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Mitochondrial distribution in human oocytes changes drastically during their maturation

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Maturation of mammalian oocytes is essential for their fertilization that requires large amounts of energy for supporting the biochemical reactions, such as meiosis, polar body formation and remodeling of their plasma membranes. Although the structure and functions of mitochondria in mammalian oocytes have been reported with various species, those in human oocytes remain obscure. To elucidate the physiological significance of mitochondria in the maturation of human oocytes, mitochondrial dynamics were analyzed with oocytes at different stage of maturation, such as germinal vesicle (GV), metaphase I (MI), and metaphase II (MII, after subsequent culture). Informed consents for using the oocytes were obtained. Oocytes were incubated with Mito Tracker Orange and observed by using a confocal laser microscope with time-lapse system. The images were obtained every 15 min for 40 hrs. Areas of cytoplasm in equatorial sections of oocytes having mitochondria were measured and assessed for 300 min before and after GV break down (GVBD). Mitochondrial localization was also analyzed by using transmission electron microscope. GV stage oocytes, but not of MI and MII stage oocytes, had subcortical area (close to plasma membranes) lacking mitochondria. Analysis by fluorescence microscopy and electron microscopy revealed that most of mitochondria in GV stage oocytes formed coloney-like clusters in cytoplasm. Kinetic analysis revealed that the cytoplasmic area enriched with mitochondria expanded markedly towards subcortical areas during the process of GVBD. The mitochondrial clusters disappeared after GVBD; most of them localized homogenously in cytoplasm of MI and MII oocytes. These and other results suggest that the dynamic change in mitochondrial localization, particularly their mobilization to subcortical area, might reflect the increased consumption of ATP in and around plasma membranes of oocytes where *de novo* synthesis and/or preparation of molecular machineries, such as formation of lipid lafts and secretion of cortical granules, required for fertilization should occur.