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The Effect of Mild Fat Infiltration in the Liver on the Fertility of Finnish Ayrshire Cows

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Heinonen, K., Y. Gröhn, L.-A. Lindberg and M. Alanko: The effect of mild fat infiltration in the liver on the fertility of Finnish Ayrshire cows. Acta vet. scand. 1987, 28, 151–155. – The objective of this work was to study the effect of mild fat infiltration in the liver on the reproductive performance of Finnish Ayrshire cows. Eighty-five multiparous and 17 primiparous cows were investigated. The mean percentage of fat in the liver at 1 week after parturition was 3.9 ± 0.5. Cows with ≤ 9 % fat in the liver at 1 week after calving conceived slightly earlier than those with > 9 % (87.1 ± 2.7 and 102.2 ± 15.0 days post partum, respectively). The difference was not statistically significant. The incidence rate of retentio secundinarum and/or endometritis was significantly higher in the > 9 % fat group than in the ≤ 9 % fat group. Unobserved oestrus and ovarian cysts occurred with equal frequency in both groups.

fatty liver; infertility; ret. sec.

Introduction

The clinical fat cow syndrome is associated with an increase in post parturient diseases (*Morrow* 1975). There is a well documented relationship between fatty liver and decreased fertility. A liver fat content over 20 % is associated with delayed onset of postpartum oestrus, lowered conception rate and increased frequency of retentio secundinarum (*Morrow* 1975, *Morrow et al.* 1979, *Reid* 1983).

Previous reports from Finnish dairy cows (*Gröhn et al.* 1983, *Gröhn* 1985) showed that the extent of liver fat infiltration had been lower than in high yielding dairy cows as reported from Compton (*Reid* 1980). Therefore it is uncertain, particularly in small farms with individual management of the cows that fat infiltration of the liver is a fertility limiting factor.

The objectives of this work were to investigate the incidence and severity of fat infiltration in the liver of Finnish Ayrshire cows at 1 week after calving, the possible association between fatty liver and postpartum reproductive functions and the incidence rate of fertility disturbances.

Materials and methods

Animals and experimental design

The experimental design has been described in detail by *Gröhn et al.* (1987). Briefly, 102 Finnish Ayrshire cows, which calved between November 1, 1984 and March 31, 1985 in the vicinity of the Ambulatory Clinic of Veterinary College, Hautjärvi and which belonged to 20 milk recorded herds were selected for the study population. The number of primiparous animals was 17, 43

cows calved for the second or the third time and 42 for the fourth to seventh time.

The cows were tied in stalls during the entire experiment and milked twice a day. They were individually fed a diet of grass silage (20–30 kg) and dry hay (2–5 kg) a day. They were given 2–10 kg of grain based on the milk yield. The mean milk yield was 6060 kg 4 % FCM per year (range 4000–8500 kg). The heat detection was performed by the owner of the herd.

Liver samples were obtained by percutaneous needle biopsy from each animal 1 week (4–10 days) after calving.

Clinical gynecological examination was performed at 4 weeks (25–31 days) post partum.

Milk samples for progesterone assay were collected by the owner of the herd 3 times a week from day 14 to 70 post partum.

Liver morphology and milk progesterone assay

Liver samples were immediately cut into pieces (1 mm^3) and processed as described previously (*Gröhn & Lindberg* 1982). Stereological analysis of liver morphology was also performed as described earlier (*Gröhn et al.* 1983).

Milk samples were stored at −20°C until analysed. Whole milk progesterone assay was performed with a commercial radio immuno assay (RIA)-method (*Laitinen* 1983).

Clinical examination

The cows were examined clinically 4 weeks post partum in order to record the stage of involution and check for possible signs of endometritis. The examination included rectal palpation of the uterus, cervix and the ovaries. External genitals were also examined for abnormal discharge. In cases of purulent discharge vaginoscopy was performed. Cows with liquid contents in the uterus and/or purulent discharge from the uterus were regarded as having endometritis. The incidence rates of retentio secundinarum, ovarian cysts and silent heat treated by veterinarians were obtained from the patient diary at the Ambulatory Clinic. Pregnancies were confirmed by rectal palpation 60 days after the last insemination. Animals which were not pregnant by 150 days after parturition were regarded as infertile. The following fertility parameters were used for each cow: the interval from calving to: 1. the first milk progesterone value $\geq$ 8 nmol l^{-1}, 2. the initiation of the first cycle of normal length ($\geq$ 17 days), 3. the first heat observed by the owner (in order to exclude undefined mucosal discharge a heat without subsequent elevation of milk progesterone value was not registered), 4. the first artificial insemination (AI), and 5. conception. The fertility rates to the first AI were calculated. The number of services per pregnancy was determined among animals which concieved. The duration of the previous gestation period was calculated for each animal.

Grouping and statistical methods

The correlations between liver fat content and fertility parameters were investigated with simple linear regression analysis and Spearman's test. Because none of the correlations were significant ($p > 0.05$) the 102 cows were classified retrospectively into 2 groups for further analysis on the basis of the percentage of fat in the liver at 1 week after parturition: A non fatty liver (non FL) group of 89 cows, all with less than or equal to 9 % fat in the liver (mean 2.3 $\pm$ 0.2) and a fatty liver (FL) group of 13 cows with more than 9 % (mean 14.9 $\pm$ 1.2) fat in the liver.

The reproductive performance parameters were compared between the groups by using Student's unpaired t-test and the Chi-square test.

Results

Mean percentage of fat in the liver parenchyma of the cows sampled at 1 week after parturition was 3.9 ± 0.5 % (range 0–21.4). The distribution of the cows by the percentage fat in the liver was 0–3 % 58 cows, 3–6 % 25, 6–9 % 6, 9–12 % 5, 12–15 % 1, and 15–22 % 7.

Nine out of the 13 cows of the FL group (> 9 % fat) became pregnant. Four cows were slaughtered (2 due to infertility, 1 due to poor milk yield and 1 due to mastitis). Sixty-nine out of the 89 cows of the non FL group (≤ 9 % fat) became pregnant. Twenty cows were slaughtered (9 due to infertility, 4 due to poor milk yield, 2 due to lameness, 1 due to mastitis and 4 cows because the entire herd was sold). There was not a statistical difference in the slaughtering rates of the two groups: FL 30.8 % (4/13) and non FL 18.8 % (16/85) ($p > 0.05$).

The incidence rate of retentio secundinarum and/or endometritis at 4 weeks after calving was 53.8 % in the FL group (7/13) and 16.9 % in the non FL group (15/89) ($p < 0.05$). There were 6 cows with more than 14 % fat in the liver: 5 of them had signs of endometritis at 4 weeks after parturition and 3 of them had retentio secundinarum. Cows with retentio secundinarum and/or endometritis (18 animals) conceived 91.8 ± 6.2 days post partum and the rest of the cows (60 animals) 92.4 ± 3.5 days post partum.

The incidence rate of ovarian cysts treated by veterinarians was 23.1 % (3/13) in the FL group and 11.2 % (10/89) in the non FL group ($p > 0.05$). The incidence rate of silent heat treated by veterinarians was 15.4 % (2/13) in the FL group and 13.5 % (12/89) in the non FL group ($p > 0.05$).

Table 1. Comparison of fertility parameters for Finnish Ayrshire cows grouped by the percentage of fat in the liver at 1 week (4–10 days) after calving.

	Fat in liver			
Interval (days) from calving to	n	≤ 9 %	n	> 9 %
First milk progesterone ≥ 8 nmol/l^{-1}	77	33.9 = ± 1.7	12	36.1 = ± 3.7
Regular cyclicity	66	39.6 = ± 1.6	12	38.2 = ± 3.0
First recorded oestrus	83	60.2 ± 2.1	12	67.4 ± 9.5
First artificial insemination	83	76.2 ± 2.1	12	84.7 ± 6.1
Conception	69	87.1 ± 2.7	9	102.3 ± 9.4
Fertility rate to first artificial insemination	69	67.6 %	11	54.6 %
Number of services per conception	69	1.6	9	2.0
Previous gestation period (days)	89	280.6 ± 0.1	13	276.4 ± 2.5

The values are means and standard errors. = Values are based on the cows which had elevated milk progesterone (≥ 8nmol l^{-1}) within 70 days post partum. There are no statistically significant ($p > 0.05$) differences between the two groups.

Discussion

The percentages of fat in the liver measured in this study were lower than those reported by other authors (*Reid* 1980, *Watson* 1985). The evidence of bimodality in the liver fat data (*Reid et al.* 1983) was not observed in this study. The finding of this trial was in agreement with earlier results from Finnish dairy cows; severely ketotic cows had 16.9 % fat and healthy cows 5.4 % fat in the liver (*Gröhn et al.* 1983). According to the classification used by *Reid & Roberts* (1983) cows which have less than 20 % fat in the liver 1 week after parturition are regarded as normal and those having over 20 % are regarded as fatty liver cows. Fertility disturbances associated with fatty liver are noticed

in animals with 20 % or more fat in the liver (*Reid* 1983). By using the criteria in the current study, only 2 cows could be classified as fatty liver cows. Thus it could be expected that fatty liver associated fertility disturbances could not be detected in this material. The reproductive parameters used in this trial are probably not sensitive enough to detect the possible mild disturbances in the course of the postpartum period. Each of the parameters measured the situation at 3 weeks or more after parturition, not at the moment of parturition, when the fat content of the liver is highest (*Reid & Roberts* 1983). The incidence rates of retentio secundinarum and/or endometritis at 4 weeks post partum were significantly higher in the FL group than in the non FL group ($p < 0.05$), but the fertility of the animals seemed to be unaffected. The cows in the FL group had slightly shorter previous period of pregnancy than the non FL group (276.4 ± 2.5 days and 280.6 ± 0.1 days respectively; ($p = 0.09$), which might, at least partly, explain the higher incidence rate of retentio secundinarum in the FL group. The tendency of the FL group to be more disposed to retentio secundinarum and endometritis was supported by the fact that there were 6 cows which had more than 14 % fat in the liver: 5 of them had signs of endometritis at 4 weeks after parturition and 3 of them had retentio secundinarum.

The FL group tended to show their first heat and be inseminated later than the non FL group, but the difference was not significant. This is in agreement with an earlier report by *Reid* (1983), who found that the cows with > 20 % fat in the liver were inseminated 20 days later than those with less fat in the liver. All cows in this study showed their first heat at 61.0 ± 2.2 days post partum, which is about 2 weeks later than reported for Finnish dairy cows in an experimental herd (*Heinonen et al.* unpublished) or Swedish dairy cows (*Larsson et al.* 1984). The importance of unobserved heat as a potential fertility limiting factor in this study was supported by the fact that 14 animals (13.7 %) were treated for unobserved oestrus by veterinarians. The percentage of cows treated for unobserved oestrus or for ovarian cysts were higher than in an earlier report in Finland (*Saloniemi et al.* 1986). This may just indicate more active veterinary service and better record keeping in the area of this study. In addition, the study was carried out during the period of indoor feeding.

It seems that the incidence rate and severity of fatty liver in the current population were so low that fertility disturbances associated with fatty liver could not be found. The greater incidence rate of retentio secundinarum and/or endometritis, and the tendency of the FL group to show heat later than the non FL group might indicate that with a larger sample size statistically significant differences could be found. However, the economical importance of fatty liver as a fertility decreasing factor seems to remain marginal in the herds studied.

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Sammendrag

Effekten av en mild fettinfiltrering i levern på fertiliteten hos finska Ayrshire kor.

Syftet med detta arbete var att studera effekten av en mild fettinfiltrering i levern på reproduktionsbeteendet hos finska Ayrshire kor. Åttiofem multipara och 17 primipara kor undersöktes. Medelvärdet i procent för fett i levern en vecka efter kalvningen var 3.9 ± 0.5. Kor med ≤ 9 % fett i levern en vecka efter kalvningen blev dräktiga något tidigare än kor med > 9 % fett i levern (87.1 ± 2.7 respektive 102.2 ± 15.0 dagar post partum). Skillnaden var inte statistisk signifikant. Fall av kvarbliven efterbörd och/eller endometrit förekom signifikativt oftare i gruppen med > 9 % fett än i gruppen med ≤ 9 % fett i levern. Osynlig estrus och cystor i ovarierna förekom lika ofta i både grupperna.

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