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Changes in the structure and functions of mitochondria in human preimplantation embryos during their development.

Masaya Yamanaka[1], Shu Hashimoto[1], Hiroshi Matsumoto[1], Takayuki Yamochi[1], Hiroya Goto[1], Masayasu Inoue[1], Yoshiharu Nakaoka[1], Yoshiharu Morimoto[2]
[1]IVF Namba Clinic, Osaka 550-0015, Japan [2]HORAC Grand Front Osaka Clinic, Osaka 530-0011, Japan.

Introduction: Although the rate of oxygen consumption (OC) and copy numbers of mitochondrial DNA (mtDNA) in mice and cattle embryos have been reported to change during preimplantation embryogenesis, those in human subjects remain unknown. To elucidate the role of mitochondria in human embryogenesis, we analyzed OC, copy number of mtDNA, and ultrastructural changes of human embryos during their preimplantation development.

Materials and Methods: Sixteen oocytes and 91 embryos were used to analyze their mtDNA copy numbers and OC. All specimens were obtained between July 2004 and November 2014, and donated from couples after they were given informed consent. Three oocytes and 12 embryos were used to determine cytochrome c oxidase activity. Mature oocytes and normally-developed embryos on day 2, 3, 4 and 5 after insemination were used to assess their OC in the presence or absence of mitotoxins. The copy number of mtDNA was determined using the samples after analysis of OC. The relationships between developmental stages and OC, and developmental stages and mtDNA copy number were analyzed. Cytochrome c oxidase activity was determined in oocytes and embryos on days 2 and 5.

Results: The respiratory function of mitochondria and their inner membranes developed with embryonic growth while mtDNA copy numbers decreased transiently compared with those of oocytes. The undifferentiated properties of inner cell mass appears to be associated with low OC. On the other hand, the mtDNA copy numbers increased and aerobic metabolism of mitochondria increased in trophectoderm cells.

Conclusion: Mitochondrial respiratory function in human embryos developed along with embryonic growth though their mtDNA copy number decreased transiently before blastulation. The present findings suggest that dynamic changes in the structure and respiratory function of mitochondria also play important roles in the development of human embryos.