

SPECIAL FEATURES OF CARBOHYDRATE METABOLISM IN SUGAR DIABETES IN THE PERIOD OF LACTATION

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The view has up to now been held that a mother suffering from sugar diabetes should not breast feed her child. Some authors have considered that this is dangerous for her in connection with the need to introduce with the food utilized in suckling the young a large amount of carbohydrates [12]. Others hold that the milk of the mother suffering from sugar diabetes does not correspond to the physiological requirements of the growing organism of the child and therefore recommend artificial feeding [17]. Still others include sugar diabetes in the category of contra-indications to lactation, without entering into an explanation [3, 11, 12 and 13].

As yet no one has demonstrated that, given rational insulin and diet therapy, the process of lactation weakens the organism and brings about deterioration in the course of diabetes in the mother, nor has it been demonstrated that the qualitative composition and quantity of milk in such a case does not correspond to the requirements of the growing organism. It may be supposed that the more frequent hypogalactosia in mothers with diabetes is caused by irrational treatment. For the purpose of verifying this, we carried out the present investigation.

EXPERIMENTAL METHODS

The observations were made on multipara dogs which were completely depancreatized and with a varying history of sugar diabetes (from 5 months to over 3 years). The dogs were in metabolism cages and twice a day received a medicinal dose of insulin and a physiological, vitamin saturated diet (1): 200-300 g rye bread, 100-150 g groats (in form of gruel in a meat decoction), 150 g raw pancreas and 15 g vegetable oil. In the period of pregnancy and lactation the dogs received the food described in an unlimited quantity. In addition, to the ration of the pregnant dogs was added 100 g of raw bone and synthetic polyvitamins and an extra 100 g of raw meat and a half a liter of milk daily (both before and in the period of pregnancy and lactation). In all dogs the daily glucosuria was examined, and for each of them a general nutritive and carbohydrate balance was maintained. Twice a week (more often in the period of lactation) the hyperglycemia, and once a week the body weight of the dog on an empty stomach were determined.

We took as the criteria of the capacity for lactation of the depancreatized dogs: 1) the qualitative composition of the milk, 2) the growth in weight of the pups and their physical development in the suckling period and after it, 3) the duration of lactation. The findings we obtained in the healthy dogs of the same age, with the same number of births and kept on the same ration as the depancreatized ones, were taken as a control. The healthy dogs did not receive insulin.*

* The pancreas was replaced for them by a corresponding amount of raw meat.

The milk was examined in diluted form and suitably corrected on calculation. The amount of lactose was established by the total content in the milk of reducing substances (according to Hagedorn and Jensen), the amount of protein according to the total nitrogen content, the percentage of fat according to Garber, the salts content by the generally accepted method of calcination of the organic substances, and the solid residue gravimetrically.

EXPERIMENTAL RESULTS

Repeated investigations throughout the period of lactation established that where other conditions were equal apart from introduction of insulin, the qualitative composition of milk both in the healthy and in the depancreatized dogs was determined by the quantity and quality of the food consumed. With uniform nourishment the milk of the experimental dogs with regard to the quantitative content of all its ingredients (lactose, protein, fat, etc.) was not inferior to the milk of the control dogs.

The obligatory condition for maintenance at the proper level of the lactating capacity of the depancreatized dogs was introduction of the insulin in doses in correlation to the food consumed by the dogs suckling their young. The findings characterizing the lactation capacity of the dogs (quality of milk, growth in weight, and behavior of pups) served as the indices of sufficiency of dosage of introduced insulin in the different stages of lactation. The consumption of insulin increased, but not in proportion to the increase in the nutritive and, particularly the carbohydrate balance.

The rise in the content of carbohydrates and proteins in the food of the healthy and depancreatized dogs upon introduction in the latter of a corresponding amount of insulin was accompanied by a considerable increase in the solid residue of the milk through a sharp growth in it of the amount of fat and an increase in the protein content; here the amount of lactose decreased.

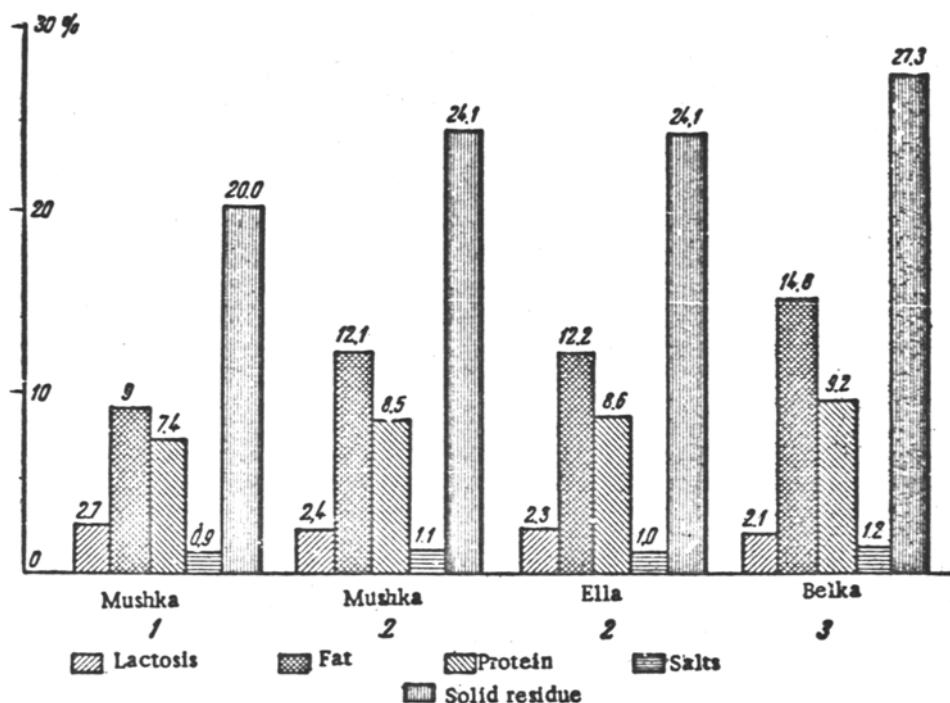


Fig. 1. Qualitative composition of milk in healthy dog (Mushka) and depancreatized dogs, Ella and Belka, with varied feeding.
Conventional signs: 1) Limited ration; 2) Extended ration; 3) Extended ration plus 50 g meat and 60 g sugar.

Figure 1 shows to what extent in the control dog Mushka, kept on a sparse diet (exclusion of raw meat and half the normal groats), the quality of the milk was worse than with subsequent lactation on the above-described extensive diet. In the depancreatized dog, Ella, which received the same food as did Mushka in the second case, the milk in no way differed from that of the latter. In the depancreatized dog Belka, which daily ate, apart from the fixed diet, 50 g of cooked meat and 60 g sugar, the quality of the milk was greatly improved. It contained an average 14.8% fat, while in the milk of the control and experimental dog kept on the fixed ration, the amount of fat was 12.1-12.2%. In this case, the positive carbohydrate balance in the dog Belka exceeded its carbohydrate assimilation before pregnancy 2.2 times, while the consumption of insulin rose only 1.8 times.

We have as yet not succeeded in noting any kind of constant relationship between the amount of fat or lactose in the milk and the magnitude of hyperglycemia in the depancreatized dogs.

More definite inverse ratios were found between the amount of fat and lactose in the milk both in the healthy and depancreatized dogs: the higher the percentage content of fat in the milk, the less the lactose found in it (Fig. 1.).

With observance of the necessary conditions (full value nourishment and suitable amount of insulin) the duration of lactation in the experimental dogs coincided with the period of lactation in the control dogs - 50 and even 60 days. A significant fall in the amount of introduced insulin, even with good feeding, was accompanied by a sharp contraction of the period of lactation, with subsequent exacerbation of the diabetes and loss of weight in the animals.

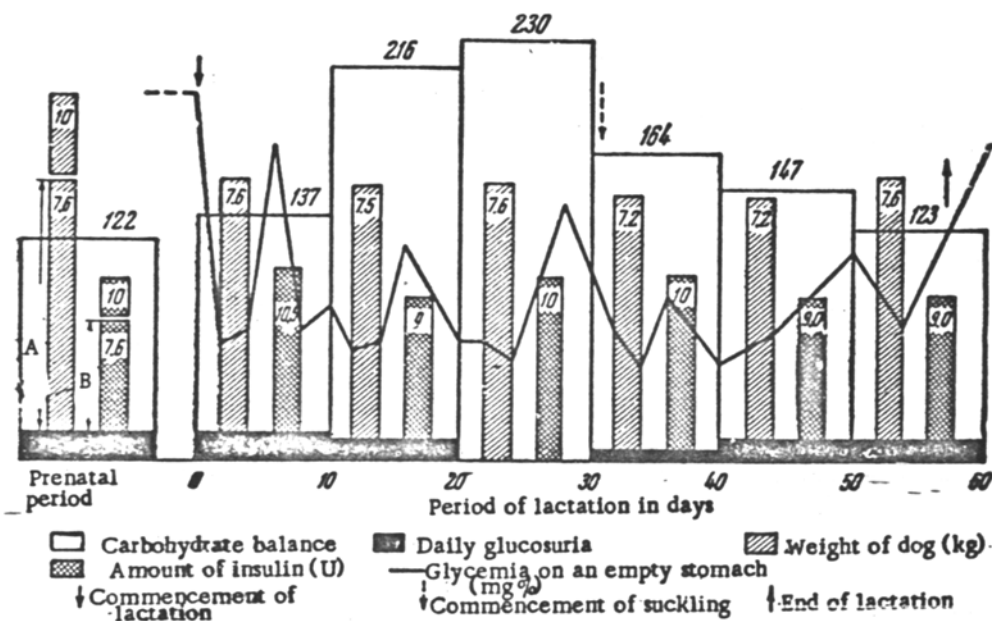


Fig. 2. Basic indices of course of sugar diabetes in the period of lactation in the depancreatized dog Ella (duration of diabetes - 3 years, third period of nourishing offspring), A) After parturitions, B) After parturitions.

Thus, for example, in one of several lactations in the dog Ella, the amount of insulin introduced into her was 40% less than its dosage before pregnancy. As a result, lactation lasted all in all for 30 days, the dog lost 1.7 kg in weight, daily glucosuria and hyperglycemia on an empty stomach was twice as great as before pregnancy and after parturition.

The growth in weight and physical development of the offspring of the experimental dogs was the same as the offspring of the control dogs in the suckling period (Fig. 2) and later (time of observation was 4-5 years).

Of crucial importance was the influence of lactation on the course of sugar diabetes. In the period of lactation we saw in all cases without exception in the depancreatized dogs a different degree of reduction in the level of blood sugar up to the point of hypoglycemia and occasionally with a convulsive reaction. Simultaneously with the fall in hyperglycemia, we saw a significant reduction of complete disappearance of sugar in the urine (aglycosuria). All this was revealed immediately after the commencement of lactation and disappeared the day after or within a few days after its cessation. The shifts indicated in the carbohydrate metabolism appeared, despite a sharp rise in the total food and carbohydrate balances (2-3 times in comparison with their level before pregnancy), with a disproportional growth in insulin consumption (Fig. 3). In the healthy dogs the fall in the level of blood sugar in the period of lactation was significantly less pronounced.

A considerable (sometimes very sharp) fall in hyperglycemia and glucosuria in the period of lactation was probably due to the milk formation process. In the experimental dog Alma, we even succeeded in detecting a perceptible fall in hyperglycemia in the first 5-8 minutes after placing the pups under her. The higher the blood sugar content before suckling started (for example, 136 or 281 mg %) the more pronounced was the fall in the suckling process itself (117-232 mg%).

We allayed the signs of hypoglycemia (dog Ella) observed in the period of lactation not by reducing the doses of insulin, but by the addition to the ration immediately after suckling the pups of easily assimilated carbohydrates (most often nutritive sugar).

The findings presented offer further proof of the great importance of carbohydrates as precursors of the milk fat [8, 9, 10 and 17].

There is a great deal of literature on the question of the role of insulin in the process of transformation of carbohydrates into fat [4]. Only a few hypotheses have been put forward concerning its participation in the general synthesis of milk. According to these, insulin is of certain importance in the process discussed based only on the fact of its regulating influence on carbohydrate metabolism [18] and disturbances of lactation in sugar diabetes [2].

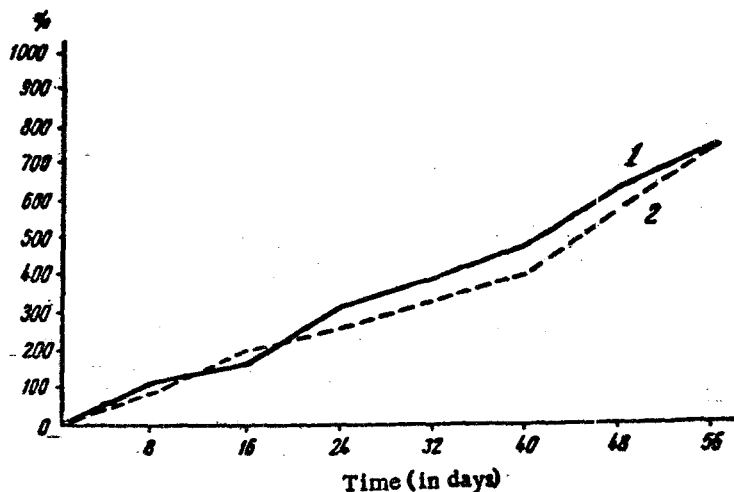


Fig. 3. Dynamic of growth of offspring of depancreatized (1) and control (2) dogs in suckling period (average increase in weight in percentages compared with original weight).

Our observations bear out that in sugar diabetes normal lactation can be ensured together with full value feeding by introducing suitable amounts of insulin.

On the basis of the findings presented, confirmed by observations on the state of some suckling females with diabetes [5, 6], in such cases it is necessary not to reduce the amounts of insulin but to increase the content in the food of carbohydrates and albumens to prevent possible hypoglycemia and strengthen the process of lactation.

In view also, of the curve of growth and then weakening of the process of lactation throughout its course, it is necessary to conduct insulin therapy very flexibly.

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* In Russian.

** Translated into Russian.