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Key Lectures

K-49
Can in vitro culture condition influence pre-implantation embryo aneuploidy?

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Natural fecundity has a low rate in humans compared to other mammals, so that the probability of pregnancy for a healthy fertile couple in each menstrual cycle is less than 25%. On the other hand, according to the available evidence, about 10-40% of pre-implantation embryos are lost after fertilization in normal healthy women. Aneuploidy is the most important cause of embryo implantation failure. Aneuploidy increases as women are aging. Some studies have reported the rate of 20 to 40 % of chromosomal abnormalities in embryos among healthy fertile women following natural conception. However, the rate of aneuploidy of in vitro fertilized embryos is much more than embryos from natural conception, and this rate increases with maternal age from 73% in women under 35 to 87% in women aged 41 or older.

The causes of aneuploidy in human embryos remain largely unknown. In addition, the level of aneuploidy in the gametes which produce these embryos is lower than the level of aneuploidy in the resulting embryos, so that approximately 20% of the retrieved oocytes in IVF cycles and about 9% of the sperm in each ejaculate have aneuploidy on their haploid chromosomes. Interestingly, about 90% of aneuploidy of human embryos originates from oocytes. In particular, the type of chromosomal abnormalities in embryos and oocytes is quite similar, mainly aneuploidy, while most chromosomal abnormalities in sperm are structural.

Furthermore, the rate of aneuploidy in embryos that underwent intracytoplasmic sperm injection (ICSI) procedure is higher compared to embryos obtained from IVF. Therefore, it seems that in vitro oocyte manipulation for ICSI has adverse effects on oocytes and leads to aneuploidy in embryos. Two hypotheses can be considered for the relatively high rate of embryo aneuploidy in IVF/ICSI cycles; controlled ovarian hyperstimulation (COH) is the first exogenous factor and the second is IVF laboratory conditions. For COH, various factors such as the type and dose of drugs, duration of ovarian stimulation, and even the aspiration from ovarian follicles can affect the integrity of the oocyte chromosomes.

However, multiple environmental variables in embryology laboratories can affect the chromosomal integrity of oocytes and embryos. These variables include the type of culture medium, culture conditions, pH, temperature, osmolality and oxygen tension, contaminants and volatile compounds, gamete manipulation, and gamete aging in terms of immaturity or post-maturity of the oocytes. Serious variations in the IVF laboratory environment may lead to mitotic spindle alterations, centrosome amplification, cell-cycle checkpoint defects, non-separation of chromatids, and telomere stability, causing defects in chromosome segregation and aneuploidy.

Studies conducted in IVF centers show as much as 40% variations in aneuploidy rates between different IVF centers; donated oocytes of young women and even the oocytes of the same donors were used in these centers by implementing a similar screening method for chromosomal abnormalities.

This represents the importance of controlling the environment of the embryology laboratory using quality assurance and quality control policy to minimize the rate of embryo aneuploidy and subsequently increase the success rate of IVF. Therefore, the aneuploidy rate of preimplantation embryos can be a key performance indicator to measure the effectiveness of an IVF laboratory and IVF center.