Prostaglandin Levels in Plasma and Follicular and Uterine Tissues of the Quail in Relation to Midsequence Oviposition

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Changes in the concentration of prostaglandin (PG) F and E in plasma and reproductive tissues were measured during the oviposition cycle in the quail. Tissue samples were collected from the shell gland (uterus), the three largest preovulatory follicles, and the largest postovulatory follicle (R1). Plasma and tissue samples were collected 16 and 8 hr before and immediately after a midsequence oviposition. Plasma PGF and PGE concentrations showed a 2-fold increase at oviposition (P<0.05). PGF concentrations in the preovulatory follicles remained stable, but the PGF level in R1 at oviposition significantly increased (P<0.05). Follicular PGE concentrations were not different from preceding point value. There were no changes in PGF and PGE concentrations of the uterine tissue throughout the oviposition cycle. These results suggest that the increases in plasma PGF and PGE levels may play a role in the regulation of oviposition in the quail and the ovarian follicle may be the origin of the increased plasma PGs at oviposition.


Key words: quail, prostaglandin, oviposition

Prostaglandins (PGs) play an important role in the regulation of oviposition in the chicken. For example, the administration of PGF_{2\alpha} will induce premature oviposition\(^1,2\)\), whereas the administration of indomethacin, an inhibitor of PG biosynthesis, will block spontaneous oviposition\(^3,3\)\). Furthermore, the plasma level of PGF significantly increases at the time of oviposition\(^4,5\) and the PG originates from the largest preovulatory follicle (F1) and the largest postovulatory follicle (R1)\(^6,7\)\).

Except for the chicken, there are few reports on the role of PG in control of oviposition of the other domestic birds including quail. Although the administration of PGF_{2\alpha} and indomethacin have been reported to induce and delay, respectively, oviposition in the quail\(^1,8,9\), no studies have reported the endogenous levels of PG in relation to oviposition. Recently, Shimada and Etches\(^10\) demonstrated a marked increase in uterine contractility of quail during the oviposition, indicating that this increase of uterine contractility may be related to the increases of plasma and follicular PG levels as demonstrated in the chicken\(^6,7\)\). This study was conducted to determine the amounts of PGF and PGE present in the three largest preovulatory follicles, the largest postovulatory follicle, the shell gland (uterus) and plasma in

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Materials and Methods

Animals. Japanese quail (WE strain, 16-week old) were individually caged. The lighting regime was 14 hr/day (lights on 0400 to 1800 hr), and feed and water were provided ad libitum. They exhibited a regular laying sequence of 5 eggs or more on consecutive days with each sequence separated by a pause day. The first egg of a sequence was laid between 1200 and 1400 hr and the last egg of a sequence was laid between 1600 and 1800 hr.

Collection of plasma and tissues. Blood samples were collected from the heart by heparinized syringes, and then hens were sacrificed by cervical dislocation to obtain the three largest preovulatory follicles, R1 and the uterus. Samples of blood and tissues were collected at 16 and 8 hr before and immediately after oviposition of the second egg of a sequence. Blood samples were kept on ice and then centrifuged at 3000 rpm for 10 min at 4°C to separate the cellular element. Plasma and tissue samples were stored at -20°C.

Follicular tissues from the preovulatory follicles were removed by the following procedure. A razor blade was used to cut through the membrane layer around the circumference of a frozen follicle. After the yolk surface thawed, the membrane layer, containing theca and granulosa layers, was rapidly separated from the yolk and re-frozen.

Radioimmunoassay of plasma and tissue PG levels. Plasma and tissue samples were thawed, and PGs were extracted as described previously. PGF and PGE were measured in duplicate by radioimmunoassay (RIA) using PGF2α and PGE2, respectively, as standards (Ono Pharmaceutical Co., Osaka, Japan). The RIA for PGs was performed as described by Evans et al. and Olson et al. using PGF2α and PGE2 antisera raised in the rabbit by T.G. Kennedy (Univ. Western Ontario, Canada). The cross-reactivities of the antisera to PGF2α and PGE2 have been described by Evans et al. and Olson et al., respectively. The PGF2α antiserum reacts 100% with PGF2α, 125% with PGF1α, and <1% with PGE2, PGE1, PGA2, and PGB1. The PGE2 antiserum reacts 100% with PGE2, 1.6% with PGE1, 2% with PGF2α, 0.7% with PGF1α, 0.46% with PGA2, and 0.001% with PGB1. Since the values of PGF2α and PGE2 may be overestimate, PGF2α and PGE2 were presented as PGF and PGE, respectively. The dose–response curve of diluted quail plasma was parallel with standard PGF2α and PGE2. The minimum detectable level was 7.8 pg/tube for PGF and PGE. The recovery of hormone was 72.4% for PGF and 66.8% for PGE. All samples were measured by a single assay, and the intra–assay coefficients of variation were 8.8% for PGF and 8.7% for PGE.

DNA determination. The Burton method was used to determine DNA contents in homogenized tissue samples.

Statistical analysis. Data were analyzed using factorial analysis of variance where variation was distributed between follicular growth stage of oviposition cycle. When a significant F value was achieved, treatment means were separated using Duncan’s
New Multiple Range test. Significance was achieved when P<0.05.

Results and Discussion

**PGF and PGE concentrations in plasma.** Plasma levels of PGF and PGE during the oviposition cycle are presented in Fig. 1. Compared to plasma PGF levels 16 and 8 hr before oviposition, plasma concentration of PGF at oviposition significantly increased (P<0.05). Also, the plasma PGE concentration significantly increased between 8 h before oviposition and oviposition (P<0.05). These results demonstrate an increase in plasma PGF and PGE concentrations at oviposition in the quail. These results together with the known oviposition-inducing activity of PG suggest that PG may be involved in the regulation of oviposition in the quail. Marked increases in plasma PGs coincident with oviposition have previously been documented in the chicken and turkey.

**DNA contents of follicular tissues.** The DNA contents of the follicular tissues from the third largest preovulatory follicle (F3) through R1 during the oviposition cycle are shown in Fig. 2. The DNA contents in the follicular tissues of F3 through R1 did not differ from the value at each preceding point. The DNA content in F1 increased by a 1.5-fold relative to that of F3, and this level was maintained in R1. The DNA content of R1 at oviposition was significantly different from the DNA contents of the second largest follicle (F2) and F3 at 8 and 16 hr before oviposition (P<0.05). These data show that DNA content in the follicle increases with follicular growth and this increase is relatively steady.

**PGF and PGE concentrations in the follicular and uterine tissues.** The PGF and
Fig. 2. Changes in the follicular DNA content during oviposition cycle (F3, the third largest preovulatory follicle; F2, the second largest preovulatory follicle; F1, the largest preovulatory follicle; R1, the largest postovulatory follicle). Each point represents the mean ± SEM from five quails. Different letters indicate a significant difference at P<0.05.

PGF concentrations in follicular tissues of F3, F2, F1 and R1 are presented in Fig. 3. The PGF concentrations in the preovulatory follicles were not different each other, but the PGF level of R1 increased about 2-fold at oviposition and was significantly different from other values (P<0.05). The follicular PGE level was not significantly different from the preceding point value. However, the PGE level of F1 at oviposition was significantly higher than those of F3 at 8 hr before oviposition and of R1 at oviposition (P<0.05).

Olson et al.6 and Saito et al.7 proposed that F1 and R1 are mainly responsible for the increase in plasma concentration of PG which occurs at oviposition in the chicken. This study suggests, however, that the increase of plasma PGF level may be related to only R1. Unlike the chicken, F1 in the quail may not be a major source of the increase in plasma PGF level at oviposition. On the other hand, the PGE level in F1 was highest at oviposition and significantly higher than that in R1 at oviposition. The increase of plasma PGE level at oviposition, therefore, may originate from F1.

There were no significant changes in either PGF and PGE concentrations of the uterine tissues during the oviposition cycle. The maximum and minimum PGF concentrations of the uterus during oviposition cycle were 1.37 ± 0.24 ng/µg DNA (at oviposition, n = 5) and 0.81 ± 0.16 ng/µg DNA (8 hr before oviposition, n = 5), respectively. The maximum and minimum PGE concentrations of the uterus during oviposition cycle were 0.22 ± 0.09 ng/µg DNA (8 hr before oviposition, n = 5) and 0.11 ± 0.03 ng/µg DNA (at oviposition, n = 5), respectively. In mammals, the uterus is a major source for PG production in relation to parturition17,18). The uterine tissue in the chicken produces PGs19,20), but the PG level in the uterine tissue does not increase at oviposition7,8). These data suggest that the uterine tissue in the quail, like the chicken,
is involved in PG production but may not contribute to an increase in plasma PG level at oviposition. Since, in the chicken, some reports suggest that arginine vasotocin, a neurohypophysial hormone, stimulates uterine contractility by mediation of PG in the uterus\(^{21,22}\), PG production in the uterus may contribute to the oviposition in the quail.

The uterine contractility in the quail increases before the first ovulation of a sequence\(^{10}\), like the chicken, and some preovulatory mechanism related to ovulation may involve uterine contractility in quail.

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