PROGESTERONE IN THE PERIPHERAL BLOOD OF GUERNSEY AND FRIESIAN COWS DURING PROLONGED GESTATION

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Summary. Progesterone was determined in the peripheral blood of five cows exhibiting a prolonged gestation period of up to 92 days beyond the normal duration of pregnancy (285 days). The blood progesterone levels during the period of prolonged gestation were similar to those found in normal cows during mid-pregnancy; however, there was no sign of a fall in the progesterone level just prior to the expected date of delivery, which is so characteristic of normal cows. The significance of these findings is discussed in relation to the mechanisms that might initiate parturition in the cow.

INTRODUCTION

Prolonged gestation is now known to occur in several breeds of dairy cattle, and the affected animals may carry their calves many months beyond the normal expected date of delivery (Jasper, 1950; Kennedy, Kendrick & Stormont, 1957; Blood, Hutchins, Jubb & Whitten, 1957; Wilson & Young, 1958; Huston & Gier, 1958). In normal cows, it is well established that the genotype of the foetus has a marked effect on the length of gestation (Jafar, Chapman & Casida, 1950; De Fries, Touchberry & Hays, 1959). Likewise, in the prolonged gestation seen in Guernsey and Friesian cows, the genotype of the foetus apparently determines the presence or absence of the condition (Gregory, Mead & Regan, 1951; Stormont, Kendrick & Kennedy, 1956). The gene in question seems to be an autosomal recessive, and pregnancy is prolonged when the foetus is homozygous for the condition. A heterozygous cow bred to a heterozygous bull would thus have a one in four chance of having a homozygous recessive foetus that would induce prolonged gestation.

Such a cow carrying an affected foetus does not exhibit the changes that normally occur prior to parturition. For example, there is no relaxation of the pelvic ligaments, no oedema of the vulva, no sudden enlargement of the udder, and no softening of the cervix. Uterine tone is poor, and the uterus fails to respond to manual stimulation via the rectum. At the estimated date of delivery, the foetus is presented to the pelvic inlet in the normal way, but during the next few days it drops back into the abdomen, and is never again presented
normally. Vaginal delivery will only occur after the death of the foetus, so live foetuses have to be delivered by elective Caesarean section.

In the Guernsey and Friesian cows from the herd under investigation, prolonged gestation is also associated with abnormal foetuses. In Guernseys, the foetus appears to stop growing at the 7th month of pregnancy, and there is a complete absence of the anterior pituitary (Kennedy et al., 1957). In Friesians, on the other hand, the newborn calf may show evidence of continued growth in utero after the normal expected date of delivery, and it may also be dehydrated. It is usually heavily stained with meconium; after delivery it invariably shows signs of an adrenocortical insufficiency characterized by a hypoglycaemia and, if it survives long enough, a loss of sodium and chloride (Holm, 1958; Holm, Parker & Galligan, 1961).

Cows exhibiting this syndrome of prolonged gestation are obviously ideal for investigating the factors responsible for the initiation of parturition. Many workers have postulated that there are changes in the concentrations of oestrogens and progesterone in the blood just prior to delivery. However, of all the species studied, it seems that only in the cow, the sow and the rabbit is there a demonstrable decline in the blood progesterone level before delivery (Short, 1960; Mikhail, Noall & Allen, 1961). It was considered of interest, therefore, to determine the plasma progesterone levels in Guernsey and Friesian cows during the period of prolonged gestation.

MATERIAL AND METHODS

Nine blood samples were obtained from six cows in California. One of these cows (No. 1) had a normal pregnancy, and the remaining five (Nos. 2 to 6) had abnormally prolonged gestations. Two of these affected animals were Guernseys, and three were Friesians; their conception dates were accurately recorded in every instance. Two hundred and eighty-five days was considered to be the longest possible ‘normal’ gestation period; the Friesian cows from the herd under investigation normally calve after the 275th day. For the purposes of the present study, Day 286 was taken to be Day 1 of the prolonged gestation.

Samples of approximately 1 litre of blood were collected from the jugular vein into a flask containing heparin. The blood was cooled in an ice-bath and centrifuged at +5° C. The plasma was then aspirated, and stored at −20° C until it could be extracted. The extractions were carried out as described previously (Short, 1958a). The crude ether extracts were transferred to small stoppered glass tubes, evaporated to dryness, labelled with a code number and sent to Cambridge by air on dry ice. The code was not broken until all the assays had been completed.

The subsequent purification and chromatography of the ether extracts was carried out in Cambridge. In every instance, however, chromatography revealed the presence of impurities in the region of progesterone. The appropriate area of the chromatogram was therefore cut out and eluted. After evaporation to dryness, the eluate was treated with a few drops of acetic anhydride and pyridine (1:1) overnight at room temperature, and then rechromatographed. This acetylation procedure successfully removed most of the impurities, so that
the progesterone eluted from the second chromatogram could be determined spectrophotometrically in the usual manner.

**RESULTS**

Table 1 shows the values obtained in the present study. The results have all been corrected for 37% losses during the extraction procedure (Short, 1958a).

**Table 1**

**BLOOD PROGESTERONE LEVELS IN ONE NORMAL AND FIVE POST-TERM COWS**

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>State of pregnancy</th>
<th>Breed</th>
<th>Progesterone ug/100 ml plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>263 days, 22 days pre-term</td>
<td>Friesian</td>
<td>0.45</td>
</tr>
<tr>
<td>1</td>
<td>1 day post partum</td>
<td>Friesian</td>
<td>0.19</td>
</tr>
<tr>
<td>2</td>
<td>308 days, 23 days post-term</td>
<td>Guernsey</td>
<td>1.38</td>
</tr>
<tr>
<td>3</td>
<td>377 days, 92 days post-term</td>
<td>Guernsey</td>
<td>0.89</td>
</tr>
<tr>
<td>4</td>
<td>307 days, 22 days post-term</td>
<td>Friesian</td>
<td>1.35</td>
</tr>
<tr>
<td>5</td>
<td>266 days</td>
<td>Friesian</td>
<td>0.97</td>
</tr>
<tr>
<td>5</td>
<td>285 days (calculated term)</td>
<td>Friesian</td>
<td>1.08</td>
</tr>
<tr>
<td>5</td>
<td>305 days, 20 days post-term</td>
<td>Friesian</td>
<td>0.78</td>
</tr>
<tr>
<td>6</td>
<td>367 days, 82 days post-term</td>
<td>Friesian</td>
<td>0.65</td>
</tr>
</tbody>
</table>

**Table 2**

**BLOOD PROGESTERONE LEVELS IN NORMAL COWS AT MID-PREGNANCY AND AT TERM**

<table>
<thead>
<tr>
<th>State of pregnancy</th>
<th>Breed</th>
<th>Progesterone ug/100 ml plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 days</td>
<td>Ayrshire</td>
<td>0.80</td>
</tr>
<tr>
<td>182 days</td>
<td>Ayrshire</td>
<td>0.74</td>
</tr>
<tr>
<td>227 days</td>
<td>Ayrshire</td>
<td>0.85</td>
</tr>
<tr>
<td>246 days</td>
<td>Guernsey</td>
<td>0.98</td>
</tr>
<tr>
<td>256 days</td>
<td>Ayrshire</td>
<td>0.83</td>
</tr>
<tr>
<td>268 days</td>
<td>Guernsey</td>
<td>0.52</td>
</tr>
<tr>
<td>274 days</td>
<td>Ayrshire</td>
<td>0.45</td>
</tr>
<tr>
<td>281 days</td>
<td>Guernsey</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Results corrected for extraction losses.

* From Short, 1958b.

For comparative purposes, Table 2 shows the progesterone levels in the peripheral blood of normal pregnant cows, as determined in a previous investigation (Short, 1958b).

Inspection of these tables shows a reasonable agreement between the two sets of results. In normal cows, the progesterone levels seem to fall some time.
before the commencement of parturition. In the prolonged gestation animals, on the other hand, no fall was observed prior to the expected date of delivery. The progesterone levels found throughout the period of prolonged gestation were in fact similar to those found in normal cows during mid-pregnancy. This was true even of Cow 3 which was 3 months overdue.

**DISCUSSION**

These results suggest that a relationship may exist between the maintained pregnancy and the maintained blood progesterone level. The concentration of progesterone in the blood of cows normally declines before calving (Short, 1958b), at a time when the urinary oestrogen excretion is at its height (Velle, 1958; Rommel & Rommel, 1958). One would imagine that such conditions would be ideal for activating the myometrium and initiating parturition. However, it must be remembered that as yet nobody has succeeded in prolonging gestation in cattle by progesterone injections (McDonald & Hays, 1958). Indeed, injections of microcrystalline progesterone (25 to 100 mg/day) after 211 days of pregnancy resulted in pelvic relaxation, the appearance of vaginal mucus and udder engorgement about 20 days after the first injection (Holm, unpublished).

It is interesting to recall that, as in cattle, prolonged gestation in sheep may also be associated with the absence of a foetal adenohypophysis (Binns, Thacker, James & Huffman, 1959; Binns, Anderson & Sullivan, 1960). However, it is still not known whether the absence of a foetal pituitary, adrenal insufficiency and prolonged gestation are in any way related to one another.

**ACKNOWLEDGMENTS**

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**REFERENCES**


Progesterone in the blood of cattle


