THE EXCRETION OF EXOGENOUS LACTOSE BY THE KIDNEYS

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The phenomenon of lactosuria (the appearance of lactose in the urine) has been known for a long time. Lactose may enter the blood from the mammary gland during the period of its active function, and may then be excreted by the kidneys. This explains the lactosuria in women in the later stages of pregnancy [5, 8] and during lactation [3, 5, 7, 10], and also the lactosuria in lactating cows [1, 2, 6]. Another, less common cause of lactosuria is the arrival of unusually large amounts of lactose from the alimentary tract. Traces of lactose have been found in the urine by the method of paper chromatography in nonlactating women, and also in men [5, 9]. Lactosuria of alimentary origin is most commonly found in unweaned infants, especially premature.

It is considered that there is no renal threshold for lactose [11], and that a considerable proportion of the lactose entering the blood stream is excreted unchanged by the kidneys, and only small amounts are metabolized in the tissues [3, 11].

Reports found in the literature dealt only with the qualitative study of lactosuria. No quantitative investigations of this phenomenon have been undertaken, although it is undoubtedly of interest in clinical medicine and applied animal physiology.

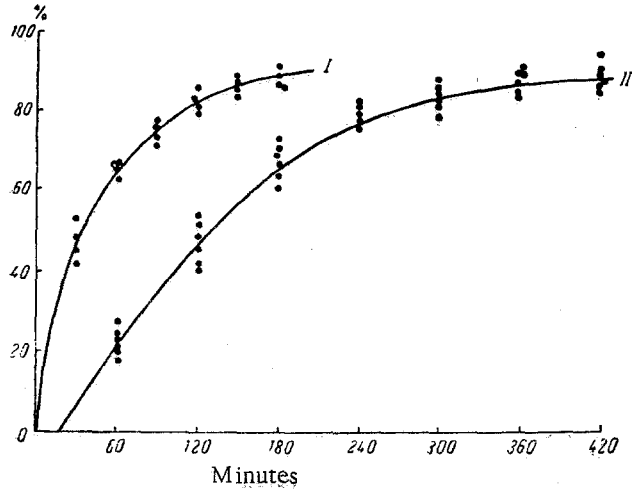
The object of the present investigation was to study the extent and the rate of excretion of lactose administered parenterally (intravenously and subcutaneously).

METHOD

Experiments were conducted on two dogs with their ureters exteriorized on the skin of the abdominal wall. Depending on the experimental conditions, the animals received subcutaneous or intravenous injections of lactose solution (from 15 to 140 mg/kg in different experiments); a single injection of lactose was given over a period of 3-5 min. Before the beginning of the experiments a qualitative Fehling's test was carried out to exclude the presence of reducing sugars in the urine, and the result in all cases was negative. After the injection of lactose the whole of the urine excreted was collected every 30 min. To determine the moment of total excretion of lactose, Fehling's test was carried out on each sample; the collection of urine ceased 1 h after a negative test for reducing sugars had been obtained.

Although the urine contained no reducing sugars before the beginning of the experiment in every case, during the quantitative estimation of lactose a preliminary fermentation of the urine samples, followed by evaporation, was carried out in order to exclude other possible reducing sugars (glucose) from the test, the appearance of which might be related to the administration of lactose. In none of the experiments were sugars found in the urine which were fermentable with bakers' yeast. The amount of lactose in each sample after fermentation and evaporation was determined by Bertrand's method [7]. From the amount of lactose contained in each sample the total amount of lactose excreted during the experiment was calculated.

*Deceased.



Excretion of lactose by the kidneys (the dog Naida II). Along the axis of abscissas—time after injection of lactose (in min), along the axis of ordinates—amount of lactose (as % of that injected). I) Excretion of lactose after intravenous injection; II) after subcutaneous injection.

RESULTS

Altogether 11 experiments were performed in which lactose solution was injected intravenously. The extent, rate, and intensity (i.e., concentration in a particular urine sample) of lactose excretion were studied. The extent of the excretion of lactose in the dog Naida I (7 experiments) was 91.1% of the total, with variations in individual experiments from 76 to 98.4%, and in the dog Naida II (4 experiments) 88.65% of the total lactose administered, with variations in individual experiments from 86 to 91%. The time taken for excretion of the lactose after intravenous injection was 3 h (see figure, I), and the largest amount of lactose was excreted during the first 30 min after its administration (in different experiments from 30 to 60% of the lactose injected). The concentration of lactose in the urine was dependent on the size of the dose injected and on the magnitude of the diuresis, but in all the experiments it was greatest during the first 30 min after injection. Hence, in the experiments in which lactose was injected intravenously, the amount of lactose excreted was slightly smaller than the amount administered. This difference can be attributed to purely technical causes and also to the partial utilization of the lactose in the process of metabolism. If the second of these suggestions is correct, it might be supposed that the amount of lactose excreted would be less, the longer it was retained in the body.

In order to prolong the time that the lactose remained in the body, and so to increase the likelihood of its utilization in the tissues, if this in fact occurs, experiments were carried out in which 10% lactose solution was injected subcutaneously. Six experiments were conducted on the dog Naida II. The proportion of the total amount of lactose excreted after subcutaneous administration was 89.8%, with variations in individual experiments from 86.2 to 95.6%, which is in agreement with the results of the proportion of lactose excreted after intravenous administration (88.65% in the dog Naida II). However, the time taken for excretion of the lactose after subcutaneous administration was 6 h, i.e., the duration of excretion was doubled, and in this case the largest amount of lactose was excreted during the 2nd and 3rd hours (see figure, II). The concentration of lactose in the urine was dependent on the amount injected, and also on the magnitude of the diuresis, although in all the experiments its concentration was greatest in the samples collected between 1.5 and 2.5 h after injection.

Some authors [4] have found that, after intravenous injection of C^{14}-labeled lactose into rats, some of it (admittedly, only a very small proportion) is eliminated in the form of $C^{14}O_2$ with the expired air. Since in our experiments the proportion of lactose excreted was completely independent of the duration of its stay in the body, it is difficult to imagine that the whole of its "deficit" is entirely attributable to the breakdown of lactose in the body tissues. It is possible, however, that rats are different in this respect from dogs.

It may be concluded from these results that lactose entering the blood stream is largely excreted by the kidneys unchanged, and is not metabolized in the tissues, so that the excretion of lactose in the urine may be used to judge the intensity of absorption of lactose from the secreting mammary gland, and to evaluate this phenomenon quantitatively.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
