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REDUCED FERTILITY ASSOCIATED WITH FATTY LIVER IN HIGH-YIELDING DAIRY COWS

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ABSTRACT

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In a group of 20 high-yielding dairy cows, 10 with mild and 10 with severe fatty liver one week after calving, there was an association between fatty liver and reduced fertility. The 10 cows with severe fatty liver had a significantly longer calving interval to the next lactation compared to the cows with mild fatty liver. In addition there was a significant positive correlation between the amount of fat in the liver and calving interval. The results support the concept that liver dysfunction at calving adversely affects subsequent fertility.

INTRODUCTION

A fatty liver is frequently found in dairy cows in early lactation (Reid et al., 1977; Reid et al., 1979) and, when severe, is associated with low concentrations of albumin in the serum. Low serum albumin concentrations in early lactation have been associated with reduced fertility in a field study of 351 dairy cows (Rowlands et al., 1977). It therefore seemed possible that reduced fertility in dairy cows might be associated with the fatty liver of early lactation. Support for this hypothesis was provided in a preliminary study of 20 high-yielding dairy cows where we were able to associate severe fatty liver after calving in 10 of the cows with a history of fertility problems in previous lactations (Reid et al., 1979). In the present paper, we examine the fertility of the dairy cows in the lactation in which the fatty liver was diagnosed in an attempt to provide evidence for a link between fatty liver and subsequently impaired fertility.

MATERIALS AND METHODS

20 Friesian cows from one of the Institute's herds were studied. The cows had all calved between October 1977 and March 1978, were in their third, fourth or fifth lactation and had given at least 5500 kg of milk in the previous lactation. The cows were loose-housed in yards and fed a complete diet comprising maize silage, lucerne silage, dried lucerne, lucerne balancer and hay. Blood samples were taken from the jugular vein 1 week after calving and the constituents of the Compton metabolic profile test analysed (Rowlands et al., 1974). Samples of liver were obtained from each cow at 1 week after calving by percutaneous needle biopsy. The percentage of liver parenchyma occupied by visible fat was estimated in toluidine-blue stained sections of plastic-embedded tissue using stereological point-counting methods (Reid et al., 1977). Probability values were estimated using 'Student's t test.

RESULTS

Analysis of the liver samples taken 1 week after calving showed that ten of the cows had less than 20% fat in the liver parenchyma (mean 12.2 ± 1.5 SEM) whereas the remaining ten cows all had more than 30% fat in the liver parenchyma (mean 46.0 ± 3.2 SEM). The cows were retrospectively classified on this basis into mild and severe fatty liver groups and the production and fertility data examined for the lactation in which the liver samples were taken (Table 1). There were no significant differences in age or milk yield between the cows with mild or severe fatty liver. However, the cows with severe fatty liver in the current lactation had a significantly ($P<0.05$) longer calving interval to the next lactation compared to the cows with mild fatty liver. A calving interval of 365 days or more was recorded in all of the cows with severe fatty liver but in only 4 of the 10 cows with mild fatty liver. Furthermore, there was a highly significant ($P<0.01$) positive correlation ($r = 0.59$) between calving interval and percentage of fat in the liver parenchyma (Table 2).

TABLE I

Production and fertility data in the current lactation of cows with mild or severe fatty liver

	Fatty liver	
	mild <20% fat n = 10	severe >30% fat n = 10
	mean ± S.E.M.	
Age at calving (years)	5.2 ± 0.30	5.4 ± 0.25
Milk yield (kg)	6090 ± 326.8	6917 ± 362.8
Lactation length (days)	302 ± 14.2	334 ± 13.4
Yield/day (kg)	20.3 ± 1.00	20.7 ± 0.48
Calving interval (days)	376 ± 16.1	443 ± 22.0*[1]
Services to conception	2.4 ± 0.34	3.4 ± 0.48 [1]

* $P<0.05$

[1] Mean of 9 cows only. 1 cow is still not in calf after 6 services.

TABLE II

Correlation coefficients between calving interval and liver function and between liver fat and serum albumin concentration

	Correlation Coefficient	Probability
Calving interval		
versus		
% fat in liver	+ 0.5925	$P<0.01$
Serum albumin concentration	- 0.5465	$P<0.05$
% Fat in Liver		
versus		
Serum albumin concentration	- 0.5630	$P<0.01$

Because of the reported relationship between low serum albumin concentrations in early lactation and reduced fertility (Rowlands et al., 1977), we examined the relationship between the serum albumin concentrations in the first two weeks after calving and subsequent calving interval in the 20 cows. It can be seen from Table 2 that there was a significant ($P<0.05$) negative correlation between calving interval and serum albumin concentration. There was also a highly significant ($P<0.01$) negative correlation between percentage of fat in the liver parenchyma and serum albumin concentrations in the first two weeks after calving.

DISCUSSION

A number of recent studies have suggested a relationship between liver function around the time of calving and subsequent post-parturient disorders, including infertility in dairy cows (Lottammer, 1974; Sommer, 1975). Work from this Institute (Rowlands et al., 1977) has shown an inverse relationship in dairy cows at peak lactation between blood concentrations of albumin - a component made exclusively by the liver - and the number of services required for conception. However, we believe the present study provides the first direct evidence of a link between liver function in early lactation and subsequent infertility in dairy cows.

The low serum albumin concentrations in cows with severe fatty liver may be due to decreased albumin synthesis by the liver. Albumin is synthesised on the rough endoplasmic reticulum of the liver cell and there is good chemical and ultrastructural evidence (Reid, 1973; Reid et al., 1977) that the concentration of rough endoplasmic reticulum is reduced in cows with fatty liver. Little (1974) concluded from experiments using radioactively labelled albumin that cows with low albumin concentrations around the time of calving had a diminished rate of albumin synthesis but he did not relate this to fatty liver.

The observations in the present study do not necessarily indicate a cause-effect relationship between fatty liver and reduced fertility or between fatty liver and low serum albumin concentrations. However, many studies have shown that the capacity of the liver to inactivate oestrogens is diminished in liver diseases in man and animals (Adlercreutz, 1970). Kley et al., (1975) showed that in male patients with fatty liver there was an increase in the ratio of oestrogen to testosterone in the plasma compared to healthy males. In the dairy cow, there is some evidence to suggest that experimental liver damage adversely affects ovarian function (Ashida and Asahi, 1960) and that liver dysfunction around the time of calving may affect oestrogen metabolism (Ashida et al., 1960; Kallela, 1964). The results of the present study are consistent with the concept of liver dysfunction at calving adversely affecting subsequent fertility, possibly by interfering with steroid hormone metabolism. We are investigating this possibility further.

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