Arginine Vasotocin Induces Bearing Down for Oviposition in the Hen

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ABSTRACT
An intravenous injection of arginine vasotocin (AVT) at 16 h before the expected oviposition of the initial egg of an egg-laying sequence caused bearing down for oviposition. Oviposition was increased up to 100% by increasing the dose of AVT up to 1 µg, but it decreased when the dose was 10 and 20 µg. Bearing down was observed even when the oviposition was not induced by the injection of a higher dose of AVT. The results of the present experiment suggest that bearing down is not necessarily caused by the entering of egg into the vagina, but instead may be caused by hormonal stimulus of AVT receptors present in vaginal tissue.

(Key words: hen, bearing down, oviposition, arginine vasotocin)

INTRODUCTION
Arginine vasotocin (AVT), a neurohypophysial hormone, is known to be related to the incidence of oviposition in the hen (Rzasa and Ewy, 1970). Oviposition is a result of successive events occurring in the oviduct, including contraction of the uterus and peristalsis of the vagina (Sykes, 1953). Contraction of the uterus is caused by the action of AVT (Munsick et al., 1960; Rzasa, 1972), presumably through binding to its receptor existing in the myometrium of the uterus (Takahashi et al., 1992). When the egg is transferred from the uterus to the vagina by the contraction of the uterine muscles, a rhythmic contraction of abdominal muscles accompanying a respiratory change occurs and forces the expulsion of the egg (Sykes, 1953; Sturkie et al., 1962). The event is called “bearing down,” and is known to be a nervous reflex induced by the expansion of vaginal lumen by the egg (Sykes, 1955; Sturkie et al., 1962). The vaginal muscles contract in response to AVT (Rzasa, 1972), presumably through binding to its receptor in this tissue (Takahashi et al., 1998). Whether AVT induces bearing down as a result of a direct action on the vagina has not been elucidated. The present study was performed to clarify the physiological action of AVT in the process of oviposition and bearing down in the hen.

MATERIALS AND METHODS
White Leghorn laying hens (20 mo of age; 1.9 to 2.1 kg BW) were kept in individual cages within one poultry house under a light regimen of 14 h (5:00 to 19:00) light and 10 h darkness. Feed and water were provided ad libitum. Hens laying five or six eggs in a sequence were used.

AVT2 was dissolved in 0.9% saline solution and injected into the wing vein of the hen at doses of 0.1, 0.15, 0.5, 1, 5, 10, or 20 µg/0.5 mL per hen (five or 10 birds at each dose). The AVT was injected 16 h before the expected oviposition (14:00 to 15:00 h) of the initial egg of the sequence. Control hens (five birds) received injections of 0.5 mL saline solution. The occurrence of oviposition and appearance of bearing down were checked during the 15-min interval following the injection. When oviposition and bearing down were not observed, the existence of egg in the oviduct was confirmed by a digital palpation through the cloaca. The Fisher exact test for 2 × 2 tables was used for analyzing differences in the occurrence of oviposition or bearing down.

RESULTS AND DISCUSSION

Results are shown in Table 1. Oviposition of soft-shelled egg was observed in hens receiving the intravenous injection of AVT at the dose of 0.15 µg or more. The incidence of oviposition increased to 100% when we raised the dose of AVT up to 1 µg. However, the incidence of oviposition decreased when the AVT dose was 10 and 20 µg. Bearing down was observed in all hens in which oviposition was induced. Bearing down was also observed in all hens in which oviposition was not induced by the injection at the higher doses: 5, 10, and 20 µg. The data show a disconnect between AVT-induced oviposition and bearing down. Essentially all levels of AVT above

Abbreviation Key: AVT = arginine vasotocin.
TABLE 1. Induction of oviposition and bearing down in the hen following an intravenous injection\(^1\) of arginine vasotocin (AVT)

<table>
<thead>
<tr>
<th>Dose of AVT (µg/hen)</th>
<th>No. of hens injected</th>
<th>Oviposition(^2)</th>
<th>Bearing down(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>0 (saline)</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.15</td>
<td>10</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>0.5</td>
<td>10</td>
<td>9</td>
<td>90(^a)</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>100(^a)</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>9</td>
<td>90(^a)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>3</td>
<td>30(^b)</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>2</td>
<td>20(^b)</td>
</tr>
</tbody>
</table>

\(^a\)Significantly different \((P < 0.05)\) from saline injection by Fisher’s exact test.

\(^b\)Significantly different \((P < 0.05)\) from 1 µg AVT injection by Fisher’s exact test.

\(^1\)Sixteen hours before expected oviposition.

\(^2\)Observed within 15 min after the injection.

1 µg induced bearing down, but after reaching threshold level for bearing down, there was a steady and consistent decline in induced oviposition. The results of the present study suggest that bearing down occurs even when the egg does not enter into the vagina, since the egg once entered into the vagina may be automatically expelled by the peristaltic contraction of vaginal muscles (Sykes, 1953). Bearing down is known to be a nervous reflex induced by stimuli arising from the vagina, such as the expansion of vaginal lumen by the egg (Sykes, 1955; Sturkie et al., 1962).

These results further suggest that bearing down is not necessarily caused by the egg entering the vagina, but instead may be caused by hormonal stimulus of AVT receptors present in vaginal tissue (Takahashi et al., 1998). AVT causes the contraction of not only uterine muscles (Munsick et al., 1960; Rzasa, 1972) but also vaginal muscles (Rzasa, 1972). Although the status of the uterus and the vagina of the hens in which oviposition was not induced by the injection of AVT was not examined in the present study, the value of the equilibrium dissociation constant of the AVT receptor in the vagina (1.04 nM [Takahashi et al., 1998]) is higher than in the uterus (0.62 nM [Takahashi et al., 1994]) at 16 h before the expected oviposition of the initial egg of the sequence. This suggests that the binding affinity of the AVT receptor in the vagina is lower than in the uterus 16 h before the expected oviposition and that the AVT acts to the vagina at higher concentration than to the uterus. The absence of oviposition in the hens receiving a higher dose of AVT may be due to an extremely intense contraction of the vaginal muscles so that the uterine egg could not enter into the vagina. These vaginal contractions at higher doses of AVT may have been sufficient to trigger the neural reflex leading to bearing down.

REFERENCES


