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Mammalian Oocyte Cryopreservation

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Oocyte cryopreservation as an adjunct to conventional IVF, complements assisted reproduction by extending its application to both fertile and infertile women as well as those faced with a new diagnosis of cancer and sterilizing therapies. In addition, oocyte cryopreservation is a successful alternative for embryo freezing during the ART therapies, thus avoiding ethical, moral and religious dilemmas.

Despite the extensive studies and the new achieved advances over the past few years in the field of female fertility preservation, limited progress has been made in cryopreservation of mammalian oocytes.

The majority of recent successes on human oocyte cryopreservation and what being reported indicating the comparable development and pregnancy rates of cryopreserved oocytes to those for cryopreserved embryos, however, have been mainly achieved by using in vivo derived MII stage oocytes followed by ICSI procedure.

In another species, the developmental competence of cryopreserved oocytes in terms of development to the blastocyst stage has remained low, and only very few successful pregnancies and offspring have been achieved which is highly dependent on the species, origin and developmental stage of the oocyte (in vivo or in vitro derived), and the cryopreservation procedures utilized.

The reasons for this lack of progress may result from a dearth of information on how the various biophysical, biochmichal, and ultra-structural changes during a cryopreservation regimen affect mammalian oocyte function. During cryopreservation, the oocytes suffer considerable structural and functional damages which are more evident compared to the embryos. This problem apart from the delicate cytological architecture of the oocyte is mainly related to the large size of the oocytes, low surface to volume ratio, making it more difficult for water and cryoprotectants to move across the cell plasma membranes.

Apart from the detrimental alterations of oocyte structural components due to cryopreservation, general shortage in mRNAs content and reduction of metabolome and proteome of the cryopreserved oocyte related to the several critical cell functions and developmental competence such as those involved in metabolism, compaction, and blastulation are the main consequences of oocyte cryopreservation.

Many attempts have been conducted to improve cryopreservation protocols in both slow and ultra rapid freezing procedures such as: using different kinds of cryodevices, application of several new cryoprotectant cocktails, and supplementation of vitrification/freezing media with free radical scavengers, conjugated isomer of linoleic acid, antioxidants, and cytoskeleton stabilizer.

Nonetheless, despite the all efforts done to facilitate the improvement of cryopreservation methods and our knowledge and progresses achieved related to the mechanisms of cryoinjuries, the unpredictable outcome of oocyte cryopreservation has prevented a breakthrough and made it hard to plead for implementation of this technology in broad practical application.

The species and maturational status of the oocyte (in vivo and in vitro) are the two most important variables among contributing factors which should be considered in designing of any cryopreservation protocol. In any case, apart from the avoidance of the three major drawbacks of cryoprocedures (ice-crystal formation, solution effects and osmotic shock), as principals of any cryopreservation protocols, other aspects of cryoinjeris such as alterations in mRNAs, metabolome and proteome contents of the oocyte especially those involved in compaction, blastulation, and post implantation development of resulting embryos should be taken into account. To achieve this goal the future approaches besides the general consideration to avoid the biophysical injuries of cryopreservation procedures on delicate ultrstructural component of the oocyte (e.g. disorganization of the spindle, alteration of microtubules and microfilaments, mitochondrial potential membrane), should elaborately be designed based on the results of the emerging studies in the field of biochemical and molecular events induced by the application of this technology. Additionally, the effects of high hydrostatic pressure application on increasing the oocyte cryotolerance and the application of cytoplasmic or mitochondrial reach fraction transfer to cryopreserved oocyte might be consider as another approaches that need to be further investigated.

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