. However, we have recently demonstrated that high-resolution 3D time-lapse OCM imaging can be obtained and this most likely will increase reproductive scientists' and clinicians' interest in this imaging method. It is also important to note, that some of the parameters proposed in our project have not been tested yet as indicators of oocyte/embryo quality, so our project is not simply an attempt to apply a novel imaging technique to embryo grading protocols, but also a search for novel markers of oocyte/embryo developmental competence. Furthermore, as aging is an important factor affecting efficiency of IVF procedure, we wish to examine whether parameters obtained by OCM can help in assessing quality of oocytes/embryos subjected to maternal and postovulatory aging. Aging impairs various aspects of oocytes physiology in heterogeneous way: some oocytes are more severely affected than the others. Therefore it is extremely important for the IVF efficiency to select reliably those oocytes/embryos that maintain the highest cellular quality. Taking into account the above-mentioned arguments, we believe that our research dedicated to the application of OCM to evaluation of oocyte/embryo developmental capacity will be an important contribution to embryology and reproductive biology, and in future it may help to improve protocols of embryo assessment in clinical and veterinary practice.