

The roles of prostaglandins in vertebrate ovulation



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Abstract

Prostaglandins are one of the biochemicals that have received much attention in the study of vertebrate ovulation. This review describes recent advances in the understanding of the roles of prostaglandins in vertebrate ovulation.

Keywords: Vertebrate; Ovulation; Prostaglandin; Oocyte maturation; Cumulus-oocyte complex expansion; Follicle rupture; Gonadotropin; Mammalian; Periovoluntary; Postovulatory follicles; Cumulus-oocyte; Hyaluronan; Teleost fish; Cytoskeleton; Ovulating follicles; Rupture; Non-mammalian vertebrates; Vertebrate ovulation; Endoperoxide; Antrum; Cumulus

Abbreviations: LH: Luteinizing Hormone; PG: Prostaglandin; COC: Cumulus-Oocyte Complex; PtgS: Prostaglandin-Endoperoxide Synthase; PGE2: Prostaglandin E2; PGF2 α : Prostaglandin F2 α ; Ptger2, Prostaglandin E2 Receptor Subtype 2; Ptger4b: Prostaglandin E2 Receptor Subtype 4b

Introduction

Ovulation in vertebrates is triggered by the preovulatory surge of gonadotropin luteinizing hormone (LH). After the LH surge, the oocyte undergoes final maturation, and phenotypic changes occur in the somatic cells, granulosa cells and the theca cells, surrounding the oocyte. Prostaglandins (PGs) are recognized as an important mediator for LH-surfed ovulation in vertebrate animals. Many studies have been conducted using mammalian species with attention directed to PGs to define their roles in ovulation [1-4]. In addition, a significant advancement of the roles of PGs in teleost ovulation has been accomplished in recent years [5]. In this review, the current knowledge on the roles of PGs in the process of teleost and mammalian ovulation is summarized.

PGs involved in vertebrate ovulation

In mammalian ovaries, prostaglandin E2 (PGE2) is involved in the process of ovulation of periovoluntary follicles [6,7], while prostaglandin F2 α (PGF2 α) plays a critical role in the luteolytic events of postovulatory follicles [4]. In teleosts, both PGE2 and PGF2 α serve as a regulator of ovulation although the molecular species of PG functional in fish ovulation varies in different species [5].

The roles of PGE2 in the ovulatory process in mammals

LH surge induces the ovulatory process in the follicles that are destined to ovulate. In mammals, the ovulatory process includes the expansion of the cumulus-oocyte complex (COC), oocyte maturation, and follicle rupture. COC is essential not only for the release of the oocyte through the ruptured follicle

envelope during ovulation but also fertilization and the development of early-stage embryos. Mice lacking the gene encoding prostaglandin-endoperoxide synthase-2 (PtgS2, also known as cyclooxygenase-2) and the PGE2 receptor Ptger2 [1,3] exhibited impaired COC expansion and a decrease in ovulation number [2]. A characteristic feature of COC expansion is the formation of a highly complex extracellular matrix in the cumulus cells and mural cells surrounding the antrum. Among the major components critically involved in the expansion of COC, the expression of glycosaminoglycan hyaluronan synthase-2 (HA-2), the enzyme responsible for hyaluronan synthesis, and the hyaluronan-binding protein TNF- α -stimulated gene 6 (TSG-6) is demonstrated to be the downstream event of PGE2/Ptger2 activation [8,9]. In addition, the involvement of PGE2/Ptger2 signaling in the process of oocyte maturation in mammals have been documented [10-12]. However, the functions of PGE2 in follicle rupture in mammals are unclear at present.

The roles of PGE2 in the ovulatory process in teleosts

PGF2 α plays a role in mediating ovulatory actions of the LH surge in many teleost fish [5], while PGE2 serves as LH-induced key ovulatory events in some teleosts, including medaka [13,14]. The possible involvement of PGs in both oocyte maturation and follicle rupture in teleosts was repeatedly reported [5]. However, the mechanism of how PGs are involved in the process remains to be answered. The role of PGs in follicle rupture during ovulation was intensively investigated using medaka [15,16], which serves as a good vertebrate model for ovulation study [17-20]. The results of these studies indicate that in this fish, PGE2/Ptger4b

signaling is activated in the follicle cells of ovulating follicles at the time of ovulation and that the receptor activation then induces intracellular actin cytoskeleton rearrangement of the cells [5,16].

Conclusion

Previous studies have revealed the differences and similarities in the roles for PGs in mammalian and teleost ovulation. Impact of PGs on oocyte maturation is conserved from teleosts to mammals. In teleosts, PGs also play an important role in the rupture of ovulating follicles. Ovulation is often described as a process of squeezing the oocyte through a rupture in the surrounding tissue [21]. This notion implies that ovulation is comprised of two phenomena involving enzymatic degradation of follicle wall and contraction of the outer somatic cell layer surrounding the oocyte. This two-phenomenon hypothesis was described for the first time by Schochet [22] for mammalian ovulation, but is undoubtedly applicable to ovulation of non-mammalian vertebrates, including teleost fish. The role of PGs in teleost ovulation is probably to facilitate the release of oocytes from the follicles by inducing the contraction of the somatic cell layer. Further comparative studies using various animals will help understand the differences and similarities in the roles of PGs in vertebrate ovulation.

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