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Mammalian Oocyte Activation by the Synergistic Action of Discrete Sperm Head Components: Induction of Calcium Transients and Involvement of Proteolysis

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Abstract

Sperm-borne oocyte-activating factor (SOAF) elicits activation sufficient for full development and originates from sperm head submembrane matrices. SOAF comprises discrete, heat-sensitive and -stable components (referred to here respectively as SOAF-I and -II) which are each necessary but not sufficient to activate oocytes. The heat-sensitive SOAF component, SOAF-I_m, becomes solubilized from the perinuclear matrix under reducing conditions (the SOAF transition) to generate SOAF-I_s. Although calcium transients likely play an important role in oocyte activation at fertilization, the question is open as to whether demembranated heads or SOAF-I_s and/or SOAF-II can induce calcium transients. We now report that injection of demembranated sperm heads into mouse oocytes efficiently induced Ca^{2+} oscillations. When injected independently, SOAF-I_s and demembranated heads heated to 48°C failed to generate Ca^{2+} oscillations. However, co-injection of SOAF-I_s and 48°C-heated heads induced oscillations, mirroring their synergistic ability to activate oocytes. This suggests that SOAF-mediated activation proceeds via pathways resembling those at fertilization and provides the first direct evidence that multiple sperm components are required to induce Ca^{2+} oscillations. We probed the SOAF-I_s liberation at the center of this activation and show that *in vitro* it was sensitive to a profile of serine protease inhibitors. These findings support a model in which mammalian oocyte activation, including the induction of calcium transients, involves proteolytic processing of SOAF from sperm head submembrane compartments.

Keywords

oocyte activation; mouse; sperm; calcium; proteolysis

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