EFFECTS OF LACTATION, SUCKLING AND OXYTOCIN ON POST-PARTUM OVULATION AND OESTRUS IN EWES

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(Received 28th March 1972)

Summary. The first ovulation and first oestrus after parturition were recorded in four groups of Merino ewes which: (a) reared their lambs normally, (b) were allowed to suckle their lambs only during three 1-hr periods each day, (c) had their lambs removed on the day after birth, or (d) had their lambs removed on the day after birth and were injected intramuscularly with 5 i.u. oxytocin ten times each day for the first 17 days after parturition.

Ewes with restricted suckling activity or with lambs removed on the day after birth showed their first post-partum ovulation and oestrus at about the same times as ewes which reared their lambs normally.

Ewes injected with oxytocin showed their first post-partum ovulation and oestrus significantly earlier than ewes in the other three groups.

INTRODUCTION

It has not been determined whether post-partum anoestrus in ewes is a consequence of gestation, parturition, milk production, suckling or a combination of any of these and perhaps other factors. Suckling appears to have contributed to post-partum anoestrus in the observations reported by Mauléon & Dauzier (1965), where ewes separated from their lambs and milked twice each day had a shorter period of post-partum anoestrus than ewes which continued to suckle their lambs. Further, a positive correlation has been recorded between duration of post-partum anoestrus and frequency of suckling during the first 2 weeks of lactation (Fletcher, 1971), though this was not necessarily a causal relationship. The present study investigated whether the duration of post-partum anoestrus could be reduced by restricting suckling activity early in lactation, and whether any effect of suckling was mediated through the associated release of oxytocin.

MATERIALS AND METHODS

Ninety-two South Australian strong-wool Merino ewes of mixed ages (2½ to 6½ years old) were taken from a flock which lambed during March 1971. Each day, ewes which had lambed 24 to 48 hr previously and still had at least one viable lamb were allotted at random, after stratification on the bases of age of ewe and whether they had single or twin lambs, to four treatment groups.

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Group sizes were increased uniformly over a 25-day lambing period to a total of twenty-three ewes/group. Treatments imposed on the four groups were as follows.

Group 1: 'control'. Ewes and lambs remained together throughout the experiment.

Group 2: 'restricted suckling'. Lambs were separated from the ewes on the day after birth (24 to 48 hr post partum), and allowed to suck only during three 1-hr periods (08.00 to 09.00, 12.00 to 13.00, and 16.00 to 17.00 hours) each day until 17 days post partum. Thereafter, ewes and lambs remained together continually.

Group 3: 'lambs removed'. Lambs were removed from the ewes on the day after birth.

Group 4: 'oxytocin'. Lambs were removed from the ewes on the day after birth. Ewes were injected intramuscularly with 5 i.u. synthetic oxytocin every hour from 08.00 to 17.00 hours each day (i.e. ten injections/day) for the first 17 days post partum.

Five ewes with twin lambs in each of the 'control' and 'restricted suckling' groups had one of their lambs removed on the day after birth so that all ewes in these groups reared only a single lamb. The 'restricted suckling' and 'oxytocin' treatments were limited to the first 17 days after parturition because the previously recorded correlation between frequency of suckling and duration of post-partum anoestrous (Fletcher, 1971) was evident only during the first 2 weeks of lactation. In the 'oxytocin' treatment, an attempt was made to reproduce in non-lactating ewes the influence of endogenous oxytocin associated with suckling during normal lactation. The dose of oxytocin was an estimate of the minimum intramuscular dose necessary to stimulate milk ejection (A. K. Lascelles, personal communication), and the frequency of injection was similar to the frequency of suckling previously observed during the daylight hours of the first 2 weeks of lactation (Fletcher, 1971).

Intervals from parturition to first oestrus were determined by running the ewes with vasectomized rams fitted with harnesses and marking crayons from the day after parturition until 84 days post partum. Ewes were held in their separate treatment groups for the first 17 days while 'restricted suckling' and 'oxytocin' treatments were applied. One ram was put with each group, and ewes detected in oestrus during the previous 24 hr were recorded each day. As ewes reached 17 days post partum, they were removed from their treatment groups and run as a single flock with another four rams fitted with marking crayons of a different colour. Daily observations of oestrus were continued until lambs were weaned and ewes were removed from the experiment as they reached 84 days post partum.

Ten ewes from each group, balanced for age and the number of lambs they produced, were used to determine the time of first post-partum ovulation. The ovaries of these ewes were observed by laparoscopy (Roberts, 1968) every 17 days after parturition until ovulation was recorded. The presence of recently formed corpora lutea superficially visible on the ovaries established that ovulation had occurred during the preceding 17 days.

Statistical methods were taken from Steel & Torrie (1960). Differences in
the incidence of post-partum oestrus were analysed by $\chi^2$ tests of independence, while intervals from parturition to first oestrus were tested by analysis of variance. Planned comparisons were made within and between the lactating (‘control’ and ‘restricted suckling’) and non-lactating (‘lambs removed’ and ‘oxytocin’) groups. Intervals from parturition to first ovulation were grouped into four classes (0 to 17, 18 to 34, 35 to 51, and 52 to 68 days post partum) and tested by $\chi^2$.

**RESULTS**

**Oestrus**

The numbers of ewes detected in oestrus within 84 days of parturition, and mean intervals from parturition to first oestrus, are shown in Table 1.

Fifteen of the ninety-two ewes (16%) showed oestrus within 4 days of parturition (one at 24 to 48 hr, thirteen at 48 to 72 hr, and one at 96 to 120 hr post partum). The incidence of early post-partum oestrus was higher in lactating than in non-lactating ewes ($P<0.05$), but was not affected by age or the number of young born. Observations of the ovaries of seven of these ewes on Day 17 post partum indicated that this early oestrus was not accompanied by ovulation. Fourteen of the fifteen ewes showed oestrus again at a mean interval of 44.5 days after parturition, but this second oestrus did not follow the early post-partum oestrus at any regular interval associated with the duration of a normal oestrous cycle (17 days), and did not differ significantly from the mean time of first oestrus (43.0 days post partum) of ewes which had not shown early post-partum oestrus.

No ewes were detected in oestrus between 5 and 15 days post partum, but all of the non-lactating ewes (i.e. ‘lambs removed’ and ‘oxytocin’ groups) and 87% of the lactating ewes (i.e. ‘control’ and ‘restricted suckling’ groups) showed oestrus between Days 16 and 84. This difference between non-lactating and lactating ewes was significant ($P<0.05$). The mean interval between parturition and first oestrus (excluding oestrus 1 to 4 days post partum) was significantly shorter ($P<0.001$) in ewes treated with oxytocin than in ewes of

**Table 1.** Incidence of oestrus and duration of post-partum anoestrus in ewes

<table>
<thead>
<tr>
<th>Treatment (23 ewes/group)</th>
<th>No. of ewes in oestrus 1 to 4 days post partum</th>
<th>No. of ewes in oestrus 16 to 84 days post partum</th>
<th>Days from parturition to first oestrus* (mean ± S.E.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ‘Control’</td>
<td>6</td>
<td>21</td>
<td>47.8±2.1</td>
</tr>
<tr>
<td>2. ‘Restricted suckling’</td>
<td>5</td>
<td>19</td>
<td>49.5±2.4</td>
</tr>
<tr>
<td>3. ‘Lambs removed’</td>
<td>3</td>
<td>23</td>
<td>44.7±2.7</td>
</tr>
<tr>
<td>4. ‘Oxytocin’</td>
<td>1</td>
<td>23</td>
<td>31.8±2.5</td>
</tr>
<tr>
<td>Differences between treatment means:</td>
<td></td>
<td></td>
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<tr>
<td>1 versus 2</td>
<td>N.S.</td>
<td>N.S.</td>
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<tr>
<td>3 versus 4</td>
<td>N.S.</td>
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<td>(1+2) versus (3+4)</td>
<td>$P&lt;0.05$</td>
<td>$P&lt;0.05$</td>
<td>$P&lt;0.0001$</td>
</tr>
</tbody>
</table>

* Excluding oestrus 1 to 4 days post partum.
the other three groups. Differences in mean duration of post-partum anoestrus among the remaining three groups were not significant.

**Ovulation**

The intervals after parturition at which ovulation was first recorded in ten ewes from each treatment group are shown in Text-fig. 1. Ewes treated with oxytocin ovulated earlier than ewes in the other three groups ($\chi^2 = 22.9$, d.f. = 3, $P<0.001$). Differences between the ‘control’, ‘restricted suckling’ and ‘lambs removed’ groups were small, though ‘lambs removed’ ewes ovulated slightly earlier than ewes in the other two groups ($\chi^2 = 8.1$, d.f. = 3, $P<0.05$).

The mean numbers of corpora lutea/ewe recorded at the first post-partum ovulation were 1.1, 1.0, 1.1 and 1.3 in the ‘control’, ‘restricted suckling’, ‘lambs removed’ and ‘oxytocin’ groups, respectively. Differences between these means were not significant.

![Text-fig. 1. Numbers of ewes with recently formed corpora lutea at successive 17-day intervals after parturition (○, 'lactating'; ●, 'restricted suckling'; □, 'lambs removed'; ■, 'oxytocin').](image)

Thirty-nine of the forty ewes in which ovulation was recorded showed oestrus and from these ewes, the number of ovarian cycles between first ovulation and first oestrus could be estimated. Only five ewes showed oestrus at their first post-partum ovulation. Assuming that the first post-partum ovulation was followed by further ovulations at intervals of approximately 17 days, then twenty-three ewes would have ovulated once, ten ewes would have ovulated twice, and one ewe would have ovulated three times before the first post-partum oestrus. The number of ‘silent’ ovulations before first oestrus (mean 1.2) did not differ significantly among the four treatment groups.

**DISCUSSION**

The incidence of oestrus without ovulation in 16% of the ewes 1 to 4 days post partum is comparable with other reports of anovulatory oestrus soon after
parturition (Barker & Wiggins, 1964a; Mauléon & Dauzier, 1965; Smith, 1966). In view of its high degree of synchronization (thirteen of fifteen ewes were detected in oestrus 48 to 72 hr after parturition), this early post-partum oestrus may represent a behavioural response to the increase in circulating oestrogen immediately before parturition reported by Challis (1971). In this case, the difference in early post-partum oestrus between lactating and non-lactating ewes, if real (the difference was just significant at the 5% level), may have reflected a greater sensitivity to oestrogen in ewes which continued to suckle their lambs. Because it was anovulatory, occurred in only few ewes, and had no effect on the expression of subsequent ovulation and oestrus, early post-partum oestrus appeared to be of no consequence in assessing the ability of ewes to breed again soon after parturition.

Removal of lambs on the day after birth had only a small effect on post-partum anoestrus. More ewes treated thus showed oestrus within 12 weeks of lambing, but the mean intervals from parturition to first ovulation and first oestrus were reduced only slightly. The effects of removing lambs at birth or at various stages during the suckling period have been reviewed by Hunter (1968), and he points out that there are only a few instances in which an effect has been well demonstrated. Nevertheless, the results of this experiment contrast with reports from Barker & Wiggins (1964b) and Mallampati, Pope & Casida (1969) that the removal of lambs soon after birth reduced the duration of post-partum anoestrus by 16 to 30 days. There is no obvious explanation for this discrepancy, though differences in nutrition or breed of ewe may be involved. Season of lambing cannot be implicated since this experiment was carried out at the season (autumn) where Mallampati et al. (1969) found the effect of removing lambs to be greatest. It is clearly impossible to form any general conclusion but, under the conditions of this investigation, it would not be necessary to wean lambs early in lactation in order to promote the prompt re-breeding of ewes after lambing.

An effect of suckling activity on post-partum anoestrus might be inferred from reports that post-partum anoestrus was shorter in ewes milked twice each day than in ewes which continued to suckle their lambs (Mauléon & Dauzier, 1965) and that the duration of post-partum anoestrus was positively correlated with frequency of suckling during the first 2 weeks of lactation (Fletcher, 1971). In the present investigation, restricting suckling activity to three 1-hr periods each day had no significant effect on post-partum ovulation or oestrus. No effect of a single component of lactation (suckling) could be expected, however, when total lactation (milk production+suckling) had as small an effect on post-partum anoestrus as was recorded here. Indeed, the effect of removing lambs on the day after birth was so small that post-partum anoestrus could be regarded as a consequence of gestation and/or parturition, and not of subsequent lactation. This obviously differs from the previously discussed results of Barker & Wiggins (1964b) and Mallampati et al. (1969), and it remains open to question whether post-partum anoestrus might be affected by suckling activity in those situations where the duration of post-partum anoestrus is prolonged by lactation.

The effects of oxytocin in reducing the intervals from parturition to first ovulation and first oestrus were contrary to the hypothesis being tested, i.e.
that the release of endogenous oxytocin associated with suckling inhibited *post-partum* ovulation and oestrus. It is not clear whether the doses of oxytocin administered were grossly different from physiological levels associated with suckling in the lactating animal, or whether the effects of oxytocin were modified by removing lambs on the day after birth. Peters, First & Casida (1969), for example, found that exogenous oxytocin decreased ovarian follicle development in *post-partum* sows when piglets were present but not when piglets had been removed. Nevertheless, in this report and in others which recorded the effects of exogenous oxytocin on luteal function in cattle (Armstrong & Hansel, 1959) and sheep (Milne, 1963), any effect of oxytocin was inhibitory. In the present investigation, on the other hand, oxytocin clearly stimulated *post-partum* ovulation and oestrus. This stimulation cannot be readily explained, and there is an obvious need for further investigation into the effects of oxytocin on pituitary and ovarian function in the *post-partum* ewe.

**ACKNOWLEDGMENTS**

I am grateful to Mr R. J. Grimson and Mr C. R. Hutchinson for field assistance, and to Mr C. H. S. Dolling for criticism of the manuscript. The investigation was supported in part by the Australian Wool Research Trust Fund.

**REFERENCES**


